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 was changed to include the enrichment of uranium for nuclear reactor fuel elements and recycling of uranium recovered from spent fuel, and the name was changed to the “Oak Ridge Gaseous Diffusion Plant” (ORGDP). In the 1980s, a reduction in the demand for nuclear fuel resulted in the shutdown of the enrichment process and production ceased. The emphasis of the mission then changed to environmental management (EM) and remediation operations; in 1996, the name was changed to the “East Tennessee Technology Park.”

EM and remediation operations consist of operations such as waste management, the cleanup of outdoor storage and disposal areas, the demolition and cleanup of facilities, land restoration, and environmental monitoring. Proper disposal of huge quantities of waste that were generated over the course of production operations is also a major task. Beginning in the 1990s, reindustrialization (the conversion of underused government facilities for use by the private sector) also became a major mission at ETTP. Reindustrialization allows private industry to lease and purchase underused land and facilities, thus providing both jobs and a new use for facilities that otherwise would have to be demolished. State and federally mandated effluent monitoring and environmental surveillance at ETTP involve the collection and analysis of samples of air, water, soil, sediment, and biota from ETTP and the surrounding area. Monitoring results are used to assess exposures to members of the public and the environment, to evaluate the performance of treatment systems, to help identify areas of concern, to plan remediation efforts, and to evaluate the efficacy of remediation efforts. In 2019, there was 100 percent compliance with permit standards for emissions/discharges from ETTP operations.

On November 10, 2015, DOE and the US Department of Interior (DOI) signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historical Park (MPNHP). The MOA defines the respective roles and responsibilities of the departments in administering the park and includes provisions for enhanced public access, management, interpretation, and historic preservation. A portion of ETTP (the K-25 Gaseous Diffusion Building footprint) is included within the MPNHP. As part of the activities to establish the park, DOE released the K-25 Virtual Museum, which is a website that details the history of the K-25 Gaseous Diffusion Plant through narrative and photographs, and can be found **here**.

Due to different permit reporting requirements and instrument capabilities, this report uses various units of measurement. The lists of units of measure and conversion factors on pages xxvii and xxviii are included to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

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.

Figure 3.1. East Tennessee Technology Park

By 1985, the demand for enriched uranium had 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 2019. The ETTP mission is to reindustrialize and reuse site assets through leasing and/or transferring excess or underused land and facilities and through incorporating commercial industrial organizations as partners in the ongoing environmental restoration, D&D, and waste treatment and disposal.

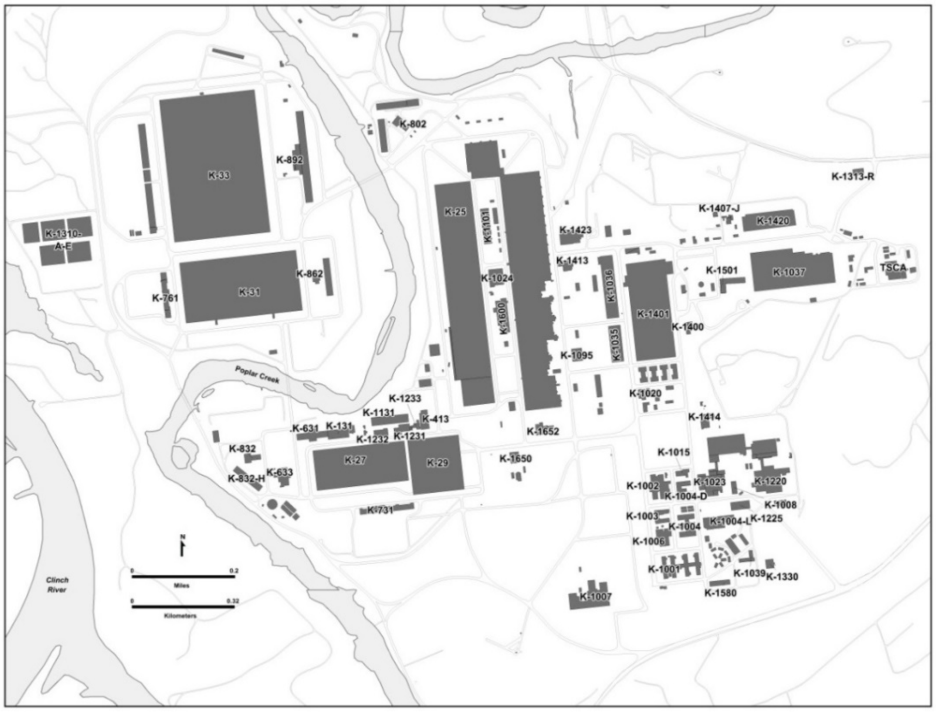


Figure 3.2. East Tennessee Technology Park before the start of decontamination and decommissioning activities in 1991

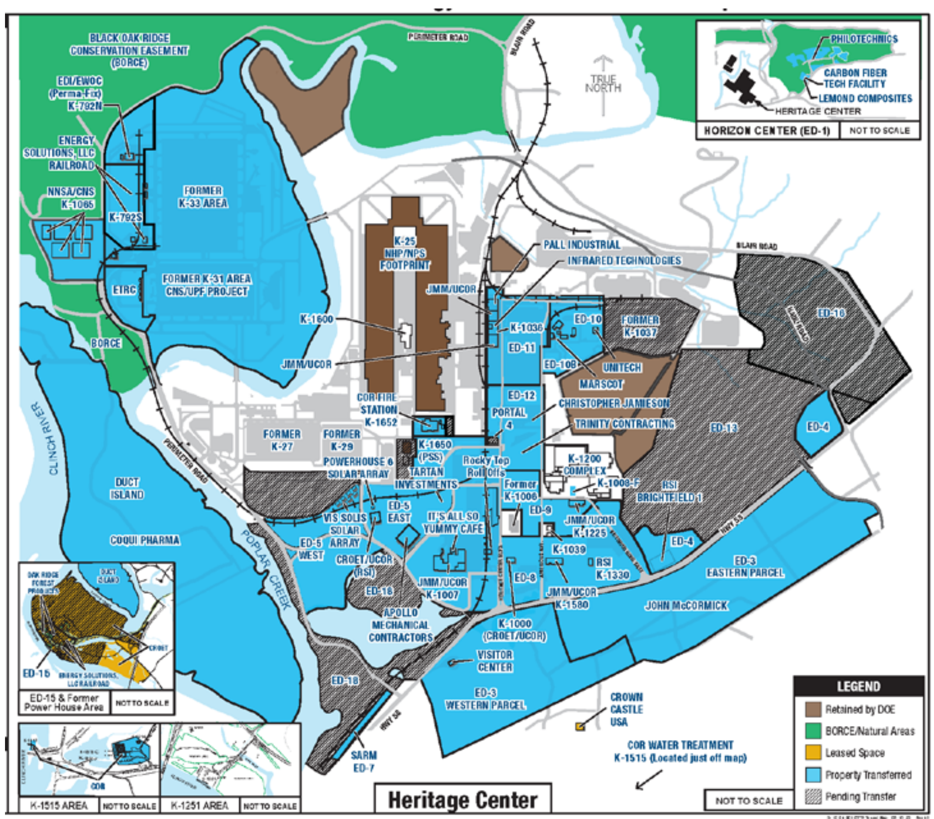


Figure 3.3. East Tennessee Technology Park in 2020, showing progress in reindustrialization

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, an Amentum-led partnership with Jacobs, 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 on non-DOE entities located on the ETTP site is not provided in this document.

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 (ISO 2004), *Environmental management systems—Requirements with guidance for use*. UCOR is committed to incorporating sound environmental management, protection, and sustainability practices in all work processes and activities that are part of the DOE 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 2019 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 2019 from the Green Electronics Council (GEC) for its use of Electronic Product Environmental Assessment Tool (EPEAT) methods. A list of the awards given to UCOR for electronics stewardship and sustainability practices in 2019 are:

- The Green Electronics Council awarded UCOR four stars for purchasing 100-percent EPEAT-registered information technology products, which included displays, monitors, computers, laptops, and servers.
- The US Environmental Protection Agency's (EPA) Federal Green Challenge Award for recycling 16.2 tons of electronic equipment with a third-party recycler, which highlights UCOR's leadership in reducing the federal government's environmental impact.
- The Tennessee Recycling Coalition recognized UCOR for finding innovative ways to reuse materials that would otherwise be disposed of in a landfill. The award came with a $1,500 prize, which was donated to the Michael Dunn Center, a vocational rehabilitation agency that provides, in part, litter control and recycling services in East Tennessee.

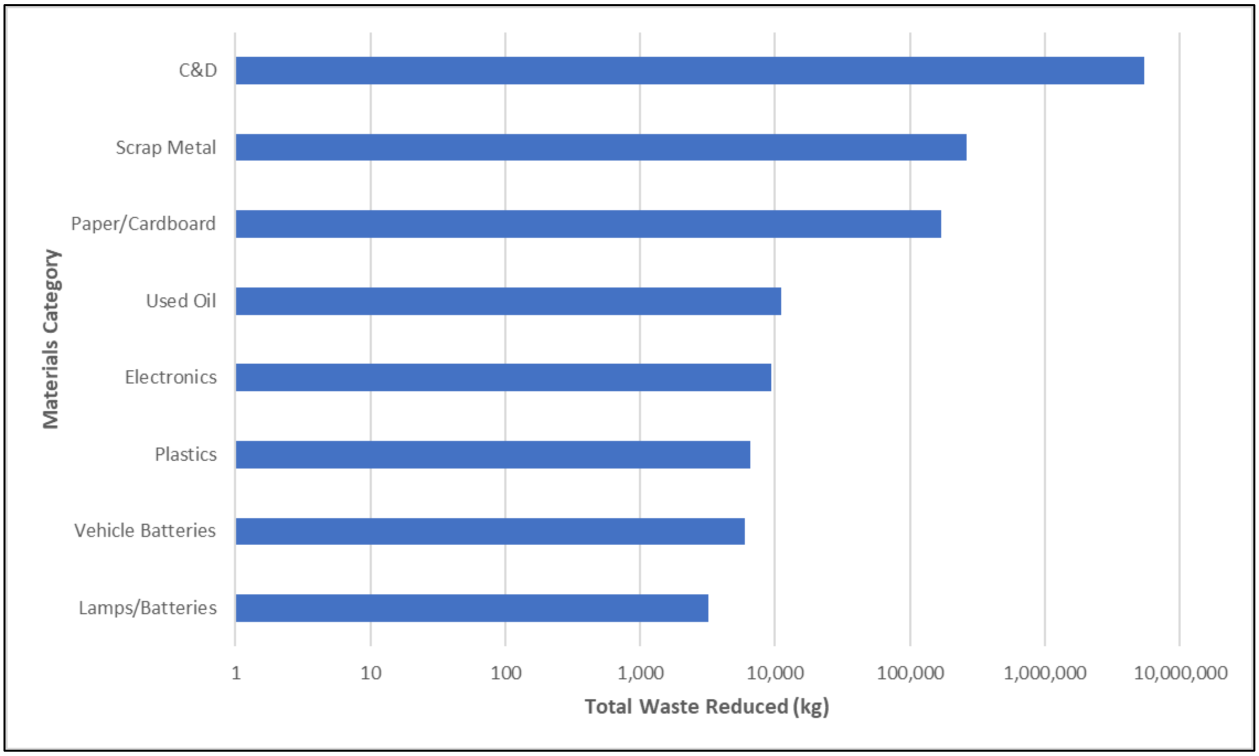


Figure 3.4. Pollution prevention recycling activities related to solid waste reduction at the East Tennessee Technology Park in Calendar Year 2019

Additionally, UCOR internally recognized five projects for their P2/waste minimization (P2/WMin) accomplishments in 2019, which are summarized below.

- The Oak Ridge National Laboratory Operations and Cleanup Enterprise Installed Process Instrumentation Team was recognized for developing a method to reduce the amount of required instrument calibrations and consolidating the remaining calibrations, conserving resources, and saving $20,000–$25,000 per year.
- The Oak Ridge National Laboratory Operations and Cleanup Enterprise project was recognized for identifying and implementing an innovative approach to accomplish the recycling of ten metal and concrete salt casks rather than disposing of them in a landfill. This resulted in a cost savings of $40,000 and conservation of 1,640 ft^3 of valuable landfill space.

- The General Plant and Capital Projects was recognized for implementing a design change that safely reduced the amount of materials used in dewatering boxes during the Zeolite Upgrade Project. This resulted in $36,000 cost savings and saved future landfill space.
- The Oak Ridge Reservation Landfill (ORRLF) Project was recognized for identifying an opportunity to divert uncontaminated soil from disposal at the landfill and reuse it as landfill cover material, saving $58,160, reducing greenhouse gases, and saving 1,950 yd^3 of limited landfill space.
- The ORRLF Project was recognized for identifying materials from ORRLF Sediment Pond 3 upgrades for reuse at Landfill V, which resulted in the conservation of resources, a cost saving of $21,500, and 750 yd^3 of landfill space saved.

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 addition to lessening the impact on the environment, P2 measures may also save money. In 2019, an estimated total in excess of $180,000 with an additional savings of $20,000–$25,000 per year was saved as a result of implementation of P2 measures by the projects.

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 Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (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 47,220 lb. (21.42 MT) of scrap metal to be recycled in fiscal year (FY) 2019 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 260 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.

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) 2019, Brightfield 1 produced 235,000 kWh of energy. During December 2019, Brightfield 1 had a single downtime due to maintenance activities, with the seasonal timing resulting in only a negligible increase in the use of conventionally supplied power.

Figure 3.5. Oak Ridge Solar Park

In addition, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and COR, a second solar farm—the Powerhouse 6 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, management and self-assessments conducted by functional or project organizations, and routine field walkdowns conducted by a variety of functional and project personnel. Management, self, and independent 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 3.4.1.

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, corporate-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 (O) 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, waste shipment, and P2/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 2019, 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 EM and protection policy. The policy is UCOR's fundamental commitment to incorporating sound EM 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). Figure 3.4 shows a summary of the types and quantities of recycled materials and equipment. Additionally, 80,443 kg of office furniture, office supplies, electronics, electrical equipment, and building materials were released to the public through property sales.

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.

Real property to be transferred must meet the release criteria established by DOE O 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, the Department of Energy's clean up 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.

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 web site**, 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 2018a, DOE/ORO-2512] and the annual cleanup progress report [UCOR 2019a, *2019 Cleanup Progress—Annual Report to the Oak Ridge Regional Community,* OREM-19-2579]).

UCOR participates in a number of public meetings related to environmental activities at the site (e.g., Oak Ridge Site Specific Advisory Board 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 2019b, UCOR-4127/R8). 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 CY objectives and targets.

3.3 Compliance Programs and Status

During 2019, 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 2019. 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 2019.

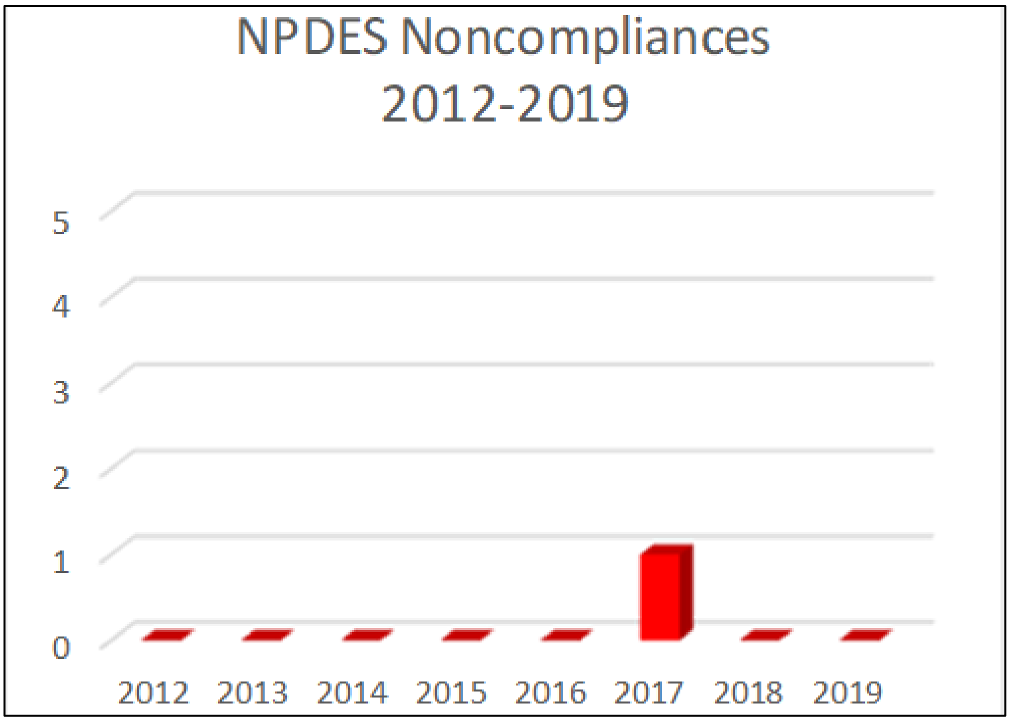


Figure 3.6. East Tennessee Technology Park National Pollutant Discharge Elimination System permit noncompliances since 2012

3.3.1 Environmental Permits Compliance Status

Table 3.2 contains a list of environmental permits that were in effect at ETTP in 2019.ETTP received no notices of environmental violations or penalties in 2019

Table 3.3 presents a summary of environmental audits and oversight visits conducted at ETTP in 2019.

Table 3.2. East Tennessee Technology Park environmental permits, 2019

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	DOE	UCOR	UCOR
CWA	NPDES permit for storm water discharges	TN0002950	02-01-2015	03-31-2020	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	TFE	TFE	TFE
CWA	SOP—ETTP holding tank/haul system for domestic wastewater	SOP-99033	07-01-2015	06-30-2020	UCOR	UCOR	UCOR
UST	Authorized/certified USTs at K-1414 Garage	Customer ID 30166 Facility ID 073008	03-20-1989	Ongoing	DOE	UCOR	UCOR
RCRA	ETTP container storage and treatment units	TNHW-165	09-15-2015	09-15-2025	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.

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
UST = underground storage tank

Table 3.3. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2019

Date	Reviewer	Subject	Issues
June 17	COR	Sewage Network Discharge Inspection	0
October 2	TDEC	RCRA Compliance Inspection	0
December 5	TDEC	NPDES Storm Drain Inspection	0
December 10	TDEC	K-1065-B and -C Closure Inspection	0

Acronyms:
COR = City of Oak Ridge
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment and Conservation

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 2019, 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 (ORO) has approved generic categorical exclusion (CX) determinations that cover certain proposed activities (i.e., maintenance activities, facility upgrades, personnel safety enhancements). A CX 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 CX determinations are used. During 2019, seven 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 (NRHP), 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 NRHP. 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.

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 and a construction subcontract was awarded for the K-25 History Center in 2018. Construction of the K-25 History Center began in 2018 and is scheduled to open in 2020.

The *Memorandum of Agreement Between the United States Department of the Interior and the United States Department of Energy for the Manhattan Project National Historical Park* was signed by DOI and DOE on November 10, 2015 (DOE 2015), creating the new Manhattan Project National Historical Park (MPNHP). The K-25 Virtual Museum website 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 2019. The ETTP ambient air-monitoring program, permitted source operations tracking, and record keeping provided documentation fully supporting a 100 percent compliance rate.

3.3.4 Clean Water Act Compliance Status

The objective of the Clean Water Act (CWA) is to restore, maintain, and protect the integrity of the nation's waters. This act serves as the basis for comprehensive federal and state programs to protect the waters from pollutants (see Appendix C for water reference standards). One of the strategies developed to achieve the goals of CWA was EPA establishment of limits on specific pollutants allowed to be discharged in US waters by municipal sewage treatment plants (STPs) 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 2019, ETTP discharged storm water to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges.

In 2019, 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.

3.3.5 National Pollutant Discharge Elimination System Permit Noncompliances

In 2019, 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 2019 was 100 percent. There were no permit noncompliances in 2019.

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 2019, ETTP had two generator accumulation areas for hazardous or mixed waste.

In addition, ETTP is permitted to store and treat hazardous and mixed waste under the Resource Conservation and Recovery Act (RCRA) Part B Permit TNHW-165. Hazardous waste may be treated and stored at permitted locations at the K-1065 complex. This hazardous waste permit was reissued on September 15, 2015, as a replacement for TNHW-117. The hazardous waste corrective action document, TNHW-164, which covers ORR areas of concern and solid waste management units, was also reissued on September 15, 2015, as a replacement for TNHW-121.

In CY 2019, ETTP prepared and submitted to the TDEC Division of Solid Waste Management the CY 2018 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 2019, ETTP was in full compliance with this Act.

The K-1414 Garage had two permitted underground storage tanks of the storage of fuel. On June 11, 2019, these two tanks were certified as closed.

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 (NPL) 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 NPL and numerous CERCLA decision documents are approved for ETTP site cleanup actions for both facility demolitions and soil remediation. In 2019, 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* (FFA, 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.

PCB waste generation, transportation, disposal, and storage at ETTP are regulated under EPA ID number TN0890090004. In 2019, ETTP operated five PCB waste storage areas in ETTP generator buildings and when longer-term storage of PCB/radioactive wastes was necessary, RCRA-permitted storage buildings were used. 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. The continued use of authorized PCBs in electrical systems and/or equipment (e.g., transformers, capacitors, rectifiers) is regulated at ETTP. 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 ORO 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. The modification in 2018 allowed the continued use of the Chuck Vacuum System in Building 9215 and the Foundry Hydraulic System in Building 9998 located at Y-12.

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 2019, 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 2019 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 2019.

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 2019, 12 were located at ETTP. These chemicals were nickel metal, lead metal (including large, lead-acid batteries), diesel fuel, sulfuric acid (including large, lead-acid batteries), Chemical Specialties, Inc. Ultrapoles, unleaded gasoline, Sakrete™ Type S or N mortar mix, CCA Type C pressure-treated wood, Flexterra FGM erosion control agent, crystalline silica, acetic acid, 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 2019, 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 2019, 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 (RICE) for emergency use. TDEC originally issued an operating permit (069346P) covering six stationary emergency RICE (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.

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 nonemergencies 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. ETTP has numerous buildings and equipment that contain ACMs. Major demolition activities during 2019 involved the abatement of ACM that were subject to the requirements of 40 CFR Part 61, Subpart M. Most demolition and ACM abatement activities 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. All other non-CERCLA planned demolition or renovation activities were individually reviewed for applicability of the TDEC notification requirements of the rule. During 2019, 11 Notifications of Demolition and/or Asbestos Renovation were submitted to TDEC for non-CERCLA ETTP activities. All of these notifications were for non-asbestos demolition. 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 2019, 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 2019.

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.

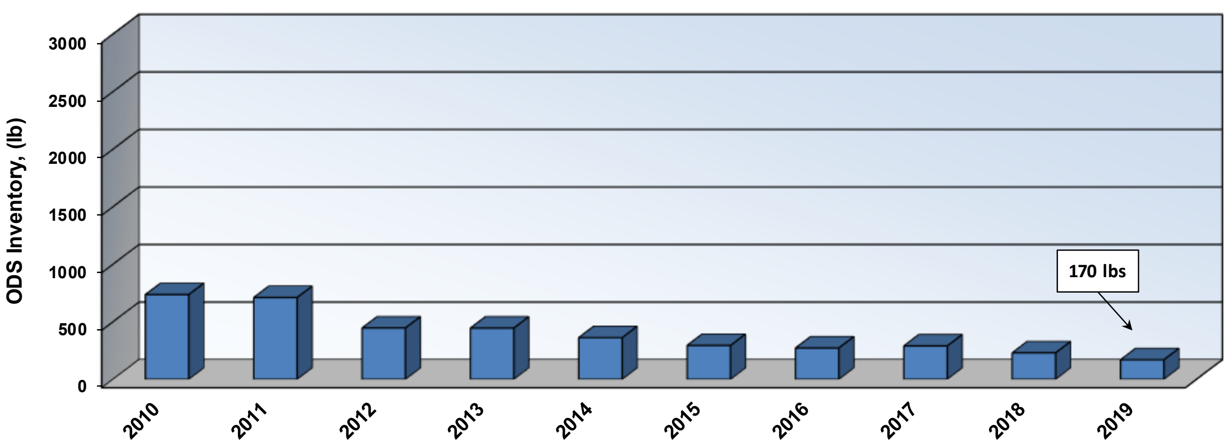


Figure 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history

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.

3.5.1.2 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. ETTP Rad-NESHAP sources that operated during 2019—the K-1407 Chromium Water Treatment System (CWTS) Volatile Organic Compound (VOC) Air Stripper and K-2500-H Segmentation Shop C—are 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 2019 reporting period.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2019 through December 2019

Station	Concentration (µCi/mL)				
	^{99}Tc	^{234}U	^{235}U	^{238}U	
K2[a]	ND[b]	1.56E-17	8.93E-19	1.63E-17	
K11[c]	2.25E-16	1.45E-16	1.30E-17	2.71E-16	
K12[c]	ND	7.04E-17	1.07E-17	2.21E-16	
	40 CFR 61, Effective Dose (mrem/year)				Total Dose
K2					0.006
K11					0.040
K12					0.030

[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.

During 2019, the on-site annual dose remained very low at 0.04 mrem at ambient air station K11 and 0.03 mrem at ambient air station K12. The highest uranium concentrations were measured in the second and third quarters at K11 and K12 and are attributed to K-131/K-631 demolition that involved radiologically contaminated materials. The results are based on actual ambient air sampling in locations conservatively representative of on-site business locations. All data continue to show potential exposures are all well below the 10 mrem annual dose limit.

3.5.1.3 Quality Assurance

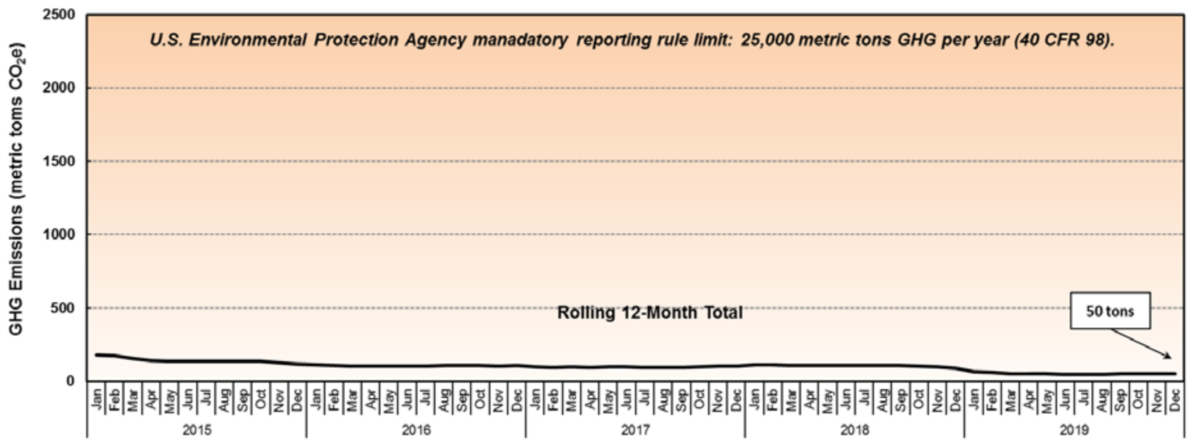
QA activities for the Rad-NESHAP program are documented in the *Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge Tennessee* (UCOR 2018b, UCOR-4257/R2). The plan satisfies the QA requirements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

3.5.1.4 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 2019 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 2019, 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 2019 of ETTP total GHG stationary emissions. For the 2019 CY, GHG emissions totaled only 50 MT CO_2e, which is 0.2 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

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 28 percent total Scope 1 and 2 GHG emissions reduction target by FY 2020 and the EO 13693 40 percent total Scope 1 and 2 GHG emissions reduction target by FY 2025.

With respect to EOs 13514 and 13693, emissions for FY 2019 Scope 1 and 2 including the landfills totaled 19,186 MT CO_2e, which is well below both the FY 2020 target level of 37,478 MT CO_2e and the FY 2025 target level of 31,232 MT CO_2e.

