3. East Tennessee Technology Park

East Tennessee Technology Park (ETTP) was originally 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 and restoration operations, and the name was changed to the "East Tennessee Technology Park."

Environmental management and remediation operations consist of operations such as waste management, the cleanup of outdoor storage and disposal areas, the demolition and/or 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 underused 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 vegetation from ETTP and the surrounding area. Monitoring results are used to assess exposures to members of the public and the environment, to assess the performance of treatment systems, to help identify areas of concern, to plan remediation efforts, and to evaluate the efficacy of remediation efforts. In 2015, there was 100% compliance with permit standards for emissions/discharges from ETTP operations.

On November 10, 2015, the US Department of Energy (DOE) and the US Department of Interior signed a memorandum of agreement (MOA) establishing the Manhattan Project National Historic Park. 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. The K-25 Building Site, formerly the K-25 Gaseous Diffusion Building, is within the boundary of the newly established National Park. As part of the activities to establish the park, DOE released the K-25 Virtual Museum, which details the history of the K-25 Gaseous Diffusion Plant through narrative and photographs and can be found at http://www.k-25virtualmuseum.org/.

3.1 Description of Site and Operations

Construction of the K-25 Site (Fig. 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 the ORGDP.

After military production of highly enriched uranium (HEU) was concluded in 1964, the two original process buildings were shut down. For the next 20 years, the plant's primary missions were 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.

Fig. 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 East Tennessee Technology Park (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 2015.

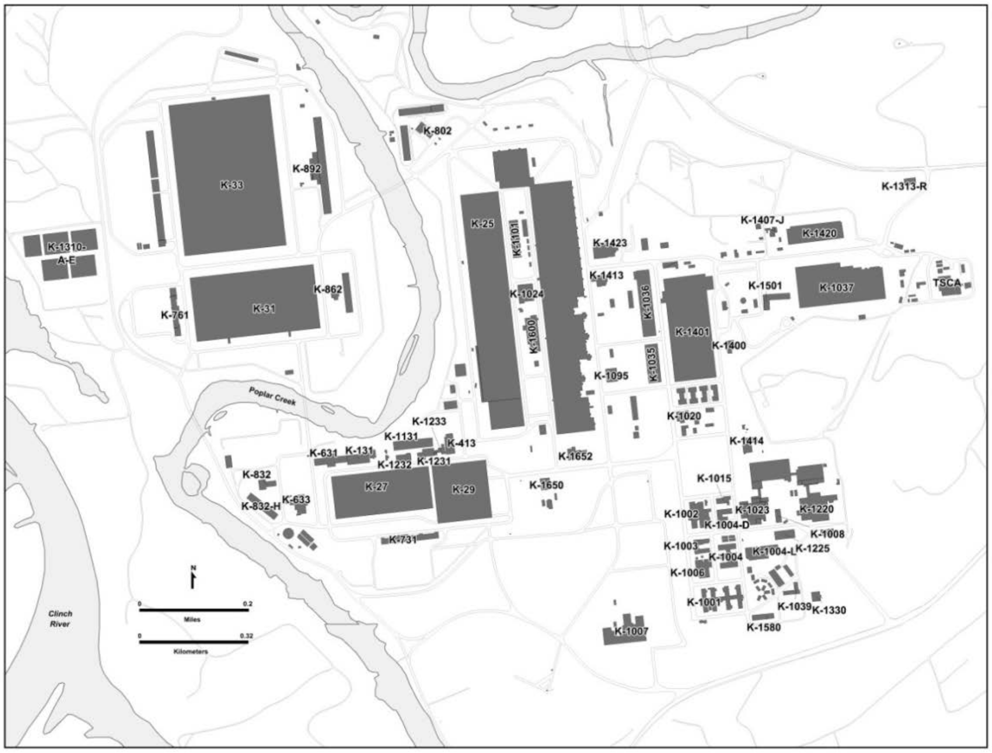

Fig. 3.2. East Tennessee Technology Park before the start of decontamination and decommissioning activities in 1991.

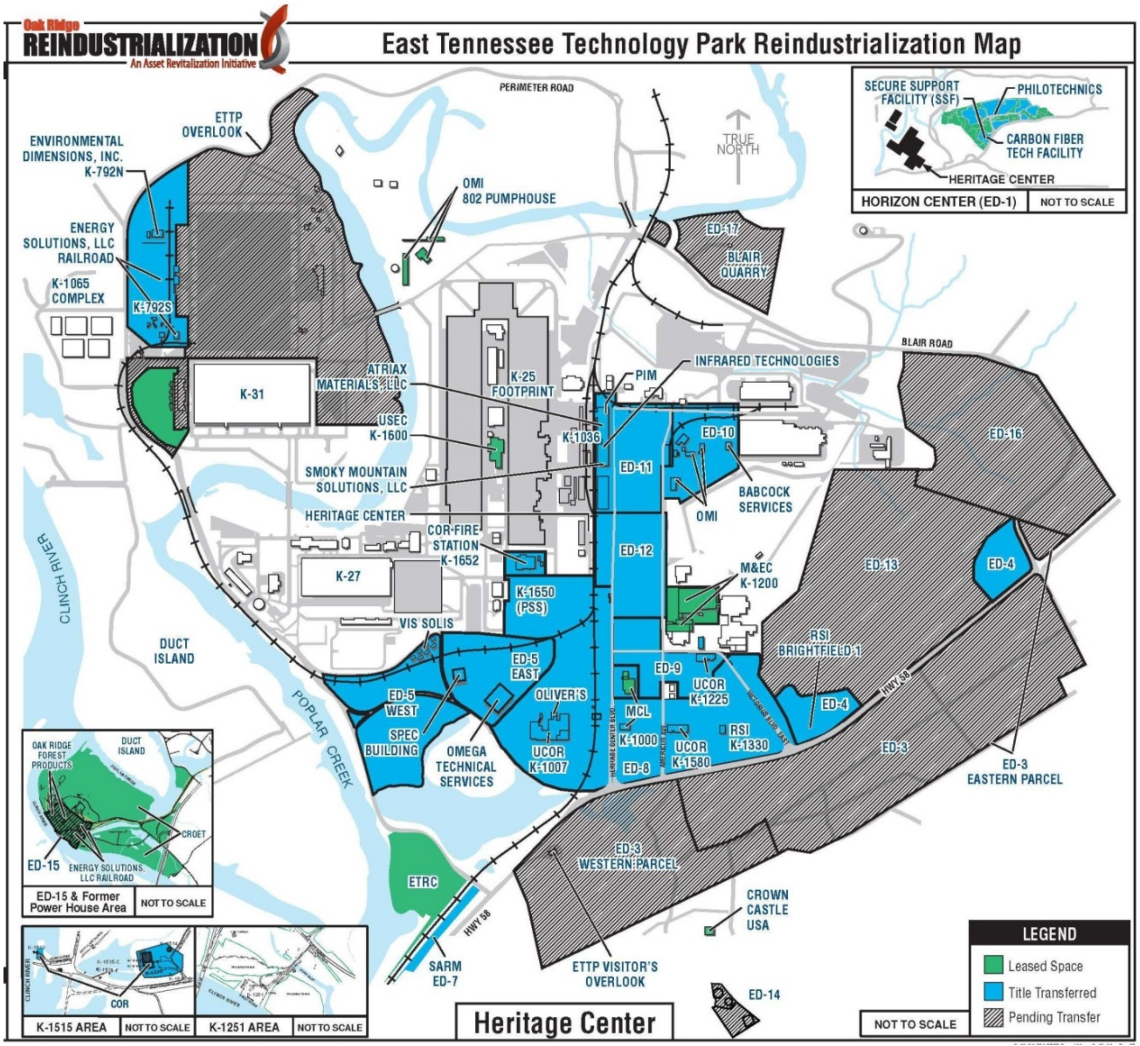

Fig. 3.3. East Tennessee Technology Park in 2015, showing progress in reindustrialization.

The ETTP mission is to reindustrialize and reuse site assets through leasing or transferring excess or underutilized land and facilities and through incorporating commercial industrial organizations as partners in the ongoing environmental restoration, D&D, and waste treatment and disposal.

The long-term goal of the US Department of Energy (DOE) for ETTP is to transfer as much of the site as practicable out of DOE ownership and control for the development of a private business and industrial park. The site is undergoing environmental cleanup of its land, as well as D&D of most of its buildings. The reuse of key facilities through title transfer is part of the site's closure plan. The cleanup approach makes land and various types of buildings (e.g., office, manufacturing) suitable for private industrial use and for title transfer to the Community Reuse Organization of East Tennessee (CROET) or other entities such as the City of Oak Ridge. The 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.

URS | CH2M Oak Ridge LLC (UCOR), the lead environmental management contractor for ETTP, supports DOE in the reindustrialization program as part of the continuing effort to transform ETTP into a private-sector industrial park. Unless otherwise noted, information 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 Environmental Management (EM) program in Oak Ridge, Tennessee. UCOR's environmental policy states in part, "Our commitment to protect and sustain human, natural, and cultural resources is inherent in our mission to complete environmental cleanup safely with reduced risks to the public, workers, and the environment." To achieve this, UCOR's environmental policy adheres to the following principles.

Management 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.

Partnership/Stakeholder Involvement—Maintain partnerships through effective two-way communications with our customers and other stakeholders.

3.2.1 Environmental Stewardship Scorecard

The Environmental Stewardship Scorecard is used to track and measure site-level EMS performance. During 2015, UCOR received "green scores" for EMS performance. As an example, Fig. 3.4 presents information on UCOR's 2015 pollution prevention recycling activities related to solid waste reduction at ETTP. UCOR recycles office and mixed paper, cardboard, phone books, newspapers, magazines, aluminum cans, antifreeze, engine oils, batteries (lead acid, universal waste, and alkaline), universal waste bulbs, plastic bottles, all types of #1 and #2 plastics, and surplus electronic assets, such as computers (CPUs and laptops) and monitors (CRTs and LCDs). Other recycling opportunities include unique structural steel, stainless-steel structural members, transformers, and electrical breakers.

UCOR's exceptional electronics stewardship earned it an award in 2015 from the Green Electronics Council for its use of Electronic Product Environmental Assessment Tool (EPEAT) methods. UCOR also received a data driven award from participating in the US Environmental Protection Agency (EPA)'s Federal Green Challenge to reduce federal government impact on the environment and make operations more sustainable.

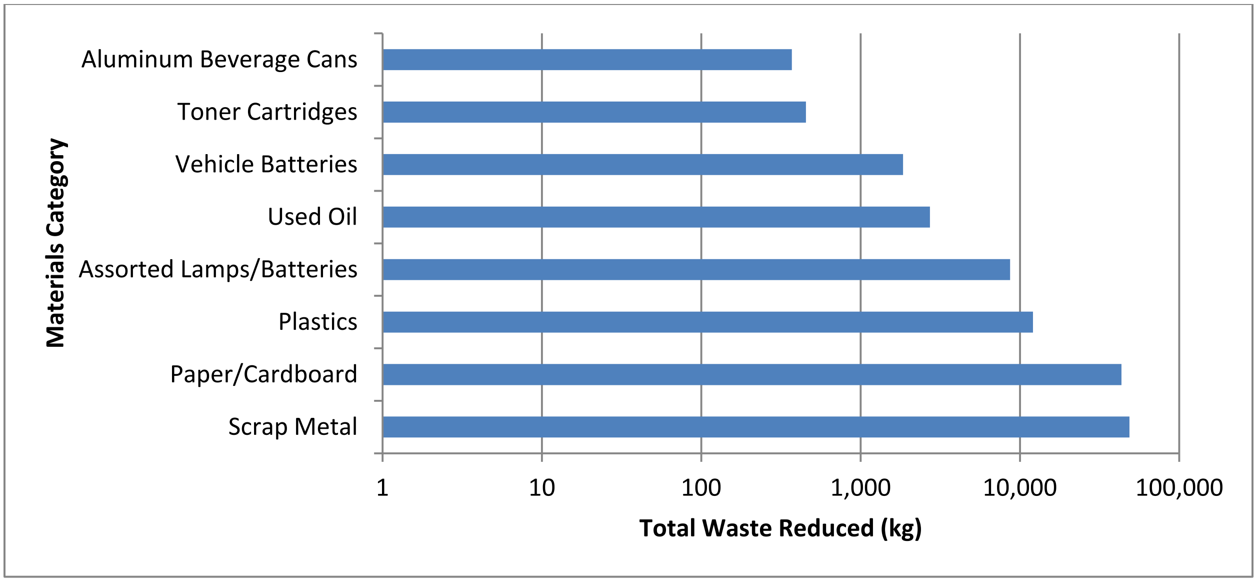

Fig. 3.4. Pollution prevention recycling activities related to solid waste reduction at East Tennessee Technology Park in CY 2015.

Additionally, UCOR internally recognized six projects for their pollution prevention/waste minimization (P2/WMin) accomplishments in 2015. This included the reuse of 1,100 yd^3 of concrete waste as fill material in the K-832 basin, the use of an enhanced waste cover and water conditioning at the Environmental Management Waste Management Facility (EMWMF), which avoided the treatment of thousands of gallons of water, and the construction and initiation of a second 1-megawatt (MW) solar farm on the west end of the park. All together, these and other projects saved in excess of $3 million and promoted sustainability goals by reducing waste, avoiding greenhouse gas production, and preserve valuable landfill space.

In the area of alternative energy, Restoration Services, Inc. (RSI), in concert with UCOR, continued operation of ETTP's first solar farm on the east end of the plant property. Brightfield 1 (Fig. 3.5), as it is known, 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.

Fig. 3.5. Brightfield 1 Solar Farm.

RSI self-financed the project, using solar panels manufactured in Tennessee, and partnering with other local small businesses for the installation. Power generated from Brightfield 1 is being sold to the Tennessee Valley Authority (TVA) through the City of Oak Ridge Electric Department using a TVA Generation Partners contract. The completed project was commissioned in April 2012 and is part of RSI's Brownfields to Brightfields (B2B) initiative that works to develop restricted use properties into solar farms. Brightfield 1 energy production in its first year was 110% more than projected, with no downtime due to maintenance issues. In Calendar Year (CY) 2015, Brightfield 1 produced 231,140 kWh of energy.

As mentioned above, through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and the City of Oak Ridge, 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 boosters development at ETTP. This project provides numerous benefits to the environment and the community at large, and includes 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 metric tons of carbon dioxide).
- Provides brownfield reuse/redevelopment at ETTP.
- Supports the City of Oak Ridge renewable energy goals.
- Supports the TVA renewable energy initiative.
- Offers community economic development jobs and property tax income to the City of Oak Ridge.
- Demonstrates benefits of ETTP reindustrialization.
- Supports DOE renewable energy goals.
- Demonstrates collaborative success between DOE and a public utility for renewable energy development.

UCOR also continued to use green products whenever possible and evaluated large quantity purchases for less toxic alternatives. In addition, UCOR maintained its extensive recycling program and benefitted the local community through donations of proceeds to local charities from its aluminum beverage can (ABC) recycling efforts.

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 assessments conducted by functional or project organizations, and routine field walk downs conducted by a variety of functional and project personnel. Management and independent assessments are performed in accordance with *Management Assessment*, PROC-PQ-1420, and *Independent Assessment*, PROC-PQ-1401. Assessments are scheduled on the UCOR Quality Assurance System (QAS) in accordance with PROC-PQ-1420. 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).

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 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 incorporating environmental protection and the elements of an enabling EMS into the daily conduct of business; fostering a spirit of cooperation with federal, state, and local regulatory agencies; and using appropriate waste management, treatment, storage, and disposal methods.

The environmental performance objectives are to achieve zero unpermitted discharges to the environment; comply with all conditions of environmental permits, laws, regulations, and DOE orders; integrate EMS and environmental considerations as part of ISMS; and, to the extent practicable, reduce waste generation, prevent pollution, maximize recycle and reuse potential, and encourage environmentally preferable procurement of materials with recycled and biobased content.

UCOR has established a set of core 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 complying with applicable legal requirements and sustainable environmental practices contained in DOE 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 pollution prevention and waste minimization (P2/WMin) and sustainable practices.
- Reduce degradation and depletion of environmental resources through postconsumer material recycling; energy, fuel, and water conservation efforts; and use or promotion of renewable energy, and transfer for reuse valuable real estate assets.

3.2.5 Implementation and Operations

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 management assessments also provide a measure of how well EMS attributes are integrated into work activities through ISMS. UCOR has embodied its program for EC&P of natural resources in a companywide EM and protection policy. The policy is UCOR's fundamental commitment to incorporating sound EM practices into all work processes and activities.

3.2.6 Pollution Prevention/Waste Minimization (P2/WMin)

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 or other wastes generated is evaluated in all cases.

- The ETTP EMS program fosters pollution prevention at every level of its operations, from routine office recycling to more esoteric reuse and recycling at the project field level. UCOR's pollution prevention program is successful because it is tightly bound to its work control process. Thus many unique applications of material reuse and recycling have resulted, many of which have been captured through its internal P2 awards program. Some recent examples are: The reuse of 1,100 yd^3 of concrete waste as fill material in the K-832 basin and the reuse of rock from the K-31 berm in fill material for a total savings of $89,000.

- The innovative water conditioning at the EMWMF contact water ponds (CWPs) to chemically reduce hexavalent chromium to the less toxic trivalent chromium. The cost avoidance associated with water shipment and treatment was estimated at $3.2 million.

- The reuse of various UCOR properties through the Government Services Administration's property reuse program, which included 38 printers, 34 monitors, and 638 shoring jacks. This avoided disposal and saved valuable landfill space.

- The disposition of approximately $50,000 of unused office supplies through the ORNL's property sales. The UCOR Local Safety Improvement Team (LSIT) sponsored a cleanout of the K-1007 building, which was responsible for the success of this project.

- The reuse of 400 yd^3 of clean soil at the Nuclear High Hazard Operations (NHHO) Y-12 National Security Complex (Y-12), which resulted in a $20,000 savings. The NHHO Oak Ridge National Laboratory (ORNL) group also recycled 20 yd^3 of unused metal pipe, which resulted in a cost savings of $4,000, in addition to saving valuable landfill space.

- Through the cooperative efforts of DOE, UCOR, RSI, Vis Solis, Inc., CROET, and the City of Oak Ridge, a second solar farm was built and made operational in April 2015. It is a 1-MW solar farm that provides renewable energy, provides long-term lease income to CROET, and boosts development at ETTP.

Total savings of the winning projects were in excess of $3.3 million and in many cases, valuable landfill space and virgin materials were conserved. The internal awards will be evaluated for possible nomination for national levels awards (e.g., the DOE Headquarters Annual Award Program).

3.2.7 Competence, Training, and Awareness

The UCOR training and qualification process ensures that needed skills for the workforce are identified and developed. The process also documents knowledge, experience, abilities, and competencies of the workforce for key positions requiring qualification. This process is described in PROC-TC-0702, *Training Program*. Completion and documentation of training, including required reading, are managed by the Local Education Administration Requirements Network (LEARN).

3.2.8 Communication

UCOR communicates externally regarding environmental aspects through the UCOR public website, which includes a link to its environmental policy statement, POL-UCOR-007; a list of environmental aspects; and a link to the *Integrated Safety Management System Description*, PPD-EH-1400. 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., ASER and the annual cleanup progress report (UCOR 2015a)]. UCOR participates in a number of public meetings related to environmental activities at the site [e.g., Oak Ridge Site Specific Advisory Board (ORSSAB) meetings, which include community stakeholders, permit review public meetings, and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 decision document public meetings]. 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 Do-Act-Check, it provides a framework by which work incorporates environmental hazards into its work control and planning. This translates into many returns to the organization. UCOR uses EMS objectives and targets, an internal pollution prevention recognition program, environmentally preferable purchasing, work control processes, and a recycle program to meet sustainability and 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 2016, UCOR-4127/R4). In 2015, the UCOR EMS program underwent the independent program verification required triennially by EO 13423 (CEQ 2007, EO 13423), which resulted in zero findings, two observations, and four proficiencies.

3.2.10 Management Review

Senior management review of EMS is performed at several layers and frequencies. A formal review/presentation with UCOR senior management that addresses the requirement elements contained in this section is conducted at least once per year. At least two of the senior managers are present for management reviews. The ISMS description is updated annually to address improvements and lessons learned and to update objectives and targets as necessary and signed by the UCOR president and project manager. The environmental policy is also reviewed during the management review annually and revised as necessary.

3.3 Compliance Programs and Status

During 2015, ETTP operations were conducted in compliance with contractual and regulatory environmental requirements, and there were no National Pollutant Discharge Elimination System (NPDES) permits or Clean Air Act (CAA) noncompliances. Figure 3.6 shows the trend of NPDES compliance at ETTP since 1999. One environmental violation was issued at the ETTP during a routine inspection for a missing used oil drum label on a drum in the facility's garage. The condition was immediately corrected and documented in UCOR's QAS tracking system. The following sections provide more detail on each compliance program and the related activities in 2015.

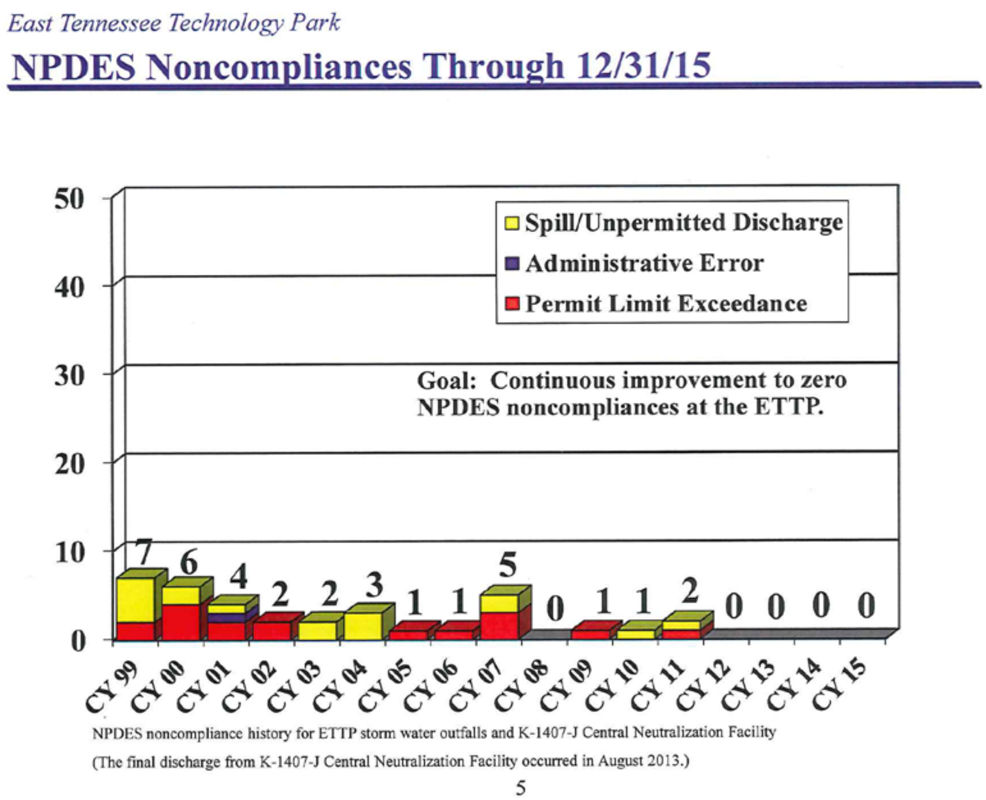

Fig. 3.6. East Tennessee Technology Park (ETTP) National Pollutant Discharge Elimination System (NPDES) permit compliance since 1999.

3.3.1 Environmental Permits

Table 3.1 contains a list of environmental permits that were in effect at ETTP in 2015.

3.3.2 Notices of Violation and Penalties

ETTP received one environmental violation in 2015. This violation occurred at ETTP during a routine inspection for a missing used oil drum label on a drum in the facility's garage. The condition was immediately corrected and documented in UCOR's QAS tracking system. There were no penalties assessed in 2015.

3.3.3 Audits and Oversight

Table 3.2 presents a summary of environmental audits and oversight visits conducted at ETTP in 2015.

Table 3.1. East Tennessee Technology Park Environmental Permits, 2015

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	069346P	03-03-2015 Amended 04-21-2015	10-01-2024	DOE[a]	UCOR	UCOR
CWA	NPDES permit for storm water discharges	TN0002950	2-01-15	3-31-20	DOE	UCOR	UCOR
CWA	State operating permit—waste transportation project; Blair Road and Portal 6 sewage pump and haul permit	SOP-05068	07-01-14	02-28-19	DOE	TFE	TFE
CWA	State operating permit—ETTP holding tank/haul system for domestic wastewater	SOP-99033	07-01-15	06-30-20	UCOR	UCOR	UCOR
UST	Authorized/certified USTs at K-1414 Garage	Customer ID 30166 Facility ID 073008	03-20-89	Ongoing	DOE	UCOR	UCOR
RCRA	ETTP container storage and treatment units	TNHW-165	09-15-15	09-15-25	DOE	UCOR	UCOR
RCRA	Hazardous waste corrective action document (encompasses entire ORR)	TNHW-164	09-15-15	09-15-25	DOE	DOE/All[a]	DOE/All[a]

[a]DOE and all ORR 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)
NPDES = National Pollutant Discharge Elimination System
ORR = Oak Ridge Reservation
RCRA = Resource Conservation and Recovery Act
SOP = state operating permit
TFE = Technical and Field Engineering, Inc.
UCOR = URS | CH2M Oak Ridge LLC
UST = underground storage tank

Table 3.2. Regulatory oversight, assessments, inspections, and site visits at East Tennessee Technology Park, 2015

Date	Reviewer	Subject	Issues
March 9	TDEC	Annual RCRA Compliance Inspection	1
June 2	TDEC	RCRA TNHW-117 Permit Renewal	0
June 24	TDEC	D&D Waste Shipment Audit	0
June 15	TDEC	TDEC NPDES Permit Writer	0
September 24 and 28	TDEC	NPDES Compliance Evaluation Inspection	0
October 21, 2015	TDEC	Asbestos NESHAP Compliance Inspection	0

Acronyms

NPDES=National Pollutant Discharge Elimination System
RCRA = Resource Conservation and Recovery Act
TDEC = Tennessee Department of Environment & Conservation
NESHAP =National Emission Standards for Hazardous Air Pollutants

3.3.4 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.

During 2015, 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 to 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, facilities upgrades, personnel safety enhancements). A CX is one of a category of actions defined in 40 Code of Federal Regulations (CFR) Part 1508.4 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 2015, no new CX determinations for activities at ETTP were issued by DOE.

Compliance with the National Historic Preservation Act (NHPA) 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 National Park Service program to identify, evaluate, and protect historic and archeological resources in the US, as well as numerous facilities that were not eligible for inclusion on the 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.

Consultation for the development of a Memorandum of Agreement (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 (SHPO), and the Advisory Council on Historic Preservation (ACHP) entered into an MOA that included the retention of the north end tower (also known as north wing and 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. Another series of consultation meetings ensued in 2009 and DOE advised that prohibitive costs and safety considerations precluded fulfillment of three stipulations in the 2005 MOA, including the preservation of the north end tower. The parties offered a wide array of potential mitigation measures and, in the absence of consensus on how best to commemorate Building K-25, DOE, SHPO, and ACHP entered into a bridge MOA until the parties could reach a final agreement. After completing an evaluation of the structural integrity of the K-25 building and interpretative approaches for the site, DOE distributed a preferred mitigation plan to the consulting parties in October 2011. The DOE final mitigation plan, which addressed comments submitted by consulting parties in November 2011, 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. A final MOA was signed in August 2012, finalizing the aspects set forth in the mitigation plan. During 2013, a request for proposal was issued for a "Professional Design Team and Museum Professional," as specified in the MOA. Nine firms were prequalified, and the selection and awards were executed April 1, 2014. The procurement process for the K-25 "virtual museum" web design firm was also begun in 2013 and awarded September 2, 2014.

On December 14, 2014, Congress authorized the establishment of the Manhattan Project Historical Park to commemorate the history of the Manhattan Project. 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.

The Final Conceptual Design Report, Final Conceptual Site Exhibit Plan, and the Final Conceptual Design Museum Plan were completed and provided to the Consulting Parties in January 2015. The Consulting Parties reviewed the report and plans and provided comments.

An MOA was signed by the US Department of Interior and DOE on November 10, 2015 (DOE 2015d), creating the new Manhattan Project Historic National Park. The K-25 Virtual Museum website (K-25 Virtual Museum 2015) was launched in conjunction with the signing of the MOA.

3.3.5 Clean Air Act Compliance Status

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, 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 2015. The ETTP ambient air monitoring program permitted source operations tracking and record keeping provided documentation fully supporting a 100% compliance rate.

3.3.6 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 2015, ETTP discharged to the waters of the state of Tennessee under the individual NPDES permit TN0002950, which regulates storm water discharges.

3.3.7 National Pollutant Discharge Elimination System Permit Noncompliances

In 2015, 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 2015 was 100%.

3.3.8 Safe Drinking Water Act Compliance Status

Since October 1, 2014, all water at the ETTP site is supplied by the City of Oak Ridge drinking water plant, located north of the DOE Y-12 Complex in Oak Ridge, Tennessee.

3.3.9 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. This amount includes hazardous waste generated under permitted activities (including repackaging or treatment residuals). At the end of 2015, ETTP had three generator accumulation areas for hazardous or mixed waste.

In addition, ETTP is permitted to store and treat hazardous and mixed waste under Resource Conservation and Recovery Act (RCRA) Part B Permit TNHW-165. Hazardous waste may be treated and stored at permitted locations in Building K-1423 and 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 the ORR CERCLA areas of concern and solid waste management units was also reissued on September 15, 2015, as a replacement for TNHW-121.

There was one RCRA generator or permit noncompliance in 2015. During the annual TDEC RCRA inspection, a used oil drum was observed at the K-1414 garage without the required "used oil" label. The label was immediately placed on the drum.

ETTP prepared and submitted to the TDEC Division of Solid Waste Management the 2015 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.

3.3.10 Resource Conservation and Recovery Act Underground Storage Tanks

Underground storage tanks (USTs) containing petroleum and hazardous substances are regulated under RCRA Subtitle I (40 CFR Part 280). EPA granted TDEC authority to regulate USTs containing petroleum under TDEC Rule 0400-18-01, *Underground Storage Tank Program*; however, EPA still regulates hazardous substance USTs. During 2015, operations of USTs at ETTP were in complete regulatory compliance.

3.3.11 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.

3.3.12 East Tennessee Technology Park RCRA-CERCLA Coordination

The *Federal Facility Agreement for the Oak Ridge Reservation* (FFA, DOE 2015a, 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.

3.3.13 Toxic Substances Control Act Compliance Status—Polychlorinated Biphenyls

On April 3, 1990, DOE notified EPA headquarters (as required by 40 CFR Part 761.205) 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 is regulated under EPA ID number TN0890090004. In 2015, ETTP operated eight PCB waste storage areas in ETTP generator buildings, and when longer term storage of PCB/radioactive wastes were necessary, RCRA-permitted storage buildings were used. ETTP operated one long-term PCB waste storage area at ETTP where non-radioactive PCB waste was stored in a facility that was not a RCRA-permitted storage facility. The continued use of authorized polychlorinated biphenyl (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. Most Toxic Substances Control Act (TSCA)-regulated equipment at ETTP has been disposed of. However, some ETTP facilities continue to use or store nonelectrical PCB-contaminated equipment for future reuse.

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 2012, ORR-PCB-FFCA), which became effective December 16, 1996, and was last revised on May 23, 2012. The modification in 2012 incorporated institutional controls at the TSCA Incinerator where limited areas of contamination remain in place at the facility after the facility closure actions were completed. The institutional controls will remain in place until future PCB cleanup actions, which will be addressed during CERCLA demolition actions.

The 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) each year per 40 CFR 761.180(a). 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.

3.3.14 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 require that facilities report inventories that exceed threshold planning quantities and releases of hazardous and toxic chemicals. The reports are submitted to the local emergency planning committee, and the state emergency response commission, and the local fire department. ETTP complied with these requirements in 2015 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 CERCLA and EPCRA, in 2015.

3.3.14.1 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 2015, 12 were located at ETTP. These chemicals were nickel metal, lead metal (including large lead acid batteries), sodium metal, diesel fuel, sulfuric acid (including large lead acid batteries), Chemical Specialties Ultrapoles, creosote-treated wood, unleaded gasoline, Sakrete Type S or N mortar mix, CCA Type C pressure-treated wood, Flexterra F6M Erosion Control Agent, and sodium chloride.

3.3.14.2 Toxic Chemical Release Reporting (EPCRA Section 313)

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. A Form R for each chemical must be submitted by July 1 of each year. DOE electronically submits annual TRI reports to EPA on or before July 1 of each year. The reports address releases of certain toxic chemicals to air, water, land, and waste management, recycling, and pollution prevention 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 2015, the only chemicals that met the reporting requirements were diisocyanates associated with foaming activity to stabilize deposits in pipes undergoing remediation actions.

3.4 Quality Assurance Program

3.4.1 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 independently of 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 2015, ETTP DOE EM operations were under UCOR responsibility for regulatory compliance.

3.5.1 Construction and Operating Permits

UCOR ETTP operations are subject to amended 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. UCOR initially had responsibility for five RICE units subject to permitting and therefore prepared and submitted permit applications. TDEC issued a Permit to Construct or Modify (967220P) with an effective date of August 22, 2013. The permit covered compliance demonstration requirements for four emergency generators and one fire water booster pump system. Due to installation issues associated with a new unit, a request to extend the expiration date of the permit was requested and granted by TDEC on June 26, 2014. Prior to the expiration date of the amended permit a second fire water booster pump system was to be transitioned from another contractor to UCOR. That contractor had not obtained the required permit for this unit. To assure full compliance by UCOR, a request for an operating permit was prepared and submitted to TDEC prior to the transition of this unit. The operating permit request included the addition of this fire water booster pump system. TDEC issued an operating permit (069346P) covering six RICE units on March 3, 2015. The current permit covers the six units through October 1, 2024.

Compliance for all units is demonstrated by following specified maintenance schedules, limiting hours of operations for nonemergencies to 100 h 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.

3.5.1.1.1 Control of Asbestos

ETTP's asbestos management program ensures all activities involving demolition and all other actions impacting asbestos-containing materials (ACMs) are fully compliant with 40 CFR Part 61, Subpart M. This includes using approved engineering controls and work practices, inspections, and monitoring for proper removal and waste disposal of ACMs. ETTP has numerous buildings and equipment that contain ACMs. Major demolition activities during 2015 involved the abatement of significant quantities of ACMs 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 2015, no individual non-CERCLA ETTP activity required a notification submittal. 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 2015, 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 ACMs occurred at ETTP during 2015.

3.5.1.1.2 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, including 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.

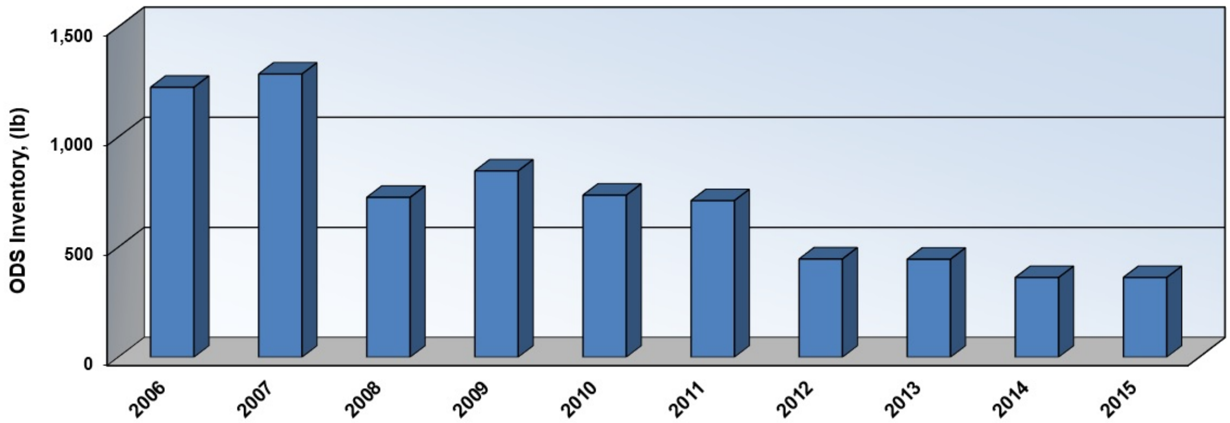

Fig. 3.7. East Tennessee Technology Park total on-site ozone-depleting substances inventory, 10-year history.

3.5.1.2 Fugitive Particulate Emissions

ETTP has been the location of major building demolition 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, as needed, to minimize airborne dusts caused by vehicle traffic.

3.5.1.3 Radionuclide National Emission Standards for Hazardous Air Pollutants

Radionuclide airborne emissions from ETTP are regulated under 40 CFR Part 61, National Emission Standards for Hazardous Air Pollutants (Rad-NESHAPs). 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 (ED) 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—the K-1200 Building South Bay, the K-1407 Chromium Water Treatment System (CWTS) Volatile Organic Compound (VOC) Air Stripper, and K-2500-H Segmentation Shops A, B, C, and D—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. Figure 3.8 provides a historical dose trend for the most impacted on-site member of the public. The increased dose impact during the fourth quarter of 2013 was coincidental to nearby major demolition activities. Over 80% of the dose during that period was due to ^{99}Tc (^{99}technetium). The isotopes (atoms of an element having the same number of protons in their nuclei but differing in the number of neutrons) of uranium dose contributions during this same period were consistent with historical variations. The results are based on actual ambient air sampling in a location conservatively representative of the on-site location.

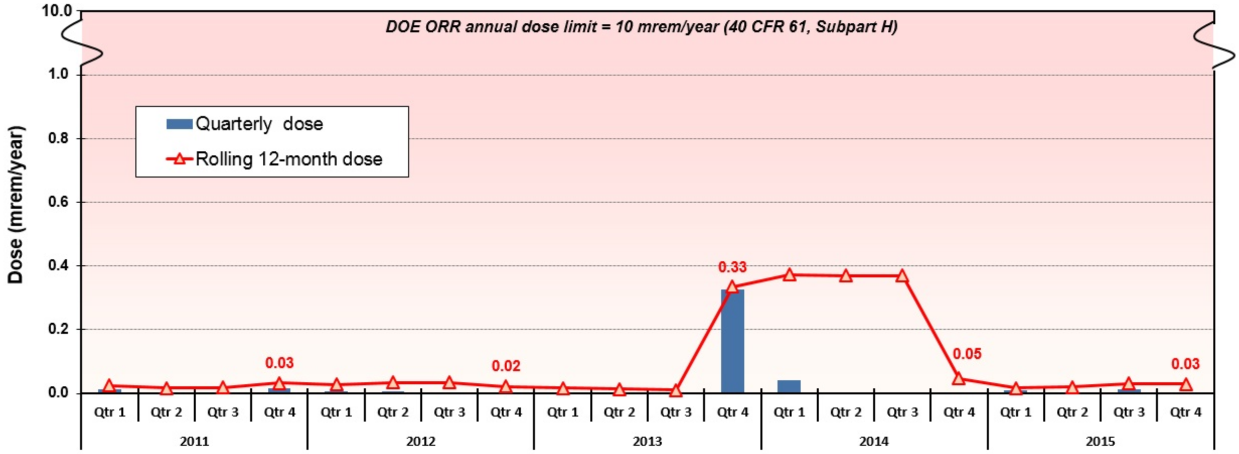

Fig. 3.8. East Tennessee Technology Park ambient air station K11 radionuclide monitoring results: 5-year rolling 12-month dose history up through 2015.
(DOE = US Department of Energy and ORR = Oak Ridge Reservation)

3.5.1.4 Quality Assurance

QA activities for the Rad-NESHAP program are documented in the *Quality Assurance Program Plan for Compliance with Radionuclide National Emission Standards for Hazardous Air Pollutants, East Tennessee Technology Park, Oak Ridge Tennessee* (UCOR 2015b, UCOR-4257). 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 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 2005a).

3.5.1.5 Greenhouse Gas Emissions

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

- carbon dioxide (CO_2),
- methane (CH_4),
- nitrous oxide (N_2O),
- hydrofluorocarbons,
- perfluorocarbons, and
- sulfur hexafluoride (SF_6).

A 2015 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 2015, 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 metric tons 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 3.9 shows the 5-year trend up through 2015 of ETTP total GHG stationary emissions. For the 2015 CY period, GHG emissions totaled only 118 metric tons.

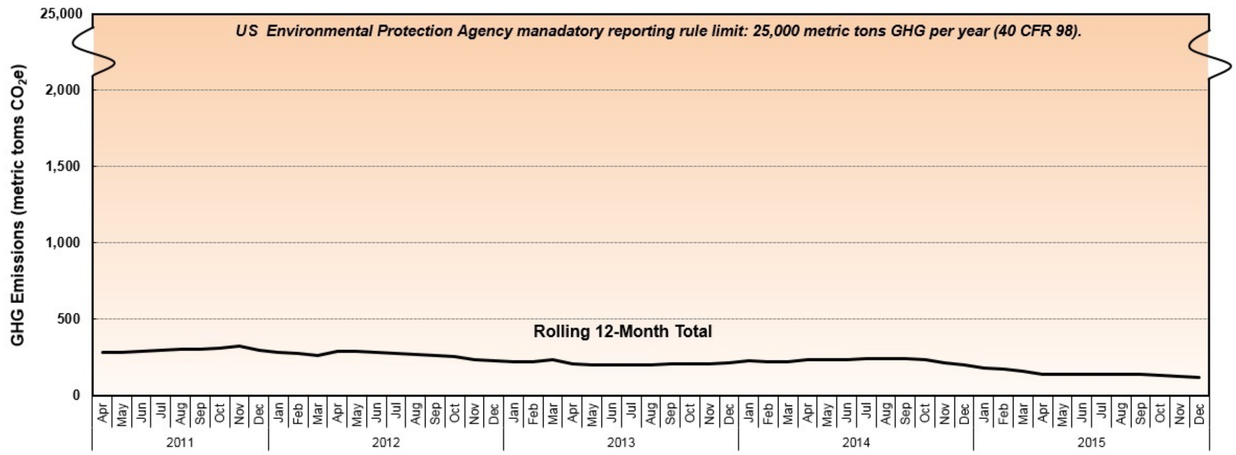

Fig. 3.9. East Tennessee Technology Park stationary source greenhouse gas (GHG) emissions tracking history *[in carbon dioxide equivalent (CO_2e)].*

Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance*, was signed by President Barak Obama on October 5, 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. Scope 1 is essentially direct GHG emissions from sources that are owned or controlled by a federal agency; Scope 2 encompasses GHG emissions resulting from the generation of electricity, heat, or steam purchased by a federal agency; and 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%, as compared to the 2008 baseline year.

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

The information reported here includes GHG emissions from the industrial landfills at Y-12 that are managed by UCOR. The landfills are not part of the contiguous ETTP site; however, DOE requested that UCOR 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 3.10 shows the trend toward meeting both the 28% total Scope 1 and 2 GHG emissions reduction target by FY 2020 and the 40% goal by FY 2025.

With respect to EO 13514, emissions for FY 2015 totaled 20,821 metric tons CO_2e, roughly 44% below the FY 2020 target level of 37,478 metric tons CO_2e and a 60% reduction to date compared to the 2008 baseline year level of 52,053 metric tons. When compared to the EO 13693 target, FY 2015 data show that the targeted 40% reduction has already been achieved by comparing the FY 2015 total of 20,821 metric tons to the 40% target level of 31,232 metric tons.

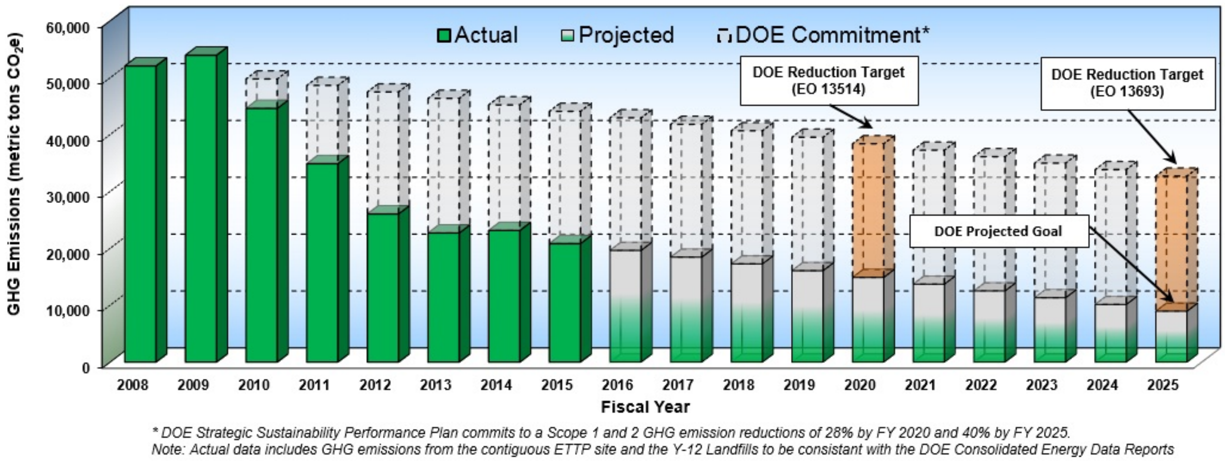

Fig. 3.10. East Tennessee Technology Park (ETTP) greenhouse gas (GHG) emissions trend and targeted reduction commitment *[in metric tons carbon dioxide equivalent (CO_2e)].*

Figure 3.11 shows the relative distribution and amounts of all ETTP FY 2015 GHG emissions for Scopes 1, 2, and 3. 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 FY 2015 was 25,867 tons, as compared to the 30,662 tons for FY 2014.

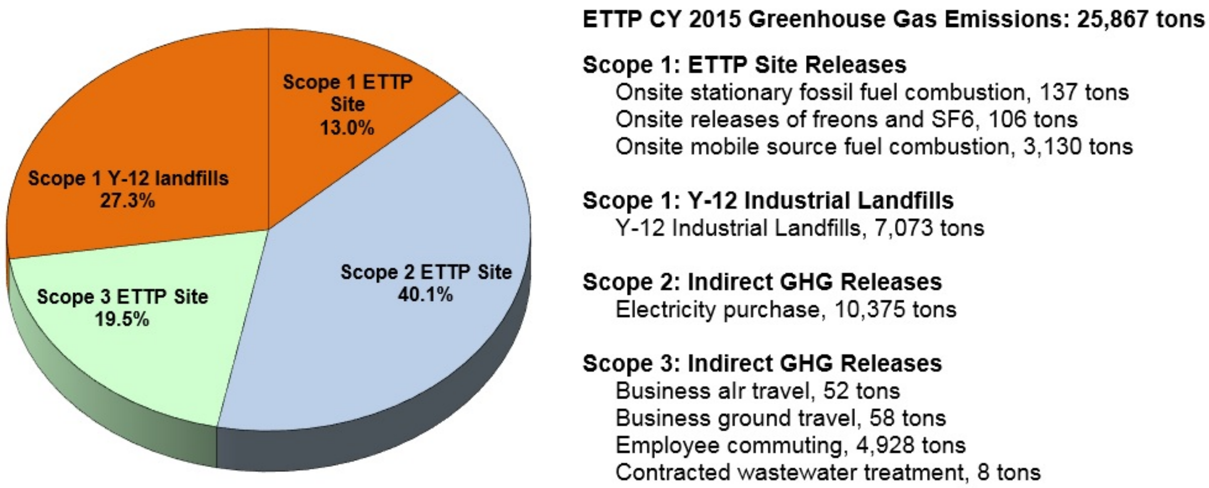

Fig. 3.11. CY 2015 East Tennessee Technology Park (ETTP) greenhouse gas (GHG) emissions by scope, as defined in Executive Order 13514.
(Y-12 = Y-12 National Security Complex ***and*** *SF6 = sulfur hexafluoride)*

3.5.1.6 Source-Specific Criteria Pollutants

Until July 1, 2011, ETTP operations included only one functioning stationary source with permit restrictions for any form of criteria air pollutant emissions: the Central Neutralization Facility (CNF) VOC air stripper. This permit was surrendered following an updated potential to emit review that identified air pollutant emissions to be below any regulatory requirement for permitting. During December 2011, the new CWTS began operations. 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 2015 for CWTS was only 0.012 ton/year as compared to an emission limit of 5 ton/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 permitting for existing and new stationary emergency generators powered by RICEs (i.e., emergency or e-RICEs). These amendments apply only to non-CERCLA e-RICEs. TDEC originally issued an amended construction permit for six on-site units. Four of the units are emergency generator engines (K-1007, K-1039, K-1095, and K-1652) and the remaining two units are the fire water booster pump engines (K-802 and K-1310-RW). The effective date of the permit was August 22, 2013, with a new expiration date of August 23, 2015. An application for an operating permit was prepared and submitted to TDEC dated September 26, 2014. TDEC issued an operating permit for the six e-RICE units with an effective date of March 3, 2015. The operating permit supersedes the construction permit with an expiration date of October 1, 2024.

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. The current permit specifies conditions that must be met to demonstrate compliance. These requirements include performing scheduled maintenance, record keeping, and tracking the runtimes of each of the five permitted units. Copies of all maintenance activities are provided for permit compliance review, and the runtimes are entered into spreadsheets to track against annual limits. Table 3.3 provides the number of hours of operations for each unit, up through December 31, 2015.

Table 3.3. East Tennessee Technology Park UCOR emergency reciprocating internal combustion engine air permit compliance demonstration, 2015

e-RICE Unit	Permit limits: Total hours/year = 100 Nonemergency hours/year = 50			
	PM Testing (hours/year)	Nonemergency (hours/year)	Total (hours/year)	Emergency (hours/year)
K-802	21.4	36.3	57.7	0
K-1007	6.1	23.0	29.1	0.5
K-1039	5.4	4.4	9.8	0.0
K-1095	6.0	0.5	6.5	0.0
K-1310-RW	0.0	0.0	0.0	0.0
K-1407[a]	5.9	0.2	6.1	3.8
K-1652	6.0	0.4	6.4	0.0

[a]K-1407 e-RICE operating under CERCLA and exempt from TDEC air emission permitting.

Acronyms

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
e-RICE = emergency reciprocating internal combustion engine
PM = particulate matter
TDEC = Tennessee Department of Environment and Conservation
UCOR = URS | CH2M Oak Ridge LLC

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.

3.5.1.7 Hazardous Air Pollutants (Nonradionuclide)

Unplanned releases of hazardous air pollutants are regulated through the risk management planning regulations under 40 CFR Part 68. To ensure compliance, periodic inventory reviews of ETTP operations were performed that used monthly data obtained through the ECPRA 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 ECPRA 311 monthly HMIS chemical inventories at ETTP with the risk management plan (RMP) 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 an RMP and to ensure 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, Sect. 112(r), "Prevention of Accidental Releases." The results of this review indicated that all RMP-listed chemicals were less than 1% of their specific trigger thresholds. Therefore, activities at ETTP are not subject to the rule. Procedures are in place 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 of air contaminant emissions from ETTP operations on ambient air quality.

The sampling stations in the ETTP area are designated as base, supplemental, or ORR perimeter air monitoring (PAM) stations. Figure 3.12 shows the locations of all ambient air sampling stations in and around ETTP that were active during the 2015 reporting period. Figure 3.13 shows an example of a typical ETTP air monitoring station.

The base program consists of two locations using high-volume, ambient air samplers. Supplemental locations are typically temporary, project-specific stations that use sampler's specific to a particular type of potential emissions. Historically, the project-specific samplers are the same high-volume systems used for the base program. All base, supplemental, and PAM samplers operate continuously with exposed filters collected weekly. The radiological monitoring results for samples collected at the two ETTP area PAM stations were provided by UT-Battelle staff and are included in the ETTP network for comparative purposes.

The analytical parameters were chosen with regard to existing and proposed regulations and with respect to activities at ETTP. Supplemental station K11 has originally deployed to demonstrate that radiological emissions from K-25 building demolition and remediation activities are in compliance with DOE dose limits to on-site members of the public. All K-25 demolition and debris removal was completed by the end of March 2014. The demolition and debris removal of the K-31 building began during October 2014 and was completed during August 2015. K11 remained a key sampling location regarding the potential

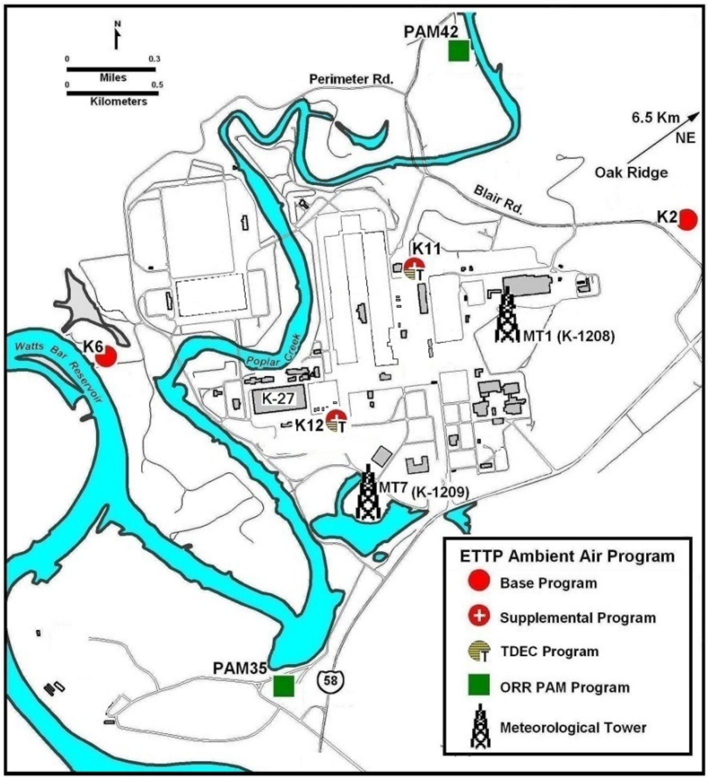

Fig. 3.12. East Tennessee Technology Park ambient air monitoring station locations.
(ETTP = East Tennessee Technology Park, MT = meteorological tower, ORR = Oak Ridge Reservation, PAM = perimeter air monitoring, TDEC = Tennessee Department of Environment & Conservation, and TSCAI = Toxic Substances Control Act Incinerator)

dose impact on the maximally exposed individual (MEI) that is a member of the public during the K-31 project. In preparation for the demolition of the K-27 building, a potential fugitive radionuclide emissions release was modeled to evaluate the dose impact on members of the public. This evaluation indicated that the MEI was in a direction and distance that was not within the current coverage by the ambient air program. To assure obtaining an applicable measurement of the dose impact on the MEI, a new supplemental sampling location (K12) was established. Station K12 began operating during October 2015 and K-27 demolition was started as planned in early 2016. The sampling results prior to the demolition will establish a baseline for tracking any measurable contribution during this project.

Changes of emissions from ETTP will warrant periodic re-evaluation 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 six months through a request for the most recent ETTP reindustrialization map.

Fig. 3.13. East Tennessee Technology Park ambient air monitoring station.

All base and supplemental stations collected continuous samples for radiological and selected metals analyses during 2015. Inorganic analytical techniques were used to test samples for chromium and lead. Radiological analyses of samples from the ETTP stations test for the isotopes ^{99}Tc, ^{234}uranium (^{234}U), ^{235}U, and ^{238}U; ORR station sampling results for ^{234}U, ^{235}U, and ^{238}U provided by UT-Battelle are included with the ETTP results.

Figures 3.14 and 3.15 illustrate the ambient air concentrations of chromium and lead for the past five years, based on quarterly composites of weekly continuous samples. All samples were analyzed by the inductively coupled plasma-mass spectrometer (ICP-MS) analytical technique. The results are compared with applicable air quality standards for each pollutant. The annualized levels of chromium and lead during 2015 were well below the indicated annual standards. Stations K6 and K11 are in the prevailing topography influenced directions to the major demolition and remediation activities on the site and generally showed slightly higher annual chromium and lead ambient air concentrations during 2015, as compared to the other sampling locations. Following the completion of the K-31 project, the downward trend for chromium during the fourth quarter of 2015 is approaching typical background levels for this pollutant. All chromium results are compared to the more conservative hexavalent chromium annual risk-specific dose standard. K11 sampling results for lead have historically trended higher and have been more variable compared to the other stations due to its close proximity to major demolition sites and the service roads for transport and other demolition machinery.

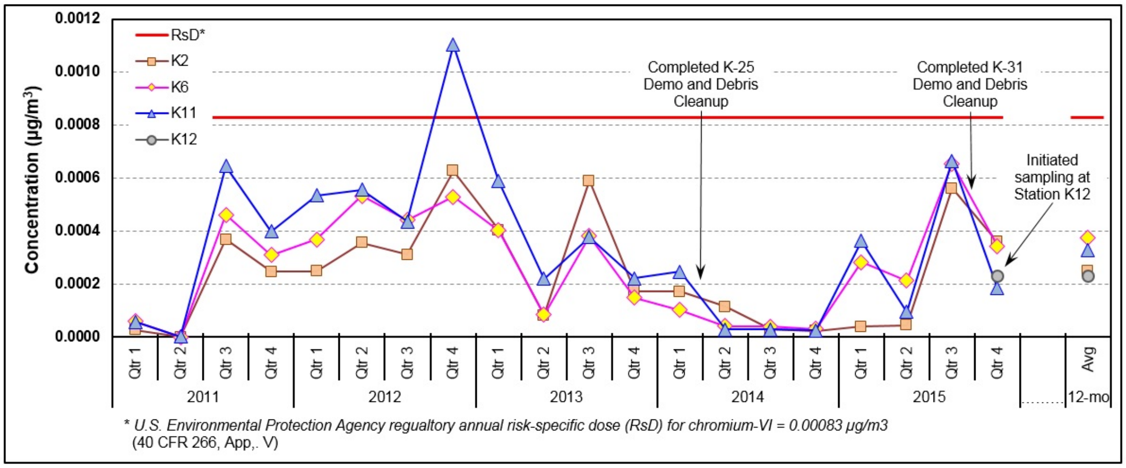

Fig. 3.14. Chromium monitoring results: 5-year history through December 2015.

(Demo = demolition)

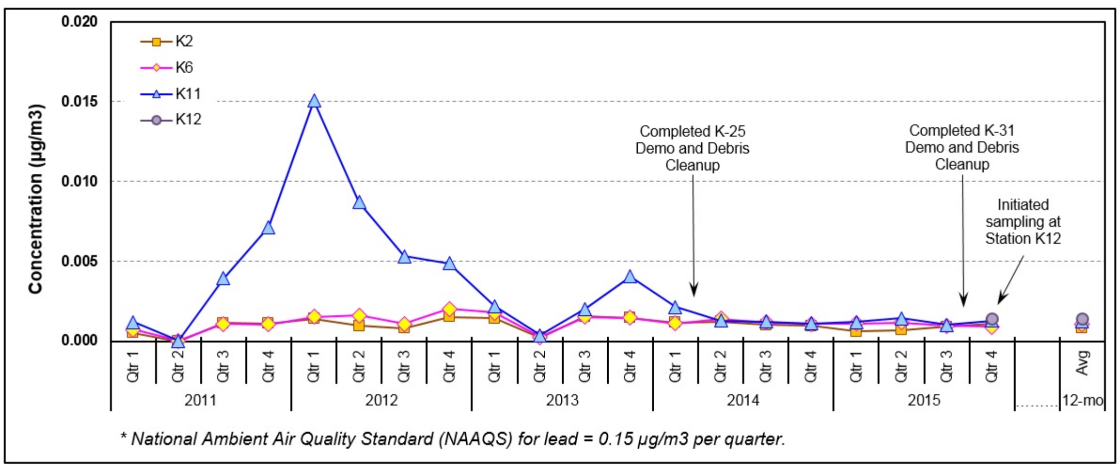

Fig. 3.15. Lead monitoring results: 5-year history through December 2015.

(Demo = demolition)

Quarterly radiochemical analyses are performed on composite samples collected at all stations. The selected isotopes of interest were ^{99}Tc, ^{234}U, ^{235}U, and ^{238}U. The concentration and dose results for each of the nuclides are presented in Table 3.4 for the 2015 reporting period.

Table 3.4. Radionuclides in ambient air at East Tennessee Technology Park, January 2015 through December 2015

Station	Concentration (µCi/mL)				
	^{99}Tc	^{234}U	^{235}U	^{238}U	Total
K2	9.10E-16	3.63E-18	6.44E-20	2.43E-19	9.13E-16
K6	1.10E-15	5.34E-18	6.72E-19	7.60E-19	1.10E-15
K11	1.07E-15	1.92E-18	7.36E-19	1.57E-18	1.07E-15
K12	6.39E-16	ND[a]	6.58E-19	ND	6.40E-16
40 CFR Part 61, Effective Dose (mrem/year)					
K2	0.027	<0.001	<0.001	<0.001	0.027
K6	0.033	<0.001	<0.001	<0.001	0.033
K11[b]	0.029	<0.001	<0.001	<0.001	0.029
K12[c]	0.002	ND	<0.001	ND	0.002

[a]ND = Not detected.
[b]On-site business receptor location.
[c]Station K12 began operating during October 2015.

The annual dose impact, as listed in Fig. 3.16, shows that Stations K2, K6, and K11 have equivalent results in 2015. The dose based on Station K12 data is only for the fourth quarter of 2015 and would represent an exposure only during that period of time. Overall, the highest dose impact on the hypothetically MEI of the public was approximately 0.03 mrem, as compared to the annual limit of 10 mrem. This exposure assumes a person resides or abides at the location of the sampling locations. The most significant dose-contributing isotope was ^{99}Tc.

Figure 3.16 is a historical summary chart of dose calculation results. Each data point represents the accumulated dose over the previous four quarterly sampling periods. The highest potential dose impact for an individual over the most recent five years and working in the vicinity of Station K11 would only be 0.37 mrem, as compared to the annual limit of 10 mrem. The on-site location of Station K11 was in close proximity to major demolition and debris removal activities that impacted radiologically contaminated materials. The primary dose contributing isotope during that time was ^{99}Tc. All data continue to show potential exposures, which are all well below the 10 mrem annual dose limit.

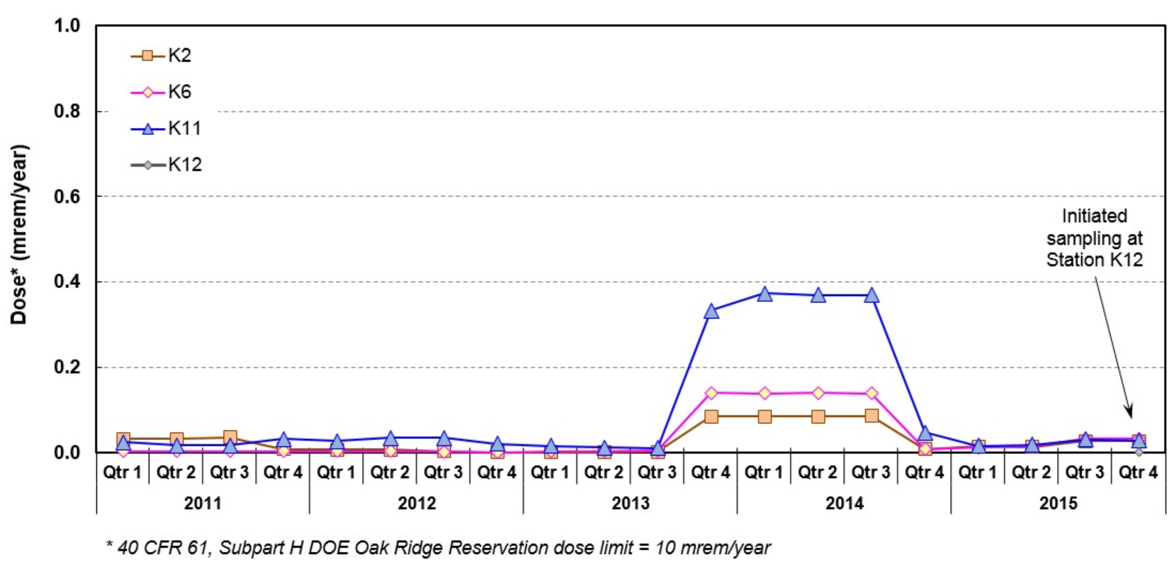

Fig. 3.16. Dose impact results: 5-year history through December 2015.

3.6 Water Quality Program

3.6.1 NPDES Permit Description

From January through March of CY 2015, ETTP was covered by an NPDES permit that was issued on April 1, 2010. This NPDES permit expired on March 31, 2015. On April 1, 2015, a new NPDES permit became effective at ETTP. The new permit will expire on March 30, 2020.

Under the permit that was in effect during January through March 31, 2015, there were 108 NPDES-permitted storm water outfalls at ETTP. As part of the NPDES permit in effect during that time period, these storm water outfalls were listed in two groups based on the types of flows being discharged through the outfalls. A total of 32 storm water outfalls were sampled as being representative of these groups.

The Group I storm water outfalls flow on an intermittent basis. These outfalls receive storm water runoff from minor site industrial operation areas that do not have a significant potential to contain contaminants. Effluent from Group I outfalls was considered to pose little or no threat of containing significant pollutants. Representative Group I outfalls were sampled on a semiannual basis for TSS, pH, and flow.

Many of the Group II storm water outfalls flow on a continuous basis. These outfalls receive storm water runoff from site industrial operations where there is a higher potential for contamination. These areas include storage areas, outside radiological areas, and other areas that pose a risk of potential contamination. These outfalls may also receive effluents described for Group I storm water outfalls. Representative Group II outfalls were sampled on a semiannual basis for oil and grease (O&G), TSS, pH, and flow.

In addition to the routine sampling of Group I and Group II outfalls, several outfalls were also sampled for mercury on a quarterly basis. The outfalls that were sampled for mercury included outfalls 170, 180, 190, and 05A. In addition, outfall 170 was also sampled on a quarterly basis for total chromium and hexavalent chromium. A Storm Water Pollution Prevention (SWPP) program was also required by this NPDES permit, but very few specific guidelines for conducting this program were included in the permit.

As part of the requirements of the current NPDES permit, storm water outfalls were no longer divided into two groups based on the types of flows being discharged through the outfalls. All outfalls were combined into a single group. A total of 27 representative outfalls are monitored on an annual basis for O&G, TSS, pH, and flow. Outfall 170 is monitored on a quarterly basis for total chromium and hexavalent chromium. Screening levels for many parameters are set at a fraction of the NPDES permit limits or AWQC, and are used by the laboratory to flag data that indicate additional scrutiny may be warranted.

The current NPDES permit also contains very specific language in relation to activities to be conducted as part of the ETTP SWPP Program. Sampling to be performed under the SWPP Program include the following:

> For bioaccumulative pollutants such as mercury that are found at ETTP, a long-term monitoring of pollutant loadings (known as flux) will be conducted as part of the current NPDES permit. This flux monitoring includes:
>
> a. Flow Monitoring
> Selected outfalls to include outfalls 100, 170, 180, and 190, will utilize field installed flow meters to gauge flows for three ranges of rainfall events at least once during the permit term at each outfall:

i. 0.1 – 0.5 inch rain event
ii. 0.5 – 1.5 inch rain event
iii. 1.5 inch or greater rain event

These flows will be utilized to compare against flows generated using the Natural Resources Conservation Service (NRCS) Technical Report-55 (TR-55), which is the current flow modeling technique utilized at ETTP. These compared values will be utilized to increase the accuracy of the TR-55 flow modeling process. Given that the flow monitoring will occur over a variety of rain events and multiple field variables can pose problems in collecting usable data, this monitoring shall be completed anytime during the permit period.

b. Mercury Monitoring
Mercury will be sampled at outfalls 180 and 190 using the flow weighted sampling technique. Specific guidelines on how these samples will be collected will be included as part of upcoming SWPP Program Sampling and Analysis Plans (SAP).

c. Flux calculation
Flow monitoring results will be used to calibrate the variable inputs to the TR-55 flow modeling process employed at ETTP. This calibrated flow model will be used with the flow paced mercury sampling results to determine mercury flux at the respective outfalls.

Also included as part of this ETTP NPDES permit, bioaccumulation monitoring will be utilized at selected locations. The bioaccumulation task will include monitoring of caged clams (*Corbicula fluminea*) placed at selected locations around ETTP and the collection and analysis of fish from Mitchell Branch (a small creek that runs roughly east to west along the northern part of ETTP) and the three major pond sites on ETTP. Both clams and fish from uncontaminated off-site locations are also analyzed as points of reference. The primary contaminants of concern (COC) for bioaccumulation monitoring at ETTP will be PCBs and mercury.

In addition, semi-permeable membrane devices (SPMDs) may also be utilized to determine the bioaccumulation of PCBs. SPMDs are used as bioaccumulators of lipophilic environmental contaminants in aqueous media. These devices mimic biological systems to provide a measure of bioavailable pollutants in water. Its passive transport mechanism is similar to that of chemical transport through fish gills. Data from these investigations will be provided to the CERCLA cleanup program for use in making decisions on-site cleanup activities.

Storm water samples will be collected at locations that will be affected by remedial action activities prior to the initiation of these activities in order to determine the conditions present before remediation begins. In addition, storm water samples will be collected at potentially affected outfalls and storm water catch basins after remedial activities have been undertaken, and after they have been completed to help gauge the potential effectiveness of the remediation efforts.

a. The results of the monitoring effort at the D&D sites will be utilized in determining the effectiveness of best management practices (BMP) developed by the DOE Environmental Management program to control off-site releases of legacy pollutants.

b. Periodic monitoring will be performed as part of the ETTP SWPP Program to monitor the continued effectiveness of the chromium collection system.