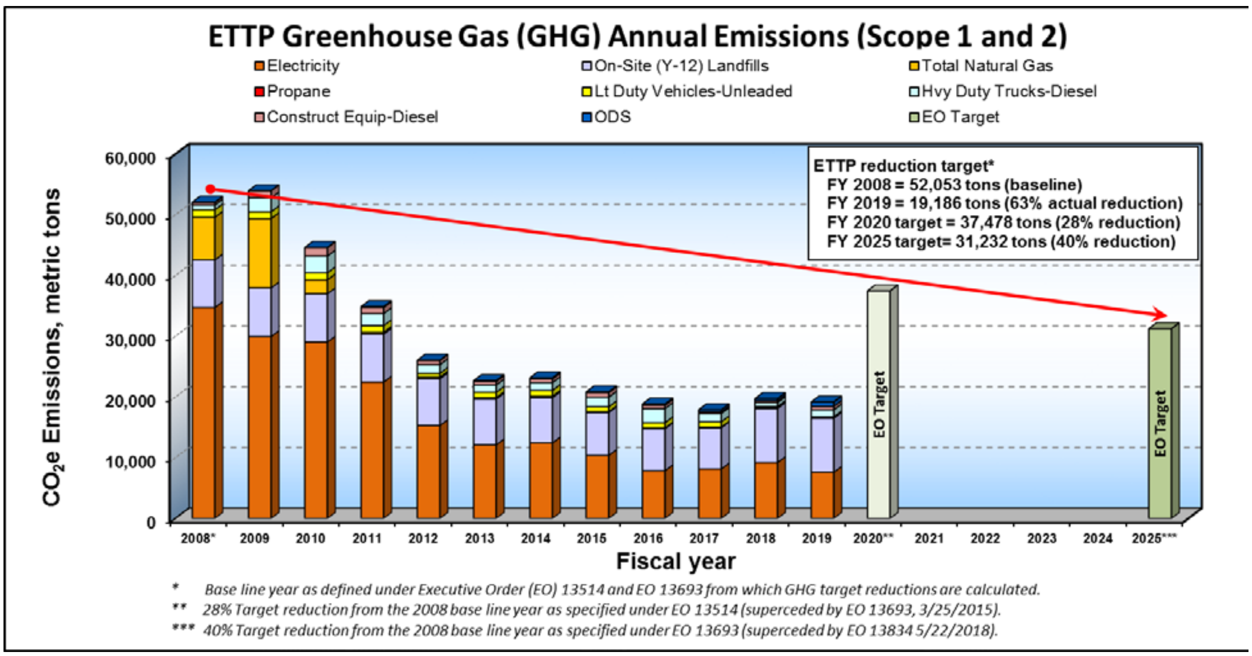
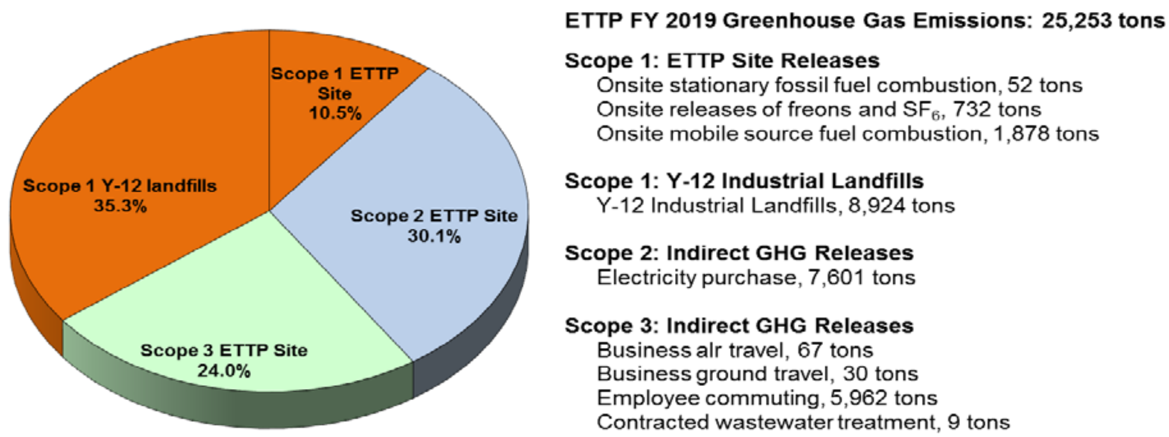


Figure 3.9. East Tennessee Technology Park greenhouse gas annual emissions (Scopes 1 and 2, including industrial landfills at Y-12)

Figure 3.10 shows the relative distribution and amounts of all ETTP FY 2019 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 2019 was 25,253 MT CO_2e. Total reduction to date starting with the 2008 baseline year of 61,453 MT CO_2e of GHG emissions is 58.9 percent.



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

Figure 3.10. FY 2019 East Tennessee Technology Park greenhouse gas emissions by scope, as defined in Executive Order 13514

3.5.1.5 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 2019 for CWTS were only 0.007 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 RICE-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 2019 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.

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 2019.

ETTP operations released airborne pollutants from a variety of minor pollutant-emitting sources, such as stacks, 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.

3.5.1.6 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

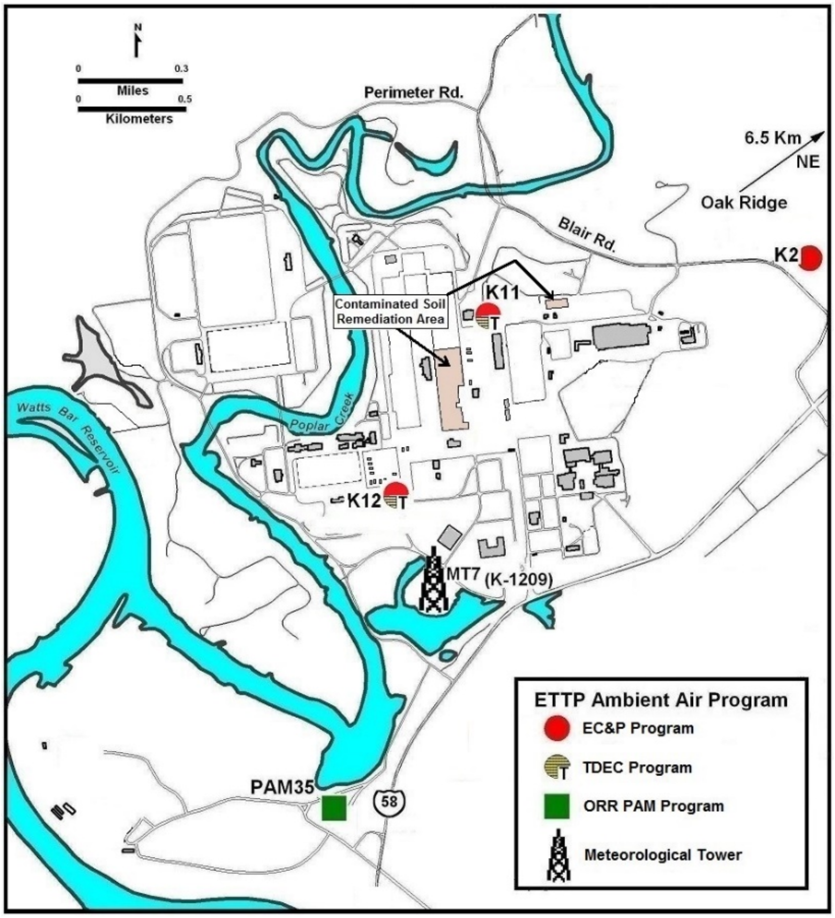
Compliance of fugitive and diffuse sources is demonstrated based on environmental measurements. The ETTP Ambient Air Quality Monitoring Program is designed to provide environmental measurements to accomplish the following:

- 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 (PAM) program. Figure 3.11 shows the locations of all ambient air sampling stations in and around ETTP that were active during the 2019 reporting period. Figure 3.12 shows an example of a typical EC&P program air monitoring station.

The EC&P program consisted of three sampling locations throughout 2019. All projects are operating similar high-volume sampling systems. The EC&P, TDEC, and PAM samplers operate continuously with exposed filters collected weekly. The radiological monitoring results for samples collected at the one ETTP area PAM 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, periodic requests for results from the other programs are made for comparison purposes.

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 is 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 and debris removal of Buildings K-131 and K-631 and the removal of ^{99}Tc-contaminated soil from the Building K-25 footprint.



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 3.11. East Tennessee Technology Park ambient air monitoring station locations

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 2019. Radiological 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. Stations K11 and K12 are located to provide a conservative measurement of the impact to on-site members of the public.

Figure 3.12. East Tennessee Technology Park ambient air monitoring station

3.6 Water Quality Program

3.6.1 NPDES Permit Description

The latest ETTP NPDES permit became effective on April 1, 2015. The permit expired on March 31, 2020. The application for renewal was submitted on September 18, 2019. A total of 27 representative outfalls are monitored on an annual basis for oil and grease, total suspended solids (TSS), pH, and flow. Outfall 170 is also monitored quarterly for total chromium and hexavalent chromium.

In addition to periodic monitoring requirements specified in the ETTP NPDES permit, several additional monitoring efforts were included to support the CERCLA actions that are ongoing at ETTP. This monitoring was conducted as part of the Storm Water Pollution Prevention (SWPP) Program and/or the ETTP Biological Monitoring and Abatement Program (BMAP).

3.6.1.1 RA Activities, CERCLA, and Legacy Pollutant Monitoring

In addition to periodic monitoring requirements specified in the ETTP NPDES permit, several additional monitoring efforts were included to support the CERCLA actions that are ongoing at ETTP. This monitoring was conducted as part of the SWPP Program and/or the ETTP BMAP. Storm water monitoring is conducted at outfalls that drain areas affected by RA activities in order to provide a pre-RA baseline, to determine the efficacy of RA activities, and to suggest area for future RA activities.

3.6.1.2 Permit Renewal Monitoring

Sampling required for the completion of the NPDES permit renewal application was conducted as part of the ETTP SWPP Program. The application for this permit renewal was submitted to TDEC on

September 18 2019, approximately 2 weeks ahead of the submittal deadline. Based on previous TDEC guidance, composite samples were collected as time-weighted composites due to the short travel time for storm water runoff in the storm drain piping system and to site conditions within the watersheds. Monitoring was conducted to ensure all required samples were collected to complete EPA Form 2F, *Application for Permit to Discharge Storm Water Discharges Associated with Industrial Activity* for each representative outfall.

Representative outfalls were sampled to ensure completion of EPA Form 2F, Section VII, Discharge Information, Parts A, B, and C, as required. Information collected included:

- Part A—Parameters were collected in compliance with Form 2F. Oil and grease, total nitrogen, total phosphorus, and pH were collected as grab samples per EPA guidance. Biochemical oxygen demand, chemical oxygen demand, and TSS were collected either as grab samples or as time-weighted composites.
- Part B—All facilities generating process wastewater at ETTP have been closed, and the respective NPDES permits have expired. Therefore, ETTP is no longer subject to any effluent guidelines, and there are no sampling requirements under Part B at any storm water outfall at ETTP.
- Part C—Each representative storm water outfall was sampled only for pollutants that could potentially be present based on the characteristics and uses of the drainage area for that outfall. The potential pollutants to be considered for monitoring are shown in Tables 2F-2, 2F-3, and 2F-4 of EPA Form 2F. Based upon historical site knowledge and analytical monitoring results, metals, mercury, and PCBs were collected from all representative outfalls. In addition, each representative outfall was evaluated, and VOCs, radionuclides, and other selected parameters were collected as required. Part C parameters that must be collected by grab sample, per analytical method or regulatory guidance, were collected as grab samples only. All other Part C parameters were collected as time-weighted composites only.

3.6.1.3 Investigative Monitoring

Investigative sampling was performed as part of the ETTP SWPP Program. This included sampling of storm drain networks for bioaccumulative parameters and investigations triggered by analytical results, CERCLA requirements, changes in site conditions, etc. (UCOR 2018b, UCOR-4028, *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan, Oak Ridge, Tennessee).*

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 Storm Water Pollution Prevention Program

3.6.2.1 Flux Monitoring of Storm Water

In addition to periodic monitoring requirements specified in the ETTP NPDES permit, additional long-term monitoring of pollutant loading was included as part of the current ETTP NPDES permit related to ongoing CERCLA actions. This monitoring, which was conducted as part of the ETTP SWPP Program, included flow monitoring and legacy mercury sampling at two storm water outfalls (Outfalls 180 and 190) and flow monitoring only at two additional outfalls (Outfalls 100 and 170). In order to properly monitor mercury flux, accurate flow estimates and mercury concentrations measured during storm events are required.

Flow monitoring was conducted at Outfalls 100, 170, 180, and 190 in accordance with ETTP NPDES permit requirements and the SWPP Program SAP. Flows for three ranges of rainfall events specified in the ETTP NPDES permit were required. The flows that were obtained were used to increase the accuracy of the TR-55 flow model employed at ETTP for estimation of flow for the ETTP NPDES Discharge Monitoring Report (DMR).

Flow measurements were collected at Outfall 170 in CY 2015–2016. Because the results of the flow monitoring at Outfall 170 have been discussed in previous reports, they will not be discussed in this report.

For this study, flow data and rainfall data for designated time periods were collected. In addition, the discharge flow at the beginning of the data event was also recorded. This provided an indication as to whether the flow at the outfall had returned to near base flow conditions after the previously recorded rainfall event, or if the flow was still elevated at the outfall due to the previous rainfall event. Generally speaking, the more the flow returned to base flow readings before the next recorded data event, the more representative were the flow measurements for the subsequent rainfall event. Flow data for each of these 24-h periods (a total of 288 readings per 24-h period) were averaged to determine the average flow over the 24-h period. The rainfall for the corresponding 24-h period was also totaled.

The metered flow data were then compared to the calculated flow from the outfall using the NRCS TR-55 model. A description of this model and the input information required by the model can be found in the U.S. Department of Agriculture (USDA) TR-55, *Urban Hydrology for Small Watersheds*. This model uses information about the individual outfall's piping system and drainage area to calculate the amount of runoff that would be generated as part of a specified rainfall event. When a rainfall amount is entered into the model, the amount of discharge from the outfall resulting from this rainfall event is calculated.

The objective of performing the flow study at the selected outfalls was to calibrate the TR-55 model by adjusting the model's variable inputs to more closely match the metered flows. The TR-55 model will always produce a consistent and predictable graph with a well-fitted trend line. Calibration of the curve number (CN), impervious area measurements, and base flows in the TR-55 program were performed to achieve a better correlation of metered flow and calculated flow for a given rainfall event.

Outfall 100 drains an area of approximately 4.2M ft^2 or 97 acres. The estimated hydraulic length of the Outfall 100 piping system is 14,000 linear feet (LF). At its point of discharge, Outfall 100 is a 48-in. corrugated metal pipe (CMP), but the Outfall 100 drainage system piping network is composed of piping of various sizes and materials.

Flow data from a flume and rainfall data for February 17, 2018–March 15, 2019, were collected at Outfall 100. A new base flow for Outfall 100 was determined by using the average of the flows measured by the flow meter immediately before the start of rainfall events. The new base flow at Outfall 100 is 112,000 GPD using this method. This base flow is considerably lower than the previous base flow, attributable to demolition of numerous structures in the Outfall 100 drainage area. The new base flow will be used with the TR-55 program to provide flow estimates for Outfall 100.

As seen in Figure 3.13, by using the new base flow of 112,000 GPD the new NRCS CN of 89, and the new percent impermeable value of 55 percent, a relatively close correlation between the actual flow metered at Outfall 100 using ISCO flow measurement equipment and the flow at Outfall 100 derived by using the TR-55 model was obtained, except during high flow periods. The high flow deviation may be due to instrumentation limitations.

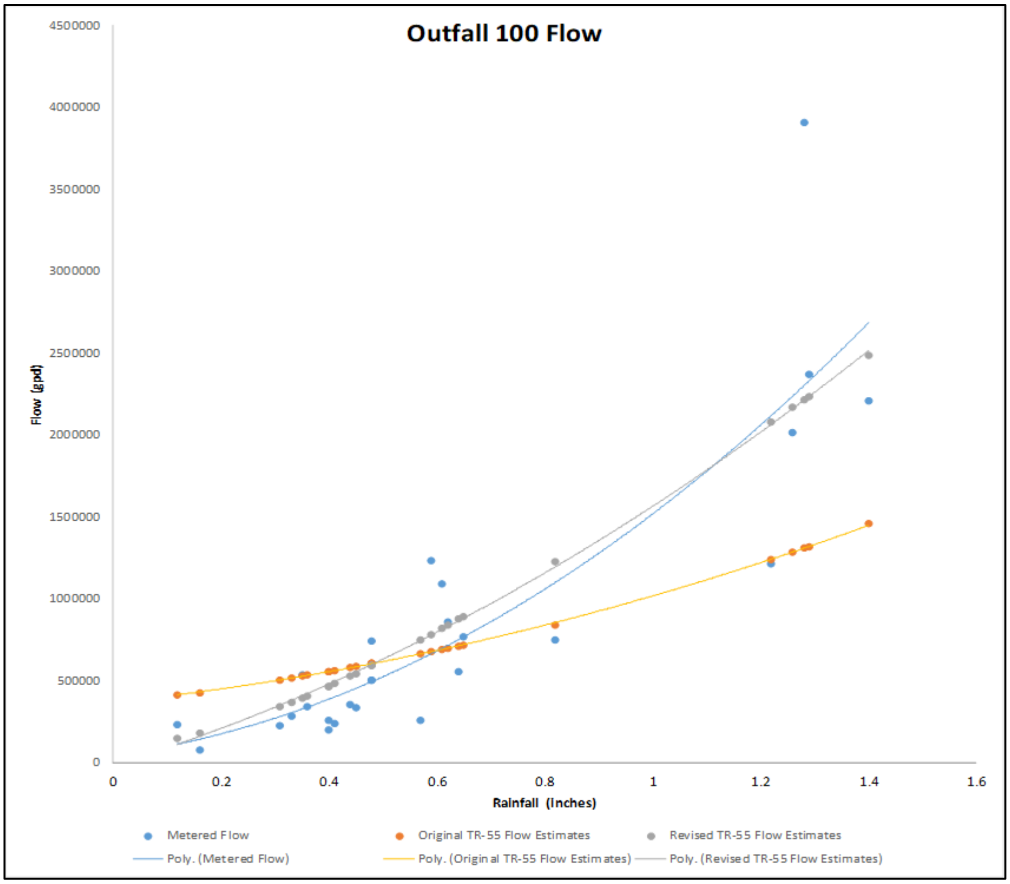


Figure 3.13. Adjusted flow curve for Outfall 100

In addition to mercury sampling, flow-paced sampling for PCBs was also performed at Outfall 100. Outfall 100 has had several historical discharges of PCBs and is considered a contributor of PCB contamination to the K-1007-P1 pond. The PCB data collected as part of this sampling effort will be utilized in the calculation of PCB flux from this outfall.

On February 11, 2019, a flow-paced PCB sample was collected at Outfall 100 after a rainfall event of 0.86 in. No detectable PCBs were identified in this sample.

Flow-paced mercury and PCB samples were collected on February 18, 2019, after a rainfall event of 1.64 in. Mercury was detected in this sample at a level of 9.69 ng/L, and PCB-1254 was detected in the sample at a level of 0.0385 µg/L.

Flow-paced mercury and PCB samples were collected at Outfall 100 on March 11, 2019, after a rainfall event of 2.53 in. Mercury was detected in this sample at a level of 36 ng/L, and PCB 1254 was detected in the sample at a level of 0.0384 µg/L. Flow-paced mercury and PCB samples were collected at Outfall 100 on March 18, 2019, after a rainfall event of 0.64 in. Mercury was detected in this sample at a level of 10.2 ng/L. No detectable PCBs were identified in this sample.

Additional flow-paced sampling for mercury and/or PCBs may be conducted at Outfall 100 as part of future SWPP Program sampling plans.

Outfall 180 drains an area of approximately 1.4M ft^2 or 32.5 acres. The estimated hydraulic length of the Outfall 180 piping system is 4100 LF. At its point of discharge, Outfall 180 is a 42-in. concrete pipe, but the Outfall 180 drainage system piping network is composed of piping of various sizes and materials.

Specifications for a flume to be installed at Outfall 180 were developed in late summer of 2016. This flume was purchased during FY 2017. Installation of the flume was completed in the summer of 2018, and flow data have been collected since that time. Because of the configuration of the Outfall 180 piping system, the flume could not be installed at the end of the piping system. Therefore, it was designed to be installed inside the pipe rather than at the end of the pipe.

Flow data using a flume installed in 2018 and rainfall data for the period from August 30, 2018–January 31, 2019, were collected at Outfall 180. A new base flow for Outfall 180 was determined by averaging the flows metered immediately before the start of rainfall events. The new base flow at Outfall 180 was determined to be 10,600 (GPD). The new base flow will be used with the TR-55 program to provide flow estimates for Outfall 180. Samples collected during the flow proportional monitoring were analyzed for mercury. Table 3.5 shows these results as well as the recorded rainfall amounts and resultant flows.

Table 3.5. Mercury results from flow-proportional composite sampling at Outfall 180

Location	Date sampled	Rainfall recorded during sampling event (in.)	Flow total during time samples were being collected (gal)	Mercury results (ng/L)
Outfall 180	9/11/18	0.25	6,239	497
Outfall 180	9/25/18	0.79	31,857	342
Outfall 180	1/25/19	1.20	456,840	39.5
Outfall 180	2/18/19	0.50	156,309	510
Outfall 180	3/11/19	1.91	767,568	73.5
Outfall 180	3/18/19	0.45	51,861	215
Outfall 180	4/15/19	0.62	249,955	163

As seen in Figure 3.14, by using the new base flow of 10,600 GPD, the percent impervious value of 35 percent, and the NRCS CN of 86, a relatively close correlation between the actual flow metered at Outfall 180 using flow measurement equipment and the calculated flow at Outfall 180 derived by using the TR-55 model was developed.

Figure 3.15 shows the relationship between the metered rainfall events discharge volumes and mercury flux in milligrams that was determined from the flow proportional sampling. The data generally indicate that mercury flux at Outfall 180 increased as rainfall event flows increased. This may be due to an increased amount of legacy mercury-contaminated sediments being flushed from the outfall during heavier rainfall events and the heavier flows from the outfall that are associated with these rainfall events. The single large variance from this trend is unexplained.

Applying the flow and mercury concentrations data from the long-term monitoring of legacy pollutant loadings presented above, the mercury flux at Outfall 180 for CY 2019 was calculated. The volume of the discharge was determined using TR-55 model, calibrated using the flow monitoring results, and rainfall data from CY 2019. Each qualifying rain event in CY 2019 was used with the TR-55 program to generate average flow (pervious plus impervious plus base flow). The TR-55 average flow and flow-paced mercury results were used to calculate the approximate mercury flux from Outfall 180 for CY 2019. The Outfall 180 mercury flux (average, maximum, and minimum) for CY 2019 is presented in Table 3.6.

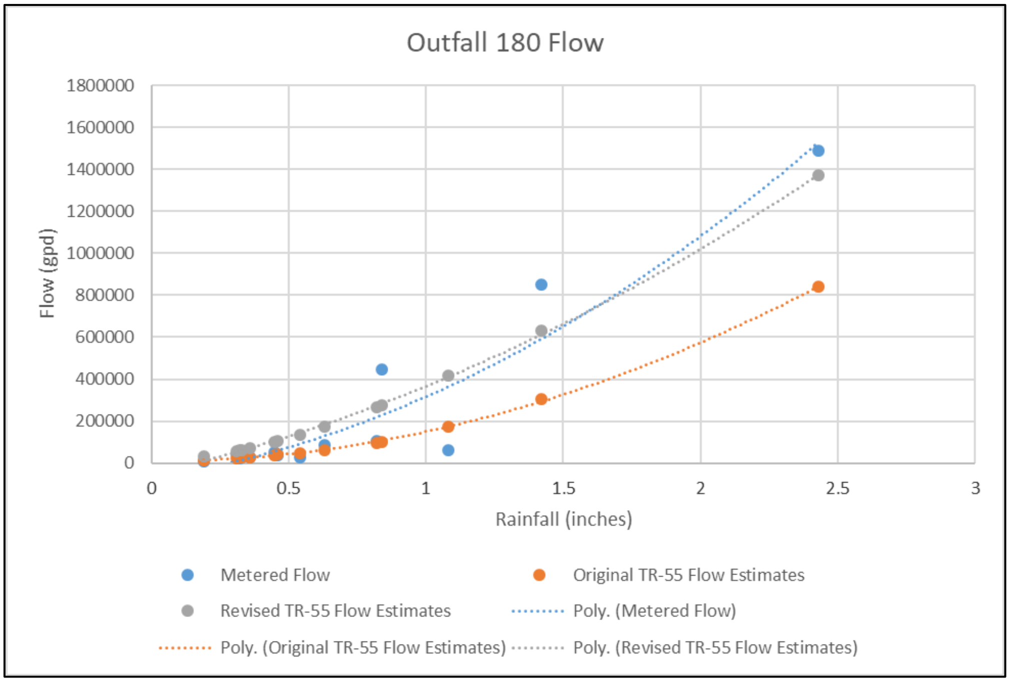


Figure 3.14. Adjusted flow curve for Outfall 180

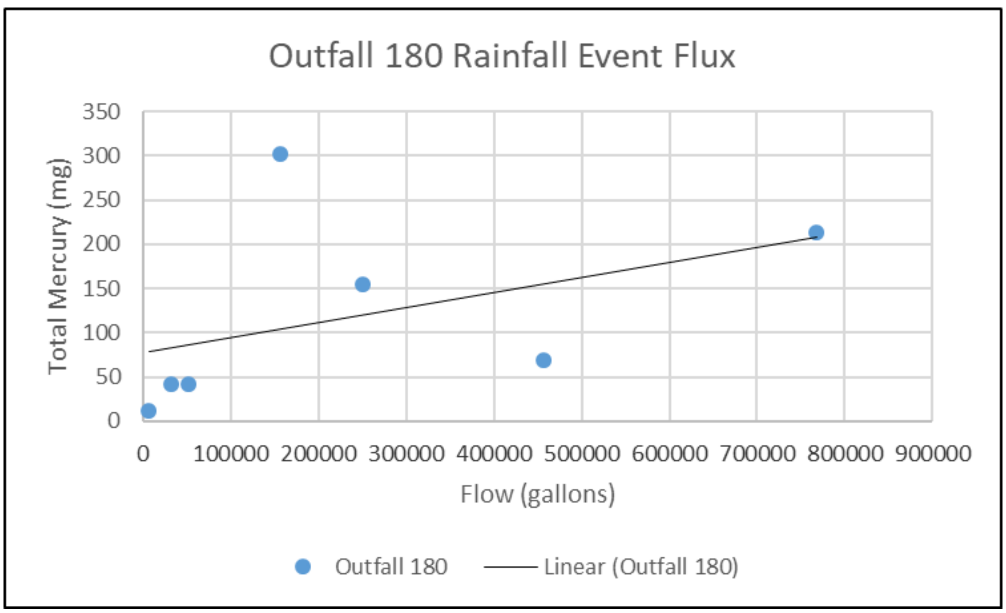


Figure 3.15. Flow-proportional mercury sampling at Outfall 180

Outfall 190 drains an area of approximately 1.25M ft^2 or 28.7 acres. The estimated hydraulic length of Outfall 190 piping system exceeds 7200 LF. At its point of discharge, Outfall 190 is a 42-in. concrete pipe, but the Outfall 190 drainage system piping network is composed of piping of various sizes and materials. A flume was installed in 2015 to measure flow from Outfall 190.

Table 3.6. Mercury flux at Outfall 180 for CY 2019

Outfall	CY 2019 Average Flow Rate (GPD)	Average Mercury Concentration (ng/L)	Average Mercury Flux (g/yr)	Maximum Mercury Concentration (ng/L)	Maximum Mercury Flux (g/yr)	Minimum Mercury Concentration (ng/L)	Minimum Mercury Flux (g/yr)
180	71,529	200.2	19.79	510	50.40	39.5	3.90

A new base flow for Outfall 190 was determined by averaging the flows measured by the flow meter immediately before the start of rainfall events that occurred December 5, 2015–March 31, 2017. The new base flow calculated from these measurements was 23,500 gal.

As illustrated in Figure 3.16, by using the new base flow of 23,500 GPD and the revised NRCS CN of 86, a relatively close match was accomplished between the flow metered at Outfall 190 using flow measurement equipment and the flow at Outfall 190 derived by using the TR-55 model. Both the new base flow and the revised NRCS CN will be used with the TR-55 program to provide flow estimates for Outfall 190.

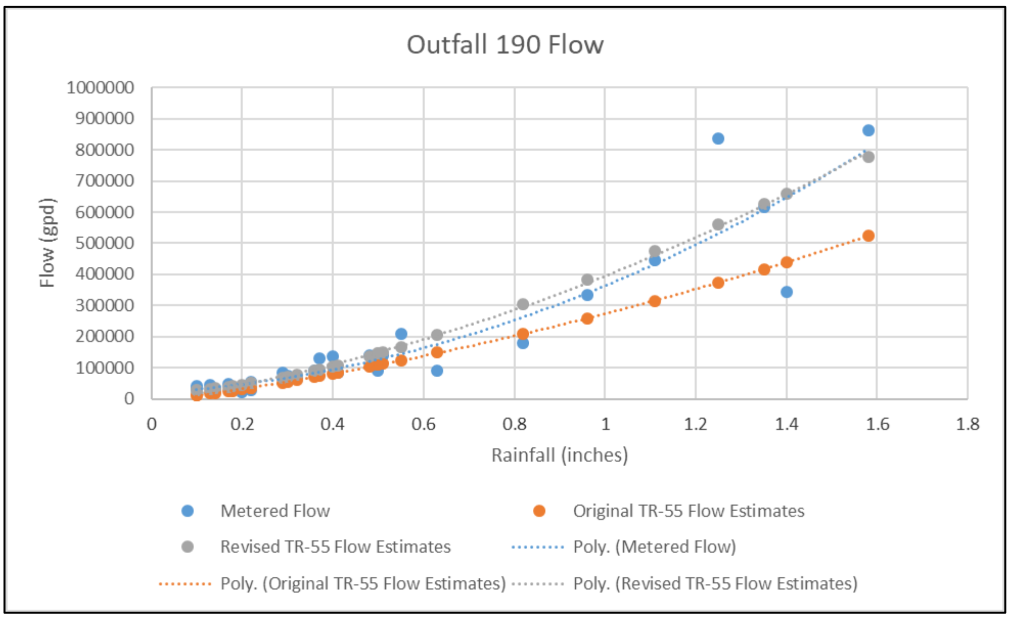


Figure 3.16. Adjusted flow curve for Outfall 190

In support of future CERCLA evaluations, such as those conducted as part of the CERCLA five-year review process, legacy mercury sampling was conducted at Outfall 190. Three flow-composite mercury samples were collected at Outfall 190 between February 2016 and February 2017. In early 2019, it was determined that insufficient data had been collected at Outfall 190 to allow for conclusions to be made concerning mercury flux at the outfall. Composite sampling equipment was reinstalled at Outfall 190, and several additional flow-composite samples were collected between February and April 2019. The results from all of these samples are shown in Table 3.7.