Sampling required for the completion of the NPDES permit application will be conducted as part of the ETTP SWPP Program. The application for this permit renewal is required to be submitted to TDEC by October 2019, to allow TDEC 180 days to review it prior to permit expiration on March 31, 2020. Additionally, DOE will require time to review the permit application before it is submitted to TDEC. Based on previous TDEC guidance, composite samples will be collected as time-weighted composites due to the short travel time and site conditions within the watersheds. Monitoring will be conducted to ensure all required samples are collected to complete the EPA Form 2E and EPA Form 2F. The following sampling will be conducted:

i. Representative outfalls meeting the requirements to complete an EPA Form 2E will be sampled as follows. Parameters that are required to be collected by grab sample per analytical method or regulatory guidance, will be collected as a grab sample only. All other parameters required to be sampled will be collected as time weighted composites only.

ii. Representative outfalls will be sampled to ensure completion of EPA Form 2F Section VII. Discharge Information, Parts A, B, and C as follows:

   a) Part A – Parameters required to be sampled for Part A will be collected as required. Oil & grease, total nitrogen, total phosphorus, and pH will be sampled as grab samples per EPA guidance. Biochemical oxygen demand, chemical oxygen demand, and TSS will be collected as either grabs or time weighted composites.

   b) Part B – At ETTP, all facilities generating process wastewater have been closed and the respective NPDES permits are expired. Therefore, ETTP is no longer subject to any effluent guidelines and there are no sampling requirements under part B at any stormwater outfall at ETTP.

   c) Part C – Each representative stormwater outfall will be sampled only for pollutants that could potentially be present based on the characteristics and uses of the drainage area for that outfall and are shown in Tables 2F-2, 2F-3, and 2F-4. Based upon historical site knowledge and analytical monitoring results, metals, mercury, and PCBs will be collected from all representative outfalls. In addition, each representative outfall will be evaluated, and volatile organic compounds (VOC), radionuclides, and other select parameters will be collected from the representative outfalls as required.

   d) Parameters selected to be sampled for Part C that are required to be collected by grab sample per analytical method or regulatory guidance, will be collected as a grab sample only. All other parameters selected to be sampled for Part C will be collected as time weighted composites only.

Investigative sampling will be performed as part of the ETTP SWPP Program. This includes sampling of storm drain networks for bioaccumulative parameters and investigations triggered by analytical results, CERCLA requirements, changes in site conditions, etc.

Storm water sampling results will be 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 East Tennessee Technology Park Storm Water Pollution Prevention Program

All storm water samples collected as part of the ETTP SWPP Program sampling effort were collected according to guidelines stated in the Sampling and Analysis Plan (SAP), *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan, Oak Ridge, Tennessee* (UCOR-4028, UCOR 2015).

3.6.2.1 Radiological Monitoring of Storm Water Discharges

ETTP conducts radiological monitoring of storm water discharges to determine compliance with applicable dose standards. ETTP also applies the as low as reasonably achievable 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 SWPP Program sampling efforts. Analytical results are used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system.

As part of the ETTP SWPP SAP, storm water samples were collected from discharges resulting from a storm event greater than 0.1 in. that occurred within a time period of 24 h or less and that occurred at least 72 h after any previous rainfall greater than 0.1 in. in 24 h. Composite samples were collected at each outfall using Isco™-automated sampling equipment. The composite samples consisted of at least three aliquots taken during the first 60 min of a storm event discharge. Samples composited by time (equal volume aliquots collected at a constant interval) were used. Outfalls 292 and 380 were sampled under these conditions.

Changes were made in the ETTP SWPP SAP regarding the conditions in which radiological monitoring samples are collected. Specified samples are to be collected from discharges resulting from a storm event greater than 0.1 in. that occurred within a time period of 24 h. No specified dry period is required before the samples may be taken. A series of at least three manual grab samples of equal volume will be collected during the first 60 min of a storm event discharge and combined into a composite sample.

Table 3.5 contains information on the outfalls that were sampled for radiological discharges. Table 3.6 contains the results of this sampling effort. Table 3.7 lists the activity levels of each of the major isotopes that were discharged from the ETTP storm water system in 2015.

Table 3.5. Storm water composite sampling for radiological discharges

Storm water outfall	Gross alpha/ gross beta (composite sample)	U isotopic (composite sample)	^{99}Tc (composite sample)
150	X	X	X
195	X	X	X
198	X	X	X
250	X	X	X
280	X	X	X
292	X	X	X
294	X	X	X
350	X	X	X
360	X	X	X
380	X	X	X
660	X	X	X
930	X	X	X

Table 3.6. Analytical results for radiological monitoring at ETTP storm water outfalls in 2015

Parameter	Screening Level	Outfall 150	Outfall 195	Outfall 198	Outfall 250	Outfall 280	Outfall 292	Outfall 294	Outfall 350	Outfall 360	Outfall 380	Outfall 660	Outfall 930
Alpha activity (pCi/L)	10	0.255 U	3.74 U	-0.663 U	-0.911 U	6.28	**92.8**	**21.8**	**18.6**	**46.8**	**30.35**	1.49 U	-1.52 U
Beta activity (pCi/L)	30	1.44 U	22.6	0.13 U	5.23 U	7.44	**40.5**	19.6	9.74	25.7	25	3.43	1.34 U
^{99}technetium (pCi/L)	1760	-1.84 U	28.8	1.36 U	-0.321 U	4.82 U	46.2	21	0.096 U	12.4	19.8	0.503 U	1.64 U
Total uranium (µg/L)	none	0.607 U	6.76	0.87 U	0.378 U	3.57	211	21.8	14.2	39.7	32.45	3.29	1.24 U
$^{233/234}$uranium (pCi/L)	28	0.305 U	3.94	0.271 U	0.128 U	2.61	**102**	10.2	9.06	23.9	12.7	1.27	0.264 U
$^{235/236}$uranium- (pCi/L)	29	0.0269 U	0.171 U	0.142 U	0.0437 U	0.243 U	7.75	0.84	0.579	1.54	0.578	0.155 U	0.066 U
^{238}uranium (pCi/L)	30	0.2 U	2.25	0.271 U	0.12 U	1.16	**69.8**	7.21	4.67	13.1	10.8	1.08	0.406 U

BOLD indicates screening level exceeded.

Table 3.7. Radionuclides released to off-site waters from the ETTP storm water system in 2015 (Ci)

Isotope	U-234	U-235	U-238	^{99}Tc
Activity level	0.0048	0.00039	0.0024	0.83

Screening criteria for gross alpha and gross beta radiation and for $^{233/234}$U and ^{238}U were exceeded at outfall 292. Screening criterion for gross alpha radiation was exceeded at outfall 294. Outfalls 292 and 294 receive storm water runoff from a radiologically-contaminated area on the K-1064 peninsula where uranium hexafluoride (UF_6) converter shells were once stored. The converter shells were removed from this area several years ago as part of the K-1064 peninsula D&D program. Discharges from this outfall have historically contained radiological contaminants at levels above screening criteria.

At outfalls 360, 350 and 380, screening criteria for gross alpha radiation were exceeded. Outfall 350 receives runoff from the former K-1066-D yard, where UF_6 cylinders were once stored. Outfall 360 once received runoff from the K-1031 building, which was demolished several years ago. Building K-1031 served as a storage facility for equipment utilized in the removal and recovery of uranium from contaminated equipment. Outfall 380 receives storm water runoff from the north side of the K-27 building, as well as from the former K-1231 and K-1232 areas. These facilities were utilized in the production and/or handling of UF_6, so the presence of elevated gross alpha radiation in storm water runoff from these areas was likely.

No screening criteria were exceeded at outfalls 150, 195, 198, 250, 280, 660, or 930.

3.6.2.2 Decontamination and Decommissioning of the K-25 Building

Final D&D activities were completed for the K-25 building in July 2014. To assess any ongoing impacts the remaining building slab will have on the quality of the storm water runoff, monitoring will be performed on an annual basis. Runoff samples were collected at outfall 490 to monitor east wing slab runoff; runoff from Outfall 334 was sampled to monitor west wing slab runoff, and Outfall 230 was sampled to monitor north end slab runoff.

Because sampling of the K-25 building slab runoff required a fairly heavy and intense downpour, samples were collected when runoff was sufficient to allow all of the samples for the given analytical parameters to be collected, regardless of the amount or intensity of the rainfall event. All of the samples collected as part of this effort were taken using the manual grab sampling method. Manual grab samples were collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA’s *NPDES Storm Water Sampling Guidance Document* (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor.

Table 3.8 provides information on the locations and parameters that were sampled.

Table 3.8. Storm water sampling for the K-25 Building slab runoff

Sampling Events for all locations	Sampling location	Gross alpha/beta	U Isotopic, ^{99}Tc[a]	PCBs[b]	Metals[c]/ Mercury	TSS
Annually	West wing (outfall 334)	X	X	X	X	X
	East wing (outfall 490)	X	X	X	X	X
	North tower (outfall 230)	X	X	X	X	X

[a] U Isotopic analysis includes: $^{233/234}$U, $^{235/236}$U, and ^{238}U.
[b] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
[c] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
PCBs = polychlorinated biphenyls
TSS = total suspended solids

Samples were collected at outfalls 230 and 490 in September 2015. Samples were collected at outfall 334 in November 2015. Results over screening levels are shown in Table 3.9.

Table 3.9. Analytical results over screening levels for Building K-25 D&D annual slab runoff monitoring in 2015

Sampling location	PCB-1260 (µg/L)	Lead (µg/L)
SCREENING LEVEL	**Detectable**	**1.8**
Outfall 230	0.87	
Outfall 490		3.57

D&D = decontamination and decommissioning
PCBs = polychlorinated biphenyls

In order to collect data for trend graphs to be reported in the Remediation Effectiveness Report (RER) and the ASER, and to collect data comparable to information that is being gathered by TDEC on an ongoing basis, concurrent samples were collected in June and August 2015 at outfall 490 and at the K-1007-B weir and analyzed for ^{99}Tc. The June 2015 samples were collected during a rain event of 0.86 in. The August 2015 samples were collected during dry weather conditions. Data from these sampling events are shown in Table 3.10.

Table 3.10. Concurrent ^{99}Tc sampling at outfall 490 and the K-1007-P1 pond

Sampling location	^{99}Tc* (pCi/L) 5/11/15	^{99}Tc* (pCi/L) 6/1/15	^{99}Tc* (pCi/L) 8/13/15
SCREENING LEVEL	**1760**	**1760**	**1760**
Outfall 490	687	443	396
K-1007-P1 pond	Not Sampled	29.1	Not Sampled

*^{99}Tc results are provided as a reference. They do not exceed screening criteria.
^{99}Tc = ^{99}technetium

The data indicate that discharges from outfall 490 containing elevated levels of ^{99}Tc are greatly attenuated by the K-1007-P1 pond. Therefore, discharges from the K-1007-P1 pond to Poplar Creek contain only a small amount of ^{99}Tc.

In the future, the concurrent sampling for ^{99}Tc at outfall 490 will be conducted each time samples are collected at the P1 pond.

In addition to the routine ^{99}Tc sample to be collected at outfall 490, a sample for ^{99}Tc will be collected at outfall 190 each time a quarterly mercury sample is collected at this outfall (see Section 2.3.1). 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 3.11 contains information on this monitoring effort.

Table 3.11. Quarterly ^{99}Tc sampling at outfall 190

Sampling location	^{99}Tc* (pCi/L) 5/11/15	^{99}Tc* (pCi/L) 8/3/15	^{99}Tc* (pCi/L) 11/2/15
SCREENING LEVEL	**1760**	**1760**	**1760**
Outfall 190	27.7	14.4	15.9

*^{99}Tc results are provided as a reference. They do not exceed screening criteria.
^{99}Tc = ^{99}technetium

From this data, it does not appear that ^{99}Tc contaminated groundwater is discharging into Mitchell Branch via storm water outfall 190.

3.6.2.3 Decontamination and Decommissioning of the K-31 Building

The K-31 building was placed in operation in 1951 for the isotopic enrichment of uranium by gaseous diffusion and was shut down in 1985. The two-story building was approximately 1200 × 622 ft and stood 67-ft tall. The building spanned a 17-acre footprint. It was comprised of six building units (K-602-1 through K-602-6) and was built of steel with cement/asbestos composite siding, concrete floors, steel structural supports, and a built-up roof. Building K-31 was used to enrich uranium for defense and power generation purposes until it was shut down in 1985. After 1985, all process and non-process equipment, with the exception of 12 overhead cranes, was removed and portions of the facility decontaminated. In 2005, most of the hazardous materials were removed from the building's interior.

Demolition of the K-31 building at ETTP began October 8, 2014. This demolition marked the removal of the fourth of five gaseous diffusion buildings at ETTP. The decontamination and decommissioning (D&D) of K-31 included several SWPP controls in addition to or supplementing the general controls identified in UCOR-4255, *East Tennessee Technology Park Storm Water Pollution Prevention Program Baseline Document* (UCOR 2016a). These controls were best management practices developed to minimize pollutant loading in storm water runoff.

- The demolition area utilized berms around the demolition area to control runoff/run on.
- Berms utilizing liner material were constructed with a liner made of high-density polyethylene with a minimum thickness of 10 mil; liner sections were overlapped approximately 12 in. and adhered with manufacturer/supplier-recommended adhesive.
- Certain portions of bermed areas were constructed of earthen materials, such as gravel or crusher run.

Several storm water catch basins in the Building K-31 drainage area were protected with sediment filtration and oil-absorbent control devices and coir matting. Sediment control measures were modified as D&D activities were conducted based on monitoring results and inspections.

In order to closely monitor the storm water runoff from the K-31 building demolition activities, sampling has been performed throughout the demolition process, as shown in Table 3.12. On April 7, 2014, pre-demolition samples were collected to provide baseline data for conditions present before demolition began. Outfalls 510 and 560, which discharge to the south into Poplar Creek, and Outfall 610, which discharges to the east into Poplar Creek, were sampled as part of this effort. Samples have also been collected at outfalls 510, 560, and 610 after each rainfall event of 1 in. or more. Table 3.13 indicates the dates these samples were collected and the parameters that were detected above screening levels.

In addition to storm water runoff sampling at outfalls 510, 560, and 610, samples were collected in Poplar Creek at the K-1250-2 and K-1250-4 bridges, which are downstream of the K-31 D&D activities. The K-1250-2 Bridge was utilized as a sampling location for Poplar Creek for the K-31 D&D project on January 12, 2015. Subsequent sampling of Poplar Creek for the K-31 D&D project were collected at the K-1250-4 Bridge. No results over screening criteria were detected in samples from Poplar Creek that were collected at the K-1250-2 Bridge. Mercury results from samples from Poplar Creek that were collected at the K-1250-4 Bridge exceeded screening criteria (25 ng/L) on several occasions. The mercury detected at these locations is believed to be due to historical releases of mercury from past Y-12 Plant operations into East Fork Poplar Creek, which discharges into Poplar Creek north of ETTP. None of the other analytical data collected as part of this sampling effort exceeded screening levels.

All storm water samples collected as part of this SWPP Program sampling effort were manual grab samples. Manual grab samples were collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA’s *NPDES Storm Water Sampling Guidance Document* (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor.

Demolition of the last portion of the K-31 building was completed in June 2015. Sampling performed upon completion of the D&D activities was conducted in July 2015. Analytical results from this sampling effort are shown in Table 3.13. No additional sampling will be performed as part of the D&D of the K-31 building.

Table 3.12. Storm water sampling to support D&D of the K-31 building

Sampling location	Sampling frequency	pH	Gross alpha /beta	U Isotopic, ^{99}Tc	PCBs[a] (individual aroclors and total PCBs)	Metals[b]/ Mercury	Hexavalent chromium
Outfall 510*	After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Outfall 560	After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Outfall 610	After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Poplar Creek at K-1250-2 bridge	After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X
Poplar Creek at K-1250-4 bridge	After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities	X	X	X	X	X	X

[a] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Total PCBs will also be reported as part of the analytical data package.
[b] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
*As described in Section 2.2.3, analytical results from samples collected at outfall 510 will be utilized for both the K-31 building D&D and the K-761 Switch House D&D.
D&D = decontamination and decommissioning
PCBs = polychlorinated biphenyls

Table 3.13. Results over screening levels for Building K-31 D&D monitoring

Sampling Location	pH	Gross Alpha	Gross Beta	^{99}Tc*	Arsenic	Copper	Lead	Selenium	Zinc	PCB-1254	PCB-1260	PCB-1268	Total Chromium	Hexavalent Chromium	Mercury
		(pCi/L)	(pCi/L)	(pCi/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(µg/L)	(ng/L)
Screening Level	**>8.5, <6.5**	**10**	**30**	**1760**	**7.5**	**7**	**1.8**	**3.8**	**75**	**Detectable**	**Detectable**	**Detectable**	**75**	**8**	**25**
OUTFALL 510**															
4/7/2014						8.32									
3/4/2015	8.8		86.5	95.6		10.8				0.0765	0.0931	0.084	186	170	
4/15/2015			30.5	39.1		9.48	4.95				0.0683		76.9	60	
6/2/2015			35	39.4		8.78	3.82								
7/14/15		14	34.2	19.5		12.8	10.1		112						
7/21/15		11.7													
OUTFALL 560															
4/7/2014															
1/12/2015		12.7	62.7	83.6	10.1	24.3	30.8		236	0.157	0.235	0.371	95.7	51	43.6
3/4/2015		16.5	103	136		19.7				0.0733	0.0792	0.0534	258	230	
4/15/2015	8.9		49.2	65.7		17.7	9.54		83.8	0.251	0.228	0.119	121	101	
7/15/15															30.4
OUTFALL 610															
4/7/2014															
11/17/2014			39.2	58.5		21	8.74	11.2	107		0.0469	0.361	452	440	
1/12/2015										0.0599	0.0818	0.115		26	
3/4/2015							3.45					0.06		15	
4/15/2015												0.0836			
K-1250-2 Bridge															
1/12/15															
K-1250-4 Bridge															
3/4/15															248
4/15/15															172
6/2/15															54.7
7/14/15															45.8
7/21/15															46.2

Except for ^{99}Tc, only results exceeding screening criteria are shown. All ^{99}Tc results are below screening criteria and are shown as a reference for gross beta radiation levels. Non-detect results for ^{99}Tc are not shown.
**As described in Section 2.2.3, analytical results from samples collected at outfall 510 will be utilized for both the K-31 building D&D and the K-761 Switch House.
D&D = decontamination and decommissioning PCBs = polychlorinated biphenyls ^{99}Tc = ^{99}technetium

3.6.2.4 Decontamination and Decommissioning of the K-761 Switch House

The K-761 building, also known as the K-31 substation, operated from 1952 through 1985. It transferred electrical power from overhead transmission lines to the K-31 cascade. K-761 was a multistory building that included a basement, first floor, mezzanine, and a second floor. The building measured approximately 306 ft by 57 ft with an 8-ft basement and was made of brick, tile wall, and reinforced concrete. Runoff from the K-761 area discharges to Poplar Creek via storm water outfall 510.

Since the K-761 Switch House and the K-31 building were demolished concurrently in 2015, samples collected at outfall 510 provided analytical data for both D&D projects. The analytical parameters collected as part of the K-761 Switch House sampling effort are presented in Table 3.14. These parameters are the same as those collected for the K-31 D&D sampling effort.

Pre-demolition monitoring was conducted at outfall 510. Monitoring and samples have been collected at that location after each rainfall event of 1 in. or more, as D&D activities were being conducted in order to closely monitor the storm water runoff from the K-761 Switch House building demolition activities. Additional sampling will be conducted at outfall 510 after all building debris from the K-761 demolition area and the remaining building slab has been removed.

3.6.2.5 Decontamination and Decommissioning of the K-892 Pumphouse

The K-892 Pumphouse was built in 1954 to pump treated water for the K-33 recirculating cooling water (RCW) system. The building consisted of three sections. One section contained water treatment chemical tanks and feed equipment. A second section contained RCW pumps, piping, and valves. A third section contained electrical transformers, diesel fuel, and chemical storage tanks. D&D activities were completed at the K-892 Pumphouse in 2015.

As shown in Table 3.19, initial sampling was performed on January 12, 2015, to provide baseline data for conditions present before demolition began. Sampling was also performed on May 4, 2015, during demolition activities after a rainfall event of more than 1 in. in a 24-h period. Additionally, sampling was performed on April 15, 2015, after D&D activities were completed.

Table 3.14. Storm water sampling for the D&D of the K-892 Pumphouse

Sampling location	Sampling frequency	pH	Gross alpha/beta	U Isotopic, ^{99}Tc, transuranics[a]	PCBs[b]	Metals[c]/ Mercury	Hexavalent chromium
Outfall 690	Prior to initiation of building demolition activities. After each rainfall event of 1″ or greater in a 24-h period. Upon completion of D&D activities.	X	X	X	X	X	X

[a] Transuranics analysis includes: ^{237}Np, ^{238}Pu, and $^{239/240}$Pu.
[b] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
[c] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
D&D = decontamination and decommissioning PCBs = polychlorinated biphenyls ^{99}Tc = ^{99}technetium

Table 3.15. K-892 Pumphouse D&D - analytical results that exceeded screening levels

Sampling Location	Lead (µg/L)	PCB-1254 (µg/L)
SCREENING LEVEL	**1.8**	**Detectable**
Outfall 690 1/12/15	3.99	
Outfall 690 3/4/15		0.0492

Post-demolition samples were collected from outfall 690 on April 15, 2015. None of the parameters that were sampled on this date exceeded screening criteria. No additional monitoring in association with the D&D of the K-892 Pumphouse will be performed.

3.6.2.6 Pre-Demolition Monitoring for the K-27 Building D&D

Building K-27 is the last remaining gaseous diffusion building at ETTP. Similar in structure to the already demolished K-25 building, the K-27 building spans more than 8 acres and is about 900-ft long, 400-ft wide, and 58-ft high.

Demolition of the K-27 building is a high priority at ETTP due to its severely deteriorated state. In 2014, workers completed inventory management and nondestructive assay measurements; characterized process equipment; performed vent, purge, and drain operations on process equipment; and prepared necessary regulatory documents. Transite was removed from outside the building in late 2015. Building demolition activities began in early 2016 and are expected to be completed in late 2016 or early 2017. Completing this project will mark the end of all gaseous diffusion buildings at ETTP.

As shown in Table 3.16, initial sampling was performed to provide baseline data for conditions present before demolition begins. This initial sampling effort was performed before the time demolition work is scheduled to begin. Sampling will also be performed during demolition activities after rainfall events of 1 in. or more in a 24-h period. Additionally, sampling will be performed after D&D activities have been completed.

Table 3.16. Storm water sampling for the D&D of the K-27 Building

Sampling location	Sampling frequency	pH	Gross alpha/beta	U Isotopic, ^{99}Tc, transuranics[a]	PCBs[b]	Metals[c]/ Mercury	Hexavalent chromium
Outfall 380	Prior to initiation of building demolition activities	X	X	X	X	X	X
Outfall 430	Prior to initiation of building demolition activities	X	X	X	X	X	X
Poplar Creek instream at Outfall 460	Prior to initiation of building demolition activities	X	X	X	X	X	X

[a] Transuranics analysis includes: Np-237, Pu-238, and Pu-239/240.
[b] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
[c] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
NOTE: Outfall 382 drains the K-131/K-631 complex rather than K-27. Since this outfall will not provide direct information pertaining to the D&D of K-27, it will not be sampled as part of the K-27 D&D sampling effort.
D&D = decontamination and decommissioning PCBs = polychlorinated biphenyls ^{99}Tc = ^{99}technetium

Prior to the initiation of demolition activities, pre-demolition samples were collected at storm water outfalls 382 and 430 and at the Poplar Creek instream location near outfall 460. Results from these sampling efforts that exceeded screening levels are shown in Table 3.17.

Table 3.17. Analytical results over screening levels for K-27 D&D sampling (prior to demolition)

Sampling Location	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	^{99}Tc* (pCi/L)	Mercury (ng/L)
SCREENING LEVEL	**10 pCi/L**	**30 pCi/L**	**1760 pCi/L**	**25 ng/L**
Outfall 380 6/30/15	29.1			
Outfall 430 6/2/15		106	177	
Poplar Creek at Outfall 460 6/2/15				164

* ^{99}Tc results are below screening criteria and are shown as a reference for gross beta radiation levels.
D&D = decontamination and decommissioning ^{99}Tc = ^{99}technetium

3.6.2.7 Pre-Demolition Monitoring for the K-731 Switch House D&D

The K-732 Switchyard is a level, gravel-covered yard, approximately 4 acres in size, that is fenced on three sides and bounded by the K-731 Switch House to the north. The gravel layer is approximately 18-in. thick, having been placed as a containment measure for any spills. The switchyard was originally constructed in 1944 to provide electrical power to Building K-27. It later became the receiving point for TVA power at 161 kV and supplying 13.8 kV power to the ETTP site. The adjacent K-731 Switch House received power from K-732 via underground conduits. The site contains a number of below-grade vaults and pits with conduits for electrical and communication cables. Use of the switchyard was phased out over the years and the yard was completely shut down in 2011. Electricity to ETTP is now provided by the City of Oak Ridge.

Demolition of the K-732 Switchyard has been contracted to CTI and Associates of Kansas City, Missouri. The project includes the demolition of the K-732 Switchyard with recovery and recycling of metals and material assets. Demolition of the K-732 Switchyard structures began in late 2015 and are expected to be completed in early 2016. Demolition of the K-731 Switch House will begin as a UCOR work scope after demolition work at the K-732 Switchyard has been completed by CTI and Associates.

Two sumps are located in the basement of K-731. Sump S-053 discharges to sump S-054. Sump S-054 discharges to storm water outfall 430. An additional five sumps (sumps S-055, S-056, S-057, S-058, and S-059) are located in the K-732 Switchyard. Sump S-055 collects water from Valve Vault 2 in the K-732 switchyard. Sump S-056 collects water from Valve Vault 3 in the K-732 switchyard. Sump S-057 collects water from Synchronous Condenser 101. Sump S-058 collects water from Synchronous Condenser 102. Sump S-059 collects water from Synchronous Condenser 103. All of these sumps discharge to outfall 440. A portion of the south side of the switchyard discharges to storm water outfall 440, as well. This discharge to outfall 440 includes surface runoff from paved sections of the switchyard area, as well as infiltration through the gravel portion of the switchyard area. The K-731/K-732 sumps and the drainage system from this area to outfalls 430 and 440 are shown in Fig. 3.17.

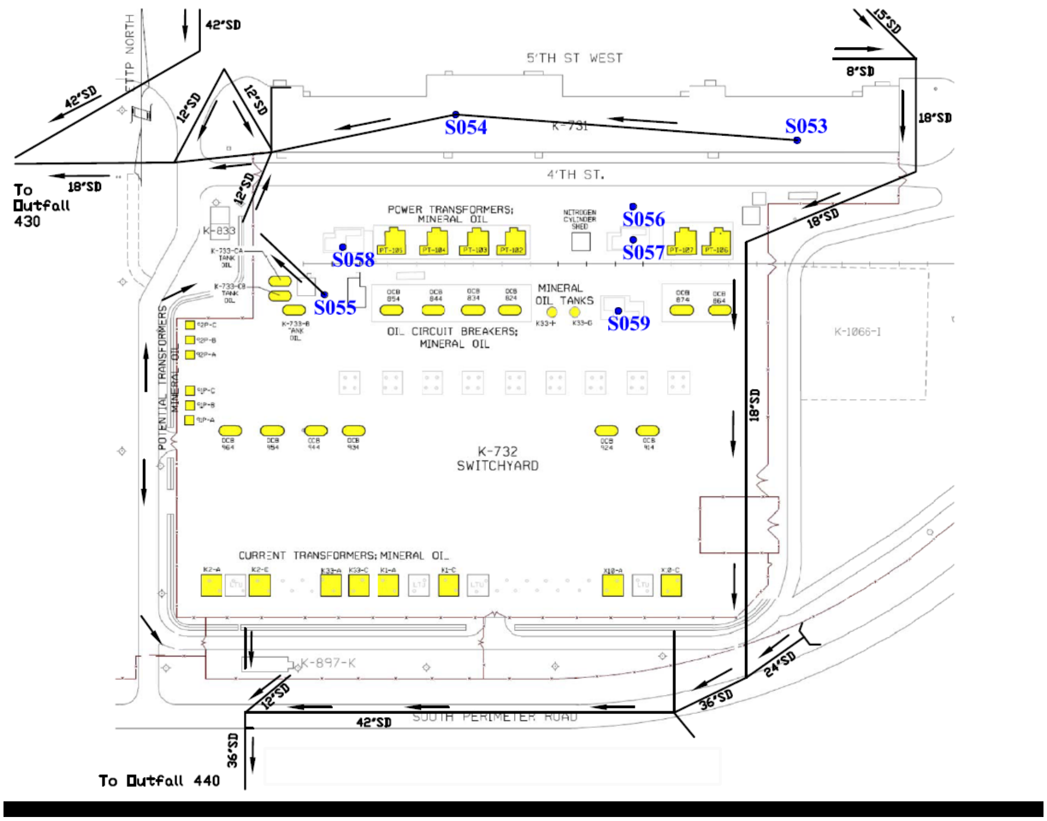

Fig. 3.17. K-731 Switch House and K-732 Switchyard Drainage System.

Because the sumps in Building K-731 are not currently in operation, water has accumulated in the basement of the building. As an initial pre-demolition action, the water that has accumulated in the basement of the K-731 Switch House must be removed and disposed. On August 27, 2015, a sample of the water in the K-731 basement was collected from a stairwell that provides access to the basement. The results from this sampling effort are shown in Table 3.18.

Table 3.18. Analytical results over screening levels for samples collected from the K-731 basement

Sampling location	PCB-1260 (µg/L)	Zinc (µg/L)
SCREENING LEVEL	**detectable**	**75**
K-731 basement (stairwell)	0.169	108

A decision on the disposition of the water in the K-731 basement will be made in CY 2016. Options for disposal of this water include discharging it into a bermed area and allowing it to infiltrate into the soil or discharging it to the storm drain system using appropriate best management practices.

In October 2015, samples were collected from outfall 440 to determine if water from sumps S-055, S-056, S-057, S-058, and S-059 or other portions of the K-732 switchyard area could be adversely affecting the discharge from the outfall. Table 3.19 indicates the parameters that were sampled as part of this effort. No results over screening levels were detected in samples collected from outfall 440.

Table 3.19. Storm water composite sampling for radiological discharges

Storm water outfall	Gross alpha/ gross beta	^{99}Tc	VOCs	PCBs/pesticides*
440	X	X	X	X

*PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
PCBs = polychlorinated biphenyls ^{99}Tc = ^{99}technetium VOCs = volatile organic compound

3.6.2.8 Monitoring of Operational Building Sumps

As part of the ETTP SWPP Program monitoring, samples were collected from each of the remaining building sumps. These sumps accumulate storm water during wet weather conditions. This sampling was performed to identify contaminants that could be discharged during the normal operation of the sumps. These sumps will be sampled at least once during each NPDES permit cycle. However, the sumps will be evaluated each year to determine if changing conditions (D&D activities, etc.) may warrant more frequent sampling.

There are no specific requirements (rainfall, specific discharge rate, etc.) for sampling the sumps. They can be sampled as long as there is adequate water present in them to allow the samples to be collected. All water samples taken as part of this investigation shall be collected as manual grab samples. Manual grab samples will be collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA's *NPDES Storm Water Sampling Guidance Document* (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor.

Preliminary activities leading to the D&D of the K-1037 building are underway. Walkdowns of the building have been conducted to identify RCRA universal waste materials such as light bulbs, spent batteries, etc., that must be collected and disposed before additional D&D actions can occur. Also, surveys of the building have been performed to identify chemicals, flammable materials, etc., that must be removed from the building. In addition to these activities, the water from the K-1037 basement must be removed.

As part of the ETTP SWPP Program sampling effort, sampling of the water in the K-1037 basement was conducted in July 2015. Accumulated water from two representative locations were sampled as part of this effort. Sump S-093 was sampled as part of this monitoring effort. Sump S-094 was also planned to be included as part of this sampling effort. However, because the sump pumps in the K-1037 basement are not currently operational, the area where sump S-094 is located was flooded and was not accessible for sampling. Therefore, a sample was collected from a flooded stairwell near columns F8 and G8 of the K-1037 building. This location is as close to sump S-094 as possible and is representative of the water in the area of the basement served by the sump. Monitoring requirements for this sampling effort are included in Table 3.20.

Table 3.20. Sampling of accumulated water in Building K-1037 basement

Sampling location	Sampling frequency	pH	Gross alpha/beta	PCBs[a]	Metals[b]/ Mercury	TSS
Sump S-093	Prior to initiation of building demolition activities.	X	X	X	X	X
Stairwell at Columns F8/G8	Prior to initiation of building demolition activities.	X	X	X	X	X

[a] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268.
[b] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
PCBs = polychlorinated biphenyls TSS = total suspended solids

Parameters that were detected at levels exceeding screening criteria are shown in Table 3.21.

Table 3.21. Analytical results above screening criteria from the sampling of accumulated water in Building K-1037 basement in 2015

Sampling location	Cadmium (µg/L)	Lead (µg/L)	Gross alpha radiation (pCi/L)	Gross beta radiation (pCi/L)	PCB-1254 (µg/L)	PCB-1260 (µg/L)
SCREENING LEVEL	**Detect-able**	**1.8**	**10**	**30**	**Detect-able**	**Detect-able**
Sump S-093			630	930		
Stairwell at Columns F8/G8	0.82	3.6	190	440	1.4	3

PCBs = polychlorinated biphenyls

Uranium and ^{99}Tc samples were also collected and analytical results were non-detectable. Additional sampling may be performed to determine why gross alpha and gross beta levels were elevated while the uranium and ^{99}TC results were non-detectable.

Personnel working on the D&D of the K-1037 building planned to install portable pumps in the basement to pump the water to the environment if it met the criteria for accumulated water discharges stated in the ETTP SWPP Program Baseline Document. However, because of the exceedances for metals, PCBs, and gross alpha/gross beta radiation, this water will not be suitable for discharge to the environment. An alternate means of disposal of this water has not yet been determined but on-site treatment as a CERCLA action is being considered.

Sump S-073A, which is located in the basement of Building K-1006, was also sampled as part of the ETTP SWPP Program. This sump is a 30-in.-diameter, 36-in.-deep concrete structure. It is located in the northeast corner basement of the K-1006 laboratory building, beneath the interior stairwell. The sump receives groundwater flow that is periodically pumped to the sanitary sewer system by a float-controlled pump. This water is then treated at the Rarity Ridge Sewage Treatment Plant. The *Baseline*

Environmental Analysis Report for the K-1006 Material and Chemistry Laboratory (K/EM-543/R1, LMES 1997) states that the sump located in the northeast corner of the basement accumulates rainwater from a drain in the concrete floor area adjacent to the outside door of the basement. Monitoring requirements for this sampling effort are included in Table 3.22.

Table 3.22. Sampling of Building K-1006 sump

Sampling location	pH	Gross alpha/beta	PCBs[a]	Metals[c]/ Mercury	TSS
Sump S-073-A	X	X	X	X	X

[a] PCB analysis includes aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Total PCBs will also be reported as part of the analytical data package.
[b] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
PCBs = polychlorinated biphenyls TSS = total suspended solids

Parameters that were detected at levels exceeding screening criteria in 2015 are shown in Table 3.23.

Table 3.23. Analytical results over screening levels for Sump S-073A in 2015

Sampling location	Copper (µg/L)	Lead (µg/L)	Zinc (µg/L)	Cadmium (µg/L)
SCREENING LEVEL	**7**	**1.8**	**75**	**Detectable**
Sump S-073A	21.2	12.5	89.3	2.04

3.6.2.9 Monitoring Runoff from Oak Ridge Forest Products Area

Oak Ridge Forest Products, LLC (ORFP) operates a wood yard and chipping facility at the K-722 site, which is located at the former Powerhouse area. The primary operation being conducted is the conversion of low-grade forest products (pulpwood) into wood chips. These wood chips are used as a biomass fuel, in paper production, and for mulching and landscaping. Wood from local logging and clearing activities is purchased on-site. The wood is then processed into wood chips by a chipper.