Figure 3.17 shows the relationship between metered rainfall event discharge volume and legacy mercury flux in milligrams that was determined from the flow proportional sampling effort. The data generally indicates that mercury flux at Outfall 190 increased as rainfall event flows increased. This may be due to an increased amount of mercury-contaminated sediments being flushed from the outfall during heavier rainfall events and the heavier flows from the outfall that are associated with these rainfall events. The two large variances from this trend are unexplained.

Table 3.7. Mercury results from flow-proportional composite sampling at Outfall 190

Location	Date sampled	Rainfall recorded during sampling event (in.)	Flow total during time samples were being collected (gal)	Mercury results (ng/L)
Outfall 190	2/2/16	1.56	1,363,753	96.5
Outfall 190	1/12/17	0.55	73,646	162.0
Outfall 190	9/7/17	1.42	695,018	566.0
Outfall 190	2/18/19	0.42	163,700	67.8
Outfall 190	3/11/19	1.97	1,209,886	328.0
Outfall 190	3/18/19	0.43	184,120	92.9
Outfall 190	4/15/19	0.63	199,001	559.0

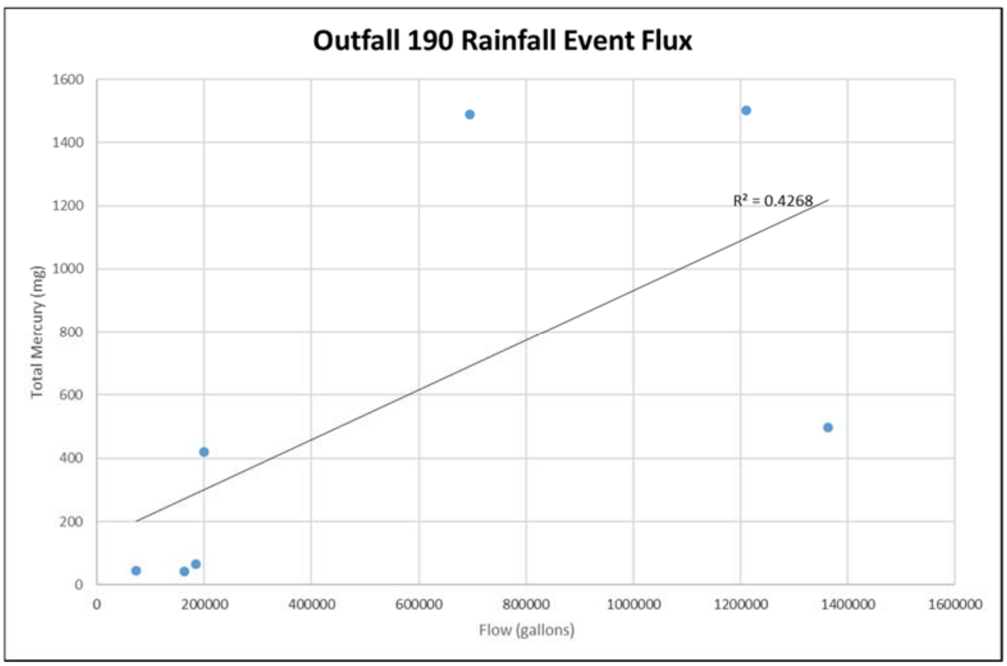


Figure 3.17. Flow-proportional mercury sampling at Outfall 190

Applying the flow and mercury concentrations data from the long-term monitoring of legacy pollutant loadings presented above, the mercury flux at Outfall 190 for CY 2019 was calculated. The volume of the discharge was determined using TR-55 model, calibrated using the flow monitoring results, and rainfall data from CY 2019. Each qualifying rain event in CY 2019 was used with the TR-55 program to generate average flow (pervious plus impervious plus base flow). The TR-55 average flow and flow-paced mercury results were used to calculate the approximate mercury flux from Outfall 190 for CY 2019. The Outfall 190 mercury flux (average, maximum, and minimum) are presented in Table 3.8.

Table 3.8. Mercury flux at Outfall 190 for 2019

Outfall	CY 2019 average flow rate (GPD)	Average mercury concentration (ng/L)	Average mercury flux (g/yr)	Maximum mercury concentration (ng/L)	Maximum mercury flux (g/yr)	Minimum mercury concentration (ng/L)	Minimum mercury flux (g/yr)
190	83,961	261.9	30.38	559	64.85	67.8	7.87

3.6.2.2 Radiologic Monitoring of Storm Water

ETTP conducts radiological monitoring of storm water discharges to determine compliance with applicable dose standards. ETTP also applies the as low as reasonably achievable (ALARA) process to minimize potential exposures to the public. Sampling for gross alpha and gross beta radioactivity, as well as specific radionuclides, is conducted as part of the ongoing SWPP Program sampling efforts. Analytical results are used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system.

Table 3.9 contains the results of this sampling effort. Screening levels for individual radionuclides are established at 4 percent of the derived concentration standards (DCS) values listed in DOE Standard 1196 (DOE 2011b, DOE-STD-1196). 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). Table 3.10 lists the cumulative activity levels of each of the major isotopes that were discharged from the overall ETTP storm water system in 2019.

Elevated radiological results were noted at Outfalls 160 and 292 as part of this sampling effort. Neither of these results exceeded the SOF of the DCS, but they did exceed reference standards. Outfall 160 receives storm water runoff from a portion of the K-1420 pad as well as radiologically contaminated paved and grassy areas north of the building. Outfall 292 receives storm water runoff from the former converter shell storage yard that was located on the K-1064 peninsula. Historical analytical results from both of these outfalls have had elevated levels of radiological contaminants.

Investigative samples were collected at Outfall 158 on November 11, 2018. The SOF of the derived concentration standard (DCS) values for Outfall 158 equaled 1.4. Because the SOF at Outfall 158 was above 1.0, it was determined that monthly monitoring of radiological parameters would be initiated in December 2018 and would be conducted for as long as was determined to be necessary.

Follow-up sampling was performed at Outfall 158 on December 20, 2018. These samples were collected after a one-day rainfall event of 1.22 in. that occurred on December 20. In addition, sampling was also performed at Outfall 158 on January 3, February 12, and March 11, 2019, after rainfall events of approximately 1.16 in., 2.94 in., and 2.55 in., respectively. Validated analytical results from monitoring conducted at Outfall 158 in December 2018 and the first quarter of CY 2019 are shown in Table 3.11.

No screening criteria were exceeded at Outfalls 100, 142, 170, 180, 190, 195, 250, 280, 360, 430, 510, 560, 690, 730, or 930.

Table 3.9. Analytical results for radiological monitoring at ETTP storm water outfalls

Parameter	Reference standard (pCi/L)	Outfall 142	Outfall 150	Outfall 158	Outfall 160	Outfall 170	Outfall 180	Outfall 190	Outfall 195	Outfall 250	Outfall 280	Outfall 292	Outfall 360	Outfall 510	Outfall 560	Outfall 690	Outfall 730	Outfall 930
Alpha activity (pCi/L)	15 (DWS)	4.3	1.49 U	**1010**	**295**	11.2	9.3	9.68	1.26 U	2.68 U	5.36	**96.5**	9.24	10.3	3.15	2.07	4.43	0.515 U
Beta activity (pCi/L)	50 (DWS)	4.38	2.18	**241**	**59.1**	14.5	10.7	7.14	5.28	1.08 U	8.6	25.1	4.6	15.9	5.45	4.98	5.03	0.445 U
Tc-99 (pCi/L)	44,000 (DCS) 100,000 (DCG)	-3.15	0.756 U	60.3	41.2	2.23	5.37 U	-2.44 U	-2.12 U	-1.85 U	1.32 U	13.2	5.33 U	-1.41	-1.68	1.08	3.96 U	1.13 U
U-233/234 (pCi/L)	680 (DCS) 500 (DCG)	1.48	1.26	**584**	208	2.2	3.61	4.32	0.946	0.0429 U	2.65	**59**	4.24	0.818	1.08	0.399	2.23	0.553
U-235/236 (pCi/L)	720 (DCS) 600 (DCG)	0.0905	0.0925 U	48.8	14	0.178	0.232 U	0.484 U	0.294	0.0779 U	0.357 U	3.2	0.198 U	0.0475	0.048	0.709	0.131 U	0.317 U
U-238 (pCi/L)	750 (DCS) 600 (DCG)	2.92	0.762	354	42	0.807	1.17	2.89	0.753	0.089 U	0.983	36.7	2.6	0.482	1.1	0.222	2.94	0.565

Bold text indicates reference standard exceeded.

Reference standards sources are defined as follows:
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*

Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, *Derived Concentration Technical Standard*), and reference standards equal 4 percent of DCS values. 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).

Table 3.10. Radionuclides released to off-site waters from the ETTP storm water system in 2019

Isotope	^{234}U	^{235}U	^{238}U	^{99}Tc
Activity level (Ci)	0.031	0.0034	0.043	0.085

Table 3.11. Analytical results for radiological monitoring at Outfall 158

Parameter	Reference standard	Outfall 158 11/11/18	Outfall 158 12/20/18	Outfall 158 1/3/19	Outfall 158 2/12/19	Outfall 158 3/11/19	Outfall 158 4/9/19
Alpha activity (pCi/L)	15 (DWS)	**1010**	**103**	**594**	**617**	**354**	**241**
Beta activity (pCi/L)	50 (DWS)	**241**	34.4	**96.2**	**101**	**96.1**	**50.9**
^{99}Tc (pCi/L)	44,000 (DCS) 100,000 (DCG)	60.3	12.5	12.7	13.8	5.07 U	71.2
$^{233/234}U$ (pCi/L)	680 (DCS) 500 (DCG)	584	52.2	364	305	210	150
$^{235/236}U$ (pCi/L)	720 (DCS) 600 (DCG)	48.8	4.36	30.6	31.8	21.8	10.1
^{238}U (pCi/L)	750 (DCS) 600 (DCG)	354	32.4	224	193	134	91.1

Bold text indicates reference standard exceeded.

Reference standards sources are defined as follows:
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*

The precipitation pattern for the January 3, February 12, and March 11, 2019, samples greatly resembled the precipitation pattern for the elevated gross alpha/beta sample collected on November 11, 2018. All of these samples were collected at the end of a rainfall event that lasted for a period of several days, whereas the December 20 sample was collected after a fairly intense one-day rainfall event. From this information, it can be surmised that sustained rainfall events may be a primary cause for the elevated radiological results, and the rainfall events that come on quickly and dissipate quickly may be of lesser concern.

Outfall 362 drains an area to the west side of the K-25 Building. Historic activities in this area included degreasing and maintenance of process equipment, and the refilling of spent cascade trap material from the enrichment cascade. Water samples were collected at Outfall 362 on July 17, 2019, for a broad suite of parameters as a follow-up to a review of radiological soil samples previously collected from the legacy contamination area in the outfall's drainage watershed. The key water results are shown in Table 3.12; as noted above, several individual parameters exceeded the respective analyte DCS limits as well as contributed to the overall SOF exceedance. Follow up monitoring served to map the distribution of contamination within the drainage area. Soil removal actions began in late 2019, and in the interim measures were taken to minimize flow from these areas to Outfall 362, including plugging some drainage lines and constructing berms around some areas. Results of recent monitoring indicate that these measures have been successful in lowering the SOF at Outfall 362 to below the DCS limits. For information on additional monitoring conducted at the K-25 Building area, see Section 3.6.3.1 below.

Table 3.12. Analytes with DCS exceedances from 7/17/19 water sampling event at Outfall 362

Date	^{226}Radium (pCi/L)		^{230}Thorium (pCi/L)		$^{233/234}$Uranium (pCi/L)		235Uranium (pCi/L)		^{238}Uranium (pCi/L)		Uranium Total (pCi/L)
	Actual	DCS	Actual	DCS	Actual	DCS	Actual	DCS	Actual	DCS	
7/17/19	270	87	255	160	1570	660	182	720	1720	750	3472

Outfall 382 drained an area to the north of the K-131 and K-631 facilities. Monitoring in 2019 indicated several results that exceeded the DCS limits (Table 3.13). In response, demolition debris in the drainage area was removed, a layer of clean fill was placed over the area, and the storm drain was plugged, eliminating storm water discharges from Outfall 382. These measures eliminated the need to any further action at this location. For information on additional monitoring conducted at the K-131/K-631 area, see Section 3.6.3.3 below.

Table 3.13. Analytes with DCS exceedances from monitoring at Outfall 382

Date	$^{233/234}$Uranium (pCi/L)		^{238}Uranium (pCi/L)	
	Actual	DCS	Actual	DCS
7/23/19	3270	660	6980	750
7/23/19	3380	660	7030	750
8/8/19	599	660	1080	750
8/13/19	705	660	1480	750

3.6.3 Storm Water Monitoring Associated with D&D Activities

3.6.3.1 Monitoring Associated with the K-25 Building

Demolition of the K-25 Building was completed in CY 2014. The last section of the east wing that was demolished was contaminated with the radioactive isotope ^{99}Tc. Rain and dust control water that contacted the ^{99}Tc-contaminated piping and other building materials is believed to have caused the migration of ^{99}Tc into the soils beneath the east wing debris pile during the demolition. During CY 2019, contaminated soils in this area were excavated and transported to the Environmental Management Waste Management Facility (EMWMF) or at offsite facilities, depending upon the radiological levels, for disposal.

Sampling is conducted following each qualifying rainfall event during the phased excavation of the contaminated soils from the K-25 pad area. Storm water runoff monitoring will be performed for each qualifying rain event for the duration of the excavation activities, as well as for any potential post-excavation mitigation actions. A final monitoring event will occur at the conclusion of actions in this area.

Sampling was conducted as part of this D&D effort on numerous occasions during CY 2019. Analytical results are shown in Table 3.14.

Table 3.14. Results for the K-25 Building pad D&D monitoring

Sampling location	^{99}Tc (pCi/L)	$^{233/234}$U (pCi/L)	$^{235/236}$U (pCi/L)	^{238}U (pCi/L)
Reference standards	**44,000 pCi/L (DCS)** **100,000 pCi/L (DCG)**	**680 pCi/L (DCS)** **500pCi/L (DCG)**	**720 pCi/L (DCS)** **600 pCi/L (DCG)**	**750 pCi/L (DCS)** **600 pCi/L (DCG)**
Outfall 210 (9/26/18)	18.3	1.47	0.382	0.5985
Outfall 210 (1/24/19)	6.8 U	1.69	0.395	0.603
Outfall 210 (7/23/19)	15.2	2.04	0.203 U	1.03
Outfall 490 (9/26/18)	131	2.1	0.0263 U	0.471

Table 3.14. Results for the K 25 Building pad D&D monitoring (continued)

Sampling location	^{99}Tc (pCi/L)	$^{233/234}$U (pCi/L)	$^{235/236}$U (pCi/L)	^{238}U (pCi/L)
Outfall 490 (11/12/18)	132	1.35	0.1543 U	0.285 U
Outfall 490 (12/31/18)	230	2.06	0.5	0.585
Outfall 490 (1/24/19)	176	2.06	0.306	0.839
Outfall 490 (4/23/19)	126	1.38	0.129 U	0.357 U
Outfall 490 (5/13/19)	157	2.1	0.0856 U	0.574
Outfall 490 (7/24/19)	146	2.51	0.299 U	0.913
Outfall 490 (8/14/19)	301	1.33	0.223 U	0.414
Outfall 490 (8/26/19)	111	1.48	0.0669 U	0.453
Outfall 490 (10/28/19)	203	1.5	0.148 U	0.537
Outfall 490 (10/31/19)	73.8	1.16	0.136 U	0.212 U
Outfall 490 (12/23/19)	115	1.06	0.104 U	0.374
Sanitary Sewer Manhole 10 (9/25/18)	21.1	1.12	0.0554 U	0.178 U
Sanitary Sewer Manhole 10 (12/31/18)	30.6	1.48	0.253 U	0.775
Sanitary Sewer Manhole 10 (1/24/19)	13.7	1.08	0.0759 U	0.273 U
Sanitary Sewer Manhole 10 (4/23/19)	36.5	0.513	0.0288 U	0.316 U
Sanitary Sewer Manhole 10 (5/13/19)	29.6	1.02	0.0355 U	0.668
Sanitary Sewer Manhole 10 (7/24/19)	26.9	0.792 U	0.0568 U	0.568 U
Sanitary Sewer Manhole 10 (8/14/19)	26.4	0.454	0.0733 U	0.268 U
Sanitary Sewer Manhole 10 (8/26/19)	26.4	0.199 U	0.125 U	0.116 U
Sanitary Sewer Manhole 10 (10/28/19)	15.6	0.916	0.0663 U	0.45
Sanitary Sewer Manhole 10 (10/31/19)	19.9	0.614	0.0783 U	0.308
Sanitary Sewer Manhole 10 (12/23/19)	13.2	0.859	0.0905 U	0.288
Sanitary Sewer Manhole 92 (9/26/18))	35.9	-0.00582 U	-0.057 U	-0.057 U
Sanitary Sewer Manhole 92 (12/31/18)	216	2.23	0.332 U	0.864
Sanitary Sewer Manhole 92 (1/24/19)	220	2.31	0.0548 U	0.868
Sanitary Sewer Manhole 92 (4/23/19)	86.2	0.198 U	0.0159 U	0.0486 U
Sanitary Sewer Manhole 92 (5/13/19)	39	0.257 U	0.0407 U	0.161 U
Sanitary Sewer Manhole 92 (7/23/19)	294	0.74 U	0.373 U	0.278 U
Sanitary Sewer Manhole 92 (8/14/19)	30.2	0.137 U	0.12 U	0.111 U
Sanitary Sewer Manhole 92 (8/26/19)	16.2	0.135 U	0.0398 U	0.159 U
Sanitary Sewer Manhole 92 (10/28/19)	0.391 U	0.0839 U	0.0197 U	0.118 U
Sanitary Sewer Manhole 92 (10/31/19)	18.5	0.749	0.0723 U	0.434
Sanitary Sewer Manhole 92 (12/23/19)	6.15 U	0.492	0.0344 U	0.112

Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, *Derived Concentration Technical Standard*), and reference standards equal 4 percent of DCS values. 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).

Acronym: D&D = decontamination and decommissioning

Based on these results, it appears that efforts to prevent the migration of ^{99}Tc from the K-25 Building pad D&D area into the storm drain system and the sanitary sewer system have been successful. Additional monitoring will be conducted during qualifying rainfall events for the duration of D&D activities at the K-25 Building pad. Remediation of the area is expected to be completed in early CY 2020.

To collect data that is to be reported in the RER and the ASER, and to collect data that can be compared to information that is being gathered by TDEC on an ongoing basis, a sample for ^{99}Tc is collected at Outfall 190 each time a quarterly mercury sample is collected at this outfall. The analytical data from this sample will assist in determining if groundwater contaminated with ^{99}Tc from the K-25 D&D project could be migrating toward the Outfall 190 drainage area and discharging into Mitchell Branch via Outfall 190. Table 3.15 contains analytical data from CY 2017 through part of CY 2019 for this monitoring effort.

As shown in Table 3.15, the storm water results for the Mitchell Branch watershed area indicate that ^{99}Tc was not detected in samples collected at Outfall 190 during sampling conducted in CY 2018 or CY 2019. 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.

The cumulative radionuclide measurements at the Mitchell Branch exit weir K-1700 location are calculated to be less than 1 percent of the DCS SOF values. The maximum ^{99}Tc measurement at K-1700 in 2019 was 19.8 pCi/L (Figure 3.18), which is orders of magnitude below the ^{99}Tc DCS value of 44,000 pCi/L. For further information on radiologic monitoring along Mitchell Branch, see Section 3.6.8.

Table 3.15. Results from quarterly ^{99}Tc monitoring at Outfall 190

	1/9/18	4/26/18	7/10/18	10/15/18	1/17/19	4/2/19	7/18/19	11/14/19
pCi/L	8.12 U	7.44 U	1.07 U	6.38 U	5.8 U	3.95 U	2.69 U	7 U

Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, *Derived Concentration Technical Standard*) of 44,000 pCi/L. Derived Concentration Guide (DCG) values for ingested water (DOE Order 5400.5 Chg. 2, *Radiation Protection of the Public and the Environment,* Chap. III) of 100,000 pCi/L is 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).

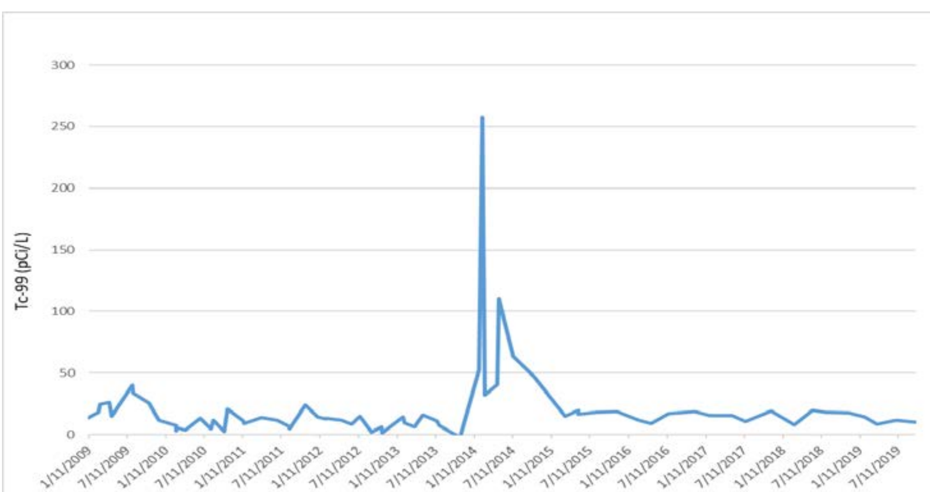


Figure 3.18. Tc-99 levels at K-1700 Weir

3.6.3.2 Monitoring Associated with the K-31/K-33 Area

The K-31 parcel (46.8 acres) was made available by DOE EM for transfer to CROET. CNS leased the property before the start of construction for the UPF/Mechanical Electrical Building. As part of the lease of the K-31 area to CNS, and in an effort to determine the feasibility of leasing other portions of the K-31/K-33 area, each of the outfalls that are located in the K-31/K-33 area were considered to determine whether they should be sampled as part of the investigation of storm water discharges from the area. In order to determine if storm water outfalls in the K-31/K-33 area could be removed from the ETTP NPDES permit as part of the transfer of the property to CNS, sampling was performed in CY 2018 at outfalls within the drainage areas of these building footprints to obtain current analytical information. In CY 2019, follow-up sampling was performed at several outfalls where reference standards were exceeded as part of the CY 2018 sampling effort. Table 3.16 contains information on the analytical results collected from the K-31/K-33 area storm water outfalls that exceeded reference standards as part of the ETTP SWPP Program sampling effort.

Table 3.16. Analytical results exceeding reference standards from the K-31/K-33 area monitoring

	Lead	Mercury	Hexavalent chromium	PCB-1254
Location	**Reference standard 2.5 µg/L (CCC) 65 µg/L (CMC)**	**Reference standard 0.051 µg/L (REC OO and REC WO)**	**Reference standard 11 µg/L (CCC) 16 µg/L (CMC)**	**Reference standard 0.00064 µg/L (REC OO and REC WO)**
Outfall 590	—	—	23	—
Outfall 690	—	—	—	0.0464
Manhole 6014 (part of Outfall 510)	5.43	—	—	—

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*

As a result of this investigation, some outfalls were plugged and abandoned and removed from the NPDES permit (Outfalls 510 and 590), and one (Outfall 690) was slated for further investigation.

3.6.3.3 Monitoring Associated with the Demolition of Support Facilities

The J-Laboratory Complex, also known as "J-Labs," consists of Bldgs. K-1004-J, K-1004-Q, K-1004-R, K-1004-S, K-1004-T, K-1004-U, K-797 (including the K-700-A-57 substation), and the K-1005 office area. Outfall 100 receives storm water drainage from the J-Lab/K-1023 area.

Sampling was performed at Outfall 100 on August 13, 2019, prior to the initiation of D&D activities at the J-Lab facilities and Building K-1023. Analytical results that exceeded reference standards for this sampling event are shown in Table 3.17.

Additional sampling was performed during J-Lab/K-1023 D&D activities and after all D&D and waste cleanup activities had been concluded. Sampling was performed on October 31 and on December 23, 2019. None of the analytical results exceeded reference standards for these sampling events.

Initial D&D activities such as transite removal, etc. were initiated at building K-1037 in January 2019. Demolition of the building began in February 2019 and was completed in July 2019. Removal of the building's concrete slab and placement of topsoil and seed were completed in October 2019. Storm water runoff sampling before, during, and after demolition of K-1037 was conducted at Outfalls 150 and 170, which are the major outfalls that drain this area.

Table 3.17. Analytical results exceeding reference standards from pre-D&D J-Lab/Building K-1023 monitoring

Location	Copper	Lead	PCB-1248	PCB-1254
	Reference standard 9 µg/L (CCC) 13 µg/L (CMC)	Reference standard 2.5 µg/L (CCC) 65 µg/L (CMC)	Reference standard 0.00064 µg/L (REC OO and REC WO)	Reference standard 0.00064 µg/L (REC OO and REC WO)
Outfall 100	2.55	0.25	0.116	2.55

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*

On February 7, 2019, baseline pre-demolition samples were collected at Outfalls 150 and 170. Sampling was performed on April 22, and May 13, 2019, during demolition of Building K-1037. Additionally, sampling was performed on July 23, 2019, after D&D activities at Building K-1037 had been completed. Sampling was conducted on August 14, 2019, before the removal of the K-1037 building slab was initiated. No contaminants were identified at concentrations exceeding reference standards in samples collected on February 7, 2019, before D&D activities at Building K-1037 began. The analytical results indicate that several metals were present in the discharges from Outfalls 150 and 170 during the demolition of Building K-1037, which could indicate possible issues with the storm water controls used during D&D activities. Other than the presence of copper and lead at levels just above the reference standards, no contaminants were observed in samples from Outfalls 150 and 170 that were collected after the completion of D&D activities at Building K-1037.

Although the K-1037 structure was removed during D&D activities that were completed in July 2019, the building slab was left in place for a future remedial action. Subsequent sampling at Outfalls 150 and 170 was conducted after each qualifying rainfall event as part of the K-1037 slab removal work, which was completed in October 2019. Analytical results that exceeded reference standards for this monitoring are shown in Table 3.18.

Table 3.18. Results over reference standards for the K-1037 D&D monitoring

Sampling location	Copper	Lead	Mercury	Thallium
Reference standards	9 µg/L (CCC) 13 µg/L (CMC	2.5 µg/L (CCC) 65 µg/L (CMC)	51 ng/L (REC OO)	0.47 µg/L (REC OO) 0.24 µg/L (REC WO)
Outfall 150—2/7/19	—	—	—	—
Outfall 150—4/22/19	---	—	63.3	—
Outfall 150—5/13/19	---	—	—	—

Table 3.18 Results over reference standards for the K 1037 D&D monitoring (continued)

Sampling location	Copper	Lead	Mercury	Thallium
Outfall 150—7/23/19	---	—	—	—
Outfall 150—8/14/19	11.1	4.09	—	0.657
Outfall 150—10/22/19	---	---	---	---
Outfall 170—2/7/19	—	—	—	—
Outfall 170—4/22/19	10.7	—	—	—
Outfall 170—5/13/19	---	—	—	—
Outfall 170—7/23/19	—	—	—	—
Outfall 170—8/14/19	—	—	—	—
Outfall 170—8/26/19	—	—	—	1.15
Outfall 170—10/22/19	---	---	---	---

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*
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*
FISH TDEC Rule 0400-40-03-.03(3)(a), (b), and (e)
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*
Permit NPDES Permit TN0002950, Part III
No Criteria Sources not listed in the TDEC General Water Quality Criteria or NPDES Permit No. TN0002950
Reference standards for radionuclides equal Derived Concentration Standard (DCS) for ingested water (DOE-STD-1196-2011, *Derived Concentration Technical Standard*), and reference standards equal 4 percent of DCS values. 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).

Removal of the K-1232 building slab, as well as other building slabs in the area (e.g., K-413, K-1131) will be completed in CY 2020. Storm water runoff sampling began in 2018 and will be conducted at Outfall 380 as part of these remedial action activities in accordance with the FY 2020 ETTP SWPPP Sampling and Analysis Plan (SAP) (UCOR-4028/R9) (Table 3.19).

Table 3.19. Results over reference standards for the K-1232 D&D monitoring

Sampling location	Lead	Mercury	Selenium	Gross alpha radiation
Reference standards	**2.5 µg/L (CCC) 65 µg/L (CMC)**	**51 ng/L (REC OO)**	**3.1 µg/L (CCC)**	**15 pCi/L (DWS)**
Outfall 380—8/20/18	28.2	119	—	—
Outfall 380—2/12/19	—	—	—	15.5
Outfall 380—7/23/19	4.87	—	10.3	—

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*
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*
REC OO TDEC Rule 0400-40-03-.03(4)(j), *Organisms Only Criteria*

Building K-1423 operated from 1969 until 1986 as a Toll Enrichment Facility, which involved the transfer of liquefied uranium hexafluoride (UF_6) product from 10- and 14-ton cylinders into 2.5-ton privately owned cylinders. Storm water Outfall 200 receives storm water drainage from the K-1423 area.