One source of potential impact to storm water runoff from this facility is fuel storage. Double-walled aboveground storage tanks with a total storage capacity of approximately 2,500 gal have been installed on-site to contain both on-road and off-road diesel fuel. Secondary containment was constructed around the above-ground tanks. Above-ground storage tanks also store water used for fire suppression and equipment cleaning. Portable restrooms are used for the handling of sanitary waste.

Sampling was performed in order to assess any potential impact that the operation of this facility may be having on the quality of the storm water runoff from the area. Guidance found in the Tennessee Storm Water Multi-Sector Permit (TMSP) for Industrial Activities was utilized in choosing the parameters to be sampled as part of this effort. Parameters required to be sampled under the TMSP for Standard Industrial Classification (SIC) code 2411 (log storage and handling areas) and SIC code 2421 (general sawmills and planing mills) were selected to be representative of the storm water discharges that may originate at ORFP.

As shown in Table 3.24, storm water runoff from outfalls 780, 810, and 820 were sampled as part of this effort. (Outfall 810 was not originally designated to be sampled as part of this effort. However, because it receives drainage from the ORFP area and because flow was present at the outfall when outfalls 780 and 820 were sampled, a sample was collected at outfall 810 to provide additional information about this area.) These samples were collected at a time when storm water runoff was observable from the ORFP facility. The analytical results from this sampling effort will be used to determine if additional sampling of these storm water outfalls will be necessary on a more frequent basis (i.e., quarterly, annually).

Field observations were also made at each of the outfalls when sampling of the storm water runoff from the ORFP facility was conducted. The discharge from these outfalls was observed for visible sheen, discoloration, foam, floating materials, suspended materials, and debris. If any debris was noted in the discharge from the outfall that does not appear as if it would fit through a 1-in.-diameter round opening, EC&P personnel were contacted.

Samples were collected from these outfalls in December 2014 and January 2015. The only parameter that exceeded screening criteria was copper at outfall 810. Copper was detected at 7.31 µg /L, which exceeds the screening criteria of 7 µg/L. None of the other parameters were present at levels that exceeded screening criteria. In addition, no adverse conditions were noted as part of the field observations conducted at the time the sampling was being performed. Therefore, it is believed that storm water discharges from the area of the ORFP facility are not creating an adverse impact on receiving waters.

Table 3.24. Storm water sampling at the Oak Ridge Forest Products facility

Sampling location	Oil and grease	TSS	COD	Metals[a]	pH
Outfall 780	**X**	**X**	**X**	**X**	**X**
Outfall 810	**X**	**X**	**X**	**X**	**X**
Outfall 820	**X**	**X**	**X**	**X**	**X**

[a] Metals analysis includes: Al, Ag, As, Ba, Be, B, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn.
COD = chemical oxygen demand TSS = total suspended solids

3.6.2.10 Legacy Mercury Investigation Sampling

Activities involving mercury that were conducted at ETTP included usage, handling, and recovery operations. Mercury usage and handling were common in such equipment as manometers, switches, mass spectrometers, mercury diffusion pumps, mercury traps, and laboratory operations. Large quantities of mercury-bearing wastes from the on-site gaseous diffusion plant operations and support buildings, ORNL, and Y-12, were processed and stored at ETTP. Mercury from soils and spill cleanups was processed on-site, as well. Mercury recovery operations were conducted in a number of buildings. Many buildings were located in watersheds that discharged primarily into Mitchell Branch.

Mercury levels that exceed the ambient water quality criterion (AWQC) of 51 ng/L at ETTP have been identified in the Mitchell Branch watershed, as well as in a number of storm water outfalls, surface water locations, and groundwater monitoring wells at ETTP. Improved analytical techniques for mercury have resulted in much lower detection limits than previously possible. In addition, knowledge of known historical mercury processes at the facility has increased substantially. These factors have led to an ongoing facility investigation to more precisely detect and quantify the extent of any mercury contamination that may exist.

Factors considered as part of the mercury investigation include weather conditions (wet vs. dry), remedial action activities (before, during, and after demolition of ETTP facilities), and types of monitoring locations chosen for sampling (in-stream, outfall, ambient, catch basin). For the purpose of the investigation activities, a dry weather period was defined as being at least 72 h after a storm event of 0.1 in. or more. Wet weather conditions were defined as a storm event greater than 0.1 in. that occurs within a time period of 24 h or less and at least 72 h after any previous rainfall greater than 0.1 in. in 24 h. In addition, manual grab samples were defined as samples collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA *NPDES Storm Water Sampling Guidance Documen*t (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor.

Two monitoring programs collected mercury data across ETTP at various locations during CY 2015. Samples were collected as specifically defined in the NPDES permit and as part of the SWPP Program.

3.6.2.11 Mercury Sampling Conducted as Part of the Previous NPDES Permit

As part of the NPDES permit compliance program for the previous ETTP NPDES permit that was in effect until March 31, 2015, mercury was sampled on a quarterly basis at outfalls 05A, 170, 180, and 190. These four locations were selected because information gathered as part of the permit application process indicated that mercury levels at these outfalls occasionally exceeded the AWQC level of 51 ng/L. Outfalls 170, 180, and 190 collect storm water from large areas on the north side of ETTP and discharge to Mitchell Branch. Outfall 05A is the discharge point for the former sewage treatment plant drainage basin into Poplar Creek on the east side of ETTP. The NPDES permit that took effect on April 1, 2015, no longer requires quarterly mercury monitoring. However, in order to continue collecting data for the analysis of trends in mercury discharges from these outfalls, quarterly mercury sampling will be conducted as part of the ETTP SWPP Program, as indicated in Table 3.25. Since mercury has not been detected at outfall 170 at levels over the AWQC of 51 ng/L for several years, outfall 170 will not be sampled as part of this SWPP Program effort. Data from this sampling effort will be utilized as part of the RER and may provide information that will be used in upcoming CERCLA cleanup decisions.

Table 3.25. Mercury sampling at storm water outfalls

Sampling Location	Parameter	Measurement frequency	Sample type
Outfall 05A	Mercury	1/quarter	Grab
Outfall 180	Mercury	1/quarter	Grab
Outfall 190	Mercury	1/quarter	Grab

Table 3.26 contains analytical data from mercury sampling performed at outfalls 170, 180, 190, and 05A in CY 2015. Samples collected during the first quarter of CY 2015 were collected as part of the requirements of the ETTP NPDES permit, which was in effect at that time. Mercury samples collected during the second, third, and fourth quarters of CY 2015 were taken as part of the requirements of the ETTP SWPP Program.

Table 3.26. Quarterly NPDES/SWPP Program mercury monitoring results – CY 2015

Sampling location	1st Quarter CY 2015 (ng/L)	2nd Quarter CY 2015 (ng/L)	3rd Quarter CY 2015 (ng/L)	4th Quarter CY 2015 (ng/L)
Outfall 170**	4.1	-----	-----	-----
Outfall 180	**219**	**53.1**	50.8	**99.3**
Outfall 190	20.3	11.1	16.7	**55.6**
Outfall 05A	**67.4**	**132**	**148**	**185**

*Results in **bold** exceed the AWQC for mercury (51 ng/L).
NPDES = National Pollutant Discharge Elimination System
SWPP = Storm Water Pollution Prevention

Figures 3.18–3.21 indicate the mercury levels at outfalls 170, 180, 190, and 05A from CY 2010–present. These graphs contain mercury information from quarterly sampling performed as part of the quarterly NPDES permit compliance/quarterly SWPP Program sampling, NPDES permit renewal sampling, D&D sampling, and other mercury sampling performed at these outfalls. Results from outfalls 180, 190, and 05A were frequently above the AQWQC of 51 ng/L.

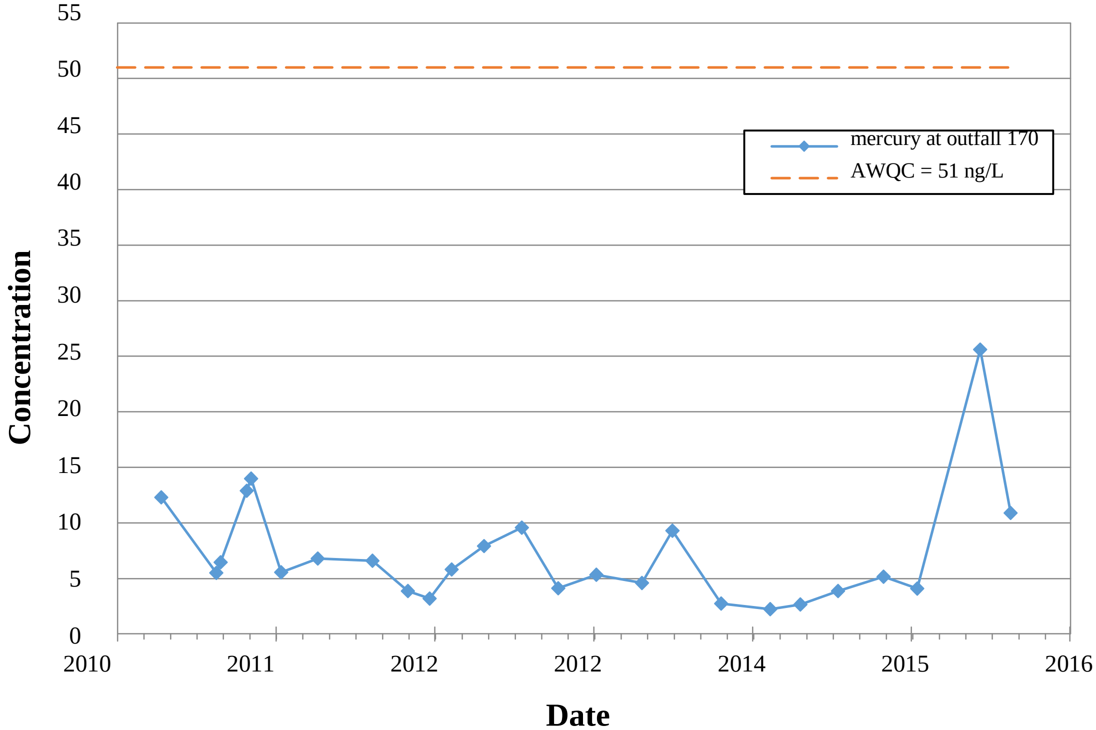

Fig. 3.18. Mercury concentrations at outfall 170. *(AWQC = ambient water quality criterion)*

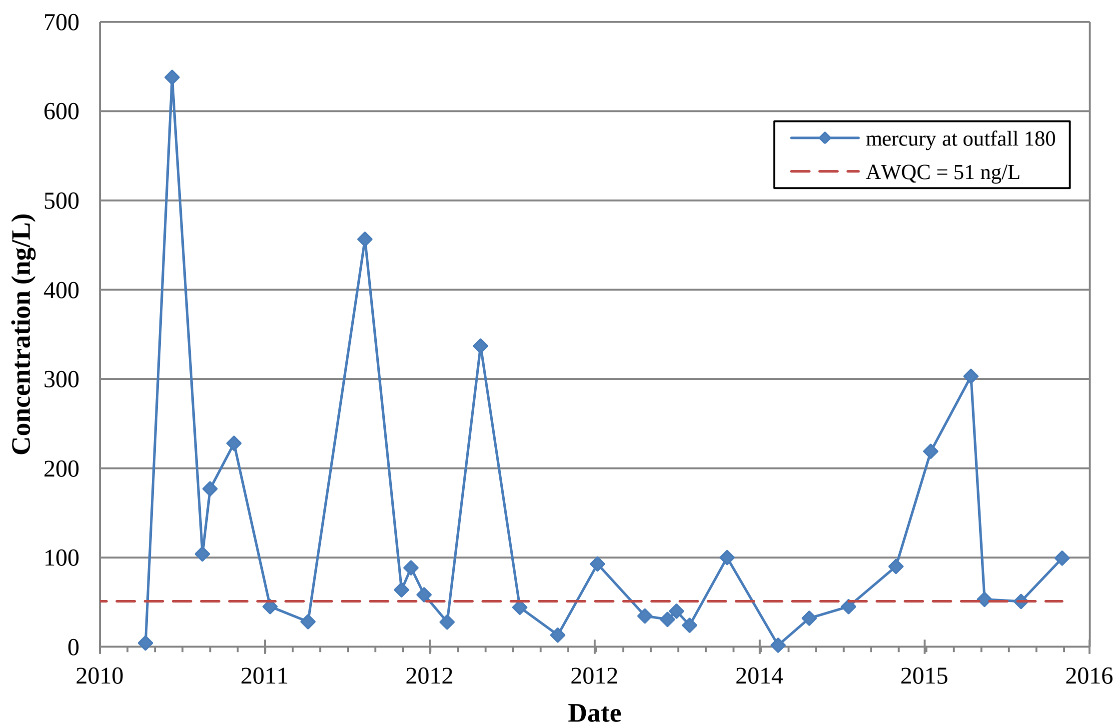

Fig. 3.19. Mercury concentrations at outfall 180. *(AWQC = ambient water quality criterion)*

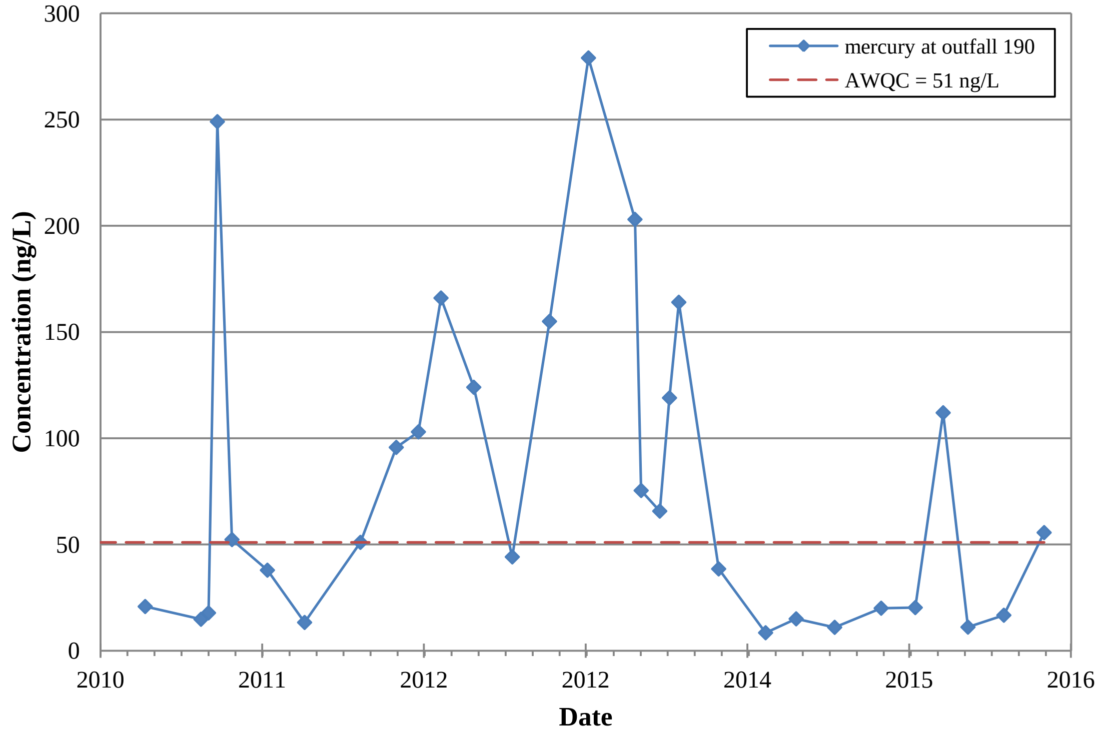

Fig. 3.20. Mercury concentrations at outfall 190. *(AWQC = ambient water quality criterion)*

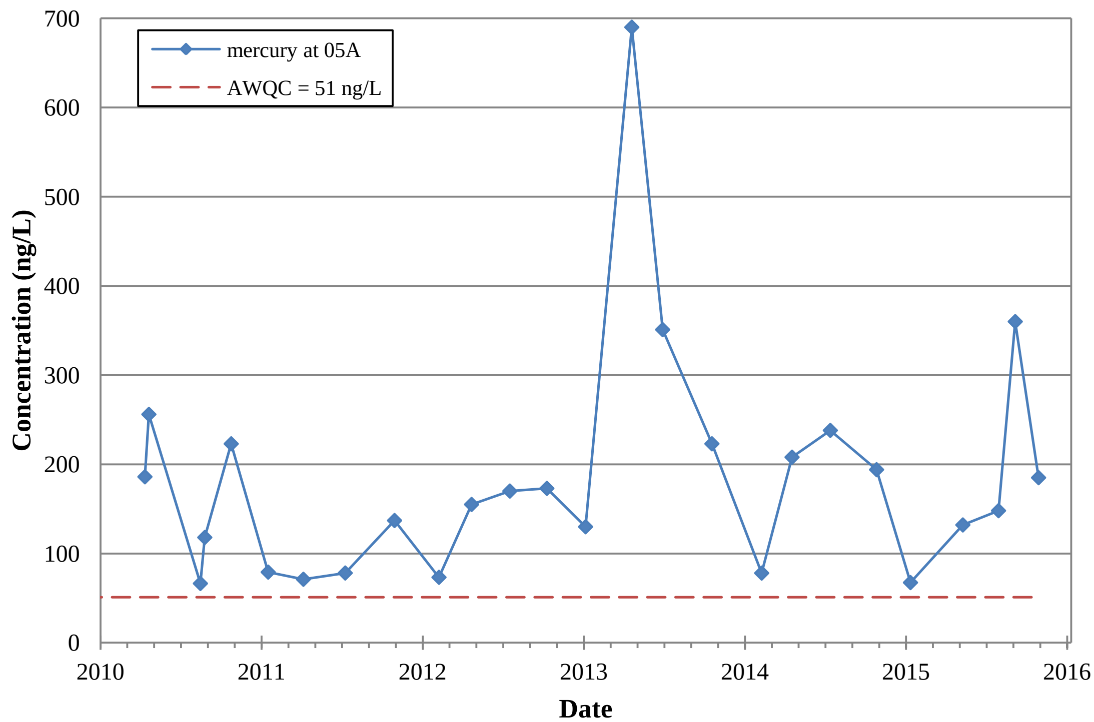

Fig. 3.21. Mercury concentrations at outfall 05A. *(AWQC = ambient water quality criterion)*

3.6.2.12 Investigation of Mercury in Selected ETTP Storm Water Outfalls

The K-1024 Dilution Pit was used during the K-1024 instrument shop operations (1945-1963) and centrifuge development laboratory operations (1970–1985) and was located on the northwest corner of Building K-1024. During 1946-1947, the K-1024 building operations cleaned mercury from line recorder chemical traps. The electronics shop frequently experienced mercury spills and elevated levels of mercury vapors. The Building K-1024 sanitary flow and acid/solvent flow were each handled by independent drain lines. A 4-in. acid waste line flowed through a dilution pit before discharging into the K-25 Site storm drain system. The dilution pit was placed in standby in 1985. In the early 1990s, it was filled and covered with asphalt.

The storm drain networks for outfalls 230 and 240 drain the former K-1024 building area. In addition to sampling at the 230 and 240 outfalls, samples were collected from selected storm drain catchment basins in the outfall 230 and 240 networks as part of the ETTP SWPP Program. The analytical results from this sampling effort will allow an assessment of the levels of mercury that may be continuing to enter the storm water drainage system.

The total mercury samples were collected during both wet weather and dry weather conditions. Flow was not present at all locations during dry weather conditions. The absence of flow was noted at each applicable location. All reasonable efforts were made to collect the wet weather or dry weather samples from a selected network within a single day.

Since water samples may inadvertently pick up sediment from the bottom of the storm drain system, both a filtered and an unfiltered sample were collected for total mercury analysis. The filtering was done in the field utilizing a 0.45 micron filter and a portable peristaltic pump.

Samples were collected as indicated in Table 3.27. Locations that were inaccessible or cannot be sampled for other reasons were noted.

Table 3.27. Sampling of outfall 230 and 240 networks

Storm Water Outfall Network	Associated manholes to be sampled	Sampling event	Total Mercury (unfiltered)	Total Mercury (filtered in the field)
230	2003, 3040, 3035, 7011, 7012, 7013, 7014	Wet and dry weather	X	X
240	2008, 2014, 2050, 7053, 7054, 7056, 7059	Wet and dry weather	X	X

Dry weather sampling of outfall 230 and its associated drainage network was performed in February 2015. As part of the monitoring of the outfall 230 network, samples were collected at manholes 2003, 3035, 3040, 7011, 7012, 7013, and 7014. Both filtered and unfiltered samples were collected at each location. Table 3.28 contains the results of the dry weather sampling performed in the outfall 230 network. Results in bold exceed the AWQC for mercury (51 ng/L).

Table 3.28. Mercury results from dry weather sampling at storm water outfall 230 and associated piping network

Sampling Location	Mercury (ng/L)*	
	Unfiltered	Filtered (Field)
Outfall 230	2.07	1.54
Manhole 2003	23.1	**69.8**
Manhole 3035	11.9	3.45
Manhole 3040	47.7	17.8
Manhole 7011	2.77	45.6
Manhole 7012	27.3	35.1
Manhole 7013	46.4	31.4
Manhole 7014	**60.1**	39.3

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

Dry weather sampling of outfall 240 and its associated drainage network was completed on March 26, 2015. At the time of sampling, only manholes 2008 and 2014 were flowing; outfall 240 and manholes 2050, 7053, 7054, 7056, and 7059 were dry. These results are presented in Table 3.29.

Table 3.29. Mercury results from dry weather sampling at outfall 240 and associated piping network

Sampling Location	Mercury Result (ng/L)	
	Unfiltered	Filtered (Field)
Manhole 2008	**447**	9.33
Manhole 2014	9.88	7.9

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

Wet weather sampling of outfall 230 and its associated drainage network was performed on April 20, 2015. As part of the monitoring of the outfall 230 network, samples were collected at manholes 2003, 3035, 3040, 7011, 7012, 7013, and 7014. Both filtered and unfiltered samples were collected at each location. Table 3.30 contains the results of the wet weather sampling performed in the outfall 230 network.

Table 3.30. Mercury results from wet weather sampling at outfall 230 and associated piping network

Sampling Location	Mercury Result (ng/L)	
	Unfiltered	Filtered (Field)
Outfall 230	36.1	14.2
Manhole 2003	**76.8**	34.7
Manhole 3035	43.2	14.4
Manhole 3040	38.6	16.4
Manhole 7011	**162**	**82.6**
Manhole 7012	**211**	**103**
Manhole 7013	**334**	**160**
Manhole 7014	**963**	**123**

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

Wet weather sampling of outfall 240 and its associated drainage network was completed on September 10, 2015. Both filtered and unfiltered samples were collected at each location. Table 3.31 contains the results of the wet weather sampling performed in the outfall 240 network.

Table 3.31. Mercury results from wet weather sampling at outfall 240 and associated piping network

Location ID	Mercury Result (ng/L)	
	Unfiltered	Filtered (Field)
Outfall 240	**116**	28.1
Manhole 2008	**141**	**87.3**
Manhole 2014	**92.2**	45.6
Manhole 7053	**580**	**415**
Manhole 7054	**706**	**642**
Manhole 7056	**534**	19.2
Manhole 7059	8.34	10.1

*Results in **bold** exceed AWQC for mercury (51 ng/L).

Manholes 7053, 7054, and 7056, which contained the highest levels of mercury detected in the outfall 240 drainage system, are located south of the former Building K-1024 and associated K-1024 Dilution Pit locations. Building K-1024 once housed an instrument maintenance operation, which serviced various types of instruments that may have contained mercury. Instrument cleaning wastes drained into the K-1024 Dilution Pit and onto the storm drain system. It is believed that this operation may be a primary source of the mercury detected in both the outfall 230 and 240 storm water drainage systems. The dilution pit was filled and covered with asphalt several years ago. Building K-1024 was demolished as part of the Building K-25 D&D project.

Mercury at levels above the screening criteria has been identified at each of the outfalls in Table 3.32 during past sampling events. In order to evaluate whether the discharge of mercury from these outfalls is part of an ongoing trend or whether it is an isolated occurrence, additional sampling at the outfalls was conducted in CY 2015 to allow for a sufficient number of data points for trend analysis.

Table 3.32. ETTP outfalls selected for mercury investigation sampling

Sampling location	Sampling event(s)	Mercury (manual grab)
Outfall 100	Wet weather	X
Outfall 195	Wet weather	X
Outfall 230	Wet weather	X
Outfall 240	Wet weather	X
Outfall 280	Wet weather	X

Table 3.33. Analytical results for mercury investigation sampling

Sampling Location	Hg Result (ng/L)
Outfall 100	8.78
Outfall 195	10.3
Outfall 230	15.6
Outfall 240	22.3

As part of the sitewide mercury investigation, a mercury sample was collected at outfall 694 on September 4, 2014. The mercury result from this sample was 910 ng/L. Because the mercury level in this sample was quite elevated, follow-up samples were collected from outfall 694 and from a catch basin in the drainage system of the outfall on July 23, 2015. The mercury results from these samples are indicated in Table 3.34.

Table 3.34. Analytical results for mercury investigation sampling at outfall 694

Sampling Location	Hg Result (ng/L)
Outfall 694 (9/4/14)	**910**
Outfall 694 (7/23/15)	30.5
Catch Basin 1B017	15.4

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

It is believed that the elevated mercury results from the September 2014 sample may have been related to sediment that was present in Poplar Creek water that had historically been pumped into the K-892 Pumphouse and may have been discharged through outfall 694. There is no clear explanation of why the detected mercury level in the follow-up sample differed so greatly from the original sample. Catch basin 1B017 is located upstream of the point where the K-892 Pumphouse discharge enters the outfall 694 network, which may explain why mercury levels in the basin were lower than mercury levels at the outfall.

3.6.2.13 Mercury Sampling Conducted as Part of the NPDES Permit Renewal

Mercury has been sampled at several outfalls as part of the NPDES permit renewal process during CY 2015. Mercury results for these NPDES permit renewal samples exceeded the AWQC of 51 ng/L at outfalls 05A, 180, and 190. The results of the NPDES permit renewal mercury sampling are included in Table 3.35.

Table 3.35. NPDES Permit Renewal - Mercury Monitoring Results – CY 2015

Sampling location	Mercury (ng/L)
Outfall 05A	**360**
Outfall 100	50.1
Outfall 142	3.84
Outfall 170	25.6
Outfall 180	**303**
Outfall 190	**112**
Outfall 195	40
Outfall 198	7.23
Outfall 334	3.24
Outfall 510	10.8

*Results in **bold** exceed the AWQC for mercury (51 ng/L).
NPDES = National Pollutant Discharge Elimination System

3.6.2.14 Sampling of Legacy Chromium Groundwater Plume Discharge

The release of hexavalent chromium into Mitchell Branch from storm water outfall 170 and from seeps at the headwall of outfall 170 resulted in levels of hexavalent chromium that exceeded the AWQC. Immediately below outfall 170, hexavalent chromium levels were measured at levels as high as 0.78 mg/L, which exceeded the state of Tennessee hexavalent chromium water quality chronic criterion of 0.011 mg/L for the protection of fish and aquatic life. The levels of total chromium were at approximately the same value, indicating that the chromium was almost completely hexavalent chromium at the release point. The reason that the chromium was still in a hexavalent state is unknown, considering that hexavalent chromium has not been used in ETTP operations for over 30 years.

On November 5, 2007, DOE notified EPA and TDEC of their intent to conduct a CERCLA time-critical removal action to install a grout barrier wall and groundwater collection system to intercept the chromium-contaminated water discharging from the storm drain 170 outfall and headwall seeps into Mitchell Branch. The action reduced the level of hexavalent chromium in Mitchell Branch by approximately 98%, from 0.78 mg/L to levels as low as 0.014 mg/L, during worst-case dry-weather base flow periods. During wet-weather periods, the level of hexavalent chromium in Mitchell Branch was reduced from 0.025 mg/L to levels that are below method detection thresholds of 0.012 mg/L. The time-critical removal action is documented in the *Removal Action Report for the Reduction of Hexavalent Chromium Releases into Mitchell Branch at the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE 2008).

In 2012, the treatment of the chromium collection system water was transitioned from CNF to CWTS. To monitor both the continued effectiveness of the collection system, as well as the effectiveness of the new CWTS, periodic monitoring is performed as part of the ETTP SWPP Program. Samples are collected at monitoring well-289, the chromium collection system wells, storm drain 170, and Mitchell Branch Kilometer (MIK) 0.79. Samples are also collected at monitoring well-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 storm drain 170 monitor the concentrations of the chromium and hexavalent chromium plume being discharged directly to Mitchell Branch. Samples are collected at MIK 0.79 to monitor chromium and hexavalent chromium concentrations in Mitchell Branch. Requirements for this sampling effort are listed in Table 3.36.

Samples at these locations are collected on a quarterly basis during varying wet and dry weather conditions. All of the samples collected as part of this effort are taken using the manual grab sampling method. Manual grab samples are collected according to the guidelines specified in Sections 3.1.2 and 3.3.1 of the EPA's *NPDES Storm Water Sampling Guidance Document* (EPA 1992) and applicable procedures that have been developed by the sampling subcontractor. All guidelines in the *East Tennessee Technology Park Storm Water Pollution Prevention Program Sampling and Analysis Plan* (UCOR-4028, UCOR 2015) were followed as part of this sampling effort. Figures 3.22 and 3.23 are graphs of the analytical data from this sampling effort.

Table 3.36. Monitoring requirements - Mitchell Branch subwatershed total and hexavalent chromium sampling locations

Sampling Location	Parameter	Measurement frequency	Sample type
MIK 0.79	Total chromium	1/quarter	Grab
MIK 0.79	Hexavalent chromium	1/quarter	Grab
Storm Drain-170	Total chromium	1/quarter	Grab
Storm Drain-170	Hexavalent chromium	1/quarter	Grab
Monitoring Well-289 (TP-289)	Total chromium	1/quarter	Grab
Monitoring Well-289 (TP-289)	Hexavalent chromium	1/quarter	Grab
Cr collection system wells (CWTS-INF)	Total chromium	1/quarter	Grab
Cr collection system wells (CWTS-INF)	Hexavalent chromium	1/quarter	Grab

NOTE: Total chromium and hexavalent chromium will be collected during varying weather conditions (for example, samples will be collected during wet-weather conditions one quarter and during dry-weather conditions the following quarter).

MIK = Mitchell Branch kilometer
TP = temporary piezometer
CWTS-INF = Chromium Water Treatment System-Influent

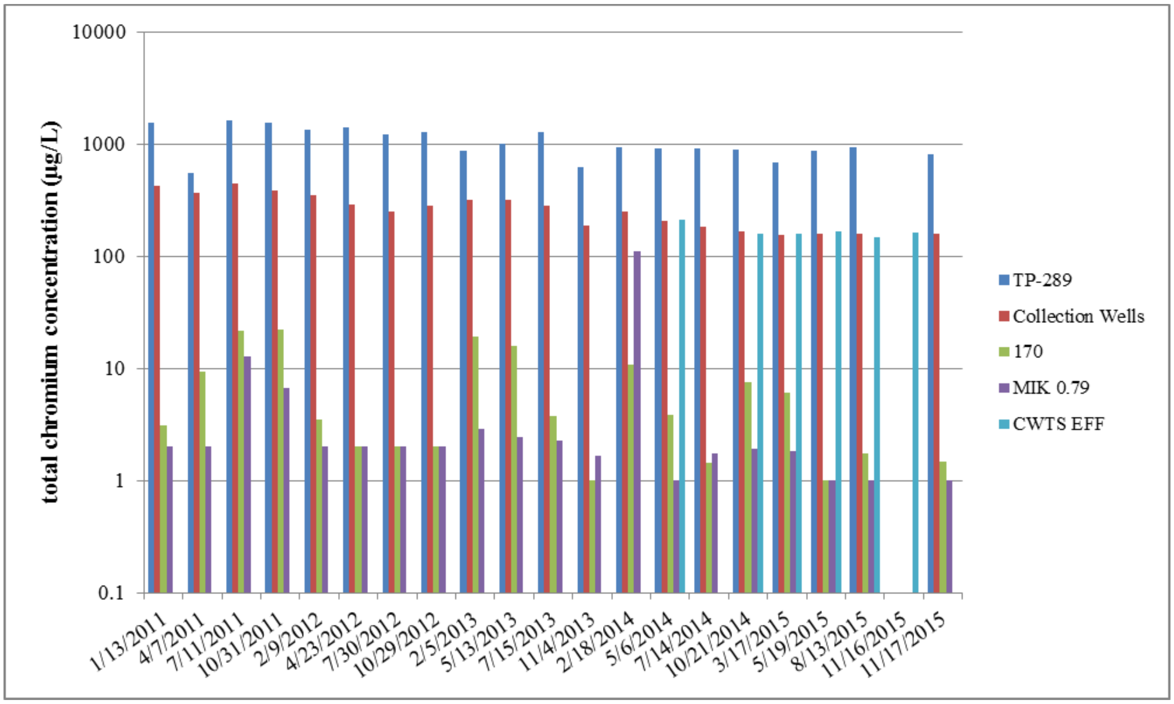

Fig. 3.22. Total chromium sample results for the chromium collection system.
(CWTS EFF = Chromium Water Treatment System Effluent, MIK = Mitchell Branch kilometer, and TP = temporary piezometer)

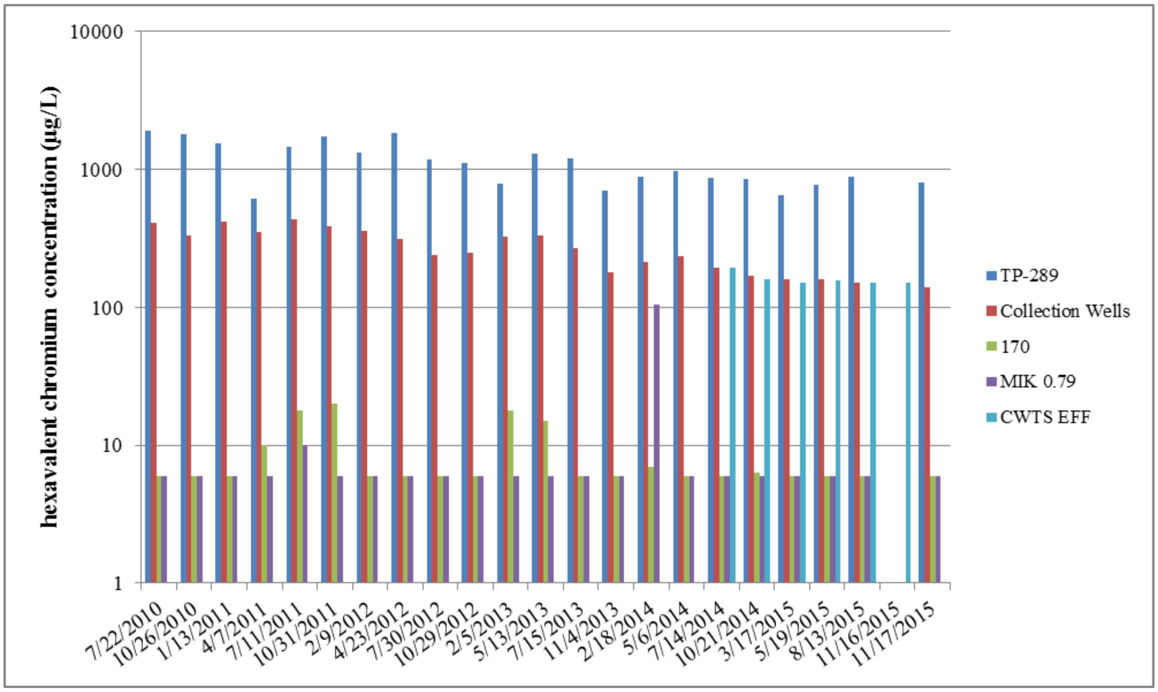

Fig. 3.23. Hexavalent chromium sample results for the chromium collection system.
(CWTS EFF = Chromium Water Treatment System Effluent, MIK = Mitchell Branch kilometer, and TP = temporary piezometer)

The analytical data indicate that chromium levels may fluctuate slightly at temporary piezometer (TP)-289, but are relatively consistent over the long term. Chromium values at outfall 170 and MIK 0.79 have much more variability. This is most likely due to the greater variability in flow rates at these two locations.