Samples were collected at Outfall 200 on August 13, 2019, prior to the initiation of D&D activities. Analytical results that exceeded reference standards are shown in Table 3.20.

Table 3.20. Analytical results exceeding reference standards from pre-D&D Building K-1423 D&D monitoring

Location	Copper	Lead	Zinc	PCB-1260
	Reference standard 9 µg/L (CCC) 13 µg/L (CMC)	Reference standard 2.5 µg/L (CCC) 65 µg/L (CMC)	Reference standard 120 µg/L (CCC) 120 µg/L (CMC)	Reference standard 0.00064 µg/L (REC OO and REC WO)
Outfall 200	36.4	11.5	130	0.344

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*

D&D of Building K-1423 was completed on August 16, 2019. A final monitoring event was conducted on October 30, 2019, at the conclusion of demolition, waste handling, and any potential post-demolition mitigation actions. Analytical results that exceeded reference standards are shown in Table 3.21.

Table 3.21. Analytical results exceeding reference standards from K-1423 post-D&D monitoring

Reference Standards[a]	Copper	Lead	PCB-1254
	Reference standard 9 µg/L (CCC) 13 µg/L (CMC)	Reference standard 2.5 µg/L (CCC) 65 µg/L (CMC)	Reference standard 0.00064 µg/L (REC OO and REC WO)
Outfall 200	9.25	6.34	0.0488 J

[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*

The EU-19 area encompasses the former K-1410 building area, the former K-1410 neutralization pit, the former K-1410-B Effluent Treatment Facility, the former K-1031 building area, and the gravel, soil, and paved areas in the vicinity of where these structures were once located. The EU-19 area receives storm water runoff from Outfalls 350, 360, and 362.

Remedial actions for the EU-19 area began in late summer of CY 2019. Samples were collected from Outfall 362 on July 17, 2019, to provide background information on discharges from the area. Analytical results from samples taken at Outfall 362 indicate the presence of mercury and PCBs at levels exceeding water quality criteria, as well as elevated levels of several radiological contaminants. These results are shown in Table 3.22.

Table 3.22. Analytical results exceeding reference standards as part of the Outfall 362/EU-19 monitoring

Location	**Nickel** Reference standards 52 µg/ (CCC) 470 µg/L CMC)	**Copper** Reference standards 9 µg/ (CCC) 13 µg/L CMC)	**Lead** Reference standards 2.5 µg/ (CCC) 65 µg/L CMC)	**Mercury** Reference standards 21 µg/ (CCC) 51 ng/L CMC)	**Selenium** Reference standards 3.1 µg/ (CCC) 20 µg/L (CMC)	**Gross alpha radiation** Reference standard 15 pCi/L (DWS)	**Gross beta radiation** Reference standard 50 pCi/L (DWS)	**U-233/234** Reference standard 680 pCi/L (DCS) 500 pCi/L (DCG)	**U-235/236** Reference standard 720 pCi/L (DCS) 600 pCi/L (DCG)	**U-238** Reference standard 750 pCi/L (DCS) 600 pCi/L (DCG)	**Radium-226** Reference standard 87 pCi/L (DCS) 100 pCi/L (DCG)	**Thorium-230** Reference standard 160 pCi/L (DCS) 300 pCi/L (DCG)	**PCB-1254** Reference standards 0.00064 µg/L (REC OO and REC WO)	**PCB-1260** Reference standards 0.00064 µg/L (REC OO and REC WO)
Outfall 362	59.9	54.1	9.86	60.8	9.25	5100	1920	1570	182	1720	270	255	0.852	0.193

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*
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*
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*), and reference standards equal 4 percent of DCS values. 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).

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 Building K-1410 and associated facilities. Results of the radiologic monitoring are discussed in Section 3.6.2.2 above. There are three pipes—a 6-in. diameter pipe, an 8-in. diameter pipe, and a 36-in. diameter pipe—that discharge storm water from the area drained by the Outfall 362 drainage system.

From this information, it was determined that the 8-in. pipe was likely a contaminated process pipe that storm water had entered through infiltration. The 36-in. pipe received relatively uncontaminated storm water runoff from area building slabs, pavement, and gravel areas. The 6-in. line may have also been a process line from K-1410. The larger drainage area that discharges to the 36-in. pipe results in a much greater discharge from this pipe that from the smaller pipes. This dilution of the flows from the smaller pipes is evident in the lower analytical results indicated in the Outfall 362 combined flow samples.

For CY 2019, the SOF result for Outfall 362 was 5.07 (primarily associated with ^{234}U, ^{238}U, ^{230}thorium [^{230}Th], ^{226}radium [^{226}Ra]), exceeding the SOF administrative limit of 1.0. The discharge of radiological contaminants from Outfall 362 were routinely communicated to DOE throughout the CY 2019 annual period.

Also in association with the EU-19 soil removal action, background samples were collected at Outfalls 350 and 360, which receive runoff from the northernmost portion of the EU-19 area. Samples were collected at Outfall 350 on October 22, 2019. Analytical results that exceeded reference standards are shown in Table 3.23. Soil removal work is ongoing in the Outfall 350 drainage area. These analytical results were considered during the planning of soil removal activities in this area.

Table 3.23. Analytical results exceeding reference standards from monitoring at Outfall 350

Reference Standard[a]	Gross Alpha Activity
	15 pCi/L (DWS)
Outfall 350	190

Reference standards sources are defined as follows:
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*

Monitoring was conducted at Outfall 360 on October 22, 2019. Analytical results that exceeded reference standards are shown in Table 3.24.

Table 3.24. Analytical results exceeding reference standards from monitoring at Outfall 360

Reference Standard[a]	Gross Alpha Activity
	15 pCi/L (DWS)
Outfall 360	23

Reference standards sources are defined as follows:
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*

The Outfall 360 drainage area has been recontoured to promote sheet flow and eliminate discharges from the Outfall 360 piping system. Since discharges from Outfall 360 have been eliminated, permission will be sought from TDEC to remove the outfall from the ETTP NPDES permit coverage.

Monitoring of Outfall 382 in 2019 produced a single result for nickel that exceeded the NPDES permit limit of 500 µg/L, and that was more than 10 times higher than previous results. In response, demolition debris in the drainage area was removed, a layer of clean fill was placed over the area, and the storm drain was plugged, eliminating storm water discharges from Outfall 382. These measures eliminated the need to any further action at this location.

3.6.3.4 Mercury Monitoring Conducted as Part of the Previous NPDES Permit

As part of the previous NPDES permit compliance program, mercury was sampled on a quarterly basis at Outfalls 05A, 180, and 190. These locations were selected because information gathered as part of the permit application process indicated that mercury levels at these outfalls occasionally exceeded the Ambient Water Quality Criterion (AWQC) level of 51 ng/L. Outfalls 180 and 190 collect storm water from large areas on the north side of ETTP and discharge to Mitchell Branch. Outfall 05A was the discharge point for the former K-1203-10 overflow sump. This sump, which was part of the K-1203 STP, collected storm water runoff from a large portion of the K-1203 area and discharged it into Poplar Creek on the east side of ETTP. Final D&D actions, including the filling of the Imhoff tanks and the K-1203-10 sump, removal of the sludge drying beds, and final filling and contouring of the K-1203-STP area, were completed in 2019. Storm water runoff and storm water and groundwater infiltration from the K-1203 area has been rerouted to the former discharge pipe formerly used by the K-1203 STP for the discharge of treated effluent into Poplar Creek. This pipe is located approximately 50 yd south of the location of the former Outfall 05A. Outfall 05A now discharges by gravity flow rather than the discharge being pumped by a lift pump. Table 3.25 contains analytical data from monitoring for mercury at Outfalls 180, 190, and 05A from CY 2018 through CY 2019.

The current NPDES permit no longer requires quarterly mercury monitoring. However, to continue collecting data for the analysis of trends in mercury discharges from these outfalls, quarterly mercury monitoring was conducted as part of the ETTP SWPP Program.

Table 3.25. Quarterly NPDES/SWPP Program mercury monitoring results, CY 2018 through CY 2019

Sampling location	1st Quarter CY 2018 (ng/L)	2nd Quarter CY 2018 (ng/L)	3rd Quarter CY 2018 (ng/L)	4th Quarter CY 2018 (ng/L)	1st Quarter CY 2019 (ng/L)	2nd Quarter CY 2019 (ng/L)	3rd Quarter CY 2019 (ng/L)	4th Quarter CY 2019 (ng/L)
Outfall 180	28.4	**235**	33.5	61	23.9	27.7	**157**	48.7
Outfall 190	39.1	29.1	23.2	15.5	11.9	17.6	16	11.6
Outfall 05A	**68.4**	**87.3**	**232**	**333**	**211**	**217**		**

Results in **bold** exceed the reference standard for mercury (51 ng/L).

Outfalls 180 and 190 are two of the major outfalls that contribute flow to Mitchell Branch. Because the discharges from Outfalls 180 and 190 routinely contain mercury at levels above screening criteria, 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. Please note that Figures 3-19 and 3-20 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. Figure 3.21 shows mercury levels at the K-1700 Weir from CY 2010 through CY 2019 (For additional information on monitoring along Mitchell Branch, see Section 3.6.8).

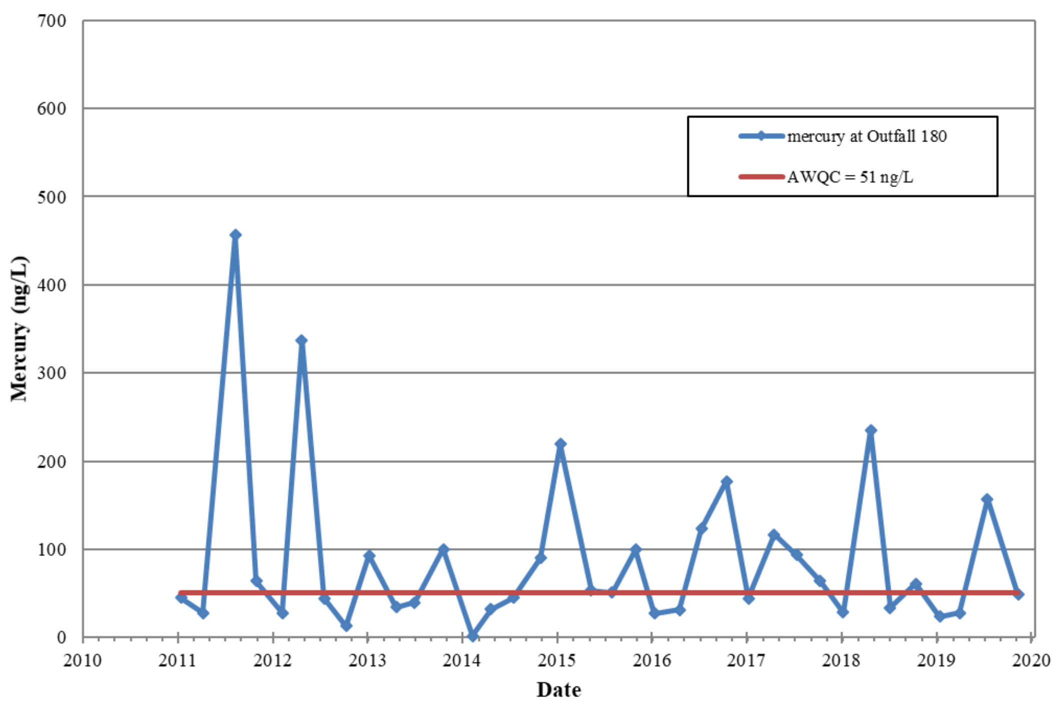


Figure 3.19. Mercury concentrations at Outfall 180

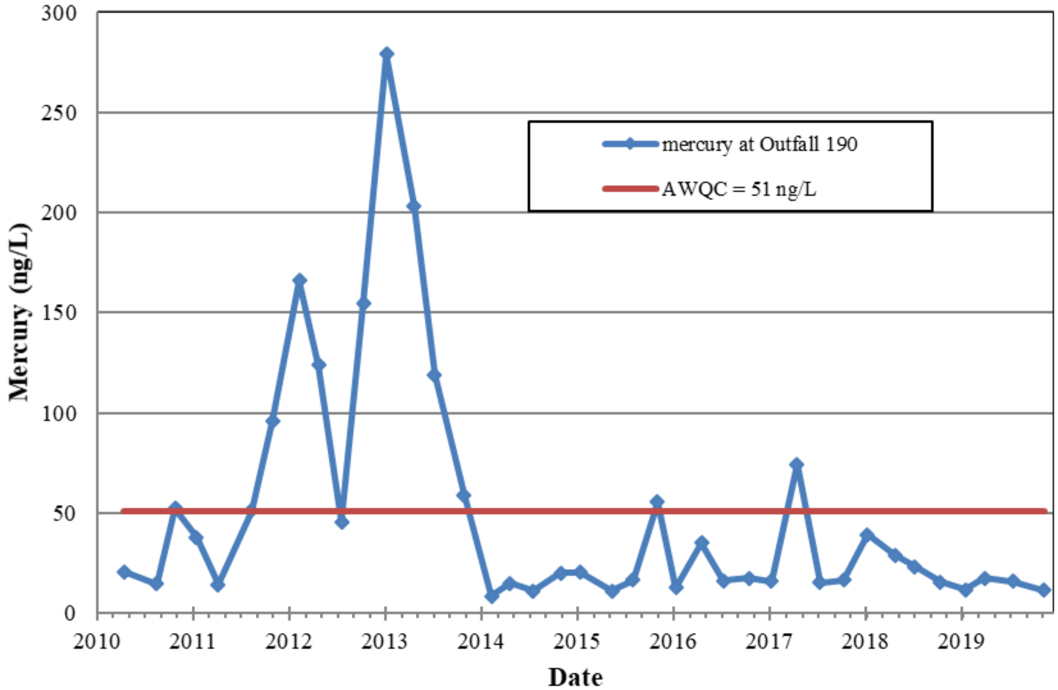


Figure 3.20. Mercury concentrations at Outfall 190

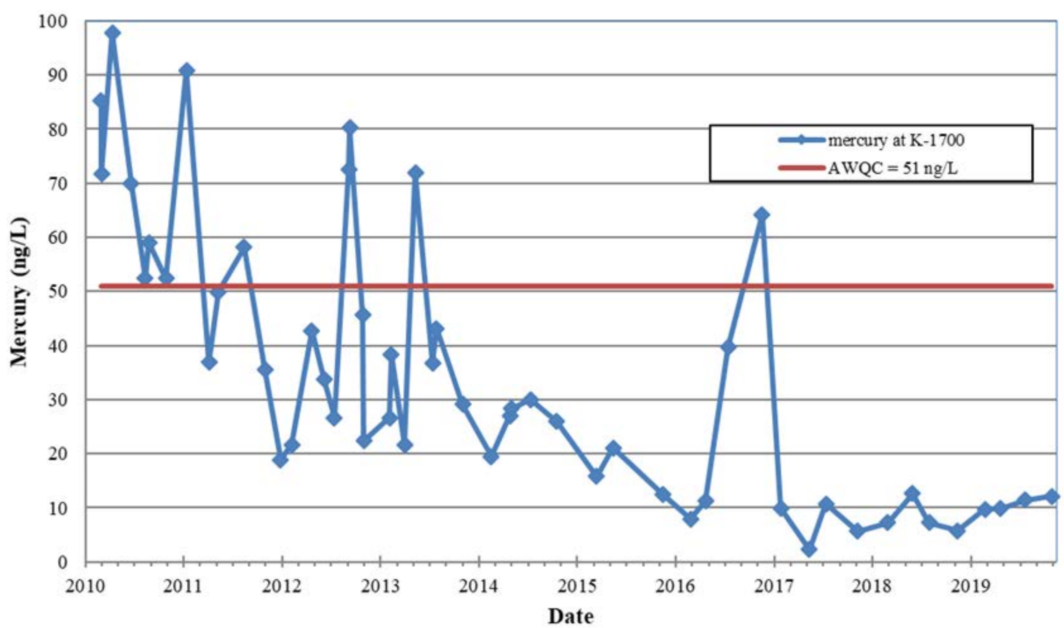


Figure 3.21. Mercury concentrations at the K-1700 Weir

Storm water Outfall 05A once drained portions of the former K-1203 STP that discharged into the K-1203-10 sump. The D&D of the K-1203 STP was completed in 2019. Figure 3.22 shows mercury concentrations at storm water Outfall 05A from CY 2010 through CY 2019. No mercury sample was collected at Outfall 05A during the fourth quarter of CY 2019 due to remedial activities being conducted in the outfall watershed.

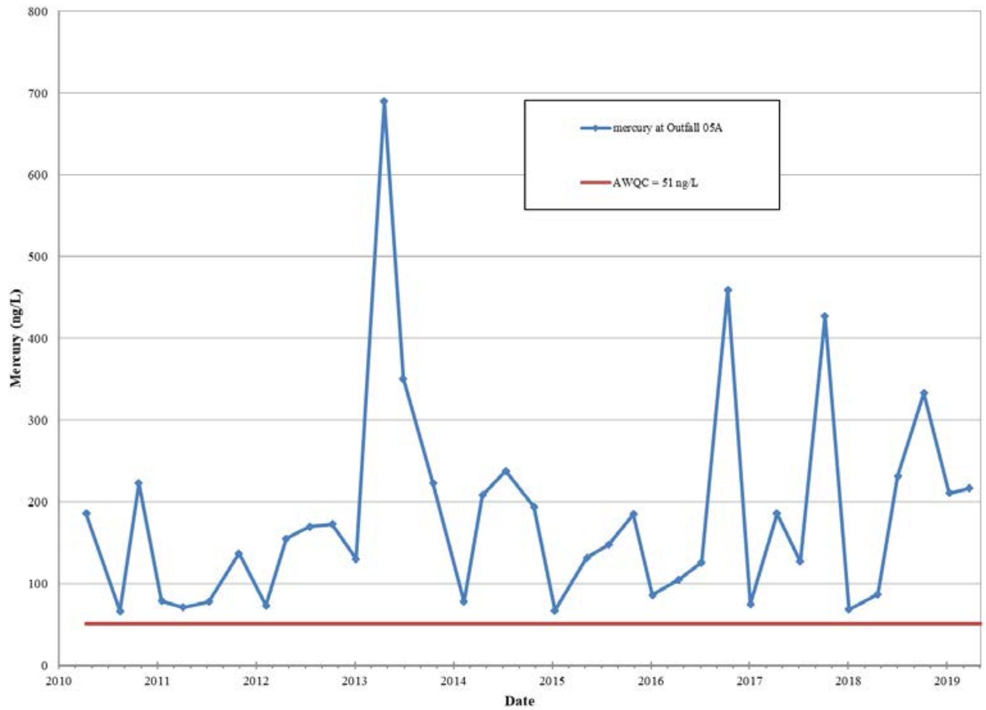


Figure 3.22. Mercury concentrations at Outfall 05A

3.6.3.5 PCB Monitoring at ETTP Storm Water Outfalls

An evaluation of PCB data collected as part of the ETTP SWPP Program from CY 2000 to the present was performed to identify locations where PCBs have been detected at storm water outfall locations. Non representative outfalls that have been grouped with representative outfalls where PCBs have been identified and have not been sampled in several years were selected to be sampled as part of the ETTP SWPP monitoring program.

PCB 1260 was detected at a concentration of 0.45 µg/L in samples collected from Outfall 830 in March 2019. Outfall 830 receives storm water runoff from the area where the K-734 building was once located. Building K-734 was constructed in 1944 and served as a pumphouse for the Fercleve S-50 Thermal Diffusion Plant. The mechanism for PCBs entering this drainage system and discharging through Outfall 830 is currently unknown.

Analytical PCB data collected as part of the storm water monitoring effort will be used to provide information for evaluating cleanup decisions and to measure the effectiveness of RAs.

Over the past several years, detectable PCBs (PCB 1254) have been noted in analytical data from Outfall 690. As part of the ETTP SWPP Program, an investigation was conducted in an effort to determine where and how PCBs may have entered this drainage system, where ongoing sources of PCBs may be located within this drainage system, and what to do about addressing the PCB concern at this outfall. This investigation involved the collection of samples from several locations in the northeast corner and along the entire eastern side of the former K-33 building area (catch basins 6093, 1032, and 1B024).Samples were collected on April 8, 2019. No PCBs were identified in samples collected from Catch Basins 6093 or 1032. No flow was detected in Catch Basin 1B024. There were also no PCBs detected in the sample from Outfall 690. However, a sample collected on November 6, 2018, indicated that PCB 1254 was present at a concentration of 0.464 µg/L.

Because no PCBs were identified in the Outfall 690 drainage network, and PCBs have been identified at Outfall 690 as part of another sampling effort, it is speculated that the source of the PCBs at Outfall 690 is likely the K-897-A oil/water separator. Because the DOE EM mission has been completed in the area drained by Outfall 690, this outfall has been recommended for removal from the ETTP NPDES permit. Final RAs for the ETTP oil/water separators is currently being discussed.

3.6.3.6 Investigative Monitoring of the K-720 Coal Ash Pile and Powerhouse Areas

A total of 5.97 million tons of coal were burned at the K-701 Powerhouse during its operation from 1944–1962. Bottom ash, coal fines, slag, and other by-products of coal combustion were buried at the K-720 coal ash pile. The K-720 coal ash pile is approximately 9 acres in size. In the mid-1990s, the coal ash pile was spread out, covered with soil, limed, and seeded.

In order to collect additional information on the effectiveness of the RAs taken in the K-720 coal ash pile area in the past, as well as to provide additional information to help in determining the long-term actions to be taken at this location in the future, additional monitoring was conducted as part of the ETTP SWPP Program. Table 3.26 provides results of metals that exceeded reference standards during monitoring in the Outfall 992 drainage system in April 2019.

Table 3.26. Analytical results exceeding reference standards from the Outfall 992 drainage area monitoring

Location	Cadmium	Selenium	Thallium
	Reference standard 0.72 µg/L (CCC) 1.8 µg/L (CMC)	Reference standard 3.1 µg/L (CCC) 20 µg/L (CMC)	Reference standard 0.47 µg/L (REC OO) 0.24 µg/L (REC WO)
Outfall 992	1.31	—	9.08
992-3	1.17	—	5.56
992-4	—	—	—
992-8	—	—	6.09
992-9	—	9.53	11.1
K-702-A Slough	1.15	—	6.58

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*

Due to the elevated metals results indicated at Outfall 992 in the initial sampling effort, a follow-up sample for metals was collected on August 27, 2019. Table 3.27 shows the analytical results that exceeded reference standards as part of this follow-up monitoring.

Table 3.27. Analytical results exceeding reference standards from the Outfall 992 follow-up sampling effort

Location	Arsenic Reference standard 10.0 µg/L (REC OO and REC WO)
Outfall 992	16.6

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

Several alternatives have been developed for the long-term remediation and management of the K-720 fly ash pile, including:

1. Replace the existing soil cover with an engineered cover designed in accordance with TDEC requirements.
2. Upgrade the existing vegetated cap and institute long-term land use controls for the area
3. Remove the fly ash and the existing cap and dispose of the materials in ORRLF.
4. Continue present maintenance activities on the existing cap and take no further actions.

A review of analytical data from storm water outfalls in the Powerhouse Area performed in early 2019 revealed several gaps in information that needed to be addressed if portions or all of the Powerhouse Area are turned over to CROET for potential lease or transfer to industrial interests. Because reference standard exceedances have been observed in historical analytical data from some of the outfalls, sampling was performed to determine if the outfalls might continue to be an ongoing source of contaminants.

A private company specializing in wood products has leased a portion of the Powerhouse Area drained by Outfall 780. Samples collected at Outfall 780 in March 2018 contained legacy mercury above the reference standards as well as elevated levels of legacy PCBs. These materials appear to be legacy contaminants unrelated to the operations of the current leasee. In an effort to identify where potential source(s) of these legacy contaminants may be entering the Outfall 780 drainage system, follow-up sampling was conducted in March 2019. Mercury and PCB samples were collected at Outfall 780 and from two locations upstream of the end of the pipe in an effort to isolate any potential sources of legacy mercury and legacy PCBs entering this system. Analytical parameters from the 2018 and 2019 sampling efforts that exceeded reference standards are indicated in Table 3.28.

Several legacy contaminants were noted at levels above AWQC levels at Outfall 780 and in its drainage network as part of the March 2019 sampling effort. Copper and lead were noted in discharges from the outfall. Mercury, PCB 1254, PCB 1260, gross alpha radiation, gross beta radiation, $^{233/234}$U, and ^{238}U were noted in samples collected upstream from Outfall 780 in the outfall's drainage system.

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. Analytical data collected over the past 20 years also indicate the presence of levels of PCBs, metals, mercury, and radiological parameters exceeding AWQC levels in discharges from Outfall 780.

Because levels of several contaminants of concern have been noted in discharges from this outfall, it was determined that Outfall 780 should be proposed for monitoring as a potential representative outfall.

Sampling will be conducted as part of the FY 2020 ETTP SWPP Program for the parameters needed to complete an EPA 2F form for this outfall.

Table 3.28. Results over reference standards for the Powerhouse outfall monitoring effort

Sampling location	Copper µg/L	Lead (µg/L)	Mercury (ng/L)	Selenium (µg/L)	PCB-1254 (µg/L)	PCB-1260 (µg/L)	Gross alpha (pCi/L)	Gross beta (pCi/L)
Reference standards	**9 µg/L (CCC)** **13 µg/L (CMC)**	**2.5 µg/L (CCC)** **65 µg/L (CMC)**	**51 ng/L (REC OO and REC WO)**	**3.1 µg/L (CCC)** **20 µg/L (CMC**	**0.00064 µg/L (REC OO and REC WO)**	**.00064 µg/L (REC OO and REC WO)**	**15**	**50**
Outfall 780 (March 2018 results)			691			0.626		
Outfall 780 (March 2019 results)	14	7.28	—	—	—	—	—	—
Outfall 780 D2	—	—	66.7	—	0.0452	0.041	354	96.1
Outfall 780 D3	—	—	102	—	0.0408	0.0342	—	—
Outfall 800	—	4.02	—	—	—	—	—	—
Outfall 830	—	—	—	6.86		0.045	—	—
Outfall 900	14.4	—	—	—	—	—	—	—

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*
DWS TDEC Rule 0400-40-03-.03, *Domestic Water Supply*
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*), and reference standards equal 4 percent of DCS values. 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).

Elevated levels of several legacy heavy metals were observed in Outfalls 800, 830, and 900. In addition, detectable levels of PCBs were noted in the discharge from Outfall 830. Additional RAs may need to be undertaken in the drainage area of these outfalls to address the metals and PCB issues before the Powerhouse property can be released to lessees for industrial use. No actions on removing the Powerhouse outfalls from the ETTP NPDES permit will be taken until investigation of the discharges from these outfalls can be completed and any necessary RAs to correct discharges of contaminants have been taken.

3.6.3.7 Chromium Water Treatment System and Plume Monitoring

The continued effectiveness of the Chromium Water Treatment System is confirmed by periodic monitoring as part of the ETTP SWPP Program. In CY 2019, monitoring was conducted at Monitoring Well TP-289, the chromium collection system wells, Outfall 170, and Mitchell Branch kilometer (MIK) 0.79. Samples are collected at TP-289 to monitor the concentrations of chromium in the contaminated groundwater plume. Samples are collected from the chromium collection system wells to monitor the chromium in the water recovered by the groundwater collection system. Samples collected at Outfall 170 monitor the concentrations of the chromium and hexavalent chromium plume being discharged directly to Mitchell Branch. Figures 3.23 and 3.24 show the results for the analyses for total chromium and hexavalent chromium, respectively.

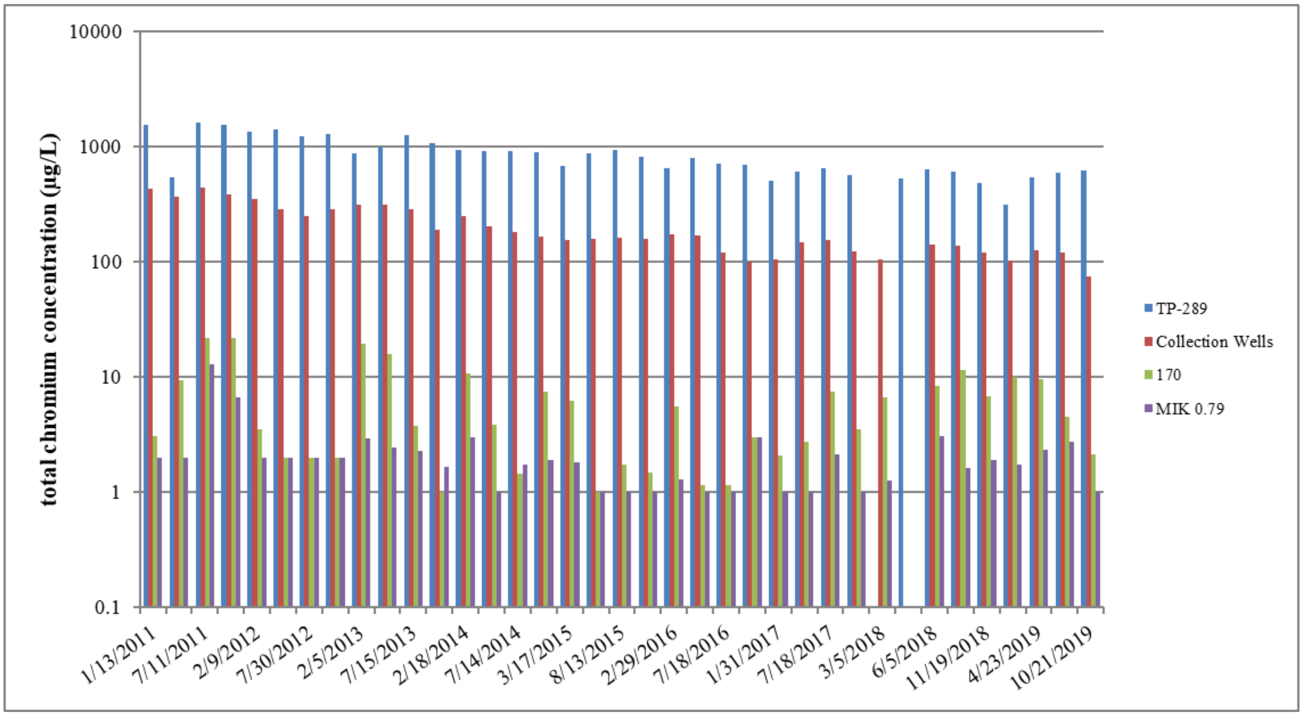


Figure 3.23. Total chromium sample results for the chromium collection system

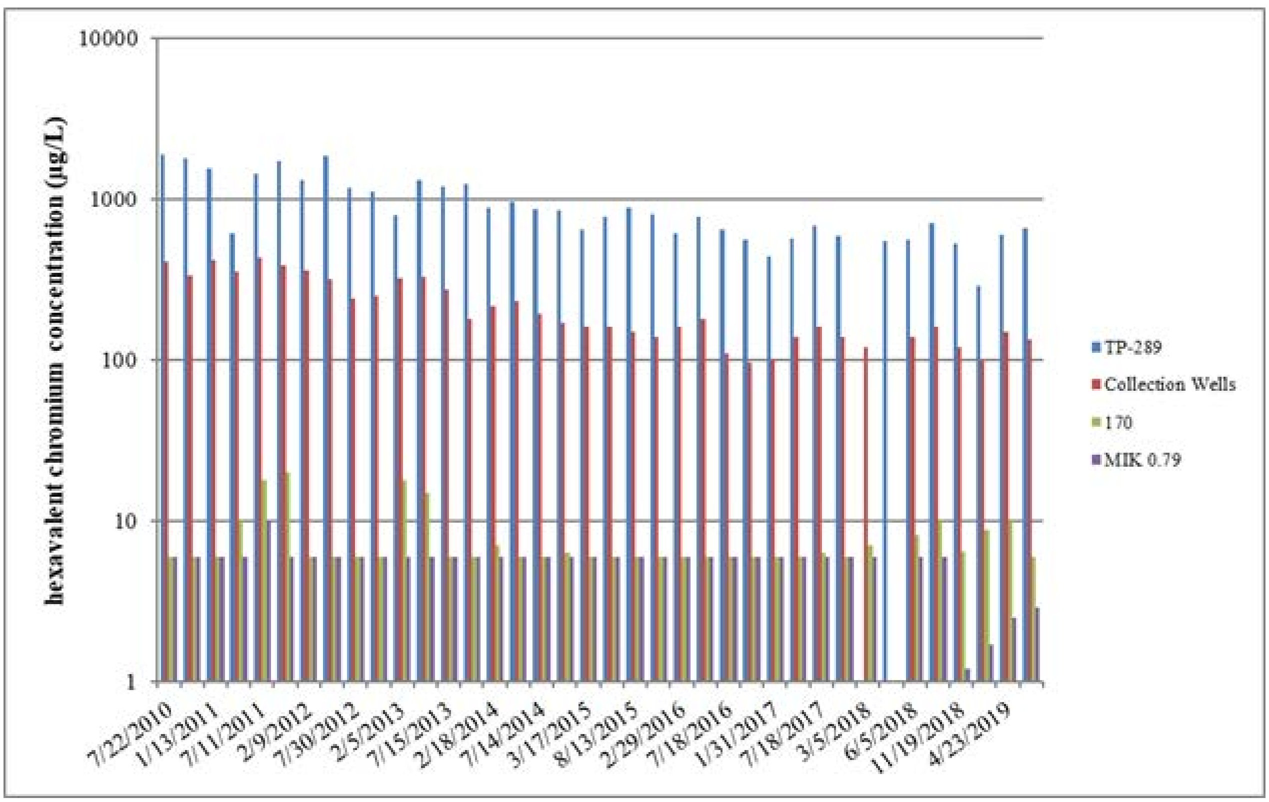
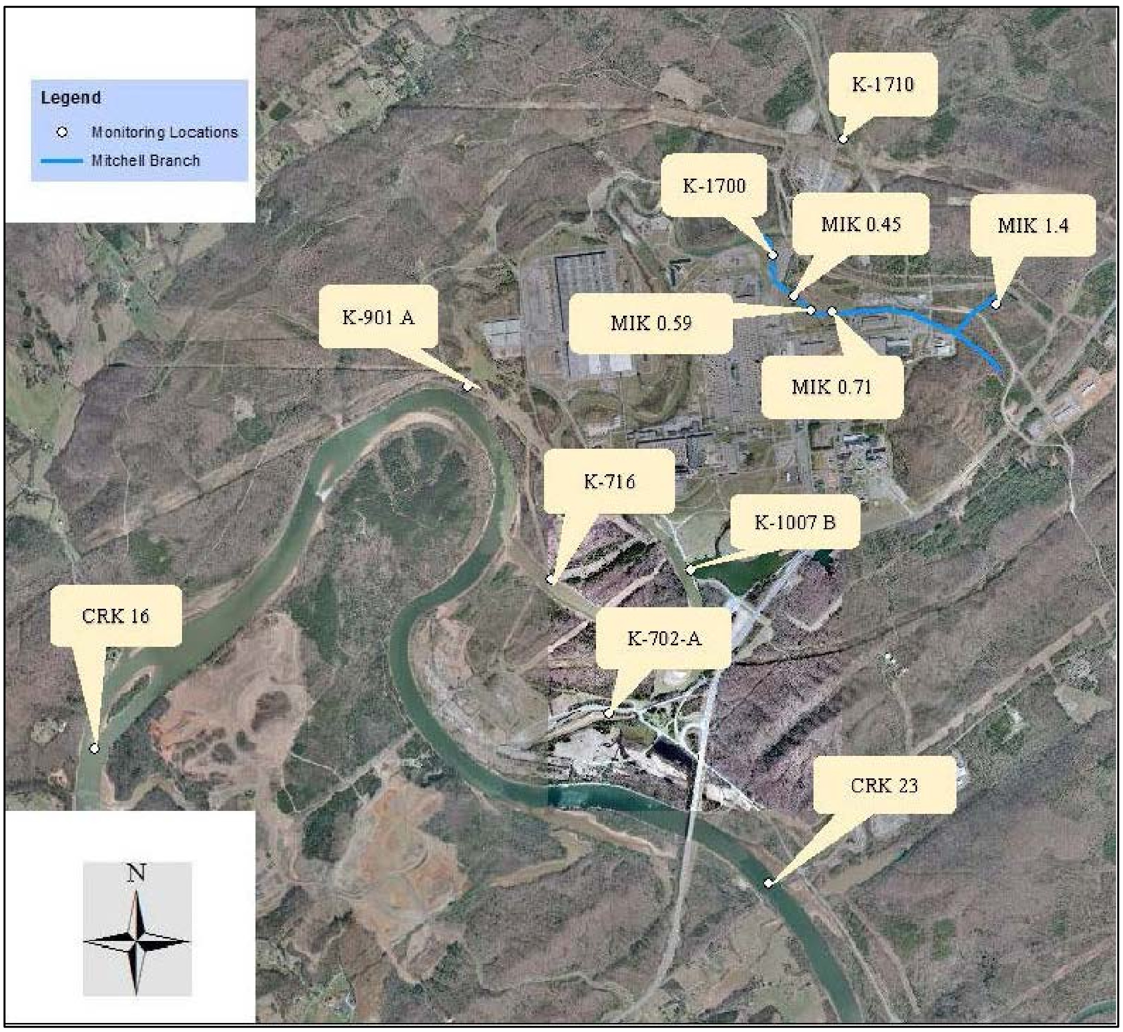


Figure 3.24. Hexavalent chromium sample results for the chromium collection system

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 over the long term. Total chromium values at Outfall 170 and MIK 0.79 are slightly more variable. This is most likely due to the greater variability in flow rates at these two locations. Figure 3.24 shows the results for total chromium at Outfall 170. Hexavalent chromium levels at Outfall 170 and MIK 0.79 have remained consistent.

3.6.4 Surface Water Monitoring

During 2019, the ETTP EMP personnel conducted environmental surveillance activities at 12 surface water locations (Figure 3.25) to monitor groundwater and storm water runoff 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). As part of monitoring the ambient stream conditions, K-1700 and MIKs 0.45, 0.59, 0.71, and 1.4 were sampled quarterly; and CRKs 16 and 23, K-716, and the K-702-A slough were sampled semiannually.

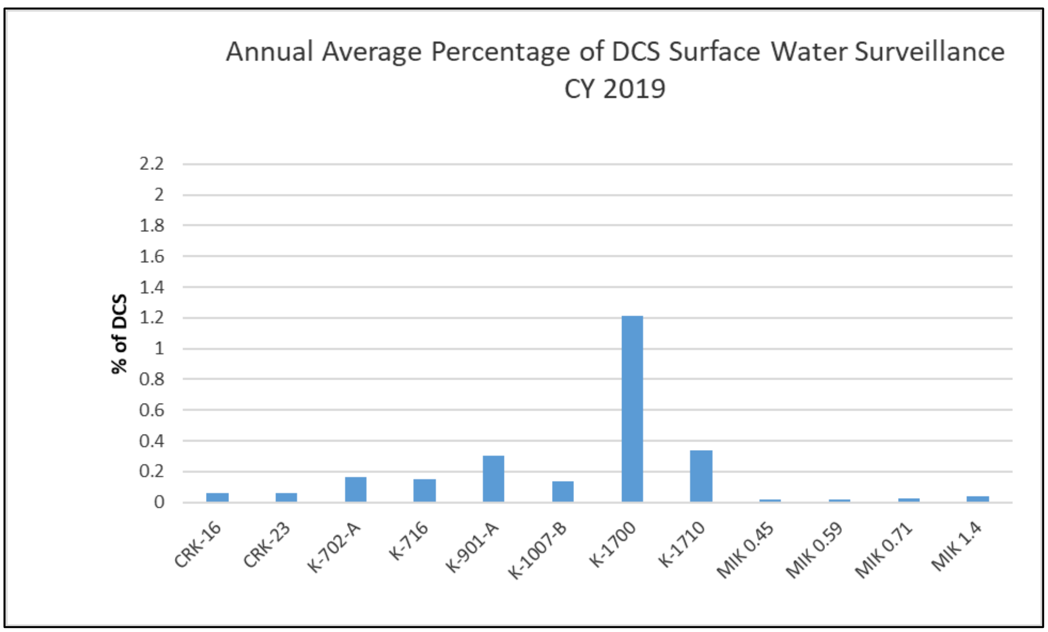


Acronyms:
CRK = Clinch River kilometer
MIK = Mitchell Branch kilometer

Figure 3.25. 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 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 2019, 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 3.26). At K-1700, the annual average SOF was 0.012 (1.2 percent). At MIKs 0.45, 0.59, and 0.71, quarterly monitoring is conducted for ^{99}Tc only.

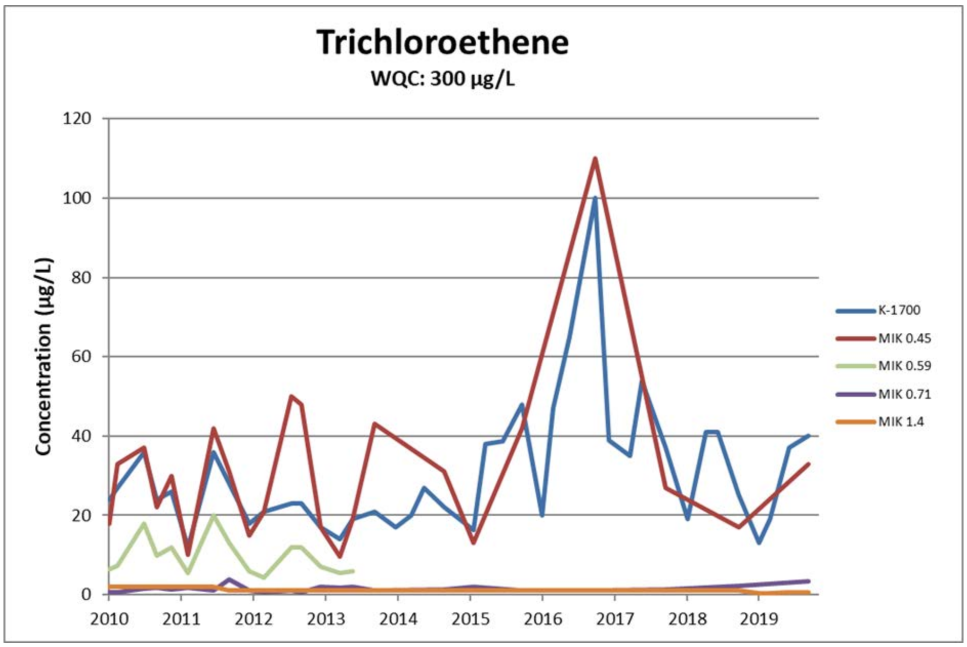
Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2019, 1756 analytical results and 236 field readings were collected under the EMP. The vast majority of these results were well within the appropriate AWQC. There were four exceptions in 2019. During the first quarter, cadmium was measured at concentrations exceeding the AWQC at both K-1700 (a result of 0.56 µg/L) and MIK 0.59 (a result of 0.59 µg/L). Since the AWQC for cadmium is dependent upon the hardness of the water in the receiving stream, the AWQC at K-1700 was 0.36 µg/l and at MIK 0.59 it was 0.29 µg/L. During the second quarter of 2019, there was an exceedance of the AWQC for mercury. At K-1710, which monitors Poplar Creek, mercury was measured at 64.8 ng/L, which exceeds the AWQC for mercury of 51 ng/L. During the third quarter, there was one failure to meet the minimum level of dissolved oxygen (5.0 mg/L). Dissolved oxygen levels were measured at 3.6 mg/L at K-901-A. 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.



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

Figure 3.26. Annual average percentage of derived concentration standards at surface water monitoring locations, 2019

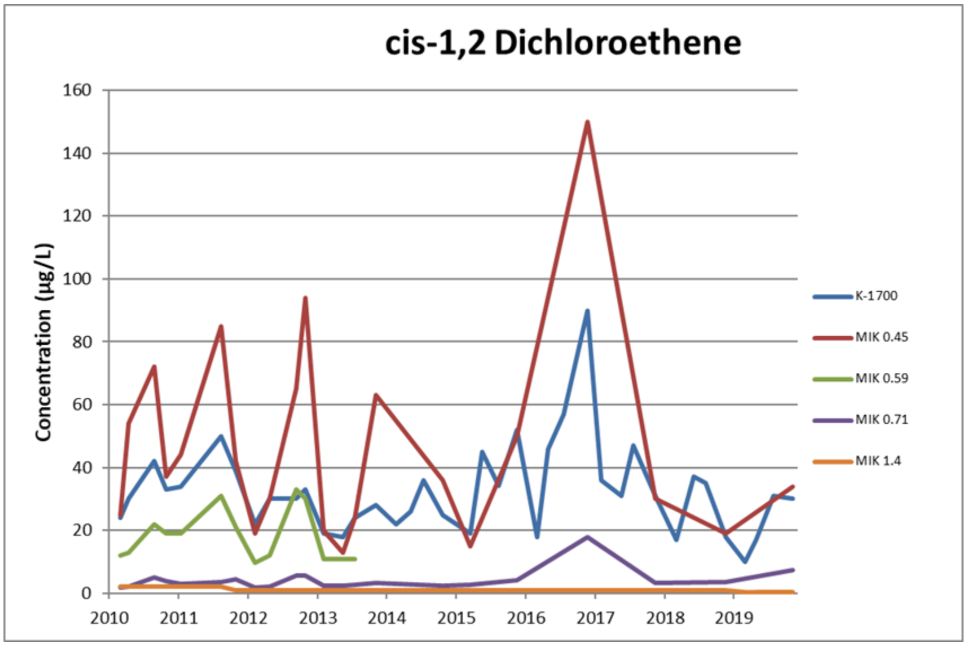
Figures 3.27 and 3.28 illustrate the concentrations of TCE (trichloroethene) and cis-1,2-dichloroethene (cis-1,2-DCE) from the Mitchell Branch monitoring locations., Although VOCs are routinely detected at K-1700 and MIK 0.45, they are rarely detected at other surface water surveillance locations across 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.



Acronym:
MIK = Mitchell Branch kilometer

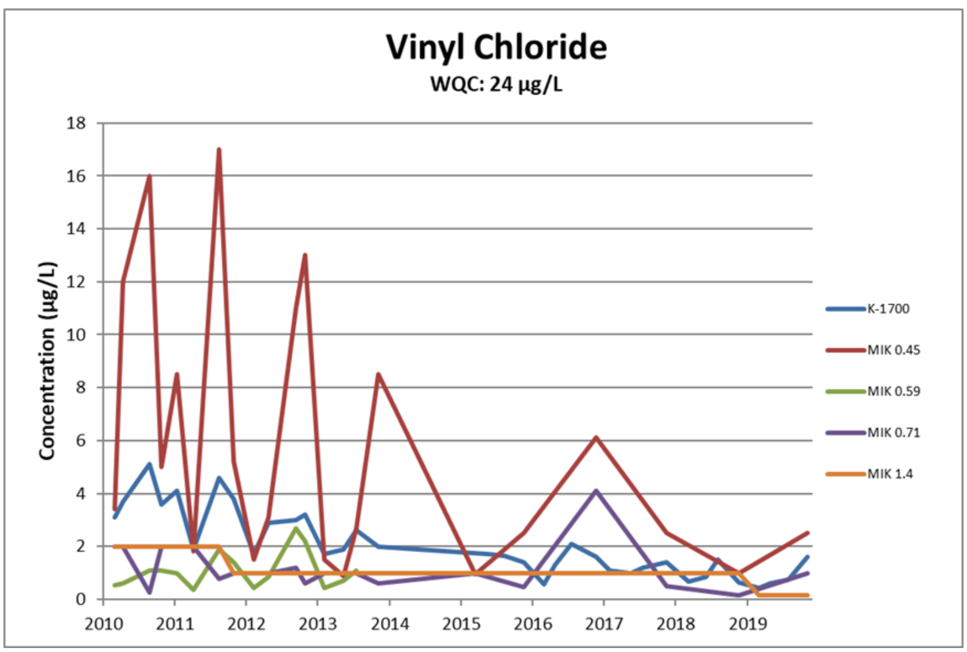
Figure 3.27. Trichloroethene concentrations in Mitchell Branch

An investigation into the cause of the spike in the reported results was inconclusive. 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 (Figure 3.29). 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; however, these compounds have generally not been detected in storm water during the monitoring of network discharges. Therefore, it appears that the primary source of these compounds is contaminated groundwater.



Acronym:
MIK = Mitchell Branch kilometer

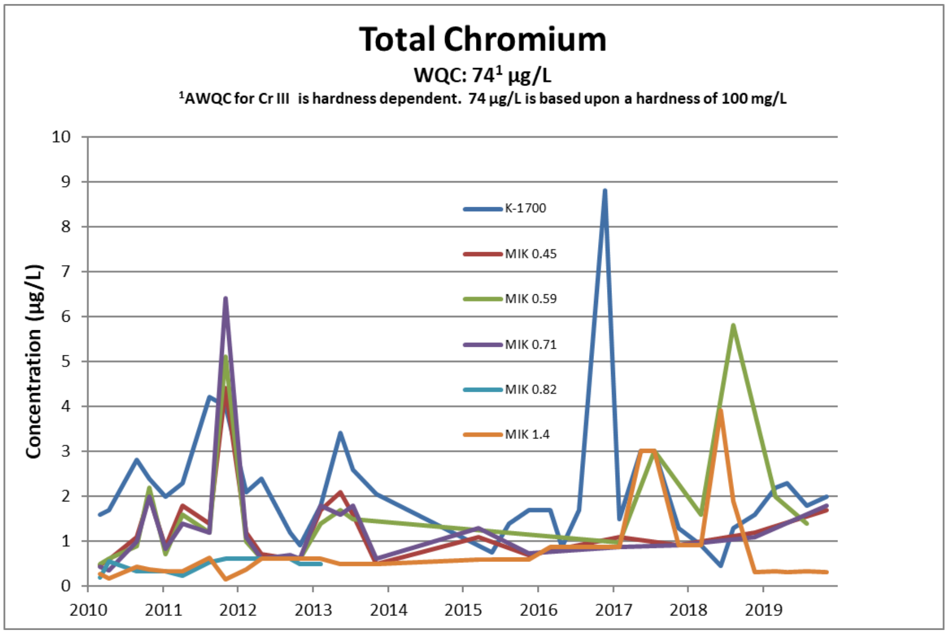
Figure 3.28. Concentrations of cis-1,2-dichloroethene in Mitchell Branch



Acronym:
MIK = Mitchell Branch kilometer

Figure 3.29. Vinyl chloride concentrations in Mitchell Branch

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 3.30). In 2019, hexavalent chromium levels in Mitchell Branch were all below the sample quantitation limit.



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 3.30. Total chromium concentrations in Mitchell Branch

3.6.5 Groundwater Monitoring at ETTP

During FY 2019, the US Department of Energy (DOE) prepared the *East Tennessee Technology Park Main Plant Groundwater Feasibility Study, Oak Ridge, Tennessee* (MPFS; DOE/OR/01-2835&D1). This report included a synthesis of existing groundwater data augmented with the data derived from installation of 31 new groundwater monitoring wells, as well as incorporation of opportunistic groundwater samples collected in conjunction with ETTP Zone 2 soil characterization activities. Main Plant area groundwater plumes were updated and revised based on the compilation of all recent groundwater data. The draft MPFS includes plume maps for individual constituents of concern identified in the updated human health risk assessment. Through the ongoing Zone 2 soil investigations and the additional well installations conducted in support of MPFS preparation, additional areas of groundwater contamination and additional groundwater plume areas were identified. The revised sitewide contaminant plume map incorporates the sum of chlorinated volatile organic compound and ^{99}Tc plumes from the MPFS. The interested reader is referred to the MPFS document for additional, detailed information.

In recognition of the emergence during 2019 of polyfluoroalkyl substances (PFAS) compounds as potential contaminants of concern, the Water Resources Restoration Program (WRRP) started planning for sampling and analysis of these compounds at ETTP. Sample planning included review of previous analytical results obtained in 2017 from groundwater and spring sampling in the vicinity of former waste burn areas. Those data indicated presence of very low PFAS concentrations mostly less than 10 ng/L when concentrations were above detection limits. Additional sampling to assess the presence and significance of PFAS will occur during FY 2020.

The principal groundwater contaminants at ETTP are chlorinated VOCs (primarily TCE and its degradation products such as 1,2-DCE 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 UF_6, which was contained inside process equipment and depleted UF_6, was returned to storage cylinders where it reverted to solid form upon cooling. 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 ORR. Chromium was used in the hexavalent form in the recirculating cooling water and fire protection water systems to prevent corrosion of pipes. Leaks of pipes that circulated the corrosion inhibiting additives were common and in some cases were of quite large volume. In a localized area 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 AWQC (see Section 3.6.12 for additional information). 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 sources may be either naturally occurring materials or materials used in general industrial and structural processes.

In the 2020 Remediation Effectiveness Report, DOE has compiled the analytical data for groundwater contaminants in wells included in the routine WRRP monitoring program at ETTP to evaluate contaminant concentrations with respect to the EPA National Primary Drinking Water Regulations maximum contaminant levels (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. Two screening levels were used—the full MCL/MCL-DC concentrations and an arbitrary value of 80 percent of the MCL/MCL-DC. The 80-percent level was selected to indicate the presence of contaminants that may be approaching the MCL/MCL-DC in the event that increasing concentration trends are occurring. Mann-Kendall (M-K) trend evaluations were conducted for data compartmentalized into a maximum time period of 10 years for longer duration trend evaluation and a secondary time period of 5 years to evaluate more recent trends. In the M-K trend evaluation it is desirable to have at least 10 data results per analyte to allow the method to attain a 90-percent confidence interval on the trend identification.

Updated VOC plumes are based on the sum of chlorinated VOCs measured in the FY 2019 WRRP groundwater monitoring and data obtained in preparation of the MPFS.

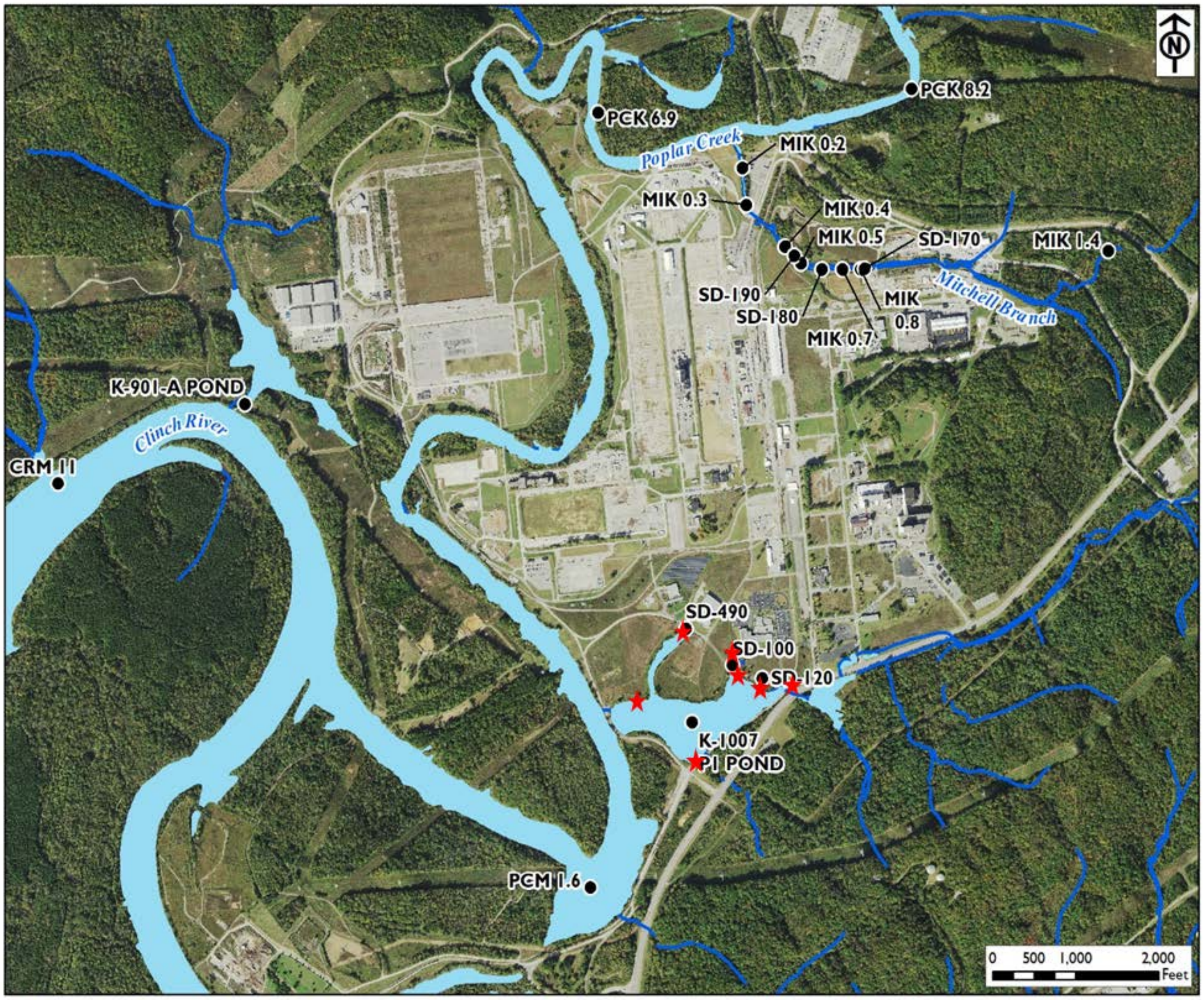
VOC concentrations in wells monitored downgradient of K-1070-C/D show that a broad area is affected by releases from the past disposal of liquid VOCs at G-Pit. While concentrations along one portion of the affected area continue to decrease, there remains an adjacent area with very high concentrations. The persistent, high concentrations of these VOCs suggest an ongoing contaminant source release from residual contamination near and beneath G-Pit.