Additional monitoring of the CWTS will be performed, as indicated in the *East Tennessee Technology Park Chromium Water Treatment System Sampling and Analysis Plan* (UCOR-4259, UCOR 2014).

3.6.2.15 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. Many of these locations are representative outfalls under the current ETTP NPDES permit and will be sampled for PCBs as part of the permit renewal sampling effort for the next ETTP NPDES permit application. Therefore, none of the outfalls that will be sampled for PCBs as part of this PCB monitoring program will be sampled during the same year as NPDES permit renewal samples are collected from them. In addition, outfalls that are to be sampled as part of ongoing D&D activities will be sampled the year after D&D activities are expected to be completed. Also, outfalls that are to be sampled as part of upcoming D&D activities will be sampled during the year before D&D activities are expected to begin. Table 3.37 indicates the storm water outfalls that were sampled for PCBs as part of the ETTP SWPP Program sampling effort.

Table 3.37. PCB samples collected during CY 2015

Sampling Location	Parameter[a]	Sample type
Outfall 100	Total PCBs and individual PCB aroclors	Grab
Outfall 210	Total PCBs and individual PCB aroclors	Grab
Outfall 230	Total PCBs and individual PCB aroclors	Grab
Outfall 240	Total PCBs and individual PCB aroclors	Grab
Outfall 360	Total PCBs and individual PCB aroclors	Grab
Outfall 390	Total PCBs and individual PCB aroclors	Grab
Outfall 490	Total PCBs and individual PCB aroclors	Grab
Outfall 700	Total PCBs and individual PCB aroclors	Grab
Outfall 710	Total PCBs and individual PCB aroclors	Grab
Outfall 890	Total PCBs and individual PCB aroclors	Grab

[a] PCB analysis includes: Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. Total PCBs will also be reported as part of the analytical data package.
PCB = polychlorinated biphenyl

Table 3.38 indicates the analytical results from storm water outfall samples for PCBs collected as part of the ETTP SWPP Program sampling effort.

Table 3.38. PCB samples collected as part of the ETTP SWPP Program sampling effort

Sampling Location	Parameter[a]	Date Sampled	Results Above Detection Limit
Outfall 100	Total PCBs and individual PCB aroclors	8/18/15	PCB-1248 - **0.112 µg/L**
Outfall 210	Total PCBs and individual PCB aroclors	9/10/15	No PCBs detected
Outfall 230	Total PCBs and individual PCB aroclors	8/18/15	No PCBs detected
Outfall 240	Total PCBs and individual PCB aroclors	9/10/15	No PCBs detected
Outfall 360	Total PCBs and individual PCB aroclors	11/30/15	No PCBs detected
Outfall 390	Total PCBs and individual PCB aroclors	8/20/15	No PCBs detected
Outfall 490	Total PCBs and individual PCB aroclors	8/18/15	No PCBs detected
Outfall 700	Total PCBs and individual PCB aroclors	8/20/15	No PCBs detected
Outfall 710	Total PCBs and individual PCB aroclors	8/20/15	No PCBs detected
Outfall 890	Total PCBs and individual PCB aroclors	12/14/15	No PCBs detected

Acronyms
ETTP = East Tennessee Technology Park
PCBs = polychlorinated biphenyls
SWPP = Storm Water Prevention Program

Analytical data collected as part of this storm water monitoring effort will be utilized to provide information for evaluating cleanup decisions and to measure the effectiveness of remedial actions.

The PCB monitoring task will also include monitoring of PCB bioaccumulation in caged clams (*Corbicula fluminea*), which will be placed at selected locations around the ETTP. Additionally, the collection and analysis of fish from Mitchell Branch and three major ponds on the site will also be performed. Both clams and fish from uncontaminated off-site locations are also analyzed as points of reference. The primary contaminants of concern (COC) for these bioaccumulation monitoring tasks at ETTP will be PCBs and mercury. Additional information on these monitoring tasks is provided in the ETTP Biological Monitoring and Abatement Program (BMAP) SAP.

3.6.2.16 NPDES Permit Renewal Monitoring

Preparations for the NPDES permit application that will be submitted to the TDEC in CY 2019 are being made. Additionally, DOE will require time to review the permit application before it is submitted to TDEC. In order for all of the required monitoring to be conducted in time for the permit application to be prepared and submitted, sampling required for the completion of the permit application was initiated as part of the ETTP SWPP Program SAP in CY 2015. Table 3.39 indicates the dates when samples were collected at representative outfalls during CY 2015.

Table 3.39. NPDES permit renewal sampling conducted in CY 2015

Sampling Location	Manual Grab Samples - Date Collected	Manual Grab or Grab-by-Compositor Samples - Date Collected	Composite Samples - Date Collected
05A	8/6/2015	8/6/2015	9/10/2015
100	8/6/2015	8/6/2015	8/18/15
142	8/6/2015	8/6/2015	9/10/2015
150	7/14/2015	7/14/2015	8/6/2015
170	3/19/2015	3/19/2015	6/9/2015
180	3/19/2015	3/19/2015	4/14/2015
190	3/19/2015	3/19/2015	3/19/2015
195	3/19/2015	3/19/2015	11/19/2015
198	9/9/2015	9/9/2015	11/19/2015
230	9/9/2015	9/9/2015	
430	11/18/2015		
510	11/18/2015		

NPDES = National Pollutant Discharge Elimination System

Table 3.40 indicates results from these NPDES permit renewal sampling efforts that exceeded screening criteria. Mercury results that exceeded screening criteria are discussed in Section 3.6.2.12.

Table 3.40. Analytical results exceeding screening levels for NPDES permit renewal sampling in 2015

Sampling Location	Copper (µg/L)
SCREENING LEVEL	**7**
Outfall 150	29.3
Outfall 190	11.8
Outfall 195	7.04

NPDES = National Pollutant Discharge Elimination System

3.6.3 Surface Water Monitoring

During 2015, the ETTP Environmental Monitoring Program (EMP) personnel conducted environmental surveillance activities at 12 surface water locations (Fig. 3.24) 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 (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 and analyzed quarterly for radionuclides, and CRKs 16 and 23, K-716, and the K-702-A slough were sampled semiannually.

At MIKs 0.45, 0.59, and 0.71, quarterly monitoring is only conducted for ^{99}Tc only. Results of radiological monitoring were compared with the Derived Concentration Standards (DCS) values in DOE Standard 1196 (DOE 2011). 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%) for the year, a 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%). At the majority of locations, the monitoring results yielded SOF values of less than 0.01 (1% of the allowable DCS) (Fig. 3.25). The exception was K-1700 with an SOF of 0.015 (1.5% of the allowable DCS).

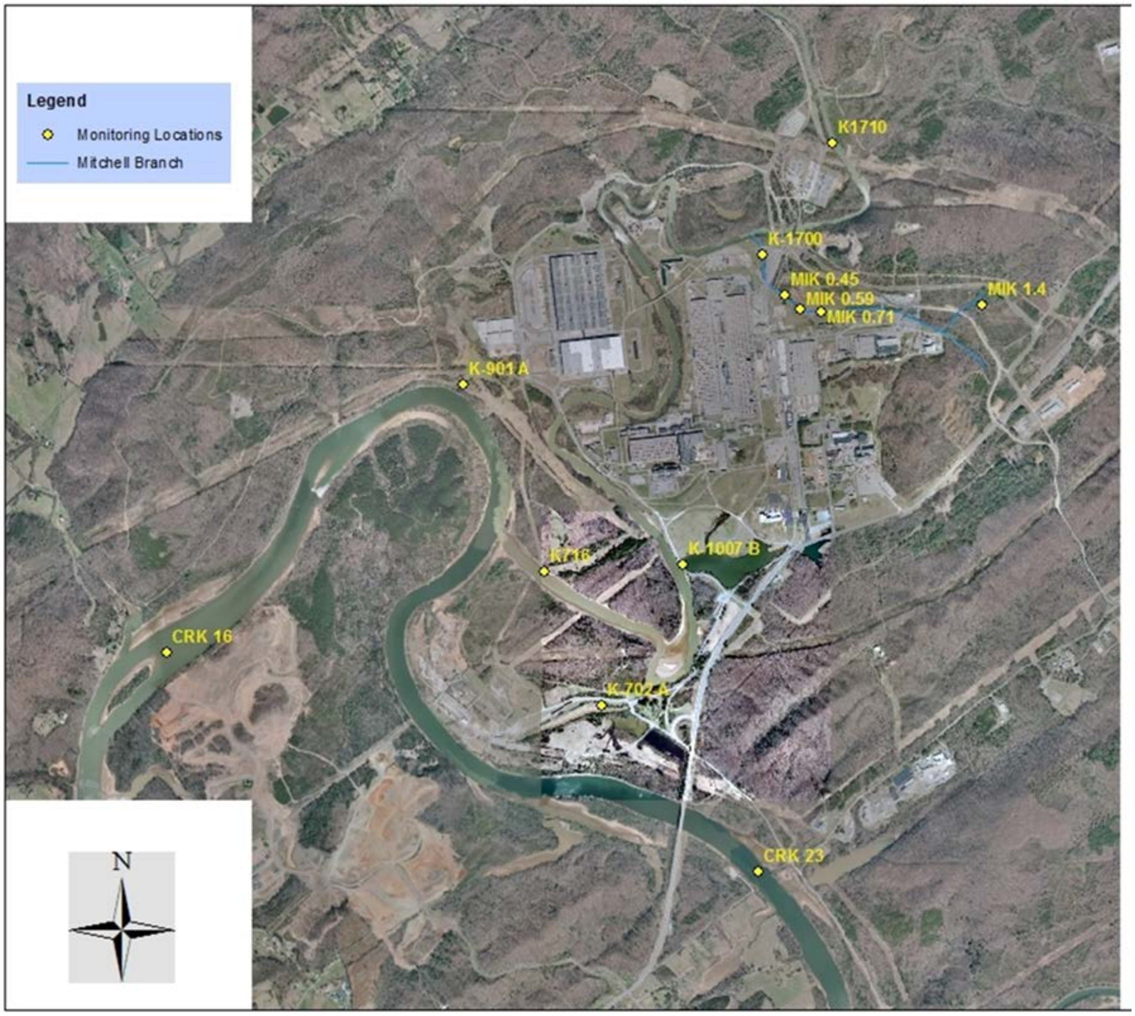

Fig. 3.24. East Tennessee Technology Park Environmental Monitoring Program surface water monitoring locations. *(CRK = Clinch River kilometer and MIK = Mitchell Branch kilometer)*

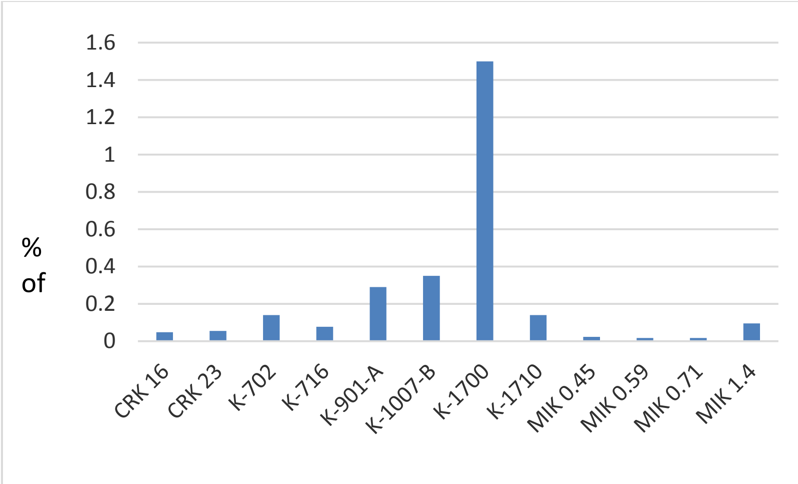

Fig. 3.25. Annual average percentage of derived concentration standards (DCSs) at surface water monitoring locations, 2015. *(CRK = Clinch River kilometer and MIK = Mitchell Branch kilometer)*

Depending on the monitoring location, water samples may be analyzed for pH, selected metals, and VOCs. In 2015, results for most of these parameters were well within the appropriate AWQC. The two exceptions were an exceedance of mercury at K-1710 during the second quarter and an exceedance of lead at K-901-A during the third quarter of 2015. The level of mercury during the second quarter at K-1710 was measured at 96.6 ng/L, which exceeded the AWQC of 51 ng/L. This location is in Poplar Creek upstream from the ETTP surface water influence, so it is doubtful that ETTP operations were the source. The level of lead in the water at the K-901-A monitoring location during the third quarter was measured at 4.5 µg/L, which slightly exceeded the hardness dependent AWQC of 4.4 µg/L. This level of lead is not typical at this location, and no operations were ongoing in the vicinity that might have caused the exceedance. No obvious signs of distress (e.g., dead fish) were observed to be associated with any of these exceedances in 2015.

Figures 3.26 and 3.27 illustrate the concentrations of TCE (trichloroethene) and cis-1,2-dichloroethene (cis-1,2-DCE) from the K-1700 weir (which is used to monitor Mitchell Branch), the only surface water monitoring location where VOCs are regularly detected. 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. Moreover, the standards for 1,2-DCE apply only to the “trans” form of 1,2-DCE; almost all of the 1,2-DCE is in the cis isomer. In addition, vinyl chloride has sometimes been detected in Mitchell Branch water (Fig. 3.28). 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, storm drain network monitoring generally has not detected these compounds in the storm water discharges. When detected, the concentrations are lower than in the stream. Therefore, it appears that the primary source of these compounds is contaminated groundwater.

Since CWTS was installed, chromium levels in Mitchell Branch have dropped dramatically, with levels of total chromium being routinely measured at less than 6 µg/L (Fig. 3.29). In 2015, hexavalent chromium levels in Mitchell Branch were all below the detection limit of 6 µg/L.

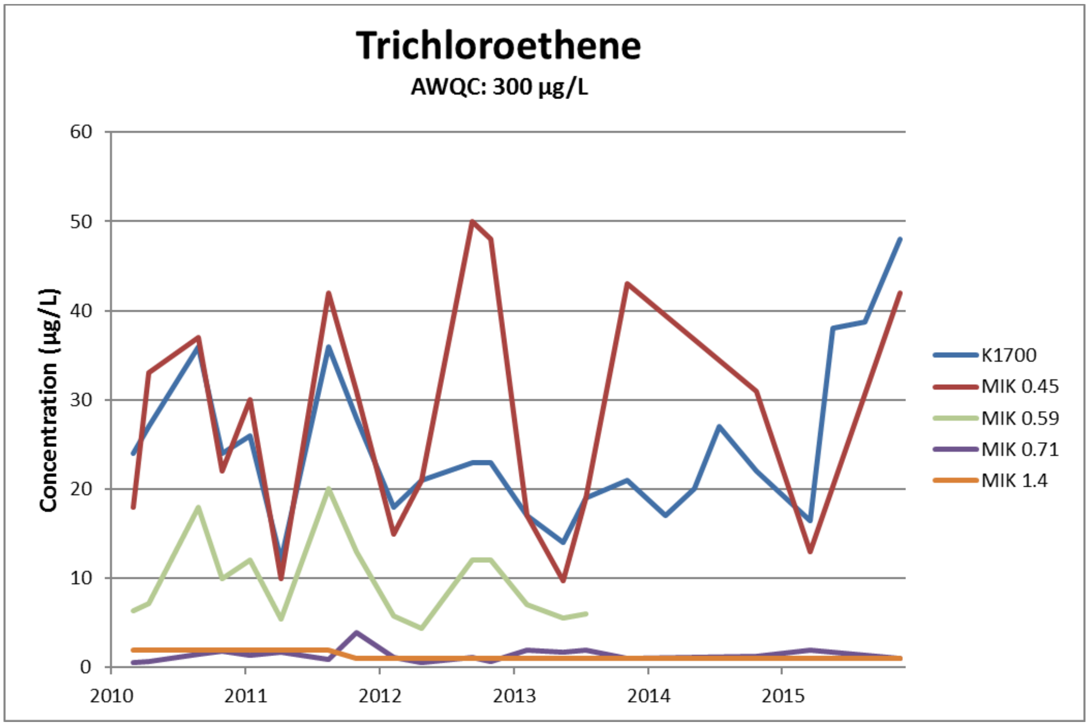

Fig. 3.26. Trichloroethene concentrations in Mitchell Branch.
(MIK = Mitchell Branch kilometer and AWQC = ambient water quality criterion)

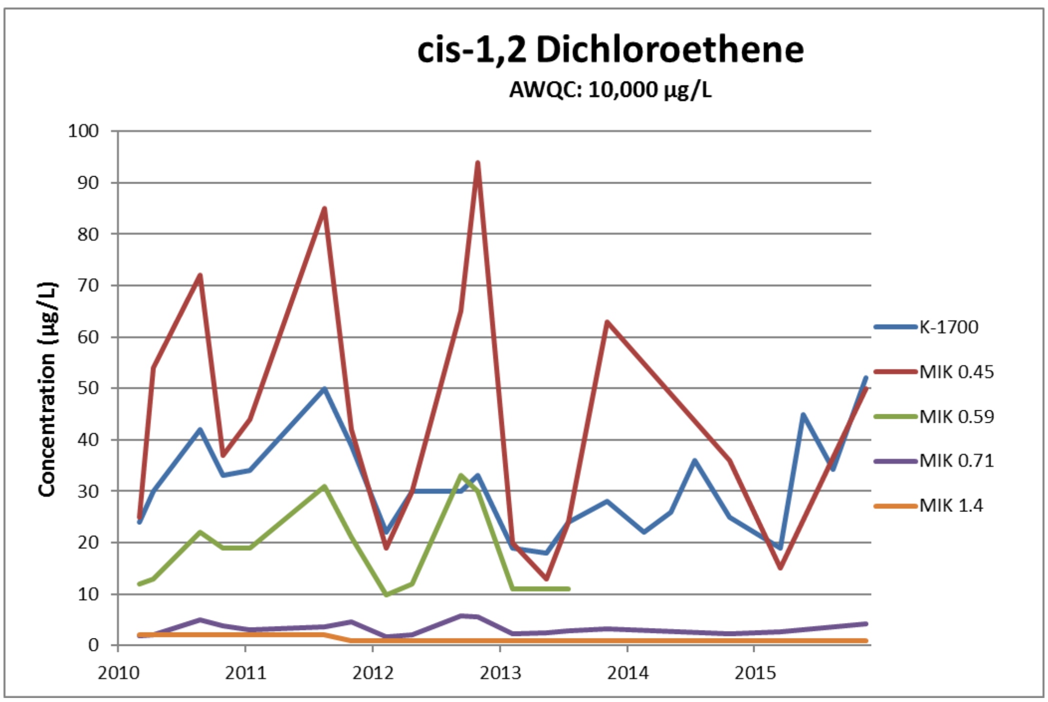

Fig. 3.27. Concentrations of cis-1,2-dichloroethene in Mitchell Branch.
(MIK = Mitchell Branch kilometer and AWQC = ambient water quality criterion)

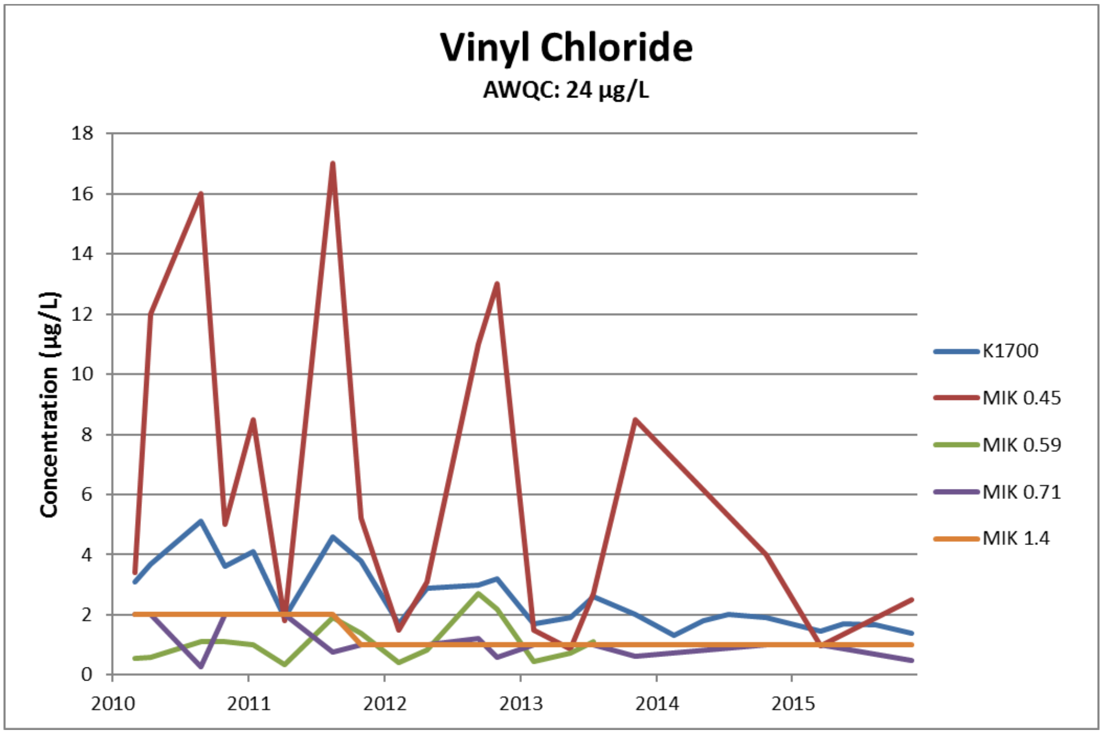

Fig. 3.28. Vinyl chloride concentrations in Mitchell Branch.
(MIK = Mitchell Branch kilometer and AWQC = ambient water quality criterion)

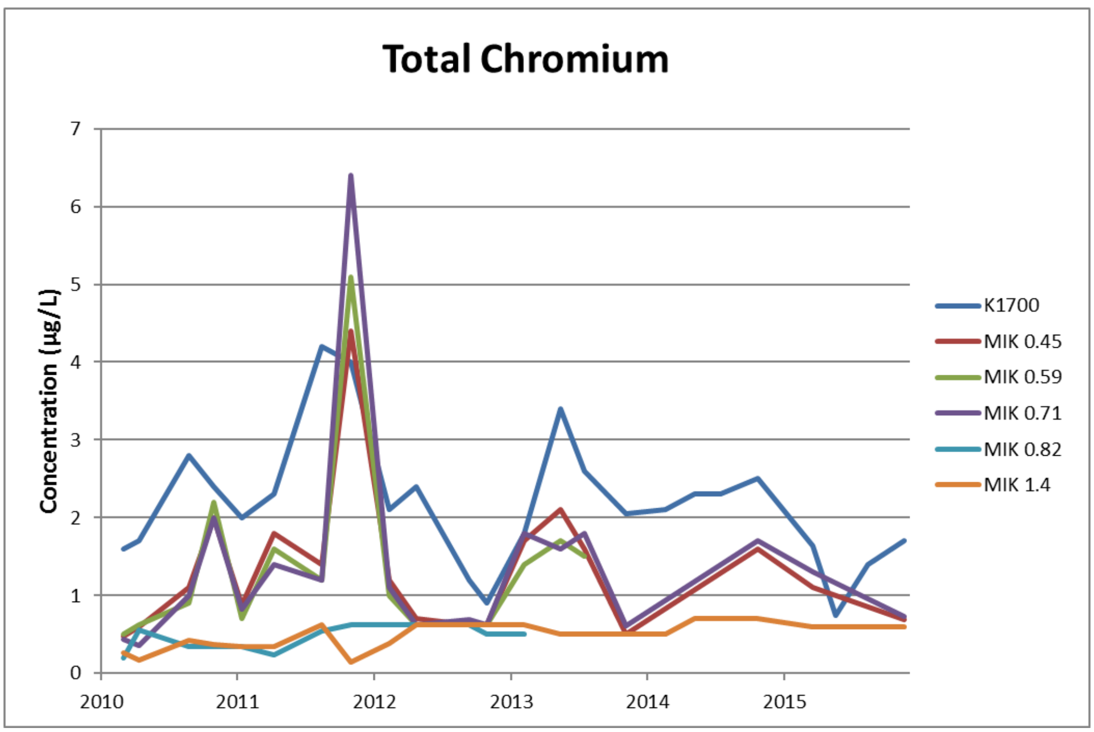

Fig. 3.29. Total chromium concentrations at K-1700.
[The AWQC for Cr(III), which is hardness dependent, is 74 µg/L, based on a hardness of 100 mg/L. The AWQC for Cr(IV) is 11 µg/L. (AWQC = ambient water quality criterion, MIK = Mitchell Branch kilometer)]

3.6.4 Groundwater Monitoring

3.6.4.1 Performance Monitoring Goals and Objectives

Major components of the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161&D2, DOE 2005) selected remedy are:

- Assess data sufficiency for each exposure unit (EU) and supplement data as necessary to determine if remediation levels are exceeded.
- Remove soil up to 10 ft in depth that exceeds remediation levels set to protect a future industrial worker.
- Remove soil to water table, bedrock, or acceptable levels of contamination, whichever is the shallowest, to protect underlying groundwater to maximum contaminant level (MCLs) and to protect human health and the environment.
- Remove or decontaminate the contaminated portions of slabs, vaults, basements, pits, tanks, pipelines, or any other subsurface structure that exceed the remediation levels to protect a future industrial worker to a depth no more than 10 ft. Use soil or concrete debris that meets Zone 2 remediation levels as backfill material in basements and deep excavations.
- Remove the debris in the K-1070-B Burial Ground, regardless of depth to minimize potential future impact to surface water and soil that exceeds remediation levels for protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock surface).
- Remove the debris and soil in the K-1070-C/D Burial Ground that exceeds remediation levels for the protection of workers (upper 10 ft) or protection of groundwater (water table or bedrock surface).
- Verify all acreage in Zone 2 as compliant with soil remediation levels established by the record of decision (ROD).
- Implement land use controls (LUCs) to prevent exposure to residual solid contamination left on-site and/or to prevent residential use of the land.

Zone 2 was divided into 44 EUs for planning and evaluation purposes. Final status assessments and associated data gap sampling efforts for EUs in Zone 2 are being conducted using a Dynamic Verification Strategy (DVS) in accordance with the *Remedial Design Report/Remedial Action Work Plan for the Zone 2 Soils, Slabs, and Subsurface Structures, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2224&D4, DOE 2015c). Successful completion of the Zone 2 cleanup requires that each of these 44 EUs be characterized, evaluated against the Zone 2 risk criteria, and remediated if necessary.

The Remediation Action Objectives for Zone 2 are to:

- Protect human health under an industrial land use to an excess cancer risk level at or below 1×10^{-4} and non-cancer risk levels at or below an HI [Hazard Index] of 1, and
- Protect groundwater to levels at or below MCLs.

Drinking water MCLs are used as screening criteria for evaluating the effectiveness of soil, buried waste, and subsurface structure cleanup. The ROD, however, specifically defers groundwater and surface water cleanup to a later CERCLA action and does not include ARAR-based performance objectives for groundwater cleanup.

The monitoring requirements are monitoring of groundwater adjacent to potential sources of groundwater contamination, including the K-1070-C/D Burial Ground (DOE/OR/01-2161&D2, DOE 2005). This monitoring will continue until the sitewide ROD is approved.

Figure 3.30 shows watershed scale and CERCLA performance monitoring locations at ETTP (groundwater monitoring locations are shown on separate figures as indicated). Table 3.41 lists performance monitoring conducted for the Zone 2 ROD and other CERCLA actions at ETTP. ETTP does not have a sole surface water integration point at which all upstream contaminant releases converge to exit the watershed, but has several subwatersheds. Therefore, there are several surface water integration points.

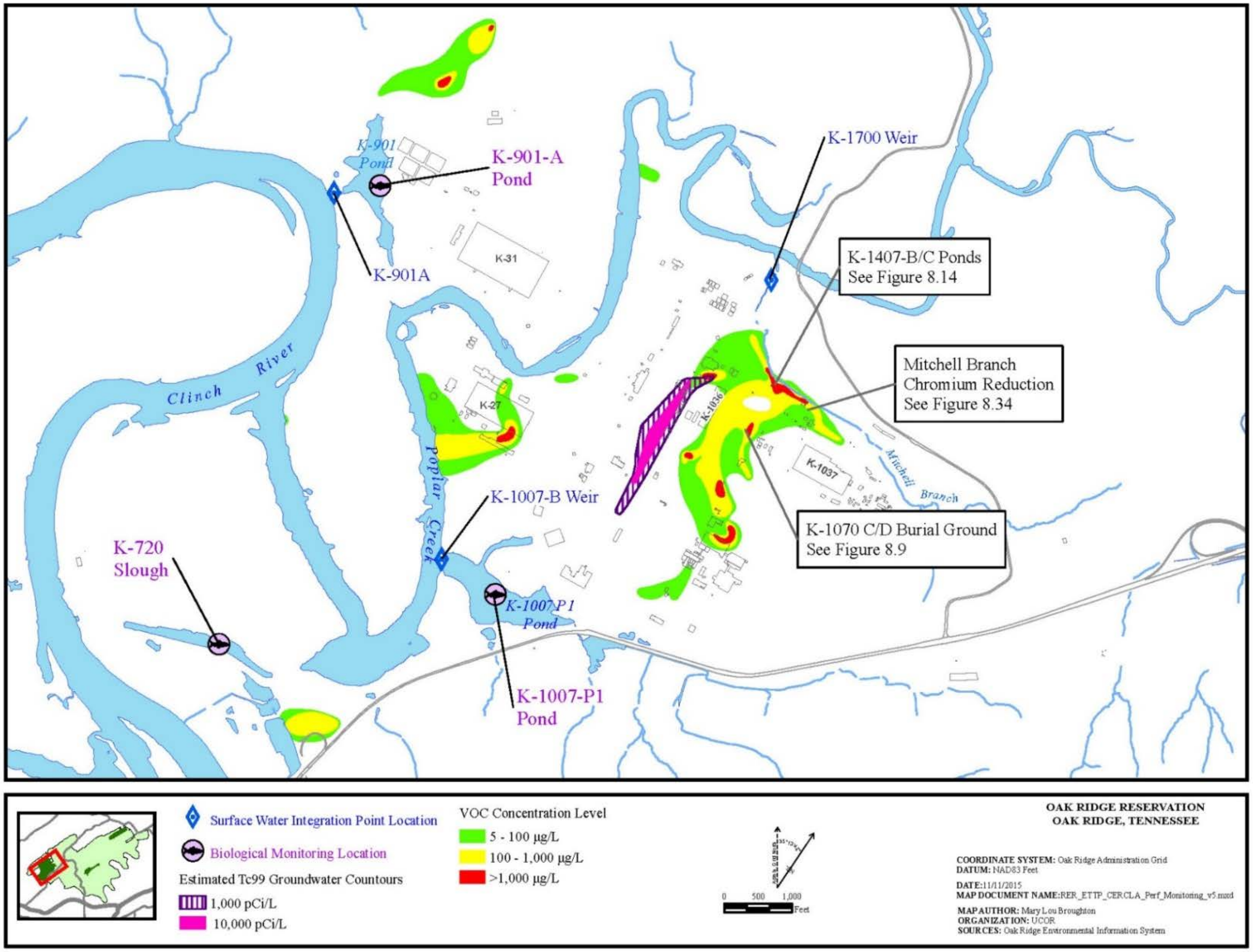

Fig. 3.30. Watershed scale and CERCLA performance monitoring locations at ETTP. *(CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act and VOC = volatile organic compound)*

Table 3.41. CERCLA action performance monitoring in the ETTP administrative watershed[a]

CERCLA action	Performance goal	**Performance standard**	**Monitoring location(s)**	**General schedule and monitored parameters**
Performance Monitoring				
Zone 2 Soil, Buried Waste, and Subsurface Structure RAs (includes K-1070-C/D Burial Ground)	Protect human health under an industrial land use to an ELCR at or below 1×10^{-4} and non-cancer risk levels at or below a HI of 1 Protect groundwater to levels at or below MCLs for drinking water	Drinking water MCLs	*Groundwater* TMW-011 UNW-064 UNW-114	Semiannual sampling (seasonally wet and dry conditions) Laboratory analyses for VOCs and water quality parameters
Long-term Reduction of Hexavalent Chromium Releases to Mitchell Branch (Non-TC RmA)	Collect and treat hexavalent chromium-contaminated groundwater to reduce its toxicity prior to discharge into Mitchell Branch Protect water quality in Mitchell Branch at levels consistent with AWQC	Hexavalent chromium concentrations below 0.011 mg/L AWQC in Mitchell Branch immediately downstream of SD-170 discharge	*Surface water* MIK-0.79 SD-170 *Groundwater* TP-289 IW-416 and IW-417 *Treatment System Discharge*	Quarterly sampling of all monitoring locations Laboratory analyses (unfiltered samples) for total and hexavalent chromium in surface water, groundwater, and treatment system discharge samples Treatment system discharge samples also analyzed for pH, total uranium, VOCs, gross alpha and beta, and select radionuclides
K-1407-B/C ponds RA	Reduce potential threats to human health and the environment posed by residual contamination in pond soils by providing isolation and shielding with rock fill and intact soil cover	Remediation target concentrations were not established in the CERCLA decision or post-decision documents	*Surface water* K-1700 weir *Groundwater* UNW-003 UNW-009	Semiannual sampling Laboratory analyses for nitrate, field parameters, VOCs, metals, gross alpha and beta, ^{99}Tc, ^{90}strontium (^{90}Sr), ^{137}cesium (^{137}Cs), $^{230/232}$thorium (^{230,232}Th), and $^{234/238}$U

[a]Changes to performance monitoring for RAs require prior approval from the EPA and TDEC.