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

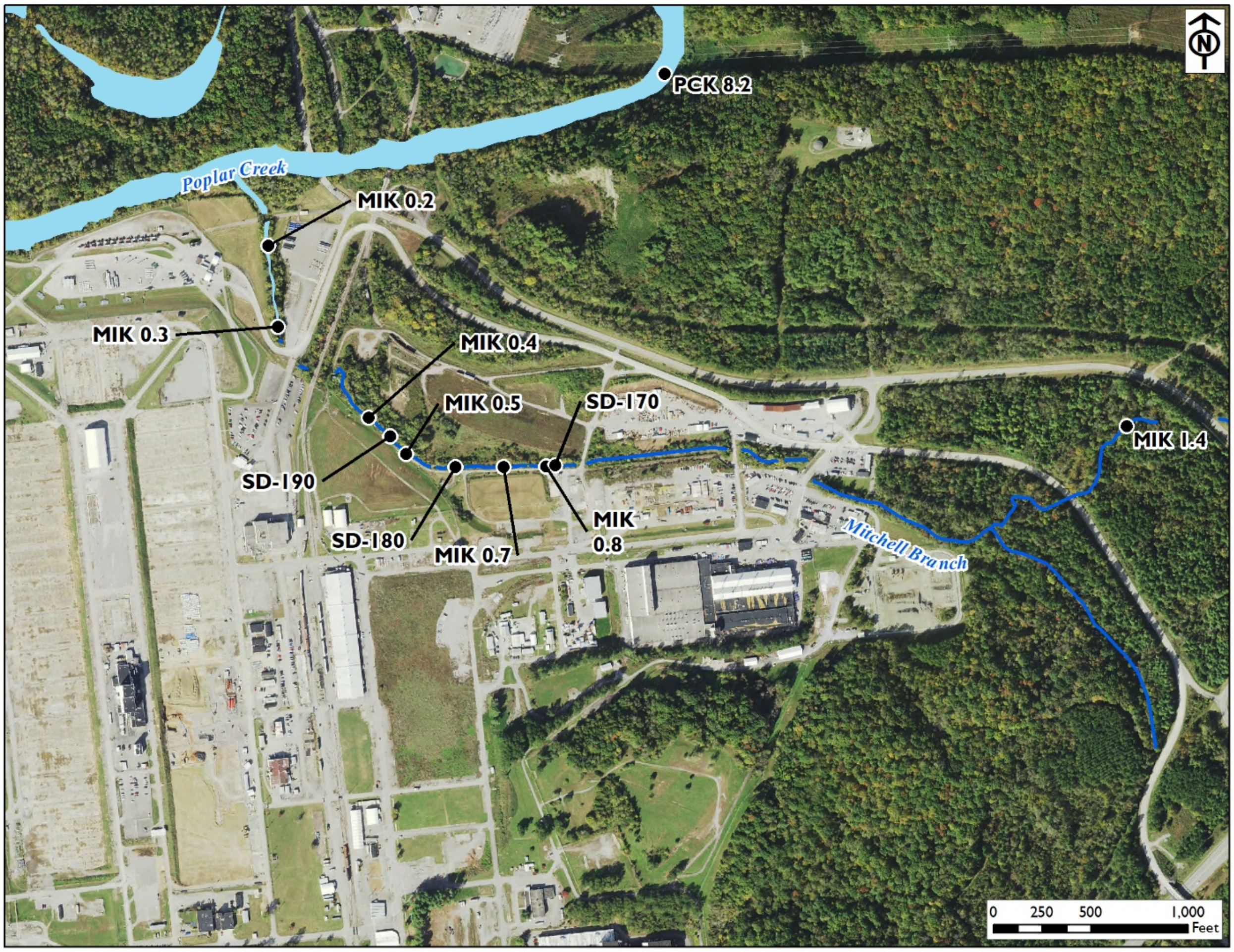
The ETTP BMAP consists of two tasks designed to evaluate the effects of ETTP legacy operations on the local environment, identify areas where abatement measures would be most effective, and test the efficacy of the measures. The results from this program will support future CERCLA cleanup actions. These tasks are: (1) bioaccumulation studies, and (2) instream monitoring of biological communities. Figure 3.31 shows the major water bodies at ETTP and Figure 3.32 shows the BMAP monitoring locations along Mitchell Branch.



Note:
Red stars indicate clam sampling locations in and around the K-1007-P1 Pond in 2019.

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

Figure 3.31. Water bodies at the East Tennessee Technology Park



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

Figure 3.32. Major storm water outfalls and biological monitoring locations on 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 2019 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.

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.

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 2019, 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 13–June 10, 2019). Two clam baskets were placed at each site with 10 clams in each basket.

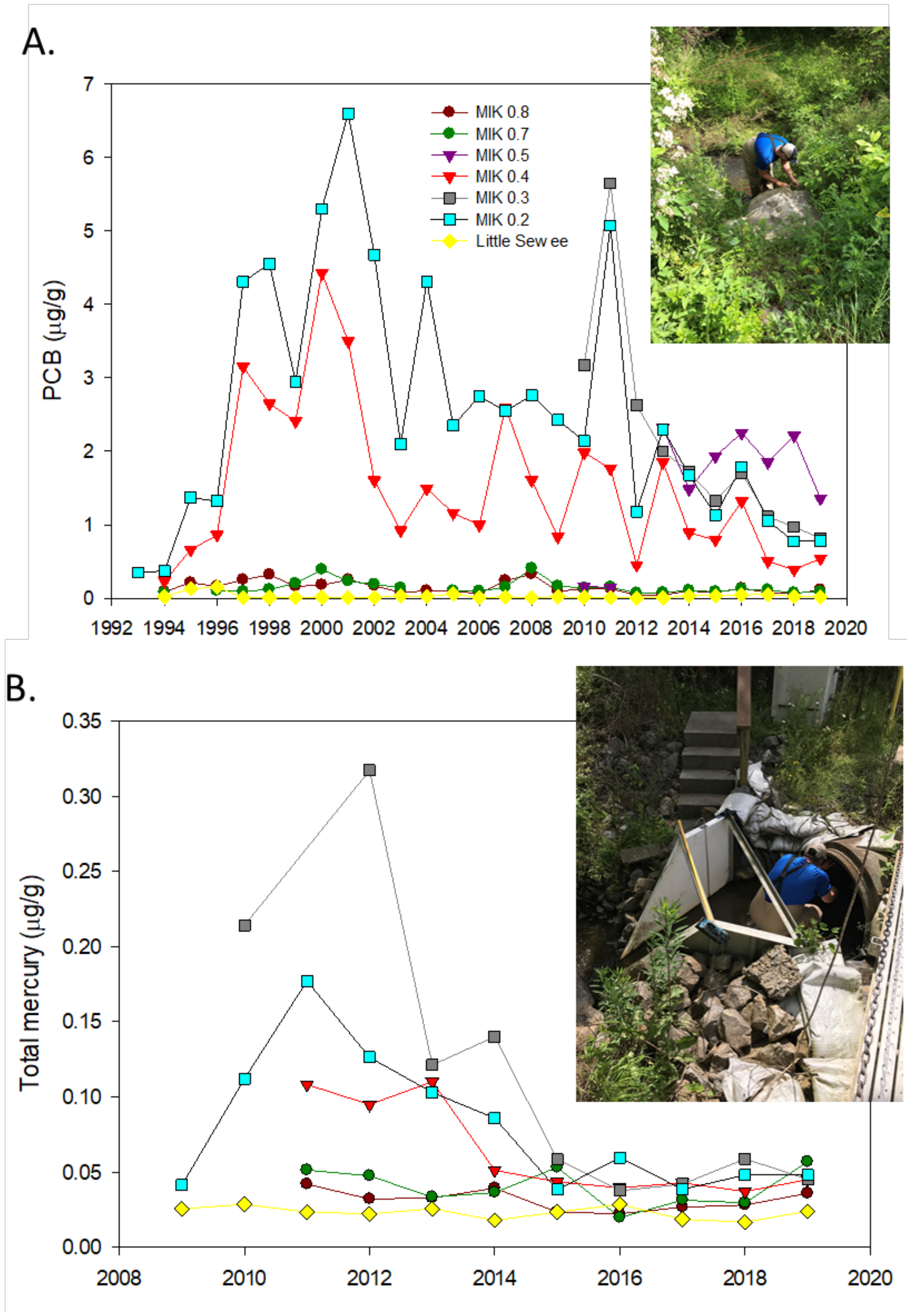
Because these animals are sedentary filter feeders, they accumulate contaminants that are present in the water and in suspended particles at a given site. They are useful indicators of the bioavailable (and therefore potentially toxic) portion of contaminants that enter the environment at a given location, 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).

Mitchell Branch

Figure 3.33 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 2019 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. The only exception to this recent trend was a slight increase at MIK 0.5 in 2018 (from 1.8 to 2.2 µg/g); however, in 2019 concentrations at this site decreased from 2.2 µg/g to 1.36 µg/g. PCB concentrations in the upper portion of Mitchell Branch were similar to previous years’ concentrations and were slightly elevated (0.11 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 fluctuate significantly, with concentrations 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. Research at ORNL has found changes in aqueous Hg concentrations between day and night, for example. 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 MeHg 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.

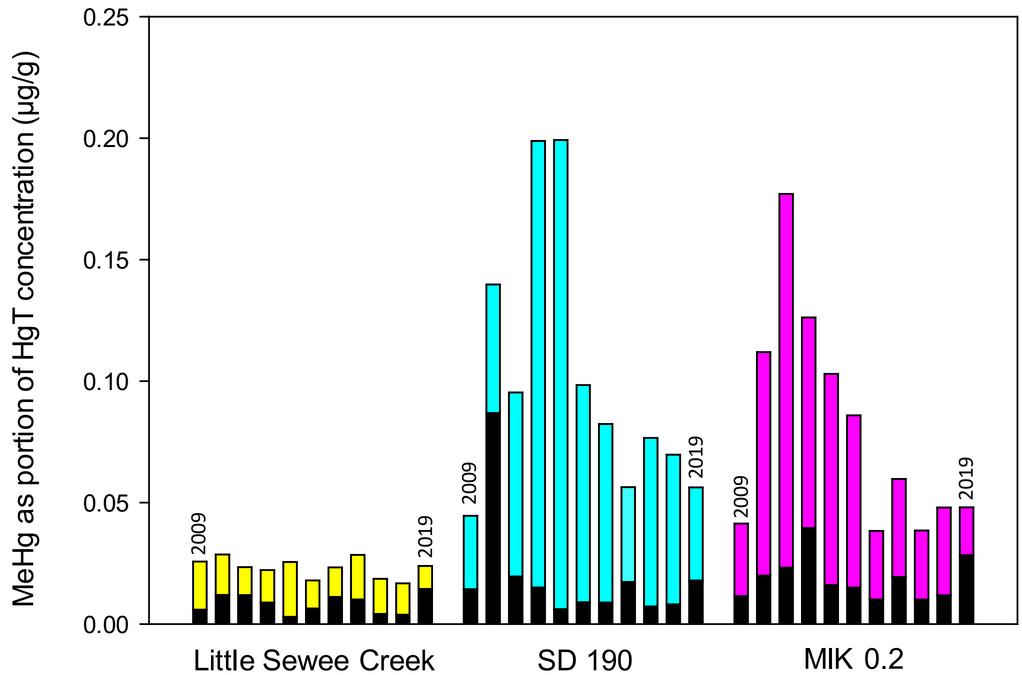


Notes:
1. N = 2 composites of 10 clams each per year.
2. Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Meigs County, Tennessee).
3. Figure A shows total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.

Acronyms:
MIK = Mitchell Branch kilometer
PCB = polychlorinated biphenyl

Figure 3.33. Mean total PCB (A: µg/g, wet wt; 1993–2019) and mercury (B: µg/g wet wt; 2009–2019) concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch

Mercury concentrations in clams deployed in Mitchell Branch in 2019 were similar to concentrations seen in 2018. In 2019, concentrations throughout Mitchell Branch were only slightly higher than at the reference site. Mercury concentrations in clams deployed at the K-1007-P1 and K-901-A ponds were again comparable to reference site concentrations. Within the Mitchell Branch system, the highest Hg concentrations were seen in clams deployed at SD 180 (0.20 µg/g). Clams deployed at two storm drains on the K-1007-P1 Pond had Hg concentrations similar to those of the reference site. Unlike in fish tissue, MeHg generally makes up a small proportion of Hg_T found in soft tissues of clams (Figure 3.34). Although MeHg concentrations in clams remained low in 2019, they were either comparable to or slightly higher than concentrations in 2018.

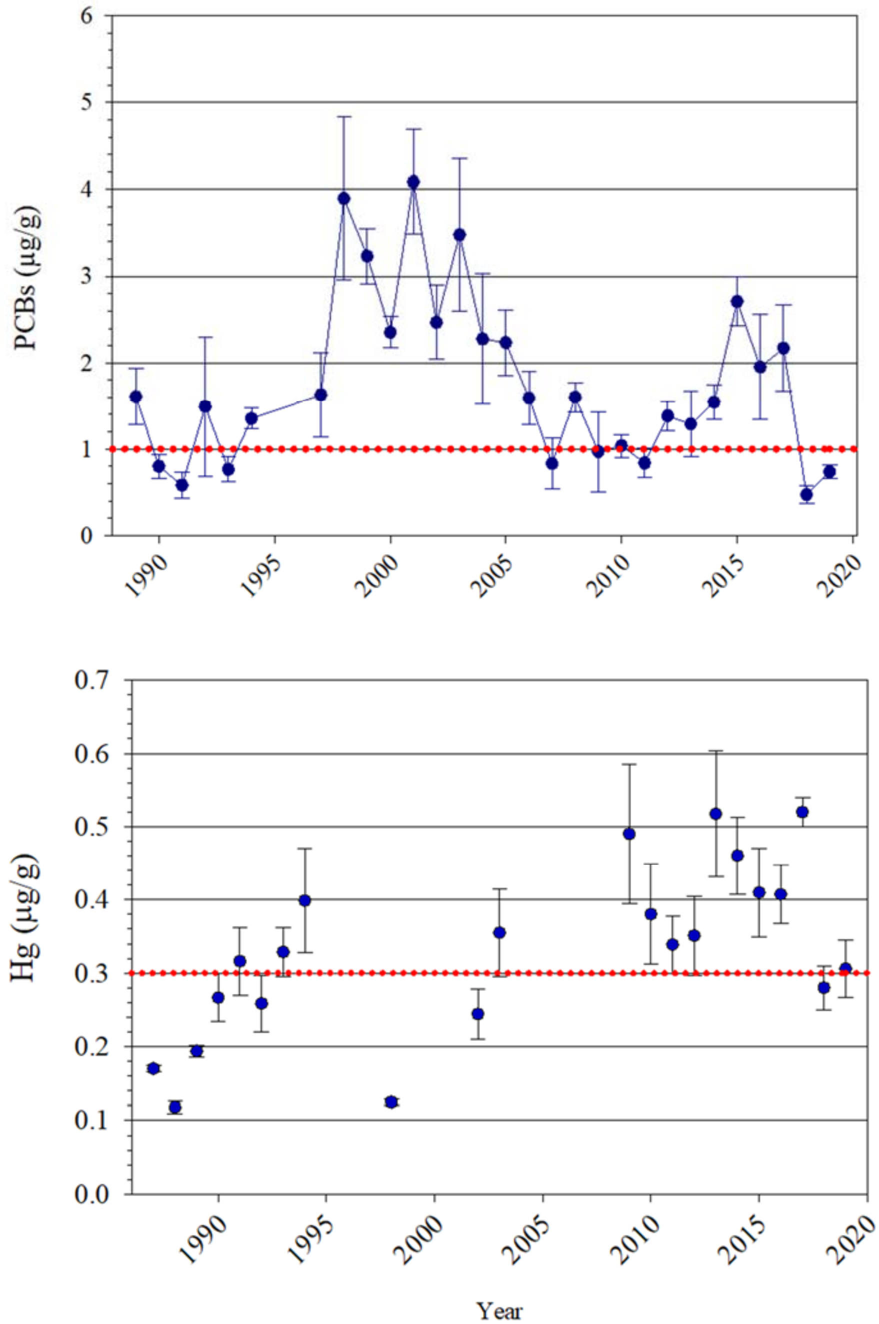


Notes:
1. N = 2 composites of 10 clams each per year.
2. Shown in yellow are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee).
3. Black bars denote MeHg concentrations, where the total height of bars (color and black band) represents Hg_T concentration.

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

Figure 3.34. Methylmercury as a portion of total mercury concentrations in the soft tissues of caged Asiatic clams deployed in Mitchell Branch (µg/g wet wt; 2009–2019)

Figure 3.35 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 2019 (0.74 ± 0.08 µg/g) were slightly higher than those seen in 2018 (0.48 ± 0.10 µg/g) but remained among the lowest concentrations reported for the past 30 years at this site (Figure 3.34). 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 2019, the mean PCB concentration in sunfish fillets was below this limit. While the observed fish tissue concentrations in Mitchell Branch are lower than they have historically been, they are still two to three orders of magnitude higher than concentrations seen in the same species at the Hinds Creek reference site in Anderson County.



Notes:
1. 1989–2019 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:

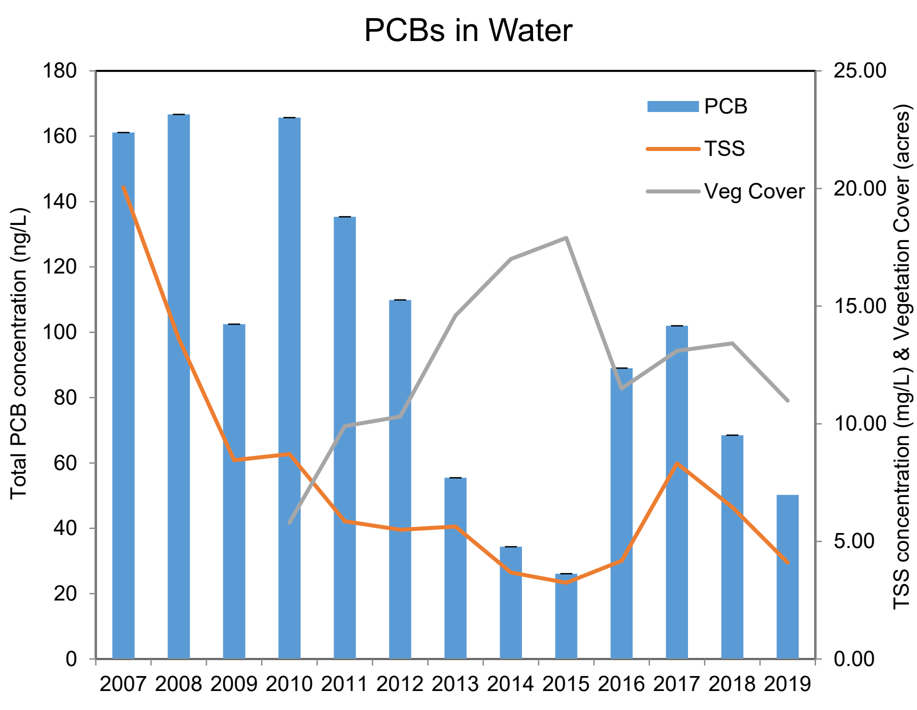
Hg = mercury
MeHg = methylmercury
MIK = Mitchell Branch kilometer
PCB = polychlorinated biphenyl

Figure 3.35. Mean PCB (top panel) and mercury (bottom panel) concentrations (µg/g, wet wt) in redbreast sunfish fillets in Mitchell Branch (MIK 0.2)

Total mercury has been monitored more sporadically in redbreast sunfish fillets at MIK 0.2. Figure 3.35 shows long-term trends in Hg_T concentrations (µg/g) in these fish. A rapid increase in fillet Hg_T 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, Hg_T concentrations at MIK 0.2 have been oscillating around the EPA's recommended AWQC for the past several years. Similar to the trends seen for PCBs, mean mercury concentrations in redbreast at this site increased slightly in 2019, averaging 0.31 $\pm$ 0.04 µg/g, just above the mercury tissue criterion.

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 prior to 2009 remediation activities (e.g., 50 ng/L in 2019 compared to 161 ng/L in 2007; Figure 3.36).Concentrations in 2019 were slightly lower than they have been for the past three years, but were above the low of 26 µg/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).



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 TSS = total suspended solids

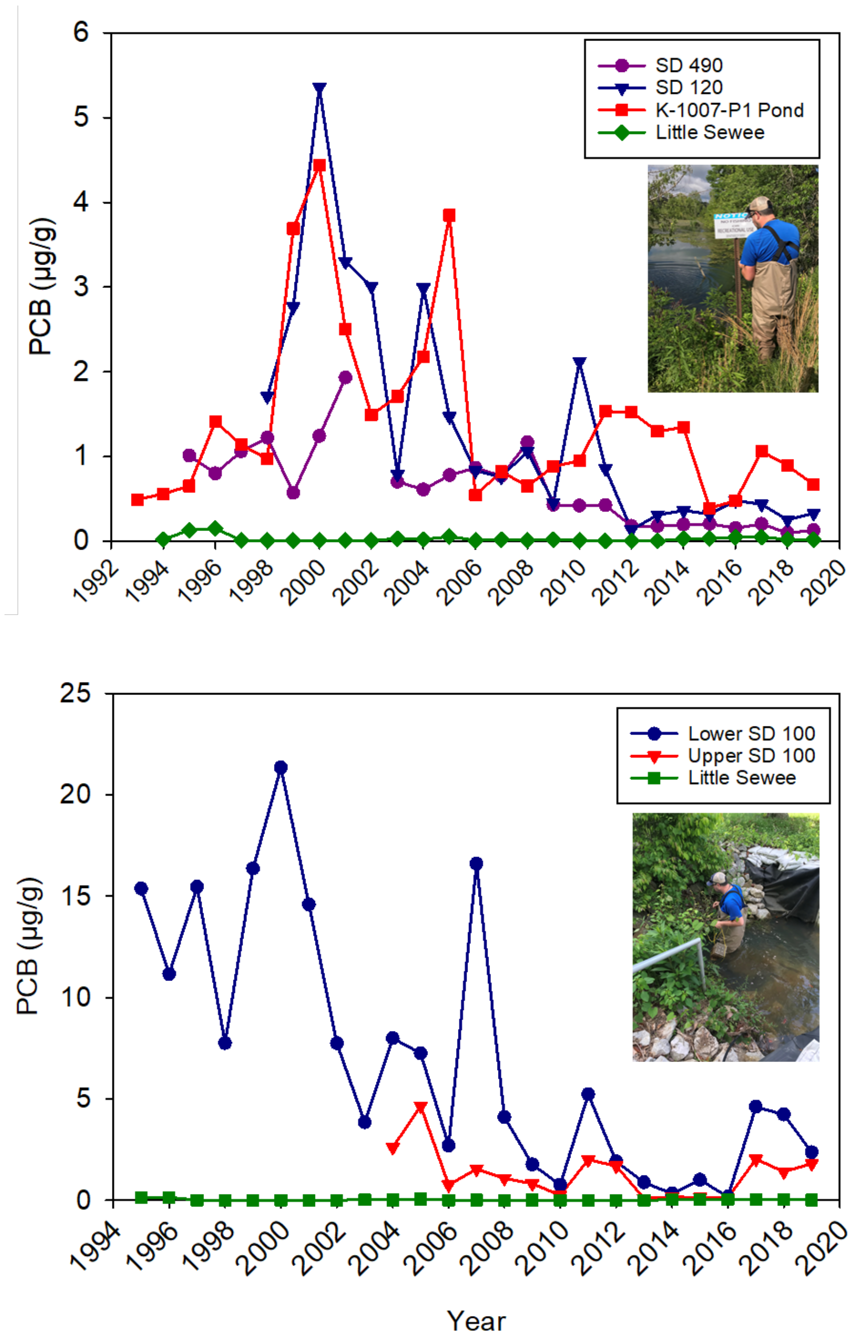
Figure 3.36. Mean aqueous total PCB concentrations, total suspended solids, and vegetation cover in the K-1007-P1 Pond, 2007–2019

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, and remained elevated with respect to the reference site in 2019 (Figure 3.37). PCB concentrations in clams placed at the K-1007-P1 outfall were also higher the past three years but were comparable to concentrations seen just after remediation actions in this pond (Figure 3.38).

To understand reasons for the fluctuations seen in PCB concentrations in the K-1007-P1 Pond, caged clams were deployed in two new locations in 2019, in outfalls serving the pond. Mean PCB concentrations in clams deployed at Outfall 124 on the northeast side of the pond were low and were comparable to concentrations seen at the reference site (0.04 µg/g). PCB concentrations in clams deployed in an unnamed outfall on the southwest side of the pond (0.94 µg/g) were higher than those deployed at the routine monitoring site in this pond (the K-1007-P1 outfall located on the northwest side of the pond), which averaged 0.67 µg/g in 2019 (Figure 3.34). It is unknown whether there are source(s) of PCB inputs on the south side of the pond or whether water column conditions at this location led to elevated concentrations seen in clams at this new location.

Similar trends have been observed in fish tissue PCB concentrations in the K-1007-P1 Pond. 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 2019 to assess the ecological and human health risks associated with PCB contamination in this pond.

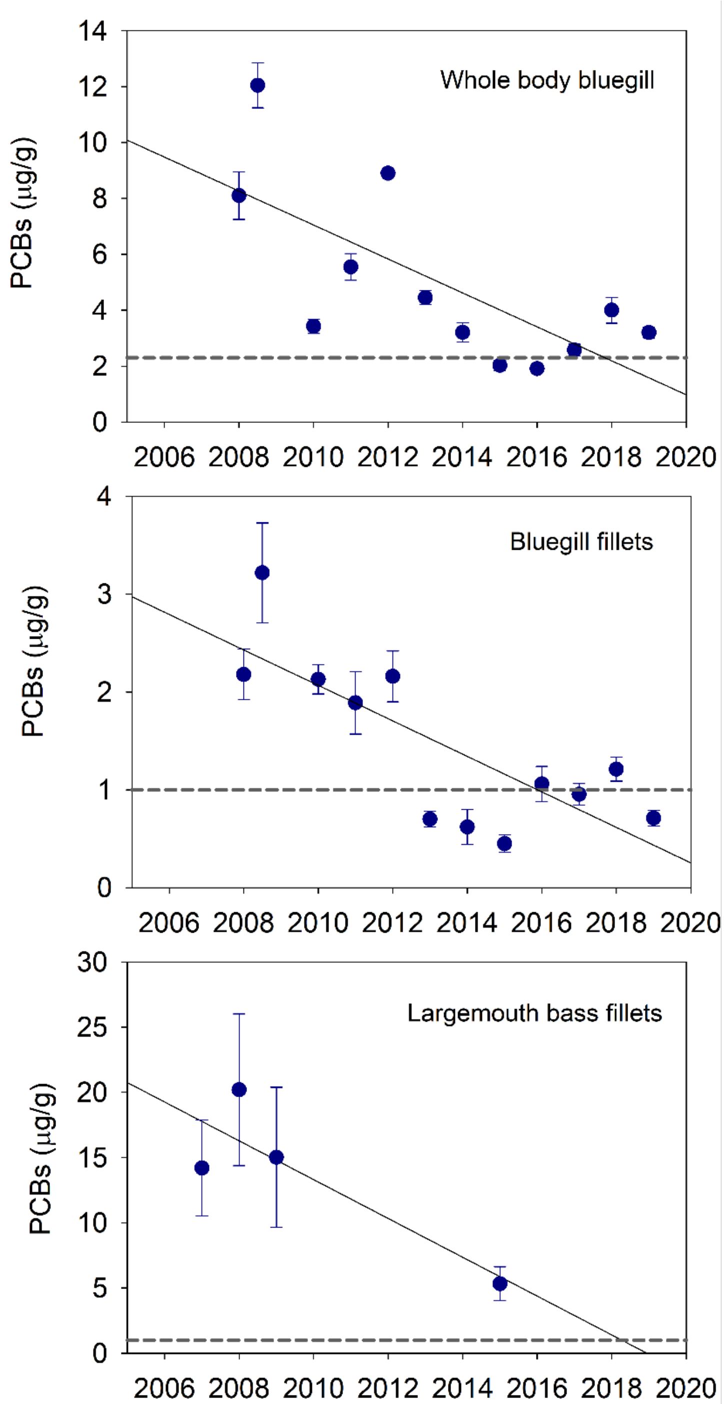
Average PCB concentrations in fish fillets and whole-body composites have decreased significantly over the past 10 years since remediation activities, with significant fluctuations. Concentrations were lowest in the 2013-2015 time period but have slightly increased over the past three years. The mean concentration in whole body composites of bluegill collected from the K-1007-P1 Holding Pond was lower in 2019 (3.20µg/g) than in 2018 (4.00 µg/g), remaining above the target concentration for whole body fish in this pond (2.3 µg/g) (Table 3.29, Figures 3.38 and 3.39). The mean concentration (0.71 µg/g) in bluegill fillets in 2019 decreased, such that it fell below the remediation goal of 1 µg/g. The interannual fluctuations in PCB concentrations could be due to water quality changes that have taken place in this pond, (e.g., higher TSS, PCB inputs, fluctuations in vegetation cover; Figures 3.32, 3.34, and 3.35). 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. 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 show a clam basket in a storm drain, and Little Sewee Creek, lower graph photos show placement of clam cages in Upper SD-100 (upper photo) and Lower SD-100 locations.