Table 3.41 (continued)

CERCLA action	Performance goal	**Performance standard**	**Monitoring location(s)**	**General schedule and monitored parameters**
K-901-A and K-1007-P1 holding ponds and K-720 slough RA	The goal of the ecological enhancement performed at the K-1007-P1 holding pond is to establish a new steady-state condition within the pond that reduces risks from PCBs by enhancing components of the ecology that minimize PCB uptake, which will reduce risks to human and piscivorous wildlife by interdicting contaminant exposure pathways associated with these receptors	PCB concentration of 1 mg/kg in fish fillets (2.3 mg/kg whole body)	Operational Monitoring at K-1007-P1 pond only:	
			1. Presence of original fish	1. Once, after fish removal
			2. PCBs in fish	2. Annually
			3. Condition of vegetation	3. 2×/yr during growing season
			4. Species of fish	4. Annually
			5. Water quality	5. 3×/yr during growing season
			6. PCBs in clams	6. Four locations annually for a four week exposure
			7. Geese/waterfowl population	7. Monthly identification and enumeration of all waterfowl in and around pond
			Performance Monitoring at K-1007-P1 & K-901-A holding ponds, and K-720 slough:	
			1. PCBs in fish	1. Annually for four years, then reassess for every other year until acceptable risk documented for each pond
			2. Species of fish in K-1007-P1 only	2. Annually for four years (reassess after four years, as above)
			3. PCBs in clams in K-1007-P1 only	3. Four locations annually for a four week exposure (reassessed after four years, as above)

[a]Changes to performance monitoring for RAs require prior approval from the EPA and TDEC.

CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
ELCR = excess lifetime cancer risk
HI = hazard index
MCL = maximum contaminant level

RA = remedial action
RmA = Removal Action
TC = time critical
VOC = volatile organic compound

3.6.4.2 Evaluation of Performance Monitoring Data

Monitoring locations, analytical parameters, and cleanup levels were not specified for groundwater monitoring at the K-1070-C/D Burial Ground (Fig. 3.31), although the primary COCs in that area are VOCs. Semiannual samples are analyzed for VOCs and general water quality parameters in wells and surface water locations outside the perimeter of the burial ground. Monitoring at the site is focused on providing data for evaluating changes in contaminant concentrations near the source units or potentially discharging to surface water within the boundaries of the ETTP. Approximately 9,000 gal of mixed volatile organic liquids were disposed in G-Pit. Historic data showed that 1,1,1-TCA was present at very high concentrations in wells monitored near the site. 1,1,1-TCA is amenable to biodegradation to 1,1-DCA by microbes in the *Dehalobacter* genus. Although 1,1-DCA is also amenable to degradation by some species of *Dehalobacter*, the presence of cis-1,2-DCE and vinyl chloride (VC) tend to inhibit the biodegradation of 1,1-DCA. Cis-1,2-DCE and VC are common biodegradation products of tetrachloroethene (PCE) and TCE, which are also present in groundwater at the site, along with 1,1-DCE, another biodegradation product of PCE and TCE.

Following remediation of G-Pit, monitoring wells UNW-114, TMW-011, and UNW-064 (Fig. 3.31) were selected to monitor the VOC plume leaving the K-1070-C/D Burial Grounds, because they were located in the principal known downgradient groundwater pathway. Results of monitoring at these wells show elevated VOC concentrations. VOC concentrations at these three wells were decreasing prior to the excavation of the G-Pit contents (during FY 2000) and continue to decrease. Although 1,1,1-TCA was formerly present at concentrations far greater than its 200 µg/L MCL, natural biodegradation has reduced its concentrations to less than the drinking water standard. Several direct push monitoring points were installed to the west of UNW-114 during investigations conducted in support of a Sitewide Groundwater Remedial Investigation in 2005 (*Final Sitewide Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge Tennessee*. DOE/OR/01-2279&D3, DOE 2007). The purpose of these monitoring points was to investigate groundwater contamination in an area along potential geologically controlled seepage pathways that may have connected the G-Pit contaminant source to the former SW-31 Spring. DOE continues to monitor two of these points (DPT-K1070-5 and DPT-K1070-6) to measure VOC concentrations and their fluctuations.

Of the three wells monitored at this site, well UNW-114 is closest to the source area. Monitoring data for well UNW-114 (Fig. 3.32) show that concentrations of most VOCs have been variable since 2005 and exhibit no trend or a stable trend. Concentrations of 1,1-DCA have gradually increased from a minimum of about 140 µg/L in 2007 to a recent concentration of 890 µg/L. 1,1,1-TCA was not detected in the March 2015 sample, but was detected at 0.3 J µg/L in an August 2015 sample from well UNW-114 during FY 2015. The lingering 1,1-DCA residual in groundwater is evidence of the former presence of high concentrations of 1,1,1-TCA in the area. Recent concentrations of most chlorinated VOCs in well UNW-114 are within factors of about two to five times their MCLs.

Well UNW-064 is located slightly further downgradient from the contaminant source area than UNW-114 and its monitoring data exhibit a slightly different behavior. Similar to the overall trend observed at UNW-114, the majority of VOC concentrations at UNW-064 (Fig. 3.33) decreased from about 2002 through 2005. Concentrations remained relatively low through the drought years of 2006 into 2008, and increased between 2008 and 2010. Since 2010, VOCs in well UNW-064 have exhibited stable to gradually decreasing concentrations with fairly strong seasonal fluctuations. At UNW-064 the 1,1-DCA, 1,1-DCE, cis-1,2-DCE, and TCE show a seasonal concentration fluctuation with higher concentration during winter than during summer. This seasonal fluctuation suggests that contaminant mass transport responds to increased groundwater recharge and seepage through the plume. DOE suspects that increased seasonal recharge drives mass transfer in the plume through two combined mechanisms. One mechanism is a rise in groundwater elevation in the source area (residual liquid waste beneath "G-Pit"), which allows groundwater seepage through fractures of higher permeability at a somewhat shallower depth. The second mechanism is simply a higher flow volume through the source area and downgradient fractures caused by the higher head imposed on the whole saturated zone. Cis-1,2-DCE, PCE, and VC have decreased to concentrations less than their respective MCLs in well UNW-064. TCE continues to fluctuate at concentrations approximately two to five times its MCL and 1,1-DCE concentrations are about five to ten times the MCL.

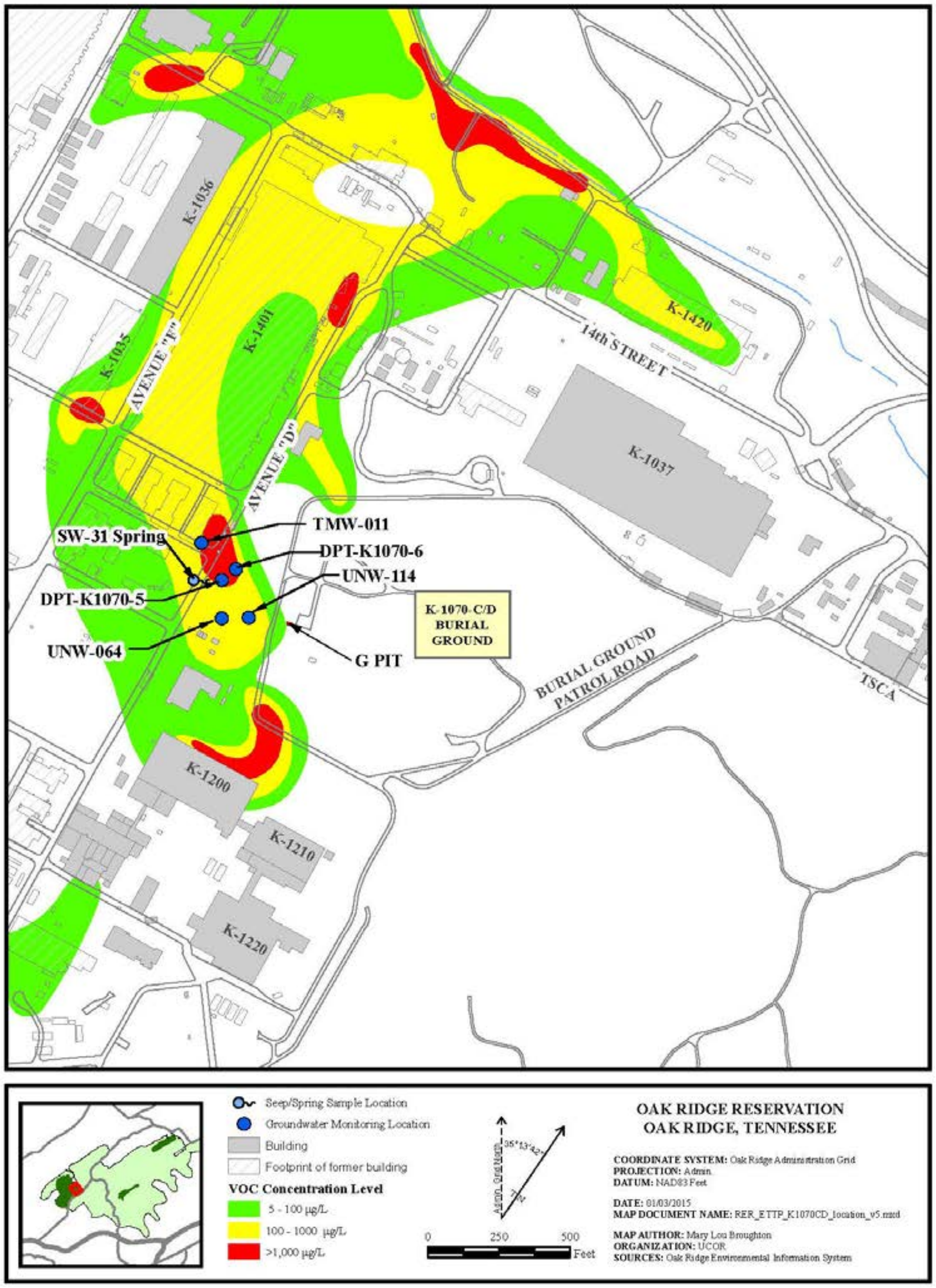

Fig. 3.31. Location map for K-1070-C/D Burial Ground.
(VOC = volatile organic compound)

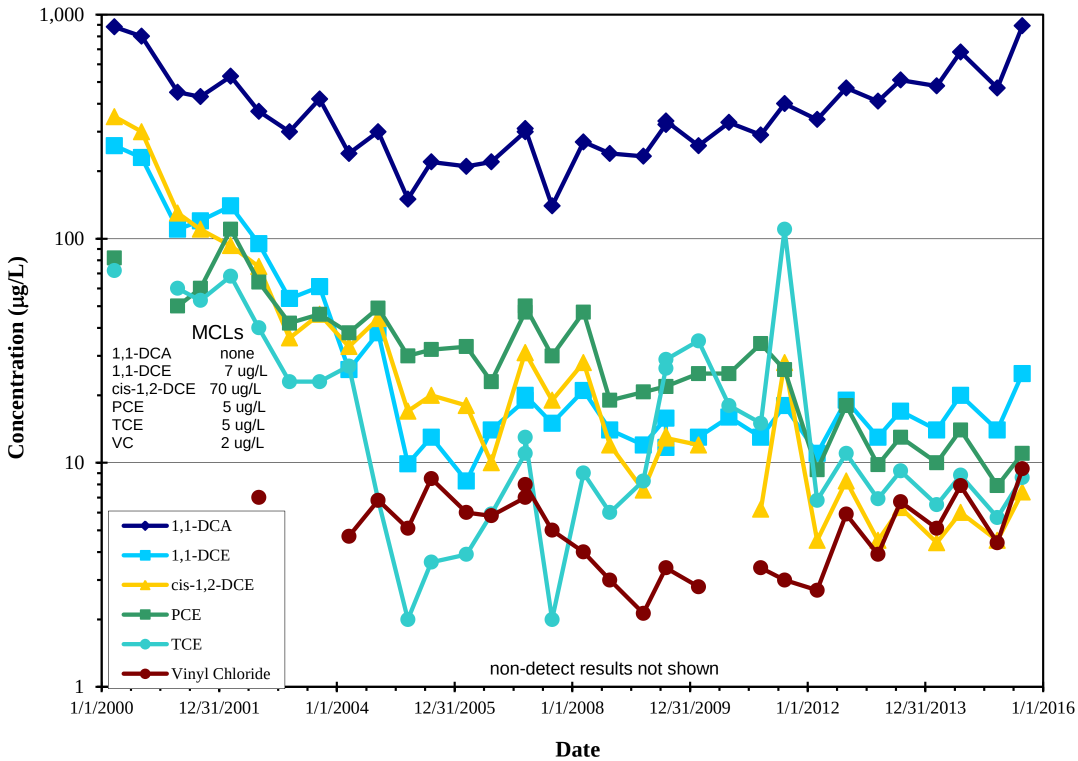

Fig. 3.32. VOC concentrations in well UNW-114 2002-2015.
(MCL = maximum contaminant level)

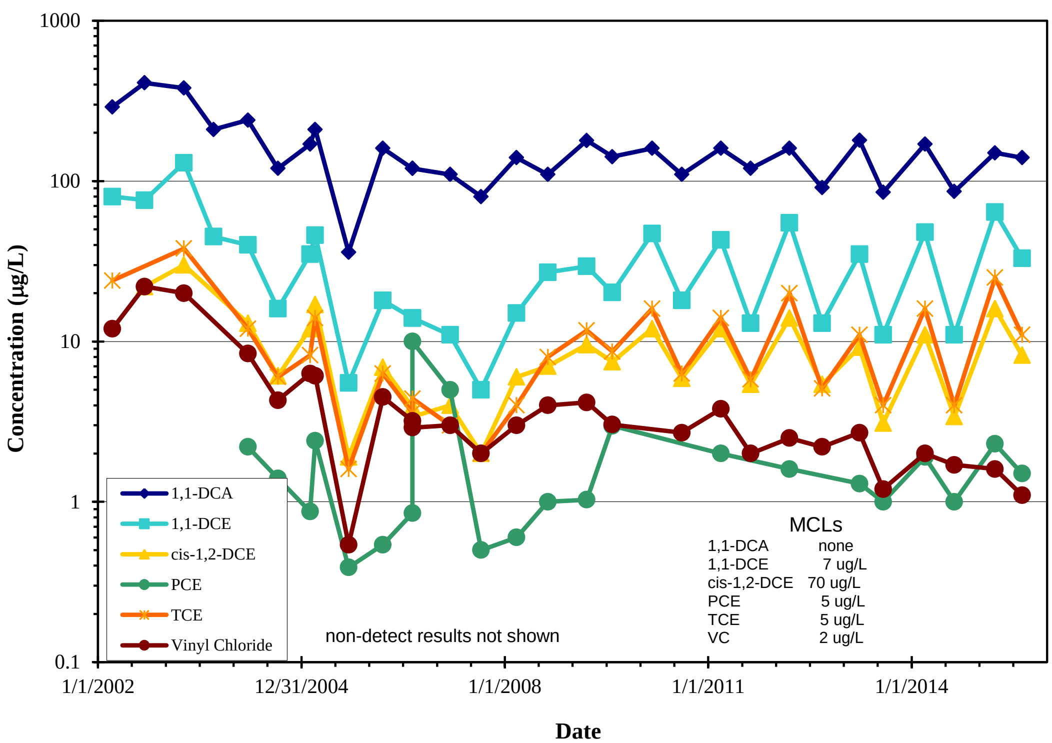

Fig. 3.33. VOC concentrations in well UNW-064 2000–2015.
(MCL = maximum contaminant level)

Well TMW-011 is located furthest from the contaminant source area near the base of the hill below K-1070-C/D. VOC concentrations at TMW-011 tend to fluctuate in a fashion similar to those at UNW-064 except that the seasonal signature is reversed with higher concentrations in summer than during winter. This relationship suggests that groundwater recharge during winter tends to dilute the VOCs near TMW-011 rather than cause a pulse of higher concentration groundwater, as was observed at the mid-slope location near UNW-064. Like the other two wells, VOC concentrations (Fig. 3.34) decreased from 2000 until early 2005, after which concentrations have fluctuated seasonally within a gradual downward trend through about 2011. Since the summer of 2012, concentrations have experienced another step-like decrease. Cis-1,2-DCE and PCE have remained below their respective MCLs since the winter of 2012. Since the winter sampling event in 2012, VC concentrations have fluctuated with winter concentrations being below the MCL and summer concentrations exceeding the MCL by factors of two to three. TCE and 1,1-DCE concentrations fluctuate at concentrations about five to 15 times their respective MCLs.

Monitoring locations DPT-K1070-5 and DPT-K1070-6 (Fig. 3.31) were installed using direct-push technology and therefore they sample groundwater just at, and somewhat above the top of bedrock. At these locations very high concentrations of 1,1,1-TCA, 1,1-DCE, and TCE persist (Fig. 3.35). Overall decreasing trends for TCE, 1,1,1-TCA and its degradation product 1,1-DCE are apparent at well DPT-K1070-5, while 1,1,1-TCA in DPT K-1070-6 fluctuates in a concentration range well above its MCL. High concentrations (500–1,000 μg/L) of cis-1,2-DCE are present in addition to some values for 1,1,1-TCA, 1,1-DCA, 1,1-DCE, and TCE in this concentration range. Other VOCs that were found in the excavated material from G-Pit, such as 1,1,2-TCA, 1,2-dimethylbenzene and chloroform, continue to be detected in these monitoring points.

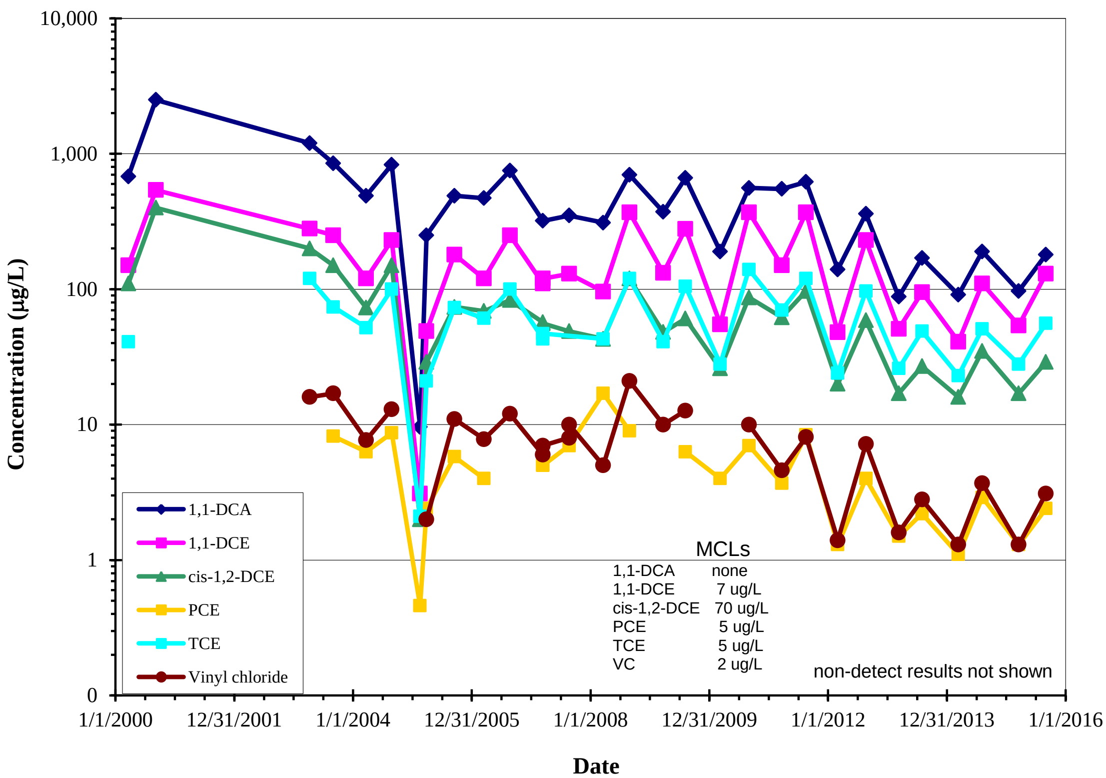

Fig. 3.34. VOC concentrations in well TMW-011 2000–2015.
(MCL = maximum contaminant level)

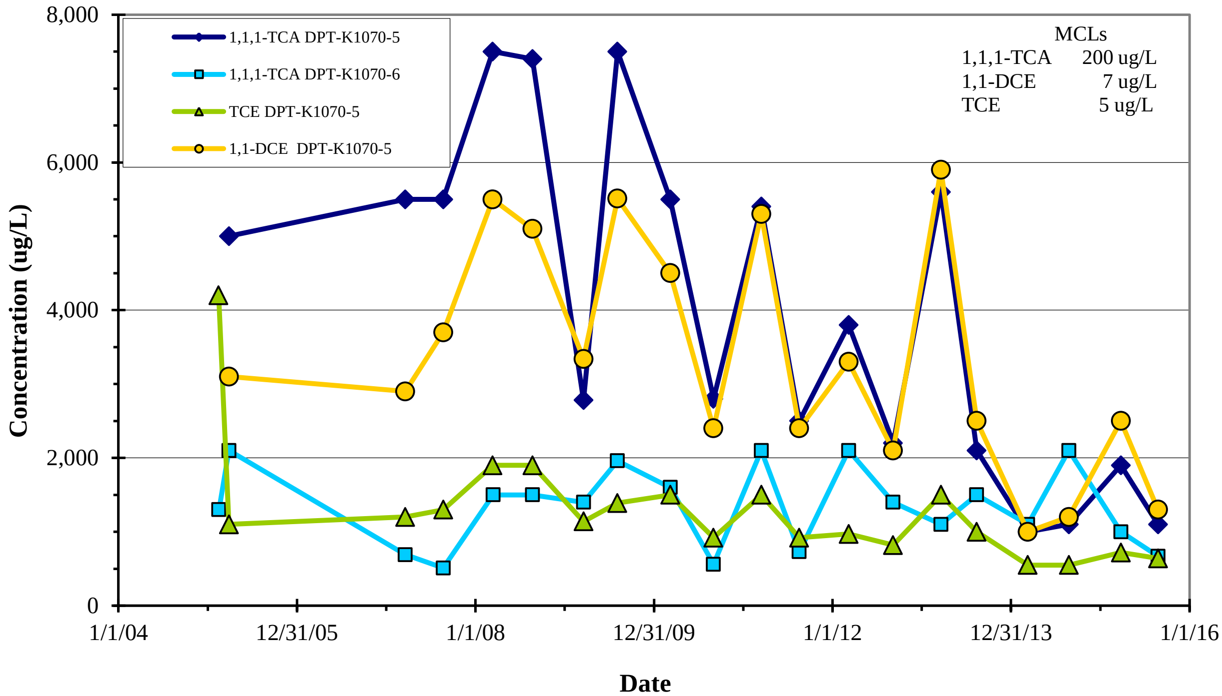

Fig. 3.35. Concentrations of selected VOCs in DPT-K1070-5 and DPT-K1070-6.
(MCL = maximum contaminant level)

3.6.4.3 Performance Summary

VOC concentrations in wells monitored downgradient of K-1070-C/D show that a broad area is affected by the releases from the G-Pit liquid VOC disposals. While concentrations along one portion of the impacted area continue to decrease, there remains a known area with very high concentrations of the contaminants disposed at the site. The persistent, very high concentrations of these VOCs suggest that a dense nonaqueous phase liquid (DNAPL) source beneath and/or downgradient of the G-Pit continues to release mass into the plume.

3.6.5 Other Long-Term Stewardship Requirements

Other long-term stewardship (LTS) requirements for the Zone 2 ROD are described below.

3.6.5.1 Requirements

The R*ecord of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161&D2, DOE 2005) establishes “industrial” as the land use to a depth of 10 ft. To implement restrictions that prohibit residential or agricultural use of this area under the ROD and to restrict access to this area until that end use has been achieved, seven LUCs will be implemented: (1) property record restrictions, (2) property record notices, (3) zoning notices, (4) the excavation/penetration permit (EPP) program, (5) access controls, (6) signs, and (7) surveillance patrols. The objectives of these Zone 2 LUCs follow:

- Control land use to prevent exposure to contamination by controlling excavations or soil penetrations below 10 ft and prevent uses of the land involving exposures to human receptors greater than those from industrial use. Significant accumulations of material with residual contamination above unrestricted use levels will also be monitored and controlled. This will avoid accumulation of contamination placed in an area not currently designated for disposal that could reestablish a risk to a future industrial user.

- Prohibit the development and use of property for residential housing, elementary or secondary schools, childcare facilities, children's playgrounds, other prohibited commercial uses, or agricultural use.
- Maintain the integrity of any existing or future monitoring systems until the ETTP sitewide residual contamination RA is implemented.
- Control and restrict access to workers and the public to prevent unauthorized uses and maintain signs to provide notice or warning to prevent unauthorized access.
- Maintain the integrity of access controls and signs at the K-1070-C/D Burial Ground for as long as the residual debris represents a concern.

Until remediation is complete and the industrial land use is achieved, the seven LUCs mentioned above will be implemented to restrict residential or agricultural use of the land. Reliance will be primarily on property record and zoning notices, the EPP program, access controls, and surveillance patrols. Once remediation is complete, property record restrictions, property record and other public notices, zoning notices, excavation permits, and less intensive surveillance patrols and fences for the short-term at the K-1070-C/D Burial Grounds will be used. In addition, when an area within Zone 2 is transferred, property record restrictions and notices will be implemented.

The PCCRs completed under the *Record of Decision for Soil, Buried Waste, and Subsurface Structure Actions in Zone 2, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2161&D2, DOE 2005) state that the No Further Action (NFA) decision means that an EU is available for unrestricted industrial use to a depth of 10 ft below ground surface (bgs) and NFA is required beyond the LUCs specified in the Zone 2 ROD.

3.6.5.2 Status of Requirements

General LUCs for Zone 2 remained in place during FY 2015. Signs were maintained to control access and surveillance patrols were conducted as part of routine surveillance and maintenance (S&M) inspections. The EPP program functioned according to established procedures and plans for the site. Required mowing was performed. Additionally, signs and access controls at the K-1070-C/D Burial Ground were inspected annually by the ETTP S&M Program.

3.6.6 K-1407-B/C Ponds

The *Record of Decision for the K-1407-B/C Ponds at the Oak Ridge K-25 Site, Oak Ridge, Tennessee* (DOE/OR/02-1125&D3, DOE 1993) addressed potential risks associated with residual wastes and soils remaining in the K-1407-B/C ponds from the initial removal of sludge conducted as a previous RCRA closure action. The location of the K-1407-B/C ponds at ETTP is shown in Fig. 3.36.

Components of the selected remedy include the following activities:

- Placement of clean soil and rock fill for isolation and shielding,

- Maintenance of institutional controls, and
- Groundwater monitoring to assess performance of the action and develop information for use in reviewing the effectiveness of the remedy.

3.6.6.1 Performance Monitoring

3.6.6.1.1 *Performance Monitoring Goals and Objectives*

The objective of the K-1407-B/C ponds remediation was to reduce potential threats to human health and the environment posed by residual metal, radiological, and VOC contamination within the pond soils (DOE/OR/01-1125&D3, DOE 1993).

The *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin, Oak Ridge, Tennessee* (DOE/OR/01-1371&D1, DOE 1995) proposes semiannual groundwater monitoring for nitrate, metals, and selected radionuclides, including gross alpha and beta activity, ^{99}Tc, ^{90}strontium (^{90}Sr), ^{137}cesium (^{137}Cs), $^{230/232}$thorium ($^{230/232}$Th), and $^{234/238}$U. Target concentrations for these parameters were not established in the CERCLA documents (DOE 1993, DOE 1995) for use in post-remediation monitoring to evaluate effectiveness. Performance monitoring is conducted in wells UNW-003, UNW-009, and the Mitchell Branch weir (K-1700 weir).

3.6.6.1.2 *Evaluation of Performance Monitoring Data*

The primary groundwater contaminants in the K-1407-B/C ponds area are VOCs. VOCs are widespread in this portion of ETTP, including contaminant sources upgradient of the ponds. Groundwater samples were collected at UNW-003 and UNW-009 in March and August/September 2015. VOCs are not detected in shallow groundwater north of Mitchell Branch in well UNW-009. VOC concentration data for well UNW-003 for the time span 2001 through 2015 are shown on Fig. 3.37. Monitoring results for FY 2015 at the wells are generally consistent with results from previous years although concentrations of PCE and TCE have increased during FYs 2014 and 2015 compared to levels measured during the preceding several years. The detection of VOCs at concentrations well above 1,000 µg/L and the steady concentrations over recent years suggest the presence of DNAPLs in the vicinity of well UNW-003. The sitewide ROD will address groundwater contamination present in the area of the former ponds.

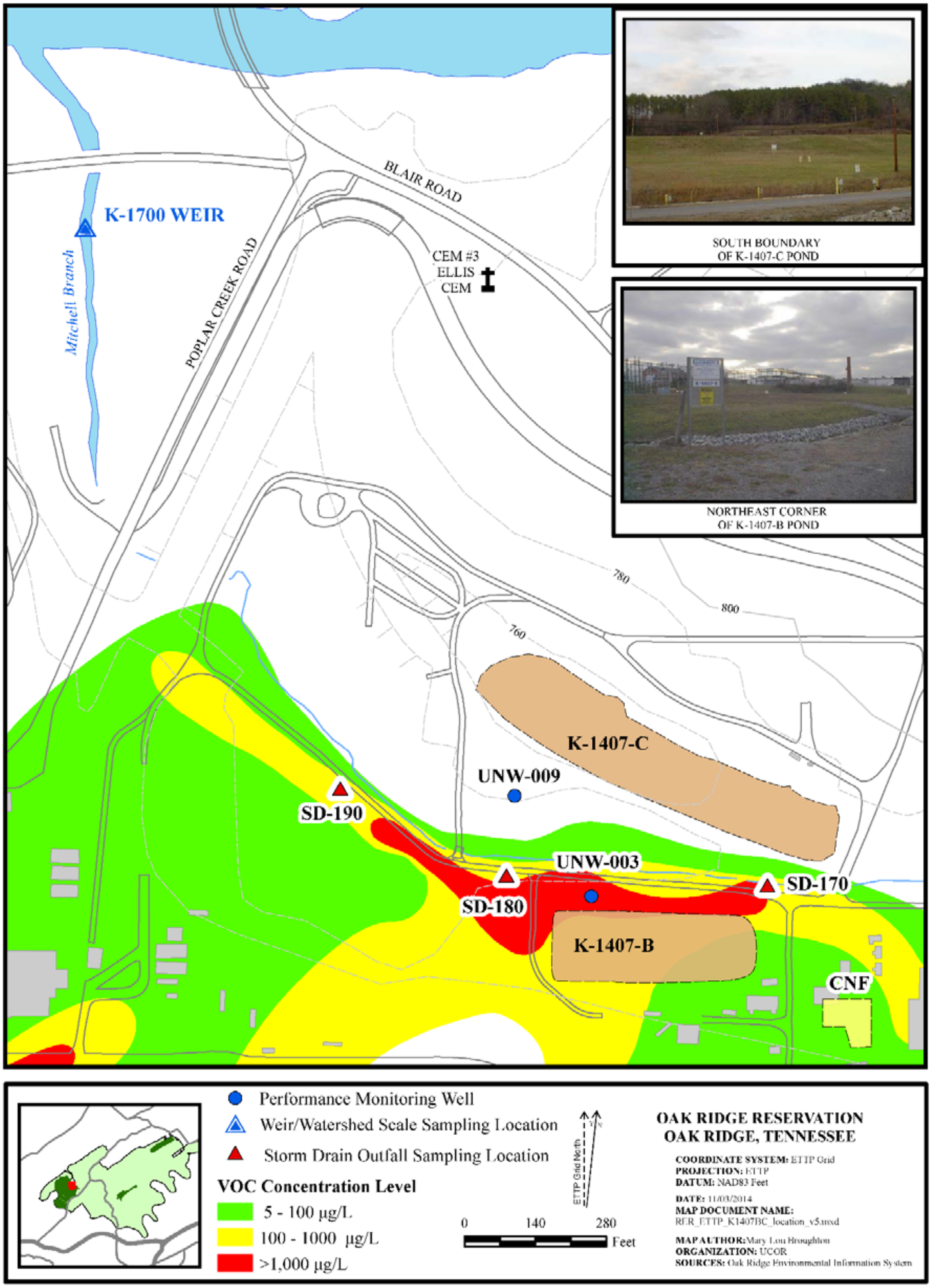

Fig. 3.36. Location of K-1407-B/C ponds.
(SD = storm water outfall and VOC = volatile organic compound)

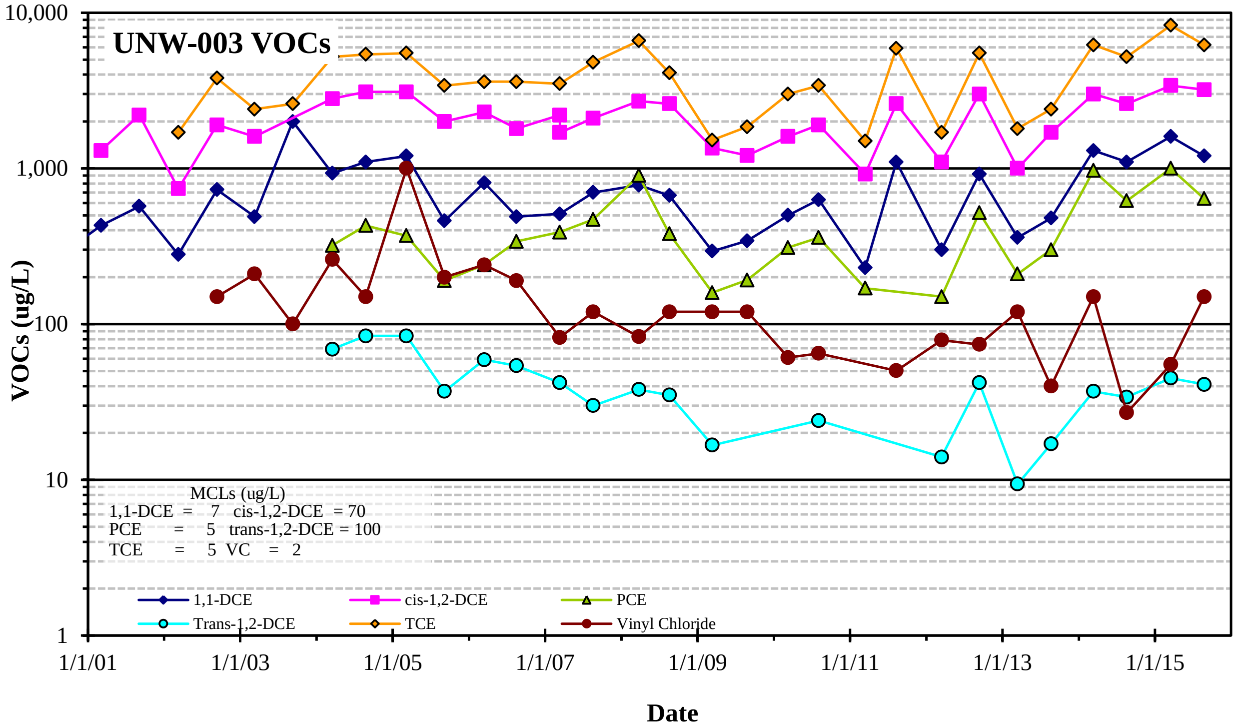

Fig. 3.37. VOC concentrations in well UNW-003, 2001–2015.
(MCL = maximum contaminant level; VOC = volatile organic compound)

3.6.6.2 Other Long-Term Stewardship Requirements

3.6.6.2.1 Requirements

LTS requirements specified in the *Remedial Action Report for the K-1407-B Holding Pond and the K-1407-C Retention Basin* (DOE/OR/01-1371&D1, DOE 1995) were clarified in an erratum approved in May 2015 and included maintenance of institutional controls.