Acronyms:
PCB = polychlorinated biphenyl
SD = storm drain

Figure 3.37. 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), 1993–2019

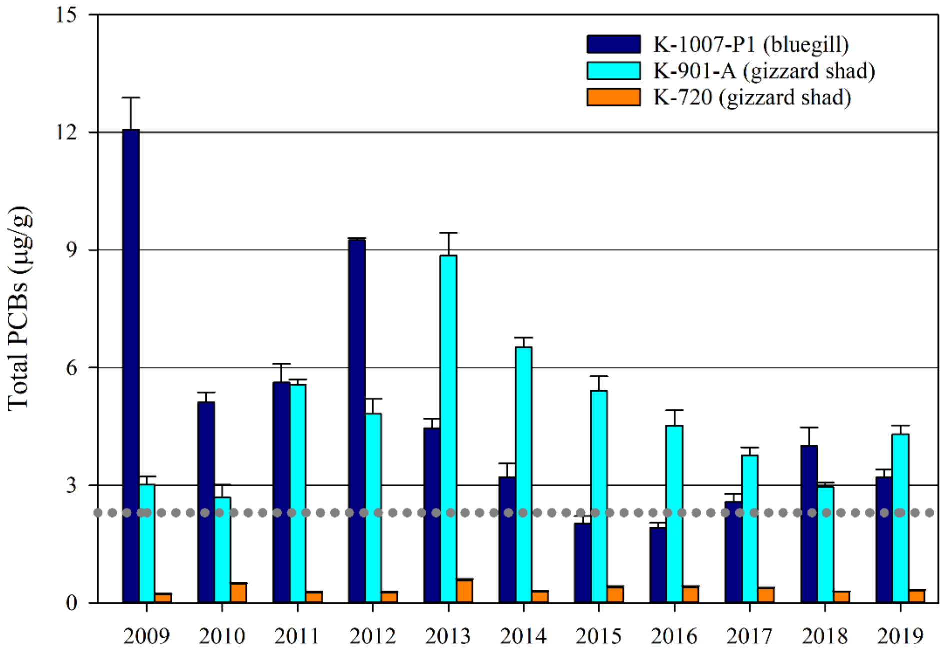


Notes:

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 3.38. Mean PCB concentrations (µg/g, wet wt) in fish from the K-1007-P1 Pond, 2007–2019



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.

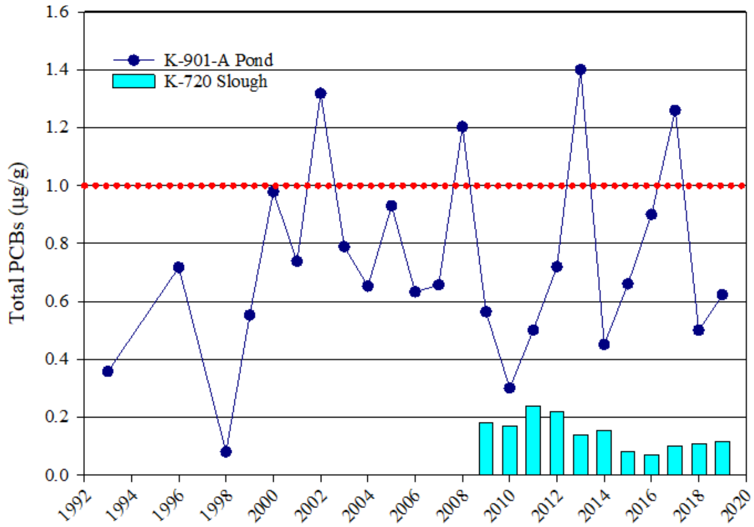
Acronym:
PCB = polychlorinated biphenyl

Figure 3.39. Mean (+ 1 standard error) total PCB concentrations (µg/g, wet wt) in whole body fish from K-1007-P1 Pond, K-901-A Holding Pond, and K-720 Slough, 2009–2019

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.

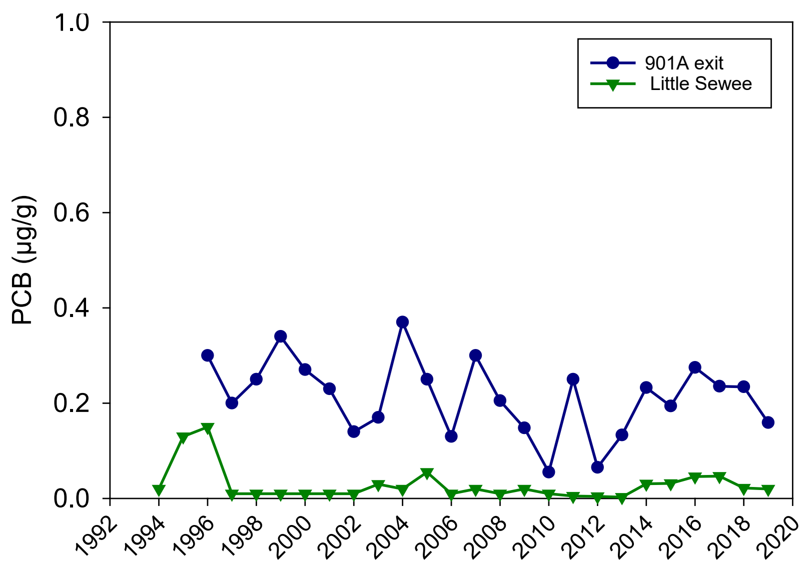
At the K-901-A Holding Pond, PCB concentrations in largemouth bass have fluctuated annually, but in 2019 were below the target concentration set for the K-1007-P1 Pond of 1 µg/g total PCBs (0.62 µg/g) (Figure 3.40). Mean PCB concentrations in carp collected from the K-901-A Holding Pond were just above this target concentration (1.22 µg/g). 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 (4.30 µg/g) than the fillets of bass and carp, and were higher than the concentrations seen in this species in the past two years, remaining above the target concentration set for the K-1007-P1 Holding Pond for whole body fish (2.3 µg/g) (Figure 3.39). 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 2019 (0.16 µg/g) to concentrations seen in 2018 (Figure 3.41).



Notes:
1. Mean PCBs (± 1 SE) in largemouth bass fillets, 1993–2019 (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 3.40. Mean total PCB concentrations in largemouth bass from the K-901-A Pond and the K-720 Slough



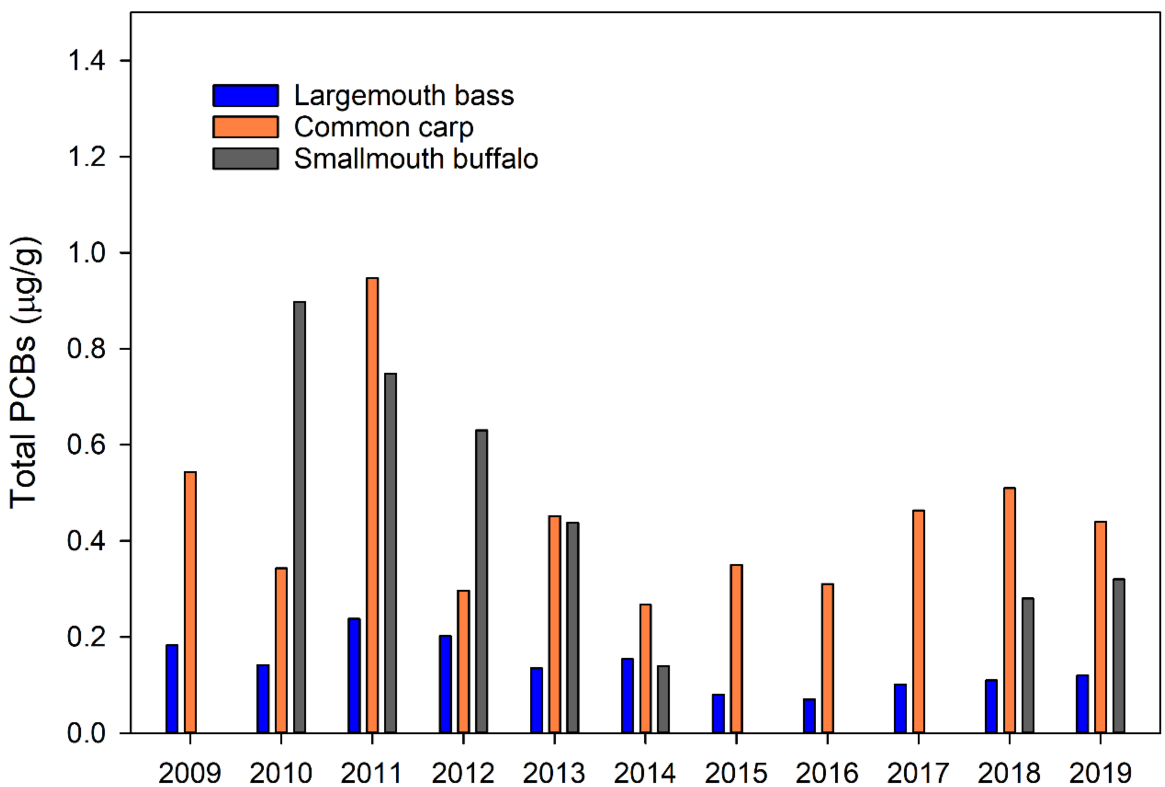
Notes:
1. Total PCBs defined as the sum of Aroclors 1248, 1254, and 1260.
2. N = 2 composites of 10 clams each per year.
3. Shown in green are data for clams collected from the reference site, Little Sewee Creek (Sweetwater, Tennessee).

Acronym:
PCB = polychlorinated biphenyl

Figure 3.41. Mean total PCB (µg/g, wet wt; 1993–2019) concentrations in the soft tissues of caged Asiatic clams deployed in the K-901-A Pond for a 4-week period

K-720 Slough

Routine bioaccumulation monitoring in the K-720 Slough began in 2009. 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 3.42 shows the temporal trends in fish fillet concentrations in the slough. In 2019, 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 3.29). PCB concentrations in largemouth bass collected from the K-720 Slough were significantly lower than those in the other monitored ponds, averaging 0.12 µg/g in 2019. Concentrations in carp and smallmouth buffalo collected from the slough were higher than concentrations in bass, averaging 0.44 µg/g and 0.36 µg/g, respectively. 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 0.32 µg/g in 2019.



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 3.42. Mean total PCB (µg/g, wet wt; 2009–2019) concentrations in the fillets of largemouth bass, common carp, and smallmouth buffalo collected from the K-720 Slough

Table 3.29. Average concentrations (µg/g, wet wt) of total PCBs (Aroclors 1248, 1254, and 1260) in fillets and whole-body composites of fish collected in 2019 near the East Tennessee Technology Park.

Site	Species	Sample type	Sample size (n)	Total PCBs (mean ± SE)	Range of PCB values	No. > target (PCBs)/n
K-1007-P1 Pond	Bluegill	Fillets	20	0.71 ± 0.08	0.24–1.61	3/20
		Whole-body composites	6	3.20 ± 0.19	2.61–3.72	6/6
K-901-A Pond	Largemouth bass	Fillets	4	0.62 ± 0.13	0.36–0.92	0/4
	Common carp	Fillets	16	1.22 ± 0.11	0.67–2.23	10/16
	Bluegill	Fillets	20	0.43 ± 0.08	0.15–1.73	1/20
		Whole-body composites	6	1.29 ± 0.08	1.03–1.56	0/6
	Gizzard shad	Whole-body composites	6	4.30 ± 0.22	3.62–5.03	6/6
K-720 Slough	Largemouth bass	Fillets	6	0.12 ± 0.03	0.06–0.21	0/6
	Smallmouth buffalo	Fillets	9	0.36 ± 0.10	0.06–0.84	0/9
	Common carp	Fillets	5	0.44 ± 0.09	0.11–0.67	0/5
	Gizzard shad	Whole-body composites	6	0.32 ± 0.01	0.27–0.36	0/6
CRM 11.0	Bluegill	Whole-body composites	6	0.07 ± 0.002	0.06–0.08	0/6
	Gizzard shad	Whole-body composites	6	0.20 ± 0.05	0.13–0.45	0/6
PCM 1.0	Bluegill	Whole-body composites	6	0.19 ± 0.01	0.14–0.22	0/6
	Gizzard shad	Whole-body composites	6	0.29 ± 0.03	0.22–0.30	0/6

Notes:

1. Values are mean concentrations (µg/g) ± 1 SE.
2. Each whole body composite sample is composed of 10 individual fish.
3. 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
No. = number
PCB = polychlorinated biphenyl
PCM = Poplar Creek mile
SE = standard error

3.7.2 Task 2: Instream Benthic Macroinvertebrate Communities

Benthic macroinvertebrate communities in Mitchell Branch are sampled using ORNL and TDEC protocols (Figures 3.43 and 3.44). 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 3.43. Collecting an invertebrate sample using Oak Ridge National Laboratory Biological Monitoring and Abatement Program protocols

Figure 3.44. Sampling for benthic macroinvertebrates with TDEC protocols

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 2019 following ORNL BMAP quantitative sampling protocols and samples collected annually (August/September) with TDEC semi-quantitative sampling protocols for estimating the Tennessee Stream Biotic Index and Habitat Biotic Index (TDEC 2011; TDEC 2017). TDEC protocol guidance was updated in August 2017 and the most recent 2017 guidance was used for the 2018 and 2019 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 3.30). 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.

Table 3.30. Stream sites included in the comparison between Mitchell Branch and other reference sites on the Oak Ridge Reservation (ORR)

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
WBK = Walker Branch
WRRP = Water Resources Restoration Program

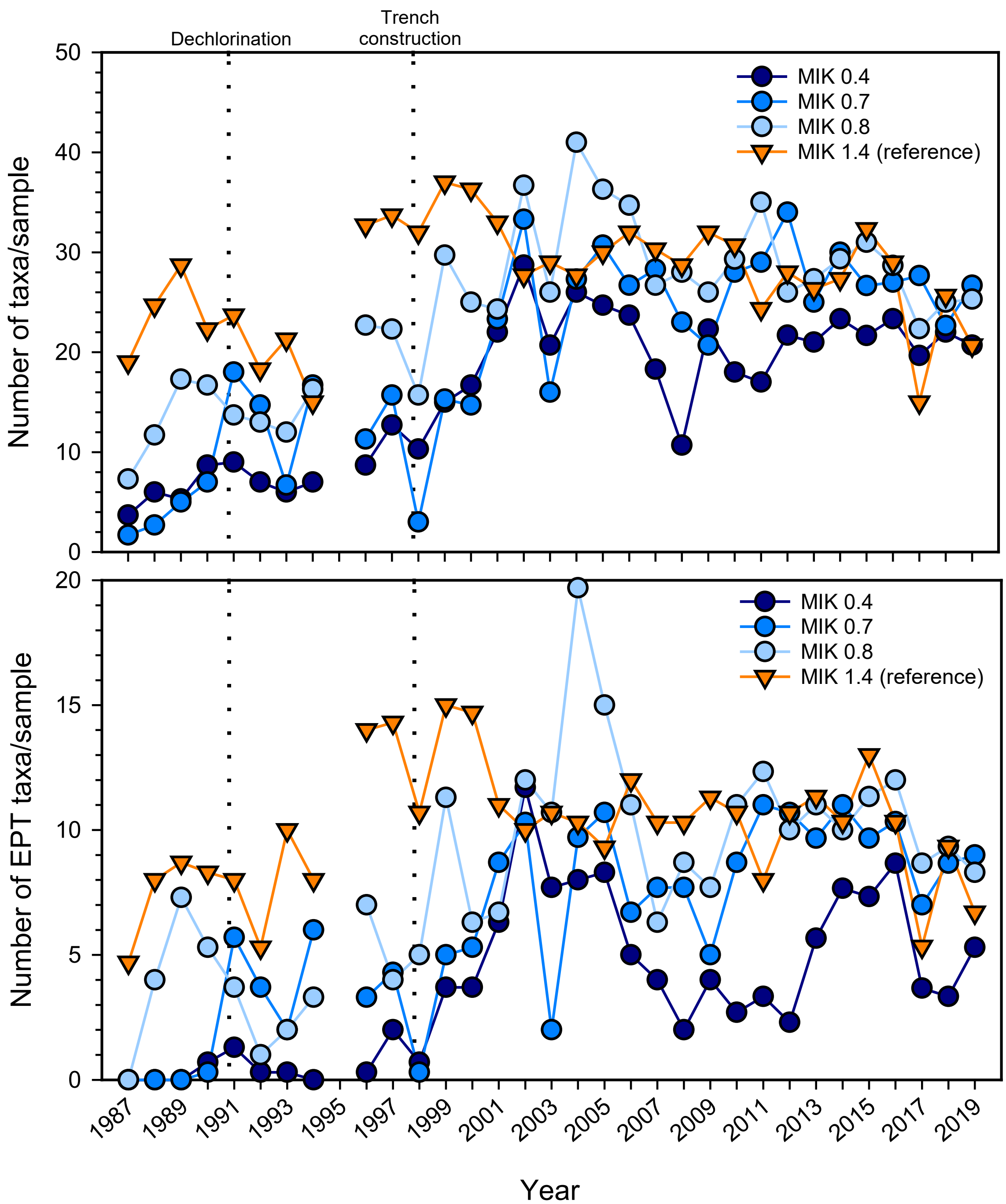
Mitchell Branch—ORNL and TDEC Protocols

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 (1986–2019) in all Mitchell Branch sites (Figure 3.45). 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 3.45). Total taxa richness and EPT taxa richness have been fairly consistent throughout the measurement period in the reference site, MIK 1.4 (Figure 3.46). In April 2019, total taxa richness and EPT taxa richness were highest at MIK 0.8 and lowest in MIK 0.4 (Figure 3.45). EPT taxa richness patterns among sites in 2019 diverted 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 3.45). In April 2019, EPT taxa richness was lowest in both MIK 1.4 and MIK 0.4 and higher at MIK 0.7 and MIK 0.8 (Figure 3.45).

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 2019, which is a pattern that has been observed in most years since monitoring began in 1987 (Figure 3.46). 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, 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 3.46). The percent of pollution-tolerant taxa at MIK 1.4 in 2019 was one of the highest values seen since monitoring began and only in 1988 and 1992 were these values higher (Figure 3.46). 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 2019 rated the invertebrate community as passing biocriteria guidelines at MIK 1.4 and MIK 0.7 while TMI scores at MIK 0.4 and MIK 0.8 fell below these guidelines (Figure 3.47). TMI scores in 2019 improved at all sites over 2018 scores except at MIK 0.4 (Figure 3.47). In 2019, MIK 1.4 received the highest scores possible for all invertebrate metrics used to calculate TMI except for total taxa and EPT taxa richness and the percentage of clingers (Table 3.31). TDEC protocol states that TMI scores should only be calculated for samples with 160–240 invertebrates identified to genus (TDEC 2017). In August 2019, only 88 individuals were collected from MIK 1.4, so results from this site should be interpreted with caution. Both MIK 0.8 and MIK 0.7 received low scores for EPT taxa richness and MIK 0.8 also received low scores for percentage EPT (Table 3.31). 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 (Table 3.26). 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 3.47).

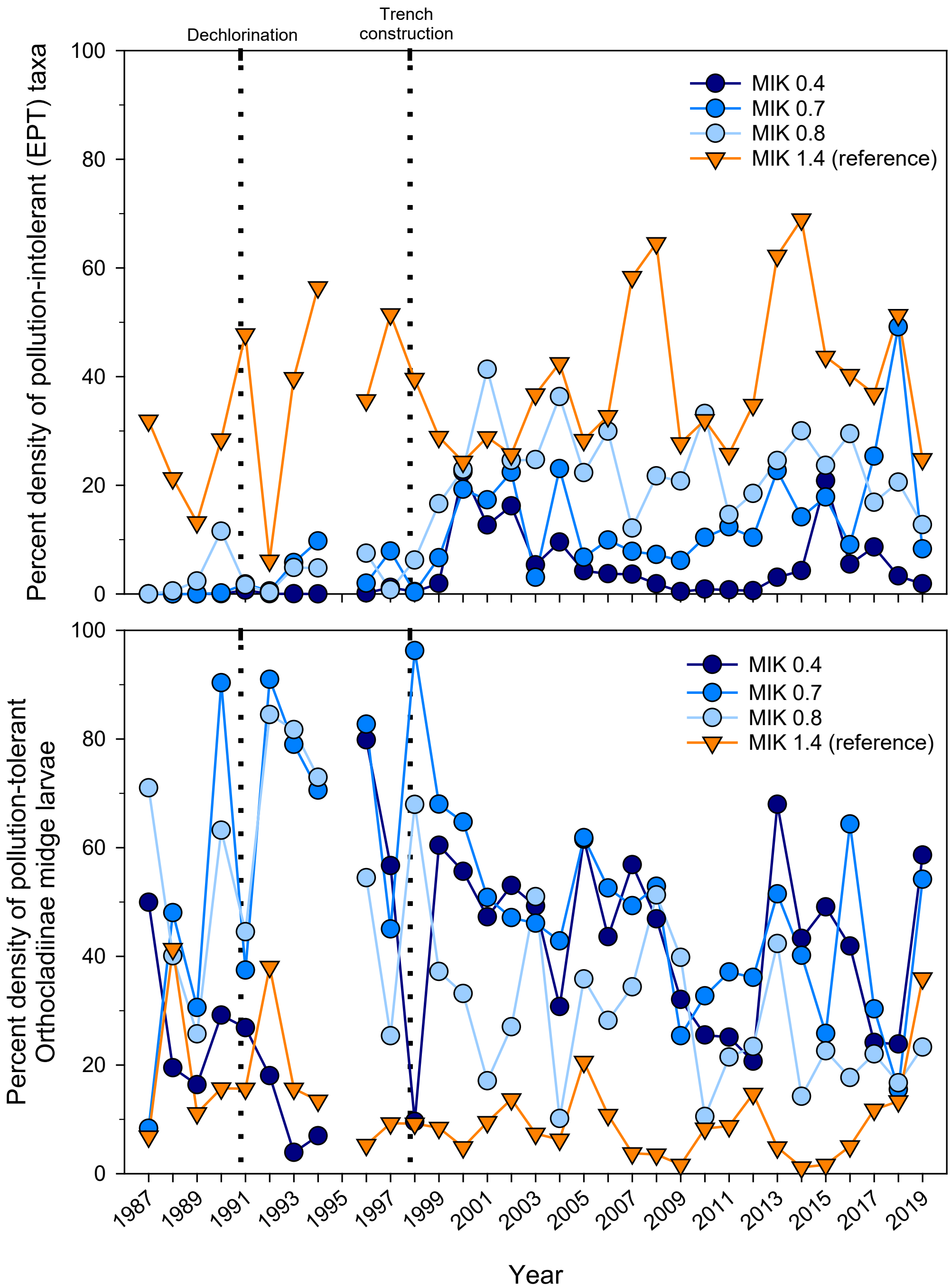
Based on TDEC stream habitat protocols, habitat quality was above the ecoregion 67f guideline at MIK 1.4, 0.8, and 0.7, and below the ecoregion guideline at MIK 0.4 (Figure 3.47). Habitat scores increased at all sites from 2018 to 2019. In general, improvements from the previous two years were primarily seen in epifaunal substrate/available cover, channel flow, and vegetative protection. However, poor substrate quality (dominance of gravel instead of cobble and excessive embeddedness) 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) decreased at all sites except MIK 1.4.



Note: Samples were not collected in April 1995, as indicated by the gaps in the lines.

Acronyms:
EPT = Ephemeroptera, Plecoptera, and Trichoptera
MIK = Mitchell Branch kilometer

Figure 3.45. Mean total taxonomic richness (top) and richness of the pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera taxa per sample (bottom) for Mitchell Branch sites, April 1987–2019



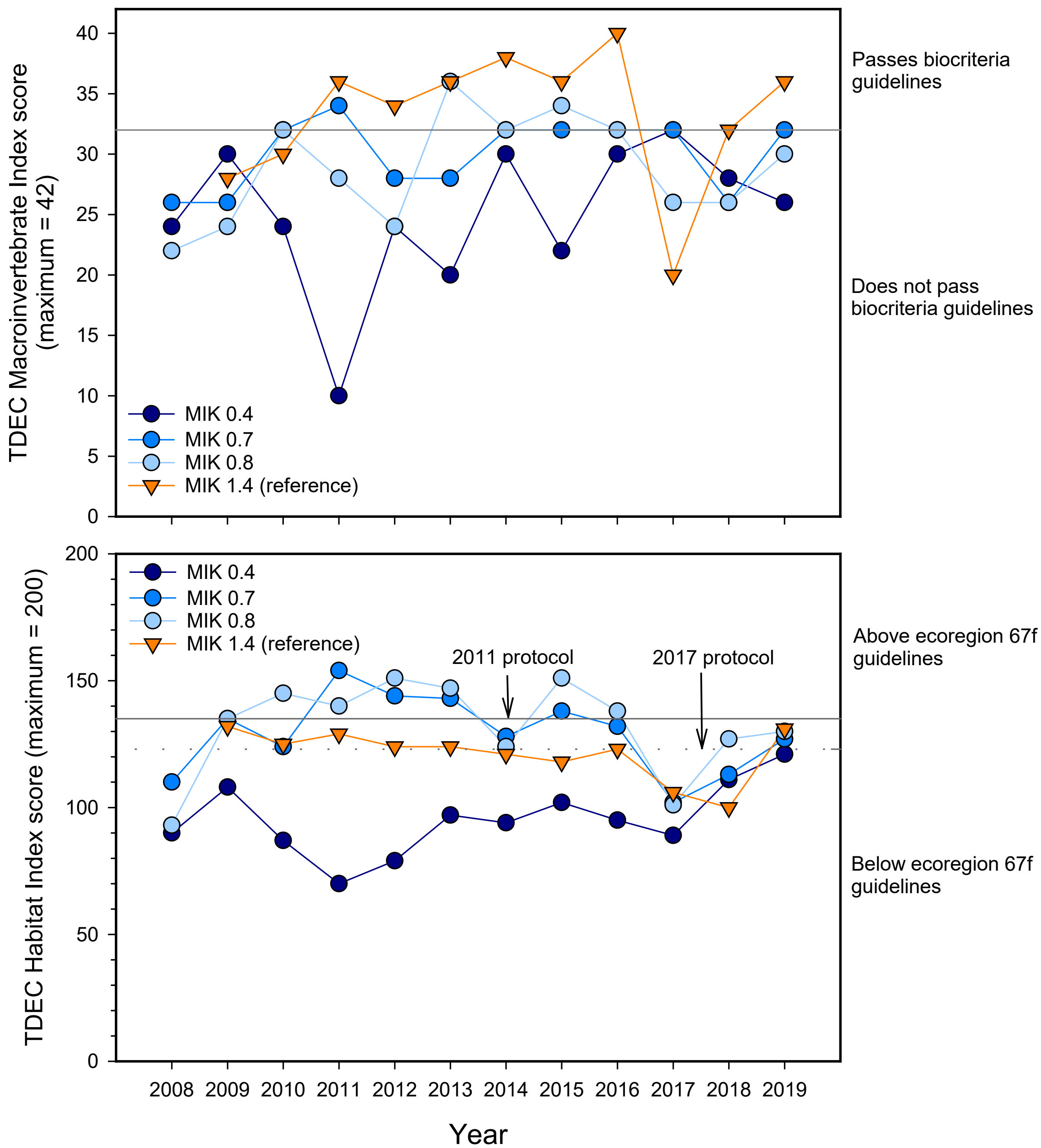
Notes:

1. Percentages were based on total densities for each site.
2. Samples were not collected in April 1995, as indicated by the gaps in the lines.

Acronym:

MIK = Mitchell Branch kilometer

Figure 3.46. Mean percent density of the pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera taxa (i.e., stoneflies, mayflies, and caddisflies), and percent density of the pollution-tolerant Orthocladiinae midge larvae (Chironomidae) at four Mitchell Branch sites, April 1987–2019



Notes:
1. Mitchell Branch site MIK 1.4 was not sampled with TDEC protocols in 2008.
2. The horizontal lines on each graph show the rating thresholds for each index; respective narrative ratings for each threshold are shown on the right side of each graph.
3. TDEC 2011 guidance used in 2008-2017, TDEC 2017 guidance used in 2018 and 2019.

Figure 3.47. Temporal trends in the Tennessee Department of Environment and Conservation Biotic Index (top) and Stream Habitat Index (bottom) scores for four Mitchell Branch sites, August 2008–2019

Table 3.31. Tennessee Macroinvertebrate Index (TMI) metric values and scores and index score for Mitchell Branch, August 19, 2019[a,b,c]

Site	Metric values							Metric scores							TMI[d]
	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	Taxa rich	EPT rich	%EPT	%OC	NCBI	%Cling	%TN Nuttol	
MIK 0.4	12	2	5.7	3.4	4.09	64.8	25.0	2	0	0	6	6	6	6	**26**
MIK 0.7	20	6	32.5	9.0	4.96	59.9	45.8	4	2	4	6	6	6	4	**32 [pass]**
MIK 0.8	24	4	21.2	5.5	5.05	80.2	46.1	4	2	2	6	6	6	4	**30**
MIK 1.4	29	11	50.6	22.0	3.68	44.0	26.2	4	4	6	6	6	4	6	**36[e] [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; %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 (green shading). TMI scores < 32 are indicated by yellow shading.