The erratum states, "*Conduct annual inspections and perform radiological and industrial hygiene surveillance and other assessment activities only as needed if activities are conducted at the site that are necessary to keep the remediated ponds in compliance with environmental, safety, and health requirements and maintain records of all related activities.*"

3.6.6.2.2 Status of Requirements

All components of the K-1407-B/C ponds site were inspected in FY 2015 by the ETTP S&M Program, including access controls and sign conditions; condition of vegetation including dead spots, excessive weeds or deep rooted vegetation, grass mowing, discoloration or withering of vegetation; soil/surface condition, including evidence of soil erosion, gullies or rills, staining, debris or trash. The site underwent routine mowing. Minor maintenance included removing vegetation from signs.

3.6.7 K-1070-C/D G-Pit and Concrete Pad

The K-1070-C/D G-Pit is the primary source of organic contaminant releases to soil and groundwater in the area. The K-1071 Concrete Pad, located in the southeastern portion of the K-1070-C/D area, was determined to pose an unacceptable health risk to workers from future exposure to soil radiological contaminants (DOE/OR/02-1486&D4, DOE 1998). The location of the area at ETTP is shown in Figs. 3.31 and 3.38. Components of the remedy included:

- Excavation of the G-Pit contents, interim storage of the material, treatment, and disposal, and
- Placement of an interim 2 ft soil cover over the Concrete Pad until remediated.

3.6.7.1 Other LTS Requirements

3.6.7.1.1 Requirements

The *Record of Decision for the K-1070-C/D Operable Unit, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/02-1486&D4, DOE 1998) and *Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1964&D2, DOE 2002) require interim LTS activities including maintaining institutional controls. An *Erratum to the Remedial Action Report for the K-1070-C/D G-Pit and K-1071 Concrete Pad, East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-1964&D2, DT, DOE 2015) approved in May 2015 contains revised frequencies. Specifically, annual inspections of the soil cover over the pad are to be conducted to look for erosion; the grass on the cover is to be mowed as needed, but not less than annually; radiological walkover surveys are to be conducted only if there is activity in the area to confirm the effectiveness of the K-1071 Concrete Pad soil cover in preventing exposure to ionizing radiation; and inspections of the fence are to be performed as needed, but no less than annually. Existing institutional controls will continue to ensure the existing EPP program remains in place.

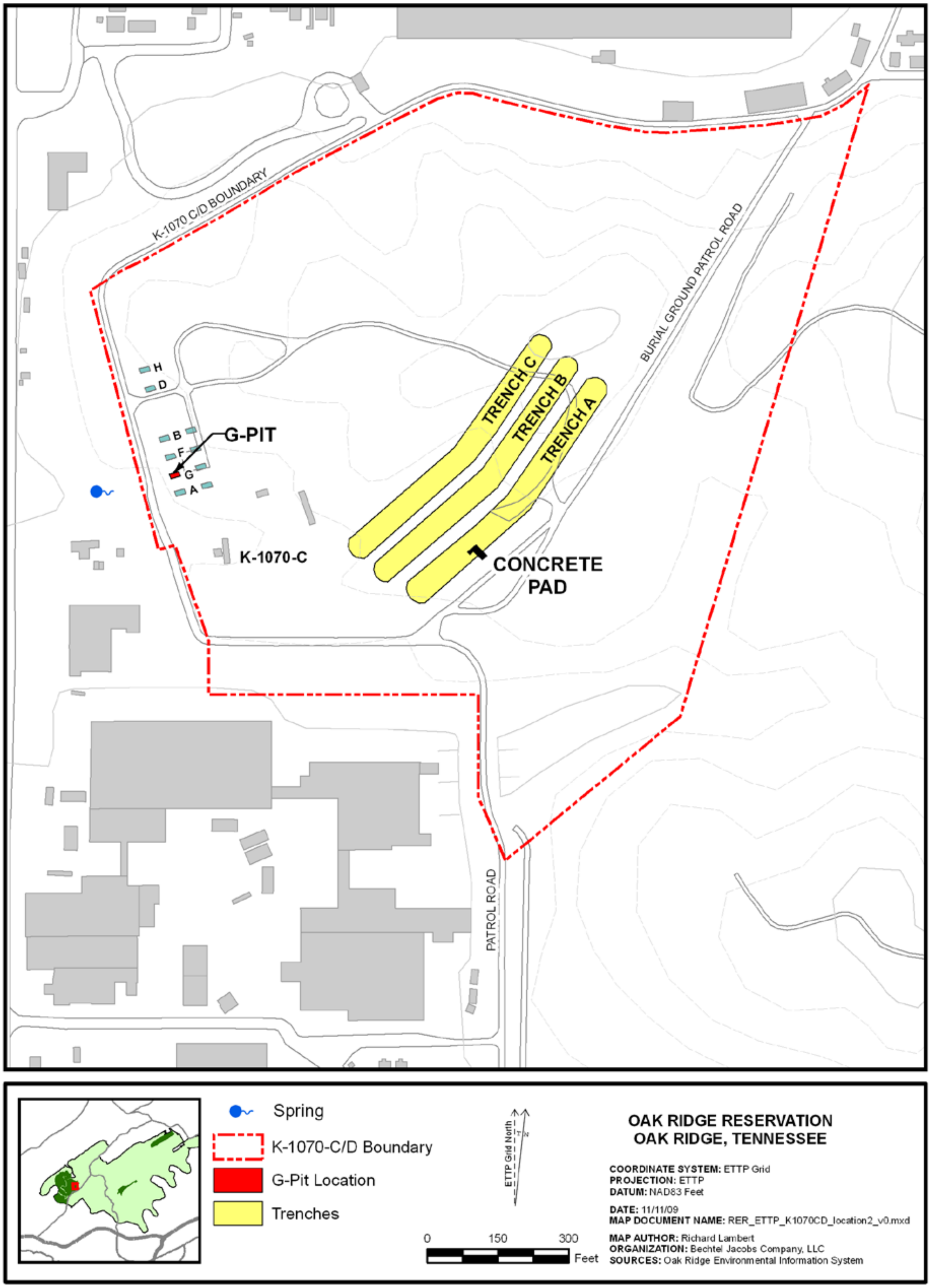

Fig. 3.38. Location of K-1070-C/D G-Pit and Concrete Pad.

3.6.7.1.2 Status of Requirements

The site was inspected by the ETTP S&M Program in FY 2015 for items including condition of the warning signs, condition of fencing and locked gate, condition of the K-1071 Concrete Pad soil cover and maintenance of vegetation including the presence of excessive weeds or deep-rooted vegetation, need for grass mowing, or discoloration or withering of vegetation. No maintenance was required.

3.6.8 Groundwater Plumes

This section provides a summary of ETTP sitewide groundwater, surface water, and aquatic biology monitoring.

Extensive groundwater monitoring at the ETTP site, using Safe Drinking Water Act (SDWA) MCLs as groundwater screening values, has identified VOCs as the most significant groundwater contaminant on-site. The principal chlorinated hydrocarbon chemicals that were used at ETTP were PCE, TCE, and 1,1,1-TCA.

Figure 3.39 shows the distribution and generalized concentrations of the sum of the primary chlorinated hydrocarbon chemicals and their transformation products, respectively, at ETTP. Specific compounds in the summation of chlorinated VOCs include chloroethenes (PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, 1,1-DCA, and VC), chloroethanes (1,1,1-TCA, 1,1,2-TCA, 1,2-DCA, 1,1-DCA, and chloroethane), and chloromethanes (carbon tetrachloride, chloroform, and methylene chloride). Several plume source areas are identified within the regions of the highest VOC concentrations. In these areas, the primary chlorinated hydrocarbons have been present for decades and mature contaminant plumes have evolved. The degree of transformation or degradation of the primary chlorinated hydrocarbon compounds is highly variable across the site. In the vicinity of the K-1070-C/D source, a high degree of degradation has occurred, although a strong source of contamination still remains in the vicinity of the G-Pit, where approximately 9,000 gal of chlorinated hydrocarbon liquids were disposed in an unlined pit. Other areas where transformation is significant include the K-1401 Acid Line leak site, and the K-1407-B pond area. Transformation processes are weak or inconsistent at the K-1004 and K-1200 area, K-1035, K-1413, and K-1070-A Burial Ground; and little transformation of TCE is observed in the K-27/K-29 source and plume area.

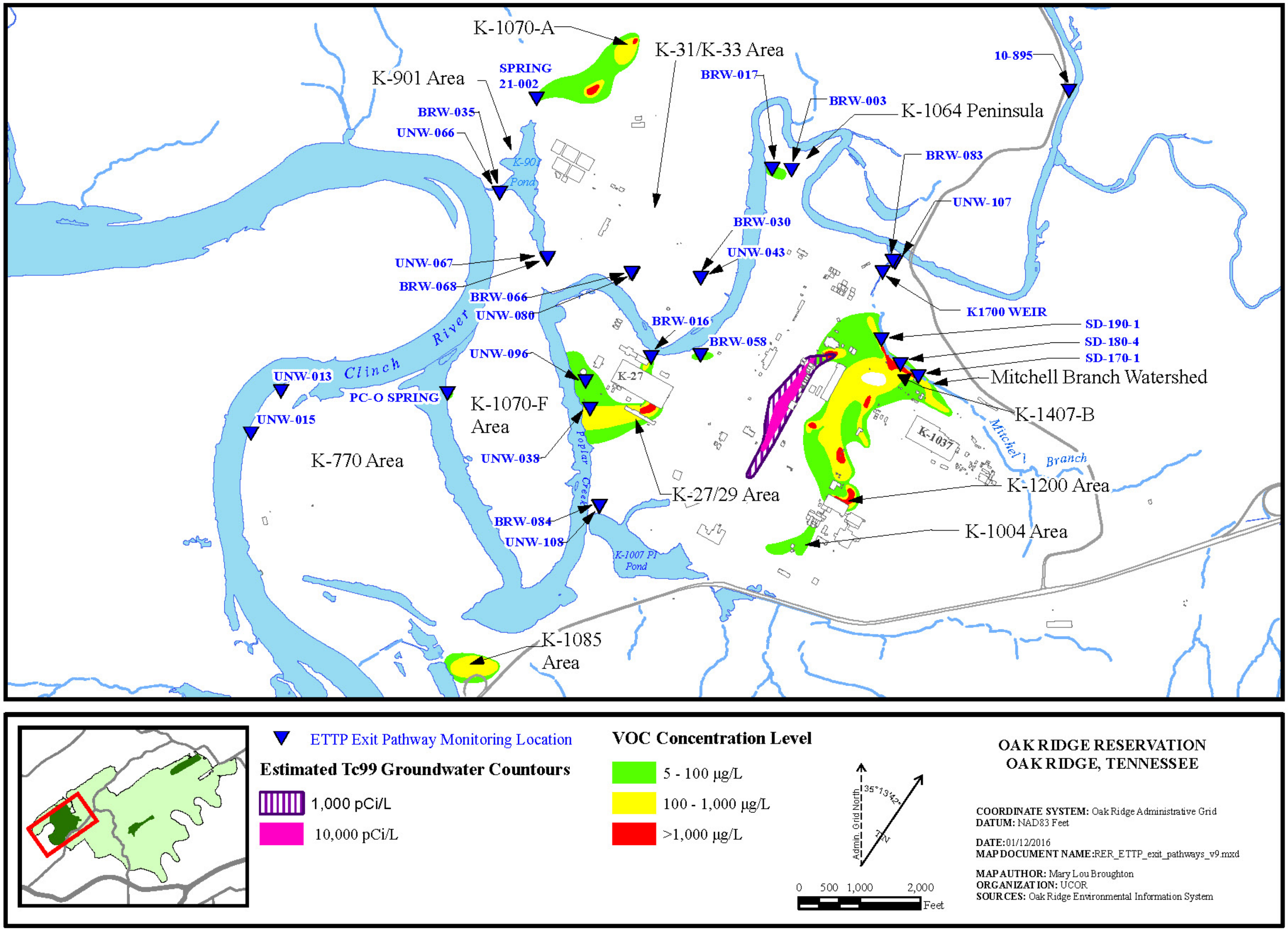

Fig. 3.39. ETTP exit pathways monitoring locations. *(VOC = volatile organic compound)*

3.6.9 Groundwater Exit Pathways

Groundwater exit pathway monitoring sites are shown in Fig. 3.36. Groundwater monitoring results for the exit pathways are discussed below.

Mitchell Branch – The Mitchell Branch groundwater exit pathway is monitored using surface water data from the K-1700 weir on Mitchell Branch and wells BRW-083 and UNW-107.

Wells BRW-083 and UNW-107, located near the mouth of Mitchell Branch, have been monitored since 1994. Table 3.42 shows the history and concentrations of detected VOCs in groundwater. Detection of VOCs in groundwater near the mouth of Mitchell Branch is considered an indication of the migration of the Mitchell Branch VOC plume complex. The intermittent detection of VOCs in this exit pathway is thought to be a reflection of variations in groundwater flowpaths that can fluctuate with seasonal hydraulic head conditions, which are strongly affected by rainfall. During FY 2015, no chlorinated VOCs were detected in BRW-083 and TCE was detected at an estimated concentration of 0.53 J µg/L in the August sample from UNW-107.

Table 3.42. VOCs detected in groundwater in the Mitchell Branch Exit Pathway

Well	Date	cis-1,2-DCE	PCE	TCE	VC
BRW-083	8/29/2002	ND	**5**	**28**	ND
	3/16/2004	0.69	2.2	**9.9**	ND
	8/26/2004	2	4.7	**20**	ND
	3/14/2007	5	**9**	**28**	ND
	3/20/2008	ND	ND	ND	ND
	8/21/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	1.31 J	ND
	8/3/2009	ND	2.66	**14.2**	ND
	3/3/2010	ND	ND	ND	ND
	8/30/2010	3.6	**5.1**	**18**	ND
	3/15/2011	2.8	**6.7**	**22**	ND
	8/10/2011	ND	ND	ND	ND
	3/1/2012	ND	ND	ND	ND
	8/16/2012	ND	ND	ND	ND
	8/6/2013	ND	ND	ND	ND
	3/13/2013	ND	ND	ND	ND
	3/13/2014	ND	ND	ND	ND
	8/7/2014	ND	ND	ND	ND
	3/30/2015	ND	ND	ND	ND
	8/20/2015	ND	ND	ND	ND
UNW-107	8/3/1998	ND	ND	3	ND
	8/26/2004	4.7	ND	3.6	ND
	8/21/2006	3.4	**14**	2	1.2
	3/13/2007	25	2 J	**23**	2[a]
	8/21/2007	17	ND	**30**	0.3 J

Table 3.41 (continued)

Well	Date	cis-1,2-DCE	PCE	TCE	VC
	3/5/2008	ND	ND	ND	ND
	8/18/2008	ND	ND	ND	ND
	3/12/2009	ND	ND	ND	ND
	7/30/2009	ND	ND	ND	ND
	3/4/2010	ND	ND	ND	ND
	7/28/2010	ND	ND	ND	ND
	3/16/2011	ND	ND	ND	ND
	8/11/2011	ND	ND	ND	ND
	3/30/2012	ND	ND	ND	ND
	9/12/2012	ND	ND	ND	ND
	8/8/2013	ND	ND	ND	ND
	3/20/2013	ND	ND	ND	ND
	3/18/2014	ND	ND	ND	ND
	8/20/2014	ND	ND	ND	ND
	3/16/2015	ND	ND	ND	ND
	8/25/2015	ND	ND	0.53 J	ND

[a]Detection occurred in a field replicate. Constituent not detected in regular sample.

Bold table entries exceed SDWA MCL screening values (PCE, TCE = 5 µg/L, cis-1,2-DCE = 70 µg/L, VC = 2 µg/L). All concentrations µg/L.

Acronyms

BRW = bedrock well
DCE = dichloroethene
J = estimated value
ND = Not Detected
PCE = tetrachloroethene
TCE = trichloroethene
VC = vinyl chloride

K-1064 Peninsula area – Wells BRW-003 and BRW-017 monitor groundwater at the K-1064 Peninsula burn area. Figure 3.40 shows the history of VOC concentrations in groundwater from FY 1994 through FY 2015. TCE concentrations have declined in both wells over that period of time. TCE was present at concentrations less than the MCL during FY 2015 at well BRW-017 and was detected at an estimated concentration of 0.66 J µg/L in the August sample from well BRW-003. In the August 2015 sample from well BRW-003 1,1,1-TCA was detected at an estimated concentration of 0.47 J µg/L following several years of non-detect results at the 1 µg/L detection limit. Cis-1,2-DCE was detected at concentrations much less than its MCL in both semiannual samples in well BRW-017.

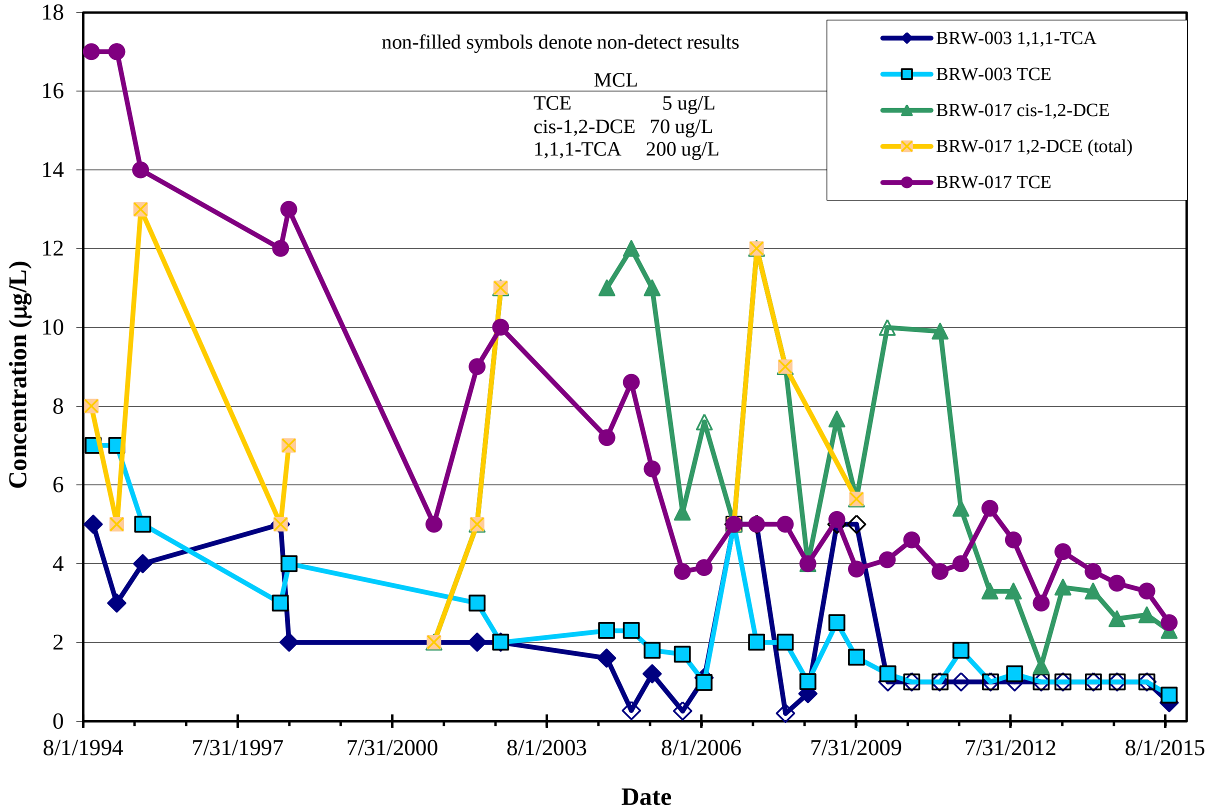

Fig. 3.40. VOC concentrations in groundwater at K-1064 Peninsula area.
(MCL = maximum contaminant level and VOC = volatile organic compound)

K-31/K-33 area – Groundwater is monitored in four wells (BRW-066, BRW-030, UNW-080, and UNW-043) that lie between the K-31/K-33 area and Poplar Creek. VOCs are not COCs in this area; however, leaks of recirculated cooling water in the past have left residual subsurface chromium contamination. Figure 3.41 shows the history of chromium detection in wells at K-31/K-33. Well UNW-043 exhibits the highest residual chromium concentrations of any in the area. Chromium concentrations in well UNW-043 correlate with the turbidity of samples, and acidification of unfiltered samples. These samples contain suspended solids, often causing detection of high-metal content because the addition of acid preservative, which releases metals that are adsorbed into the solid particles at the normal groundwater pH. During FY 2006, an investigation was conducted to determine if groundwater in the vicinity of the K-31/K-33 buildings contained residual hexavalent chromium from recirculated cooling water leaks. The data indicated the chromium in groundwater near the leak sites was essentially of the less toxic trivalent species. During FY 2008 through FY 2015, field-filtered (i.e., dissolved) and unfiltered samples were collected from UNW-043. Chromium concentrations in the field-filtered samples are consistently much lower than the MCL and during FY 2015 the chromium concentration in filtered aliquots was less than the 0.011 mg/L AWQC level for hexavalent chromium. During FY 2015, both field-filtered and unfiltered samples were collected from wells BRW-066, UNW-030 and UNW-080. Chromium was non-detect in all samples from well BRW-066 during FY 2015.

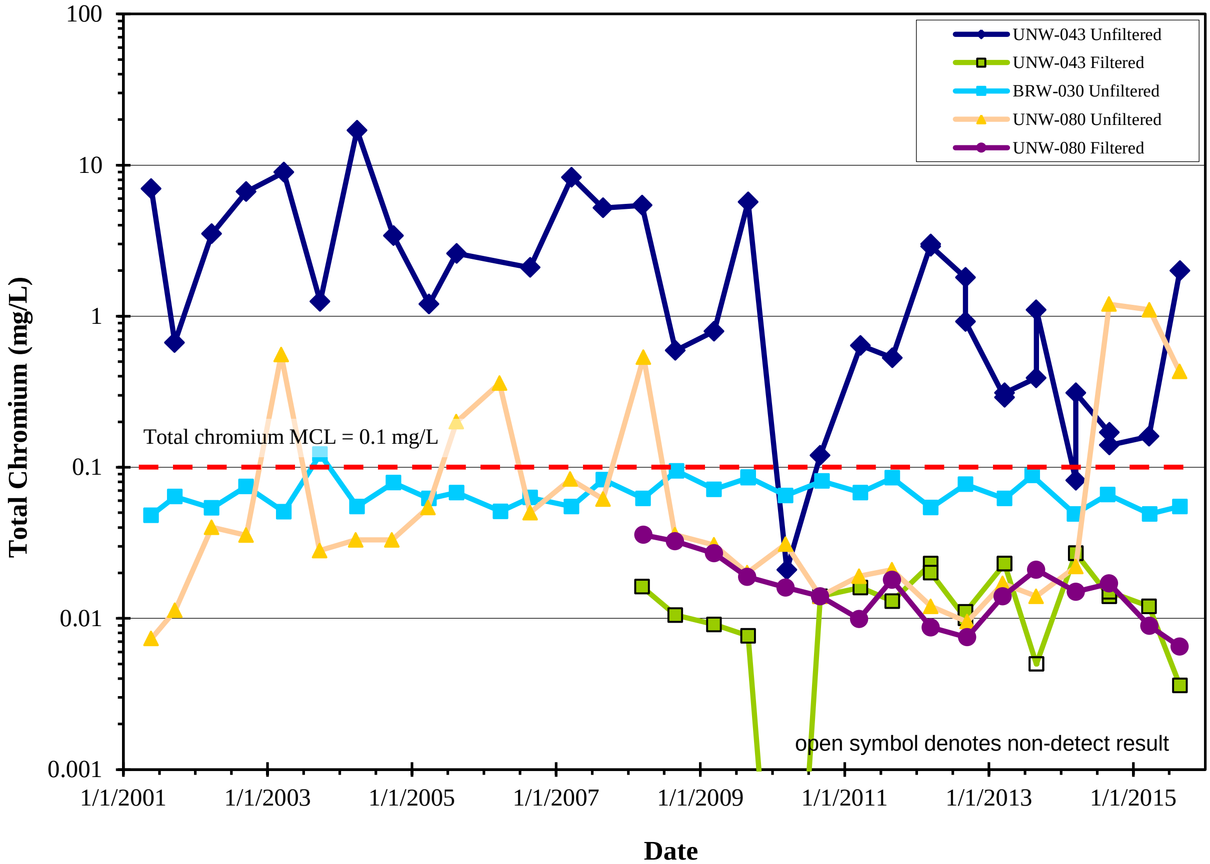

Fig. 3.41. Chromium concentrations in groundwater in the K-31/K-33 area.
(MCL = maximum contaminant level)

K-27/K-29 area – Several exit pathway wells are monitored in the K-27/K-29 area. Figure 3.42 provides concentrations of detected VOCs in wells both north and south of K-27 and K-29 through FY 2015. The source of VOC contamination in well BRW-058 is not suspected to be from K-27/K-29 area operations but is more likely associated with groundwater contamination that originates in the K-25 area. Well BRW-058 VC continues to slightly exceed the MCL, while cis-1,2-DCE remains at concentrations slightly lower than the MCL. The VOC concentrations in well BRW-016 appear to be gradually decreasing and do not exceed MCLs. TCE levels in well UNW-038 fluctuate between 10 to 20 times the MCL and appear to be in a nearly stable fluctuation range since about 2011, with higher concentrations during the wet season and lower concentrations during the dry season. At BRW-016, cis-1,2-DCE levels show a decreasing trend and VC has decreased to < 1 µg/L, which is lower than the MCL.

K-1007-P1 holding pond area – Wells BRW-084 and UNW-108 are exit pathway monitoring locations at the northern edge of the K-1007-P1 holding pond (as shown earlier in Fig. 3.24). These wells were monitored intermittently from 1994 through 1998 and semiannually from FY 2001 through FY 2015. The first detections of VOCs in these wells occurred during FY 2006 with detection of low (~10 µg/L or less) concentrations of TCE and cis-1,2-DCE. The source area for these VOCs is not known. During FY 2015 TCE was detected at 7 µg/L and cis-1,2-DCE was detected at 0.83 J µg/L in the August sample from well BRW-084. No VOCs were detected in either sample from well UNW-108. Metals have been detected in the past associated with the presence of turbidity in the samples. Very low concentrations of antimony (0.31 J µg/L in well UNW-108 in March) and selenium (0.46 J µg/L in BRW-084 in March and

0.52 J µg/L in well UNW-108 in September) were detected on filtered samples. Potential sources of these metals in this area are unknown and the detected concentrations are far below any criterion level.

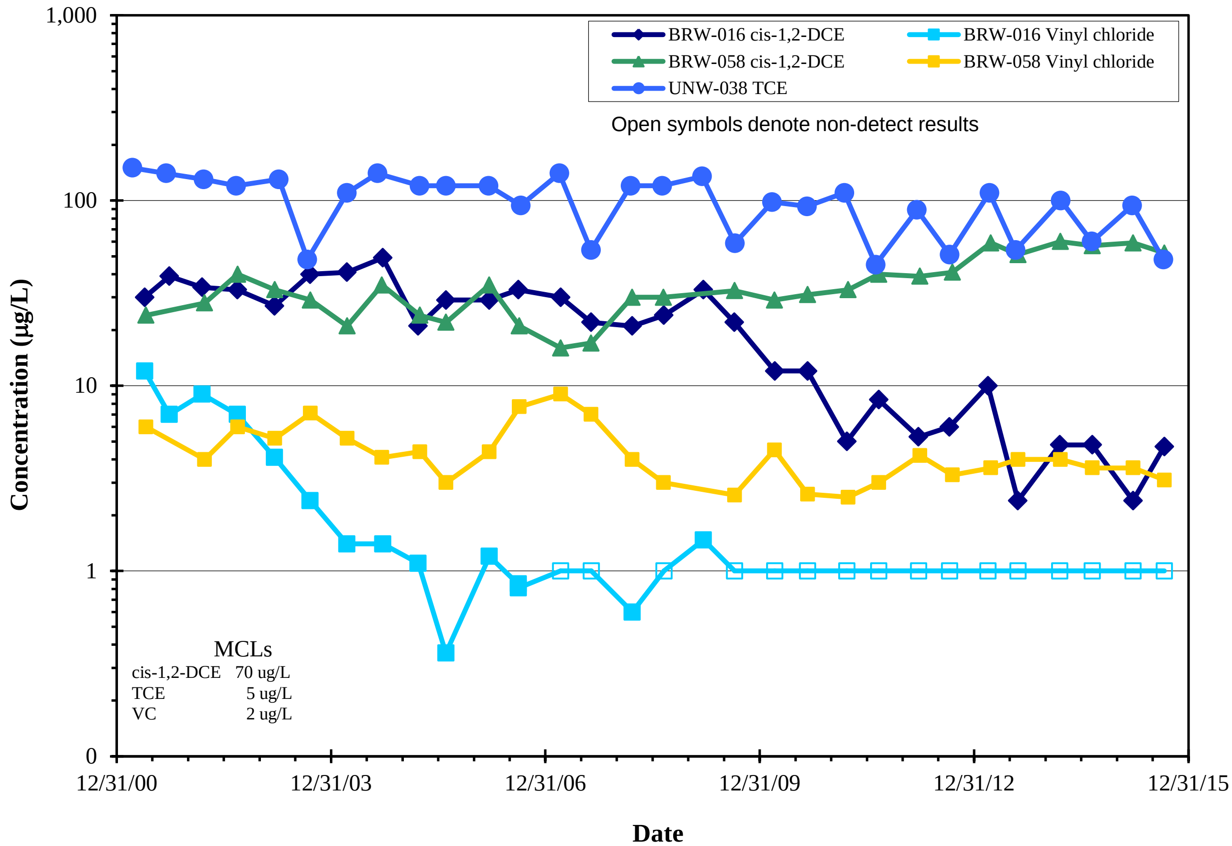

Fig. 3.42. Detected VOC concentrations in groundwater exit pathway wells near K-27 and K-29.
(MCL = maximum contaminant level)

K-901-A holding pond area – Exit pathway groundwater in the K-901-A holding pond area (also shown earlier in Fig. 3.24) is monitored by four wells (BRW-035, BRW-068, UNW-066, and UNW-067) and two springs (21-002 and PC-0). Very low concentrations (< 5 µg/L) of VOCs are occasionally detected in wells adjacent to the K-901-A holding pond. However, these contaminants are not persistent in groundwater west and south of the pond. The only VOC detected in the K-901-A holding pond exit pathway wells during FY 2015 was cis-1,2-DCE at 0.38 J µg/L in both the March and August samples from well BRW-035. Alpha activity was detected at 28.2 and 68.7 pCi/L in well UNW-066 in the March and August samples, respectively, and at 52.8 pCi/L in the August sample from well UNW-068. Beta activity was detected at 84.1 pCi/L and 81.5 pCi/L in the August samples from well UNW-06 and UNW-067. Based on the increases in detected alpha and beta activity, additional radiological analyses will be conducted in these wells during FY 2016.

TCE is the most significant groundwater contaminant detected in the springs and the historic TCE concentrations are shown in Fig. 3.43. Spring PC-0 was added to the sampling program in 2004. During April through October each year, spring PC-0 is submerged beneath the Watts Bar lake level. In late winter 2012, DOE installed a sampling pump in the mouth of the spring to allow year-round sampling. The contaminant source for the PC-0 spring is presumed to be disposed waste at the former Construction Spoil Area (K-1070-F) located on Duct Island. The TCE concentrations in PC-0 spring have varied between non-detectable levels and 26 µg/L and have decreased from their highest measured value in 2006 to concentrations less than or several times the drinking water standard. During FY 2015, cis-1,2-DCE was detected at and below about 1 µg/L in PC-0 samples collected in March and June 2015.

Although TCE is the principal contaminant detected at spring 21-002, 1,1-DCE, and carbon tetrachloride, were present at concentrations less than 2 and 3.2 µg/L, respectively. The TCE concentration at spring 21-002 tends to vary between less than 5 and 25 µg/L and this variation appears to be related to variability in rainfall, which affects groundwater discharge from the K-1070-A VOC plume. During FY 2015, TCE was detected at its MCL in a January sample and at slightly over three times the MCL in June. Alpha activity was detected at 1.14 pCi/L in the June sample and the highest detected beta activity was 6.45 pCi/L, measured in the June sample. Technetium-99 was detected in the sample collected during June 2015, at a measured activity of 8.65 pCi/L, which is much lower than the 900 pCi/L drinking water standard for this radionuclide. Uranium-234, ^{235}U, and ^{238}U were detected at less than 1 pCi/L.

TCE concentrations measured in samples from spring 10-895, which is located along Poplar Creek by Blair Road, are also shown on Fig. 3.43. This spring was added to the ETTP monitoring program during FY 2015. The highest TCE concentration measured was 5.8 µg/L. Carbon tetrachloride was detected at 0.32 J µg/L in the June 2015 sample.

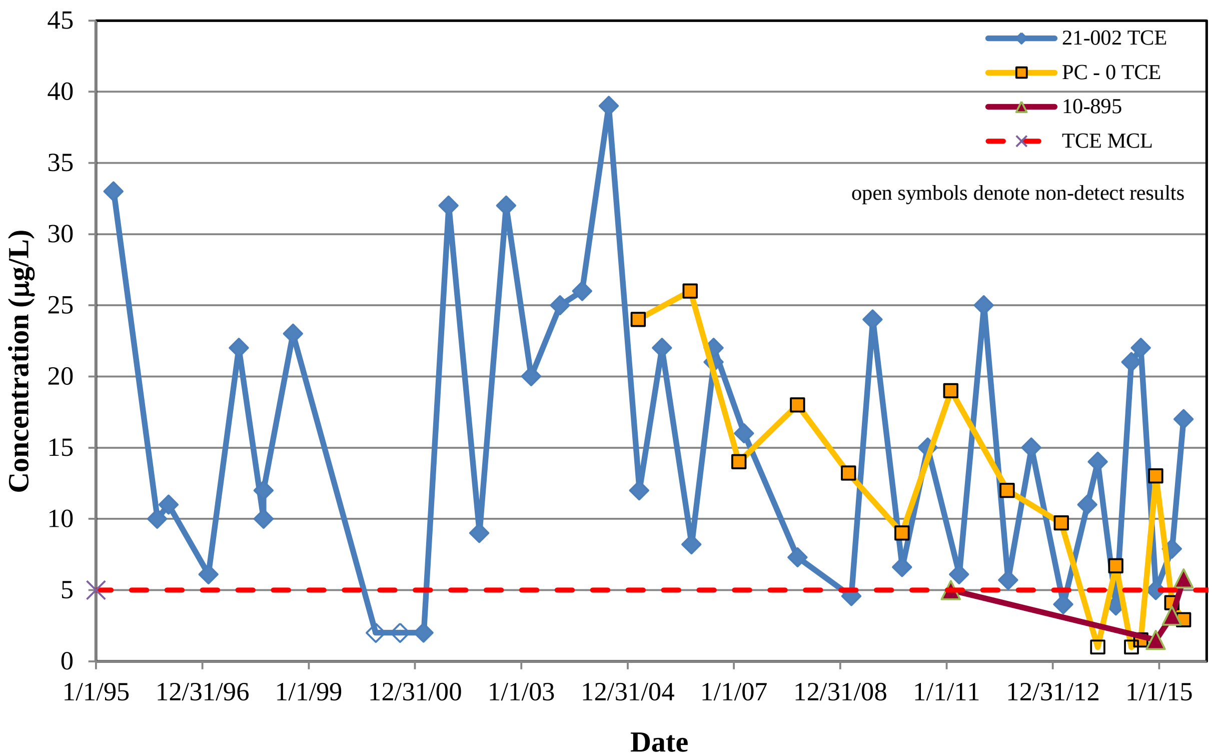

Fig. 3.43. TCE concentrations in selected ETTP K-901 area springs.
(MCL = maximum contaminant level)

K-770 area – Exit pathway groundwater monitoring is also conducted at the K-770 area, where wells UNW-013 and UNW-015 are used to assess radiological groundwater contamination along the Clinch River (Fig. 3.44). Measured alpha and beta activity levels were below screening levels during FY 2015. Figure 8.41 shows the history of measured alpha and beta activity in this area. Historic analytical results indicate that the alpha activity is largely attributable to uranium isotopes. The beta activity levels in well UNW-013 are attributable to ^{99}Tc. Much lower alpha and beta activity levels have been measured in well UNW-015 since sampling was resumed in FY 2013, following an interruption in sampling during site remediation activities.