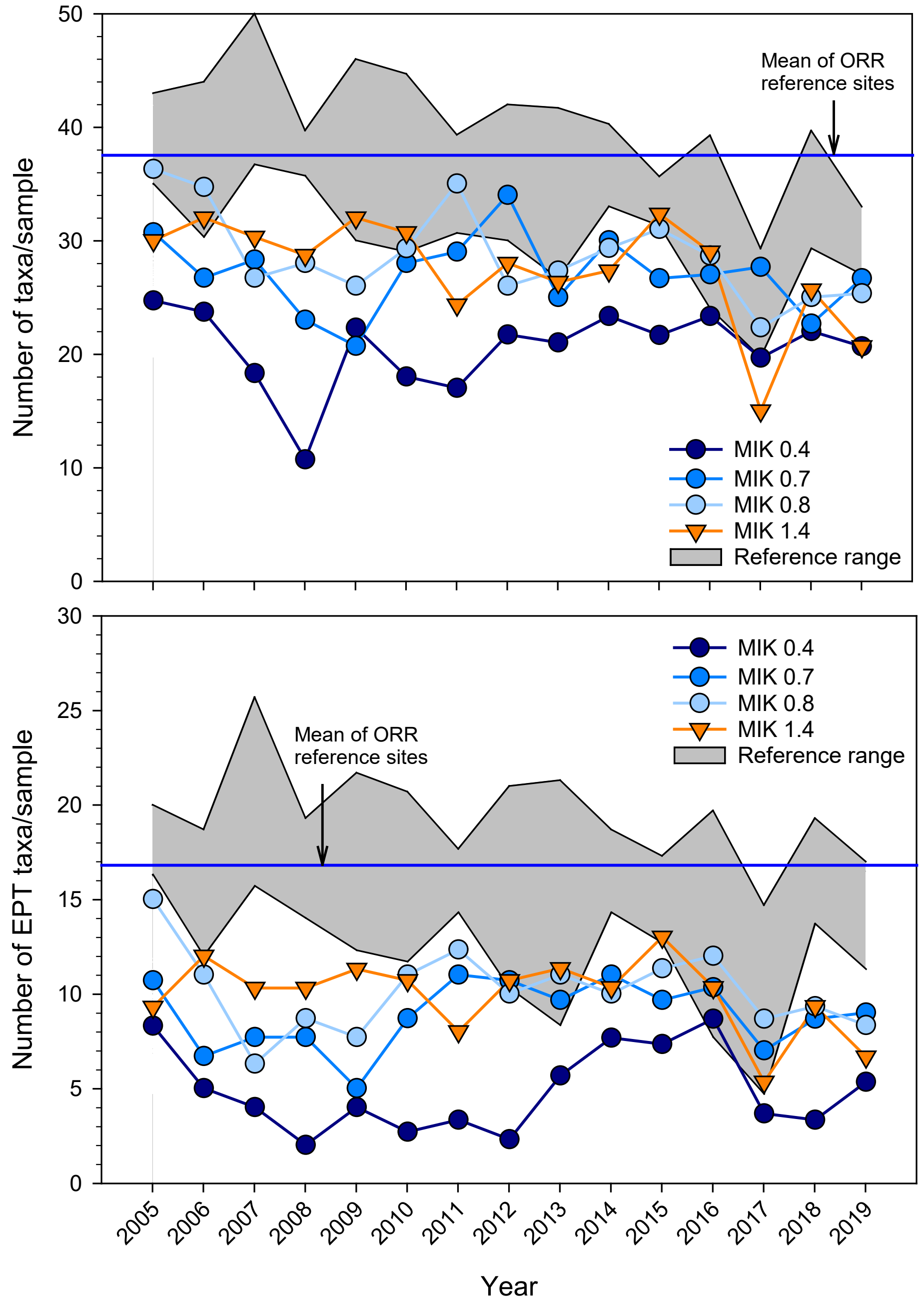
[e] TDEC protocol states that TMI scores should only be calculated for samples with 160–240 invertebrates identified to genus (TDEC 2017). In August 2019, only 88 individuals were collected from MIK 1.4, so results from this site should be interpreted with caution.

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 3.48, and percent density of the pollution-intolerant and pollution-tolerant taxa are shown in Figure 3.49. Also shown in Figures 3.48 and 3.49 is the range of metric means 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 2019, total taxa richness and taxa richness of pollution-intolerant taxa at Mitchell Branch sites, including MIK 1.4, were less than both the range of means at the five reference sites and the 15-year mean of all reference sites (Figure 3.48). This trend was observed since these comparisons began in 2005, with some exceptions (e.g., 2016, 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 range for the reference sites (Figure 3.49). As noted above, the percent density of pollution-tolerant taxa at MIK 1.4 in 2019 was the one of the highest values measured since monitoring began; however, higher values were also observed at some of the reference sites (Figure 3.49). Since 2005, the mean percent density of pollution-intolerant taxa at MIK 0.8 fluctuated in and out of the reference range, while the percent density of pollution-tolerant taxa was mostly higher than the reference range (except for the past two years; 2018 and 2019). MIK 0.7 showed marked improvement in percent density of both pollution-intolerant and pollution-tolerant taxa in 2018, but fell outside the reference range for both metrics in 2019. Except for in 2015, percent densities of both groups were outside of the reference ranges at MIK 0.4 in every year (Figure 3.49).

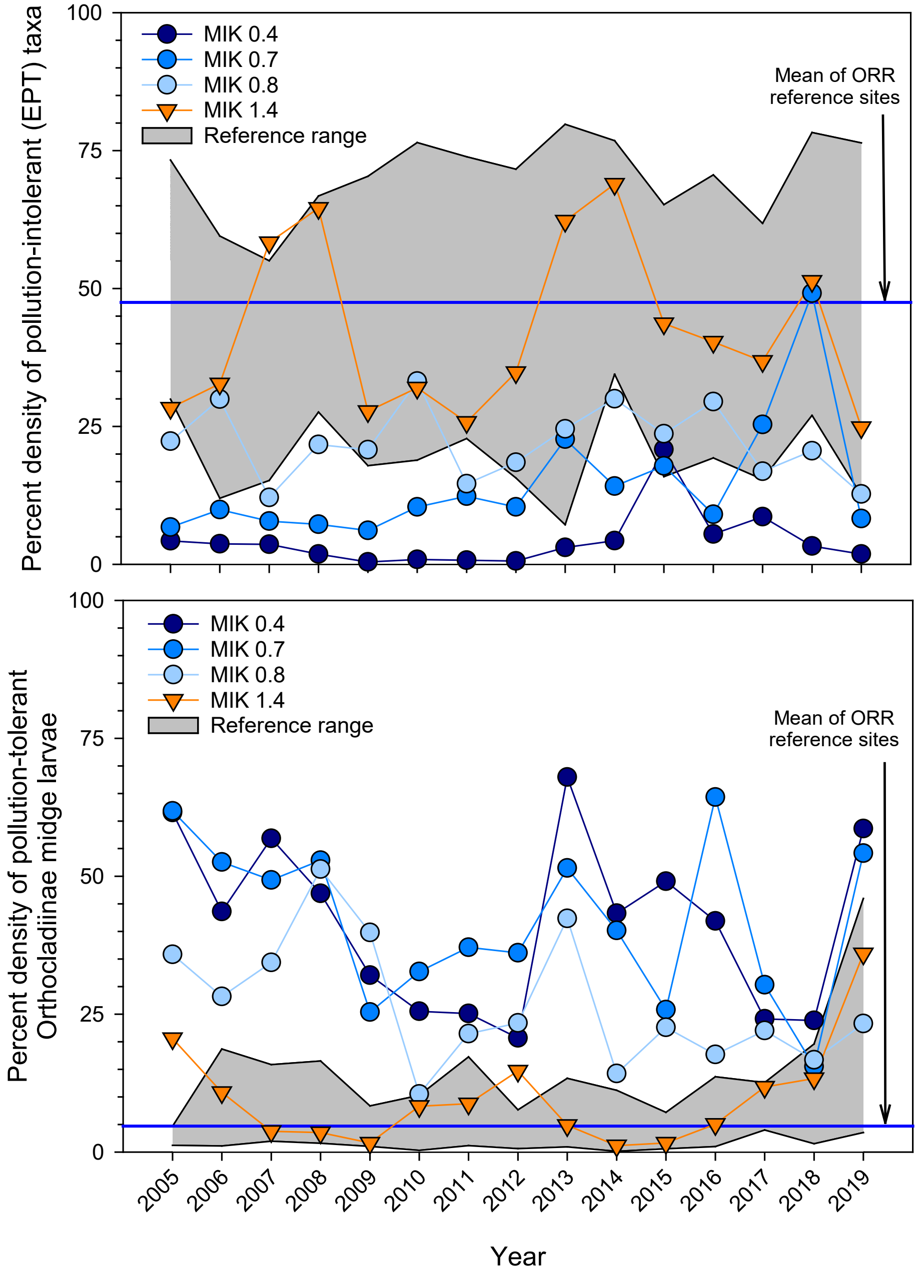
These results from the comparison of Mitchell Branch sites with the reference sites, combined with the long-term results for all Mitchell Branch sites discussed above, suggest that from the standpoint of reference sites, MIK 1.4 falls within the lower range of expected reference conditions on ORR. Factors potentially contributing to frequent excursions of invertebrate community metrics outside of the range of other reference sites include the somewhat smaller size of MIK 1.4 compared with the other reference sites (based on watershed area, Table 3.31), 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 (Figure 3.47). 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 range of values at five additional reference stream sites on ORR from 2005 to 2019, and the solid blue horizontal line on each graph is the mean of the reference sites for the same period.

Acronyms:
MIK = Mitchell Branch kilometer
MIK 1.4 = reference site;
ORR = Oak Ridge Reservation

Figure 3.48. Mean total taxonomic richness (top) and taxonomic richness of the pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera taxa per sample (bottom) for the benthic macroinvertebrate community at four Mitchell Branch sites, and the range of mean values from five reference sites on ORR, April 2005–2019



Notes:

1. Percentages were based on total densities for each site.
2. The gray shading on each graph shows the range of values at five additional reference stream sites on ORR from 2005 to 2019, and the solid blue horizontal line in each graph is the mean of the reference sites for the same period.

Acronyms:

MIK = Mitchell Branch kilometer

MIK 1.4 = reference site

ORR = Oak Ridge Reservation

Figure 3.49. Mean percent density of the pollution-intolerant taxa (i.e., stoneflies, mayflies, and caddisflies; top), and percent density of the pollution-tolerant Orthocladiinae midge larvae (Chironomidae; bottom) in four Mitchell Branch sites, and the range of mean values from five reference sites on ORR, April 2005–2019

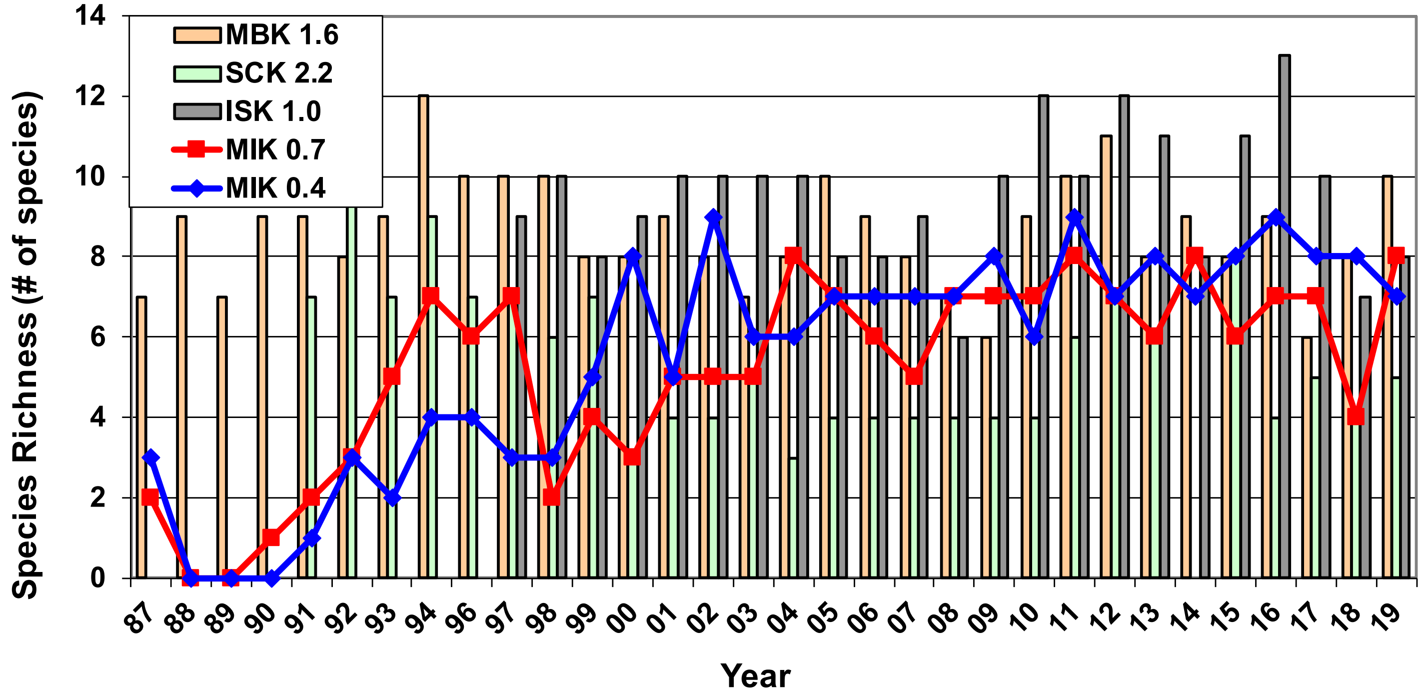
3.7.3 Task 3: Fish Community

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 3.50). 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.

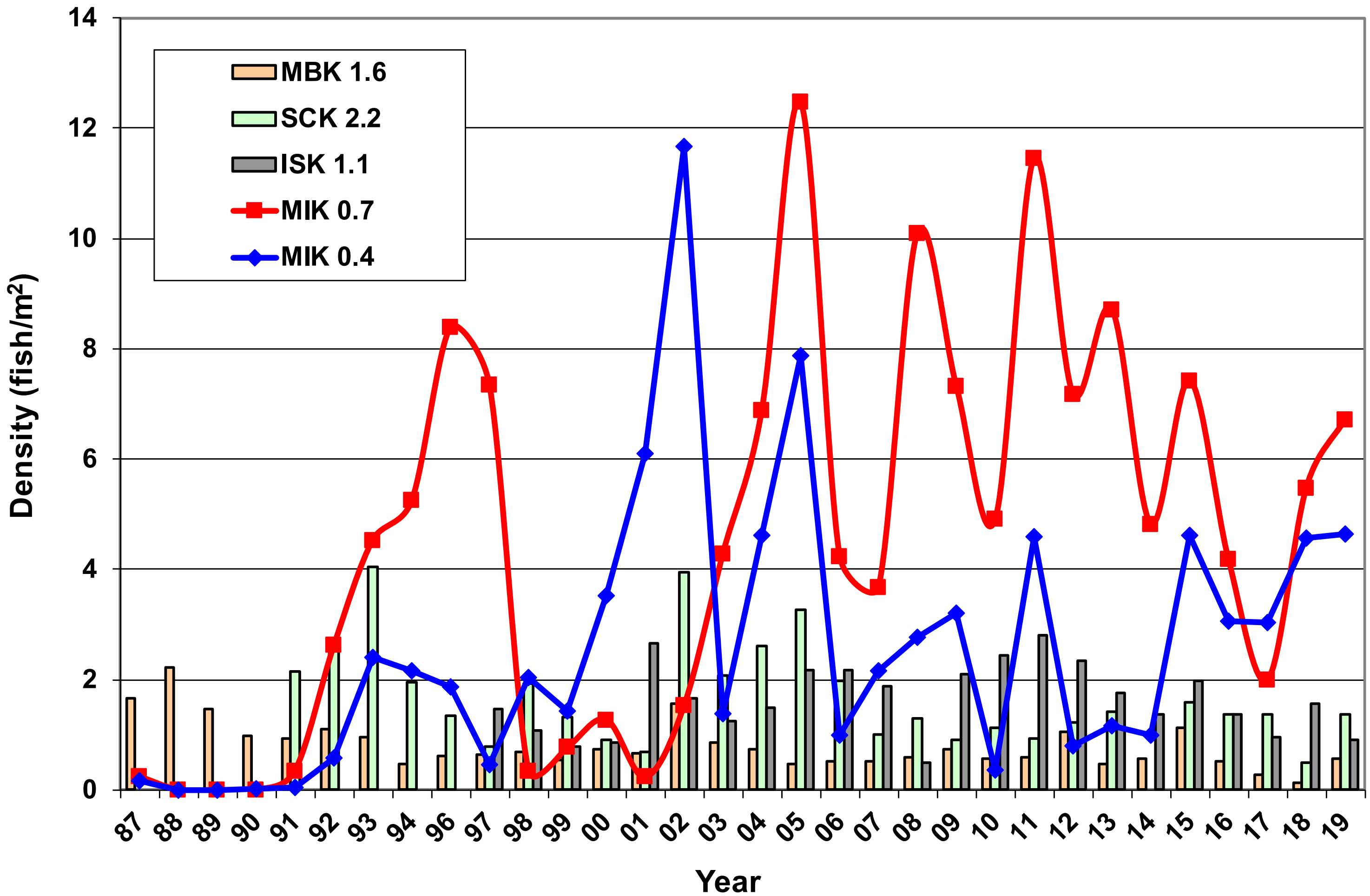
Since 2000, the fish community has had relatively stable species diversity but rather large variations in fish density and biomass (Figures 3.51-3.53), which are often reflective of unstable, impaired streams. Streams that experience high density and biomass of tolerant fish species are often indicative 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 in the summer of 2016 resulted in very low flows in many area streams. Small first and second order streams without springs or groundwater influence were most severely affected by these conditions. This may partially explain the decreased density and biomass numbers observed in spring 2017 samples and the apparent return of higher values since then.

Figure 3.50. Construction of lined section of Mitchell Branch, MIK 0.7, in 1998 (left) and more recent habitat conditions in 2019 (right)



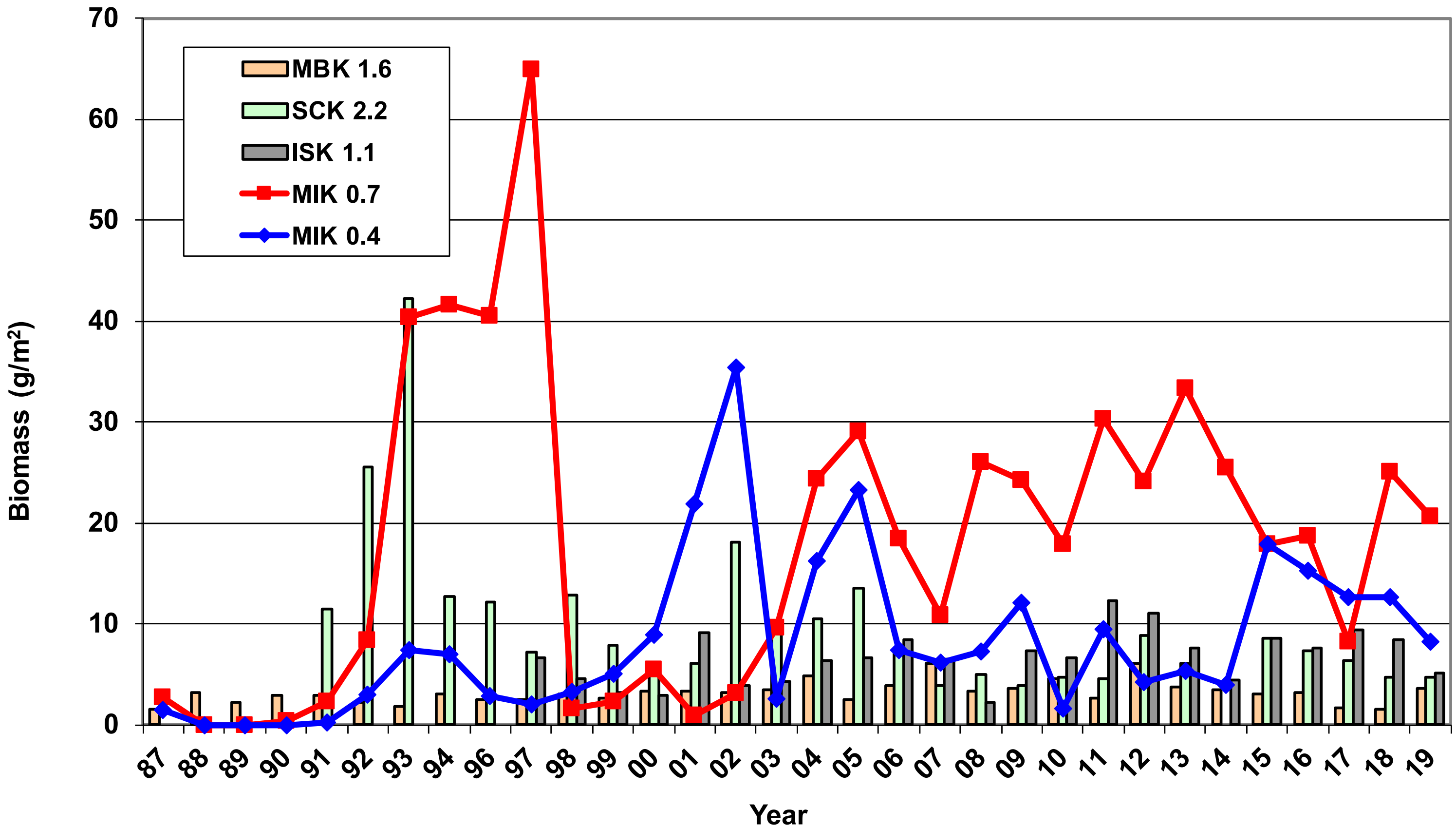
Acronyms:
ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

Figure 3.51. Species richness for the fish communities at sites in Mitchell Branch kilometer and in reference streams Mill Branch kilometer, Scarboro Creek, and Ish Creek, 1987–2019



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

Figure 3.52. Density for the fish communities at sites in Mitchell Branch kilometer and in reference streams Mill Branch kilometer, Scarboro Creek, and Ish Creek, 1987–2019



Acronyms:

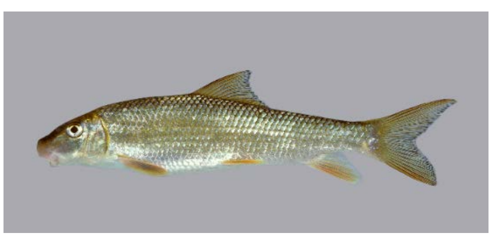
ISK = Ish Creek
MBK = Mill Branch kilometer
MIK = Mitchell Branch kilometer
SCK = Scarboro Creek

Figure 3.53. Biomass for the fish communities at sites in Mitchell Branch kilometer and in reference streams Mill Branch kilometer, Scarboro Creek, and Ish Creek, 1987–2019

At both MIK 0.4 and MIK 0.7, the 2019 sample of fish community parameters indicated continued variation, especially regarding fish density and biomass. Species richness (number of species) at MIK 0.7 recovered from 2018 values, while values at the lower site remained stable. Both sites have species richness comparable with similar sized reference streams. As mentioned above, density (number of fish) at both sites increased from 2018 and still remains well above reference conditions. Biomass (weight) decreased slightly in 2019 at both sites. Both the lower Mitchell Branch site and the upper site had reduced diversity and density of sensitive fish species in 2019. 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 two new species were observed in the Mitchell Branch fish community sites. Snubnose darter (*Etheostoma simoterum*) were collected at MIK 0.7, which represents a unique sensitive species in this reach of stream. They have been observed at the very mouth of the system in past samples. In addition, warmouth (*Lepomis gulosus*) were observed at both sites in spring 2019.

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 3.54). 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 3.54. Sensitive fish species observed in lower Mitchell Branch

3.7.4 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 February 2019 revealed the presence of 14 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 3.55). 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; however, they constitute only approximately 21 percent of the fish population at present.

A few additional strategies were used in 2017–2019 in an effort to further manipulate the fish population and overall pond ecosystem to better reflect the desired end state. These included: more strategic and targeted fish removal efforts, stocking of 61,000 juvenile bluegill over three years, and aquatic and terrestrial plantings of native plants in various areas around the pond. These efforts were designed to reduce nuisance fish presence through removal, adjust the fish community through inundation of specific fish age classes, and increase vegetative cover in areas of the pond that currently lack vegetation. Future monitoring will provide insight on the effectiveness of these efforts and provide guidance for future management techniques.

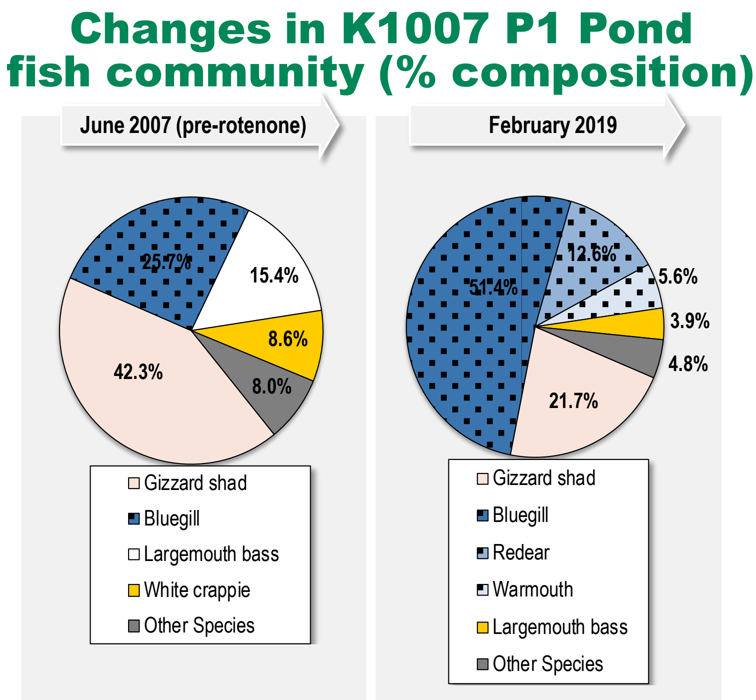


Figure 3.55. Changes in the K-1007-P1 Pond fish community (% composition) from 2007 to 2019

3.8 Environmental Management and Waste Management Activities

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.

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 3.6.7 provides a more detailed discussion of CWTS operations.

3.8.2 Environmental Remediation Activities

During 2019, substantial progress was made in remediation efforts at the ETTP site. In 2019, the last of the buildings that had conducted or supported the gaseous diffusion process was demolished. 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 *2019 Cleanup Progress—Annual Report to the Oak Ridge Regional Community* (OREM-19-2579, UCOR 2019a).

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.

3.8.2.2 K-1423 Demolition Completed

The K-1423 Toll Enrichment Facility was originally used to support the gaseous diffusion process. After enrichment operations ceased, the facility was used for a variety of waste management operations. The building was demolished in 2019.

3.8.2.3 Poplar Creek Facilities Demolition

Demolition of the last remaining buildings that had supported the gaseous diffusion process was completed in 2019. These facilities housed in these buildings had performed a number of different support functions and were located along Poplar Creek.

3.8.2.4 Building K-1037 Demolition Completed

UCOR completed demolition of Building K-1037 in 2019. The facility was once a warehouse, and was converted to a facility that manufactured all of the barrier material used in the gaseous diffusion process since 1947. This material was a key component of the gaseous diffusion process where workers separated the ^{235}U and ^{238}U isotopes.

3.8.2.5 K-1414 Garage Demolition Completed

The K-1414 Garage opened in 1949 and operated until 2018. It was the longest operating facility at ETTP. Demolition was completed in 2019.

3.8.2.6 K-29 Slab Removal Completed

The K-29 Building was a former gaseous diffusion facility that was demolished in 2006. In 2019, the concrete slab of the building was removed.

3.8.2.7 Commemoration of the K-25 Site

National historic preservation initiatives at ETTP continued in 2019. The K-25 History Center is located on the second floor of the COR-owned Fire Station #4 at ETTP. The K-25 History Center opened in 2020. Visitors to the K-25 History Center will be invited to explore the rich history of this Manhattan Project site. This facility features a theatre experience, period artifacts, equipment replicas, and workers' oral histories, placing K-25 in its proper historical context in World War II and the Cold War. An in-depth look at gaseous diffusion, the thousands of equipment stages housed in K-25, and the people who sacrificed so much to make it a reality are highlighted. The future Equipment Building and Viewing Tower design replicates the exterior appearance of the K-25 Building, and will house a representative cross-section of gaseous diffusion technology. An enclosed observation deck will provide a 360-degree view of the site.

3.8.3 Reindustrialization

As cleanup has progressed extensively at ETTP, more large parcels are becoming available for transfer to the private and commercial industrial sectors. In 2018, DOE completed transfer of Duct Island, a 207-acre parcel on the western portion of ETTP, to CROET. This transfer is the second largest transfer in the history of the program, and the largest at ETTP Heritage Center. This brings the total acreage of land transferred to 1,280 acres, with 789 of those acres at the Heritage Center. Additionally, a large area of

170 acres at the southeast corner of ETTP has been approved for transfer to Metropolitan Knoxville Airport Authority for a potential regional airport project. The general aviation airport runway would accommodate small corporate jets, private airplanes, and EMS aircraft. A final decision from the Federal Aviation Administration (FAA) on this project is anticipated in 2020. Additionally, DOE has entered into discussions with the Tennessee Wildlife Resources Agency (TWRA) to develop a partnership between the two agencies. The plan is for TWRA to acquire hundreds of acres from DOE that will become greenspace that can be used for public recreation as wildlife management areas and greenways. Two canoe launch areas on Poplar Creek have also been identified for transfer. The integration of greenspace into the private-sector industrial park will make ETTP a truly unique federal land reuse project.

DOE completed an Environmental Assessment to support the property transfer and potential construction and operation of the airport. DOE has also received EPA and TDEC approval for future property transfer of the former Powerhouse area, which is over 400 acres. The transfer of large parcels, as more of the site cleanup is completed, provides the best opportunities to date for industrial and commercial development of ETTP.

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