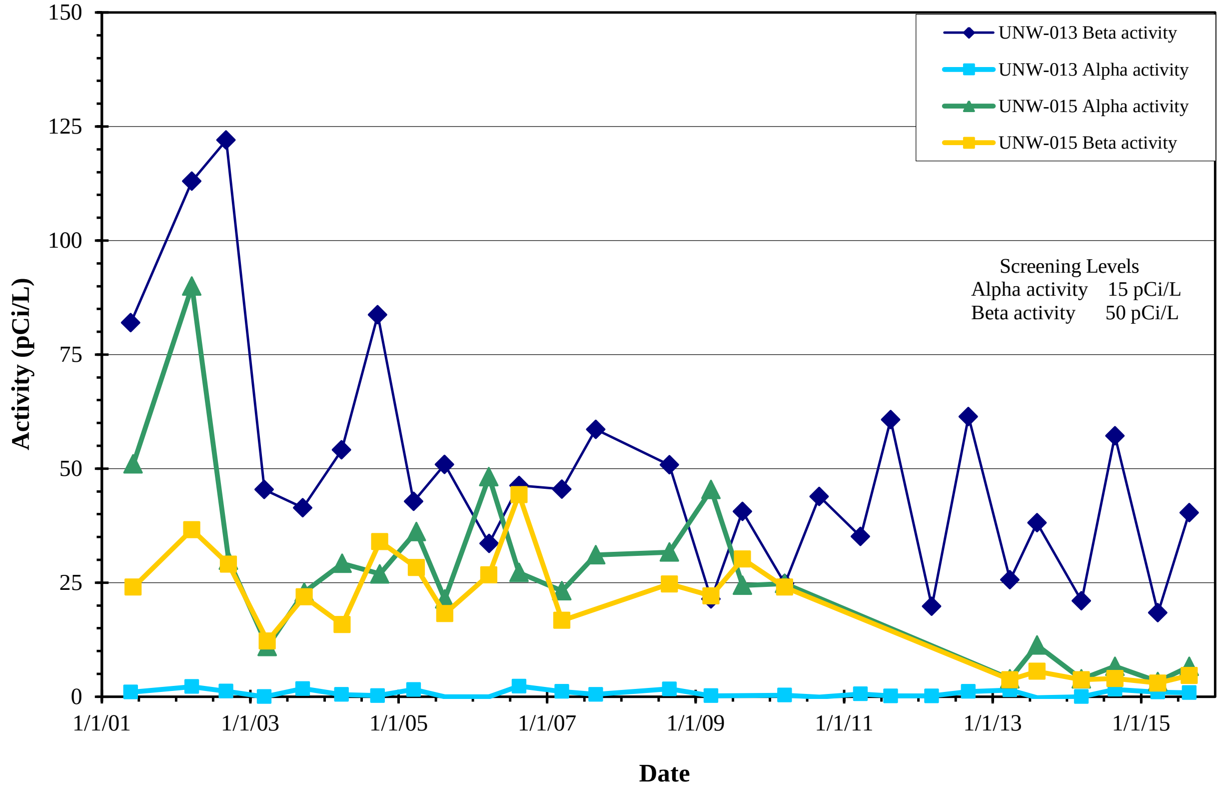

Fig. 3.44. History of measured alpha and beta activity in the K-770 area.

3.6.10 Technetium-99 in ETTP Site Groundwater

Technetium-99 is a beta particle-emitting radionuclide. There is not a specific drinking water MCL for ^{99}Tc, but its MCL-DC concentration is 900 pCi/L. Technetium-99 has been a known groundwater contaminant at the ETTP site for many years. Past CERCLA investigations have sampled and analyzed for ^{99}Tc in groundwater. In the past, the highest ^{99}Tc activity levels (as high as 6,000+ pCi/L) have been observed beneath the K-1070-A burial ground, where concentrations at a couple of wells remain in the 200–500 pCi/L range. The area along Mitchell Branch near the former K-1407 ponds has residual ^{99}Tc contaminated groundwater from the operational era of the ponds, and possibly from K-1420, with much lower activity levels (< 100 pCi/L).

3.6.10.1 Background

Environmental fate of some metal contaminants in groundwater is strongly dependent on the pH and oxidation-reduction potential of the water. A summary review of the environmental behavior of ^{99}Tc in the environment was published by Pacific Northwest National Laboratory (PNNL 2005) related to tank wastes at Hanford. Background information from that report is used in preparation of the following interpretation of potential ^{99}Tc mobility in groundwater at the ETTP site.

Under electrochemically oxidizing conditions, technetium forms the negatively-charged pertechnetate ion (TcO_4^-) with technetium assuming a valence of 7^+. The pertechnetate ion is quite mobile in aqueous settings since negatively charged ions do not tend to adsorb to mineral surfaces in soil or rock, which inherently tend to have negatively charged to neutrally charged surfaces. Under electrochemically reducing conditions, the pertechnetate ion is not stable and technetium may assume a 4^+ valence. In the 4^+ valence state technetium may form ionic combinations with oxygen and hydroxyl groups, which may be amorphous solids with lower solubilities than the pertechnetate ion. In the 4^+ valence, in the absence of complexing ligands, technetium may adsorb to mineral and organic matter surfaces, and may become bound in low solubility technetium oxyhydroxides. In the 4^+ valence, technetium may also form soluble complexes with carbonate/bicarbonate ions as well as sulfate. Thermodynamic and directly measured speciation and solubility relationships for technetium carbonate and sulfate complexes have not been established, although these complexes may be important to technetium mobility in reducing electrochemical environments.

In addition to standard physical chemical conditions, microbial processes are important as potential mediators that can lead to reduction of technetium from the highly soluble and mobile 7^+ valence in the pertechnetate ion to the 4^+ valence in the lower solubility forms. Microbial processes often occur in very localized regions in the subsurface where chemical conditions are favorable. This fact is evident in groundwater at the ETTP site, where intrinsic microbial communities are known to slowly degrade chlorinated organic compounds in some areas, but not in other areas. Factors that may favor microbial reduction of dissolved compounds include relatively slow groundwater movement, which limits influx of dissolved oxygen via groundwater recharge; presence of organic carbon that can serve as electron donor material; and presence of microbes capable of affecting the required molecular transformations.

3.6.10.2 ETTP Site Groundwater Electrochemistry and General Chemistry

Data from groundwater, spring, and surface water sampling and analyses conducted at the ETTP site as part of the ETTP Water Quality Program (EWQP) during FY 2015 have been reviewed for parameters pertinent to understanding the potential for ^{99}Tc mobility in site groundwater. During collection of all groundwater samples at ETTP, field measurement of pH and redox potential are made and recorded. The field measurements of pH and redox potential from all groundwater, spring, and surface water samples collected in FY 2015 have been plotted and superimposed over the technetium Eh-pH diagram in Fig. 8.42 of the PNNL report (PNNL 2005). Individual data points are posted for samples analyzed for ^{99}Tc and the detection/non-detection status is indicated by symbol color. The data shown on Fig. 3.45 suggest that ^{99}Tc is quite mobile under the physicochemical conditions present in site groundwater.

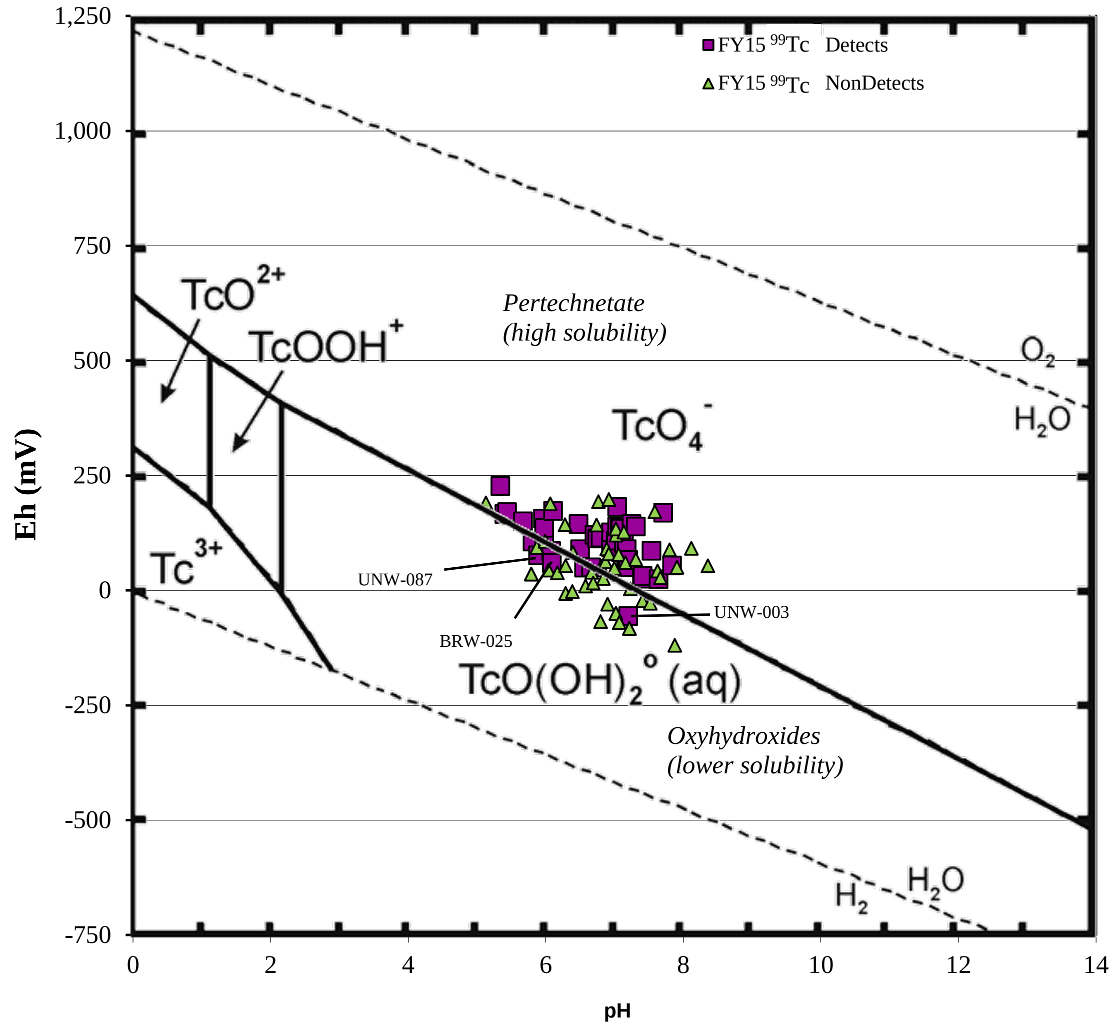

Fig. 3.45. Eh-pH region in which ETTP groundwater, spring water, and surface waters lie in relation to the technetium Eh-pH speciation regions at 25ºC and 900 pCi/L ^{99}Tc.
(ETTP =East Tennessee Technology Park and Tc = technetium)

In addition to physicochemical data, major dissolved anions, including bicarbonate, carbonate, and sulfate are measured on a subset of groundwater samples. Bicarbonate concentrations ranged from a low of 7 mg/L in well UNW-118, which monitors groundwater in the siliceous bedrock of the lower Rome Formation near State Route 58 (also known as Highway 58), to a high of 320 mg/L in well BRW-003, which monitors groundwater in the limestone-rich Chickamauga Group within Zone 2. The bicarbonate concentration in site groundwater samples averaged about 110 mg/L. Sulfate concentrations ranged from a low of about 0.6 mg/L at well UNW-121 that monitors groundwater in the soils at the K-1070-A site, to a high of 85 mg/L at well BRW-017 that monitors groundwater in bedrock in a portion of the Chickamauga Group. Sulfate concentrations averaged about 12 mg/L in site groundwater. These data indicate that ^{99}Tc could form soluble complexes with bicarbonate and sulfate ions under some conditions that would allow contaminant mobility via groundwater transport.

Much of the ETTP physicochemical data suggest that ^{99}Tc mobility would be fairly high. Under this condition, dilution and dispersion processes during groundwater transport would be the only concentration reduction processes that would reduce ^{99}Tc activities since adsorption of pertechnetate ion is negligible. Site groundwater chemical and microbial conditions in some areas may provide attenuation processes that will reduce ^{99}Tc geochemical mobility in the groundwater system. If ^{99}Tc is present where these conditions occur, these processes would be additive to dilution and dispersion processes expected to reduce contaminant levels with increasing transport distances.

3.6.10.3 FY 2015 Distribution of ^{99}Tc in ETTP Site Groundwater

During demolition of the K-25 east wing in the winter of 2014, fugitive dust suppression misting and rainfall carried ^{99}Tc off the work area. Contaminated runoff apparently percolated through soil and into subsurface utility lines and probably into backfill surrounding the buried utilities. Groundwater sampling for ^{99}Tc was increased in wells in the general vicinity of the east wing and where wells were available along potential groundwater transport pathways. During FY 2015, two phases of subsurface investigation work were completed under a Removal Site Evaluation (RmSE) (DOE/OR/01-2663&D1/A1; DOE 2015b) to assess the potential threat to human health and the environment from the elevated ^{99}Tc levels observed in groundwater, storm water, and sanitary sewage during demolition of the K-25 building. Background information about the behavior of ^{99}Tc in the environment and a summary of groundwater sampling to evaluate levels at ETTP are provided below.

The scope of investigations conducted in the ^{99}Tc RmSE focused on understanding the role of site subsurface infrastructure in migration of ^{99}Tc away from the K-25 east wing source area and the involvement of groundwater. The investigations used push technology to sample soil along and beneath portions of storm water outfall/storm drains (SDs), sanitary sewer pipes, and the abandoned electrical ductbank that formerly carried electrical cables along the east side of the K-25 building. Continuous soil cores were obtained from the ground surface to target depths of refusal on the bedrock surface. Soils were visually logged and field classified to determine soil types and textures, and all recovered soil cores were field scanned using a photoionization detector (PID) and beta gamma radiation detector. The RmSE Work Plan established criteria for collection of at least two samples per boring for analysis of VOCs and ^{99}Tc. A temporary PVC piezometer was installed in each borehole to allow observation of groundwater levels and to provide groundwater samples for ^{99}Tc and /or VOC analyses. The investigations determined that although ^{99}Tc entered and traveled through the sanitary sewer and the storm water outfall/storm drain (SD) that discharges to the K-1007-P1 pond, the amount of ^{99}Tc transport in backfill outside those pipes was minimal. The investigation found that ^{99}Tc transport through the abandoned underground electrical ductbank was an important transport pathway along the east side of the K-25 building as far south as ductbank manhole row 21. RAs conducted in Zone 1 included plugging the ductbank manholes with cement grout from row 21 to the south and west to the former steam plant located near the Clinch River in the K-770 Area. VOCs were found to not be significant contaminants in any of the borehole soils. Groundwater was sampled where available in the temporary piezometers in July 2015. The resulting ^{99}Tc-contaminated groundwater area is shown on Fig. 3.46, along with summer 2015 ^{99}Tc concentration ranges in groundwater throughout the ETTP site.

The area where detected ^{99}Tc is highest along the eastern side of the K-25 east wing. The highest concentrations occur in well temporary piezometers near ductbank manholes in row 22 – DB22LD and DB22M (25,900 pCi/L and 19,500 pCi/L, respectively). The second most highly contaminated wells are along the ductbank corridor to the north, at wells UNW-137 (9,750 pCi/L) and in wells near the K-1413 facility (UNP-008 = 10,600 pCi/L, BRW-015 = 7,430 pCi/L, and UNW-026 = 3,890 pCi/L). The conceptual model that was advanced in the previous RER was essentially confirmed by the ^{99}Tc RmSE investigations. Percolation water from the contaminated slab area probably entered the backfill around the electrical duct bank that runs north-south along the east side of the building. Rapid transport along this utility corridor carried the high concentrations of ^{99}Tc into the areas where the high concentrations are currently detected.

The plume trajectory for ^{99}Tc is to the south/southwest from the ductbank manhole rows 21 and 22 area, and to the northeast from the K-1413 area through well UNW-089, and toward Mitchell Branch. At well UNW-089, the ^{99}Tc activities apparently reached their maximum during the winter or spring of 2015 since the highest observed result of 428 pCi/L was recorded in March; by September, the result had decreased to 341 pCi/L. As indicated by the piezometric surface shown on Fig. 3.46, there is a trough in the water table surface that is formed in a now-filled valley that leads from the K-1413 area northward, toward Mitchell Branch. The inset box in Fig. 3.46 shows an inferred plume trajectory arrow from the contaminated area near K-1413 toward UNP-005. At well UNP-005 low levels of ^{99}Tc have been detected intermittently with previous results of 12.8 pCi/L in August 2010 and 7.6 pCi/L in September 2013 and 8.33 and 12.7 pCi/L in March and September 2015, respectively. Technetium-99 has also been detected intermittently in groundwater in wells UNW-003 and BRW-047 further east along Mitchell Branch. The levels in well UNW-003 have fluctuated in the range of about 10–50 pCi/L since reliable ^{99}Tc analytical data became available in 1998 and 2015 results were 13.1 and 21.5 pCi/L in March and August, respectively. A single sample result is available from well BRW-047, which contained about 45 pCi/L of ^{99}Tc. It is also noted that during construction activities in the 1940s and 1950s the culverts for the SD-190 network were laid in the pre-existing valley beneath the contour fill. Infiltration of ^{99}Tc plume water into the SD-190 culvert is expected. Groundwater sampling and analysis for ^{99}Tc in all the wells where it has been detected, as shown on Fig. 3.46 will continue.

DOE is conducting a third and final phase of investigation under the ^{99}Tc RmSE, which includes push probe sampling of areas slightly further east than the currently documented ductbank contamination, further north of the K-1413 area. Two bedrock wells are being installed to the west of the contaminated area to assess potential bedrock contaminant transport. The results of that phase of work will be included in the 2017 RER.

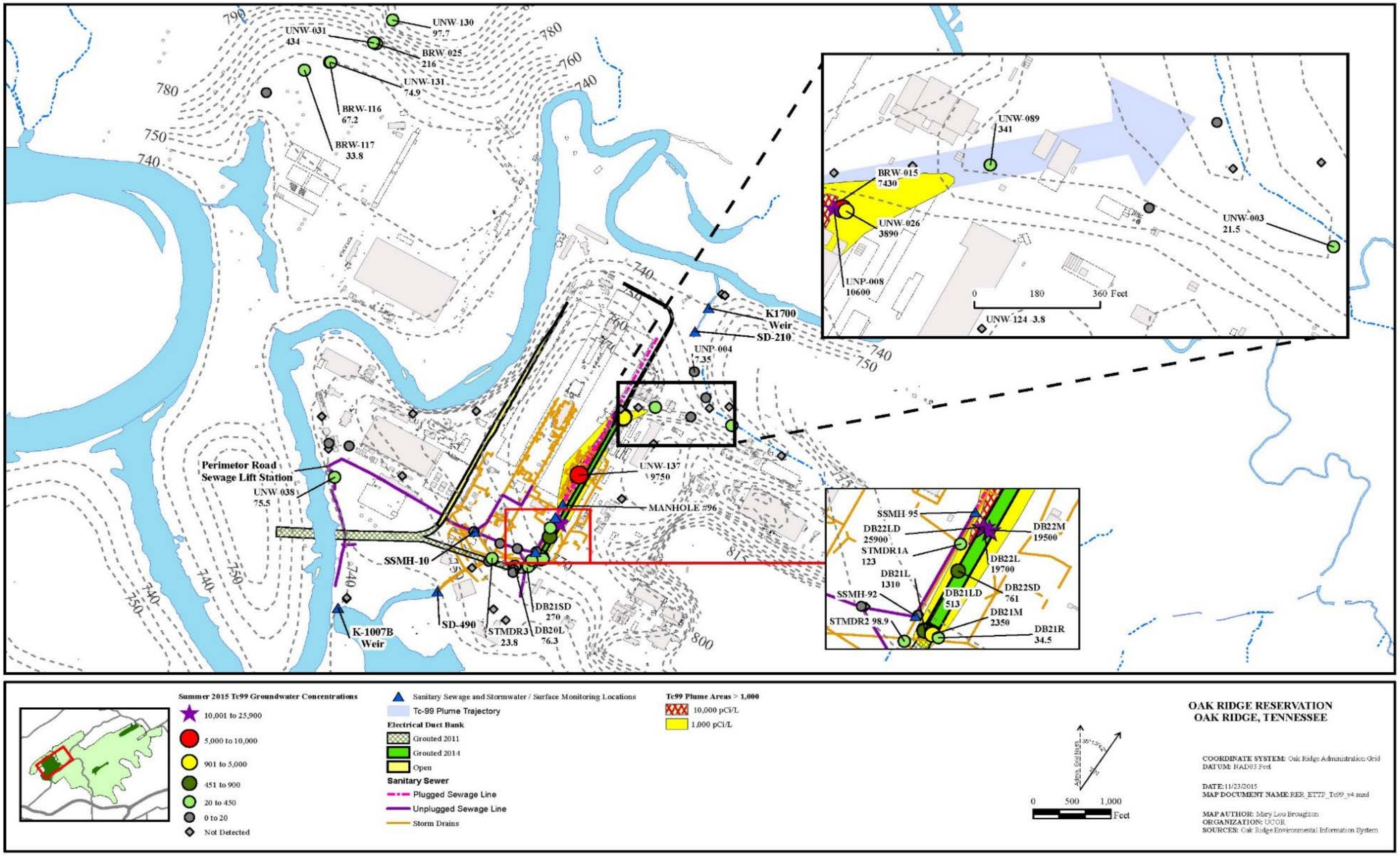

Fig. 3.46. Sample locations and maximum detected ^{99}Tc in ETTP groundwater. *(ETTP =East Tennessee Technology Park and Tc = technetium)*

3.7 Biological Monitoring

The ETTP Biological Monitoring and Abatement Program (BMAP) consists of two tasks designed to evaluate the effects of ETTP historical 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 3.47 shows the major water bodies at ETTP and Fig. 3.48 shows the BMAP monitoring locations along Mitchell Branch.

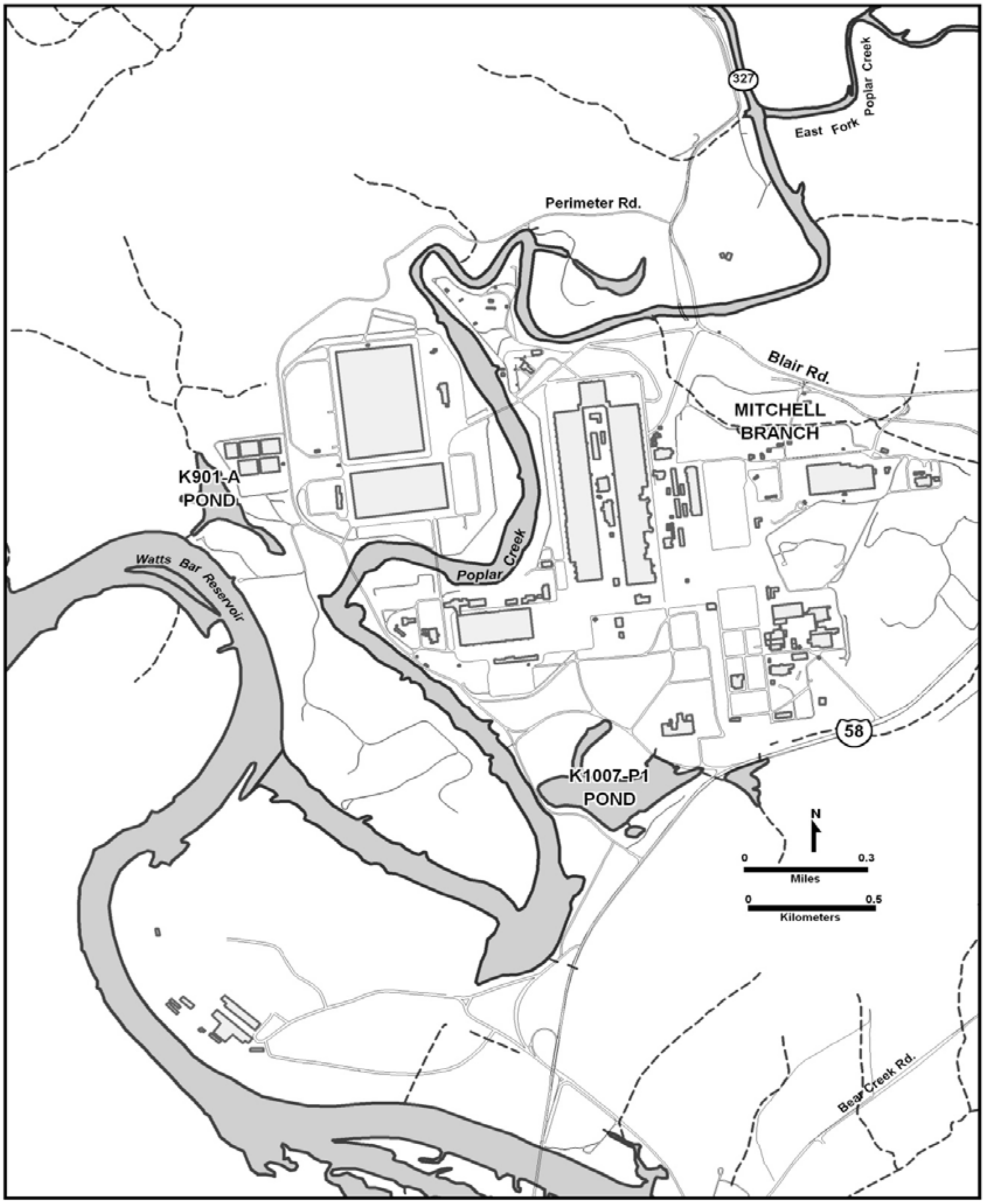

Fig. 3.47. Water bodies at the East Tennessee Technology Park.

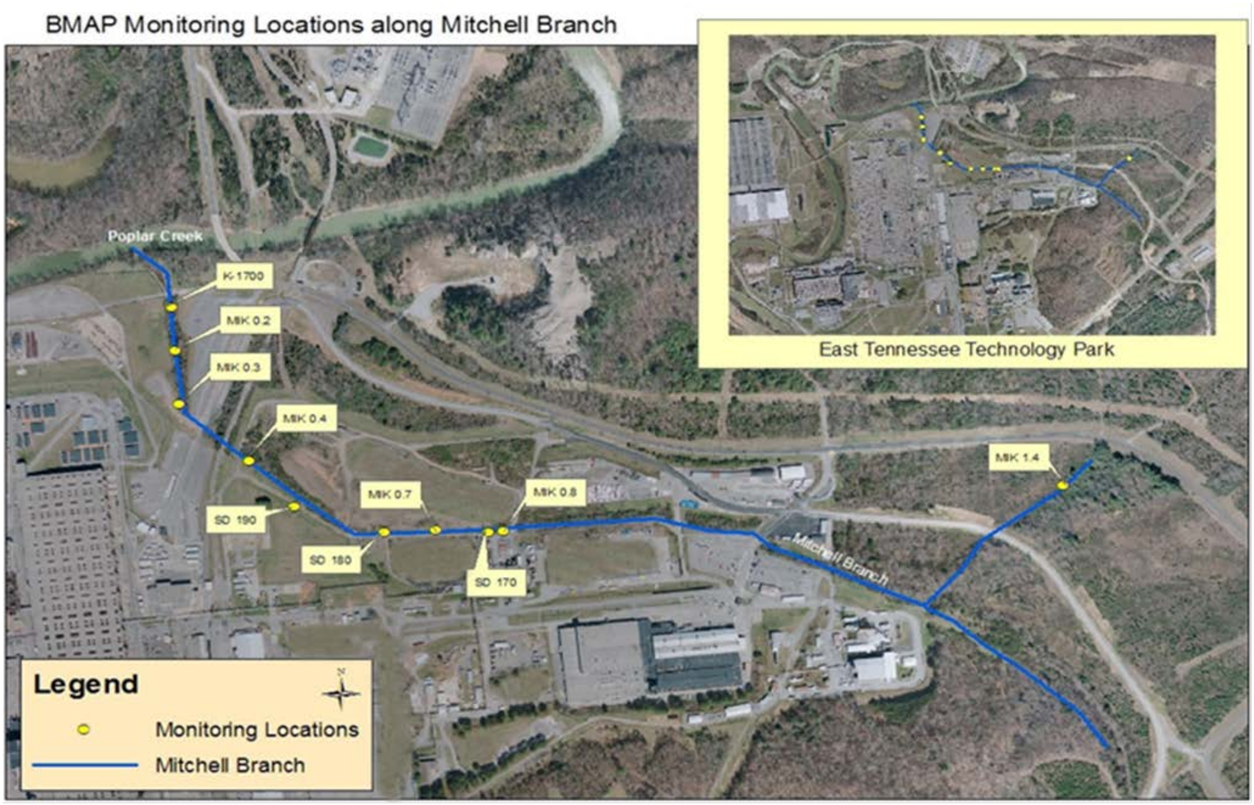

Fig. 3.48. Major storm water outfalls and biological monitoring locations on Mitchell Branch.
(BMAP = Biological Monitoring and Abatement Program, MIK = Mitchell Branch kilometer, and SD = storm water outfall/storm drain)

The bioaccumulation task includes monitoring of caged clams (*Corbicula fluminea*) placed at selected locations around ETTP and the collection and analysis of fish from Mitchell Branch and three major ponds on the site. Both clams and fish from uncontaminated off-site locations are also analyzed as points of reference. While historically the primary COC for the bioaccumulation task at ETTP has been PCBs, in recent years mercury has been added to the list of legacy COCs at selected locations.

In 2015, the clams (Fig. 3.49) were allowed to remain in place for four weeks and were then analyzed for total PCBs (Table 3.43 and Fig. 3.50) and, in a subset of clams, for total mercury (Table 3.44 and Fig. 3.51). In general, there is a significant amount of variability in the PCB concentrations in clams from year to year, although there are some overall trends of note. In 2015, the greatest concentrations of PCBs were found in the clams from storm water outfall SD 190 and downstream of that location in Mitchell Branch, as has been seen in recent years. The concentrations in PCBs in the clams from the K-1007-P1 pond were significantly lower in the 2015 monitoring, as compared to the levels seen in the 2014 monitoring, which continues an overall trend of decreasing PCB concentrations at this location.

ORNL 2010-G00934/chj

Fig. 3.49. Asiatic clam (Corbicula fluminea).

Table 3.43. Compiled data for PCB concentrations in caged Asiatic clams (Corbicula fluminea), 2009 to 2015

(µg/g, wet weight)

Location	Basket[a]	2009	2010	2011	2012	2013	2014	2015
MIK 0.8 (above SD 170)	A	0.09	0.12	0.11	0.04	0.05	0.079	0.046
	B	0.11	0.13	0.15	0.04	0.04	0.081	0.063
SD 170	A	0.27	0.21	0.16	0.08	0.12	0.121	0.055
	B	0.25	0.28	0.16	0.15	0.13	0.16	0.053
MIK 0.7 (below SD 170)	A	0.18	0.15	0.13	0.08	0.07	0.081	0.066
	B	0.15	0.13	0.17	0.07	0.09	0.088	0.062
SD 180	A						0.099	0.282
	B						0.096	0.242
MIK 0.5 (below SD 180)	A	0.25	0.15	0.13	*b*	0.09	0.099	
	B	0.2	0.17	0.16	*b*	0.11	0.096	
SD 190	A	2.07	1.22	2.36	0.84	2.13	1.329	1.824
	B	1.98	1.09	1.7	*b*	2.51	1.633	2.044
MIK 0.4 (below SD 190)	A	0.9	1.28	1.71	0.41	1.7	0.92	0.766
	B	0.78	2.69	1.82	0.5	2	0.929	0.820
SD 195	A				0.37			
	B				0.31			
MIK 0.3	A		2.93	6.74	2.52	1.8	1.56	1.525.
	B		3.42	4.56	2.74	2.2	1.43	1.125

Acronyms

MIK = Mitchel Branch kilometer
PCB = polychlorinated biphenyls
SD = storm water outfall/storm drain

Table 3.43 (continued)

Location	Basket[a]	2009	2010	2011	2012	2013	2014	2015
MIK 0.27	A			4.42				
	B			4.94				
MIK 0.2	A	2.43	2.15	5.33	0.96	2.2	1.61	1.104
	B	2.42	2.13	4.82	1.41	2.4	1.899	NA[b]
K-1700	A					2.1		
	B					2.3		
SD 992	A		2.93					
	B		3.42					
K-1203 sump	A				0.34	0.2	0.148	
	B				0.29	0.23	0.149	
SD 100 (upper)	A	0.96	0.29	2.25	1.69	0.1	0.181	
	B	0.69	0.22	1.75	1.7	0.09	0.136	
SD 100 (lower)	A	1.32	0.72	5.95	*b*	0.42	0.408	
	B	1.72	0.8	4.5	1.92	1.35	0.239	
SD 120	A	0.34	3.06	0.75	0.11	0.28	0.356	
	B	0.57	1.18	0.97	0.16	0.34	0.353	
SD 490	A	0.4	0.37	0.39	0.19	0.18	0.191	
	B	0.46	0.47	0.46	0.17	0.18	0.181	
K-1007-P1 outfall	A	0.91				1.29	1.264	0.359
	B	0.85				1.3	1.424	0.383
P1	A	0.86	0.99	1.38	1.48			
	B	1.17	0.91	1.68	1.57			
K-901-A outfall	A	0.14	0.06	0.3	0.07	0.11	0.208	0.190
	B	0.16	0.05	0.2	0.07	0.16	0.239	0.172
SD 710	A						0.282	
	B						0.321	
K-897-E	A							0.033
	B							0.078
K-897-J	A							0.057
	B							0.056
Sewee Creek	A	0.02	0.01	0	0.01	0.004	ND	ND
	B	0.02	0.01	0.01	0.003	0.002	ND	ND

[a]Sample result is the reported concentration in the composited clam sample from each cage, where A and B denote replicates. Data were extracted from tables within the 2009–2014 East Tennessee Technology Park Biological Monitoring and Abatement Program fiscal year reports.
[b]Insufficient numbers of clams survived to provide a suitable sample size for analysis.

Acronyms

MIK = Mitchell Branch kilometer
SD = storm water outfall/storm drain
ND = non-detect

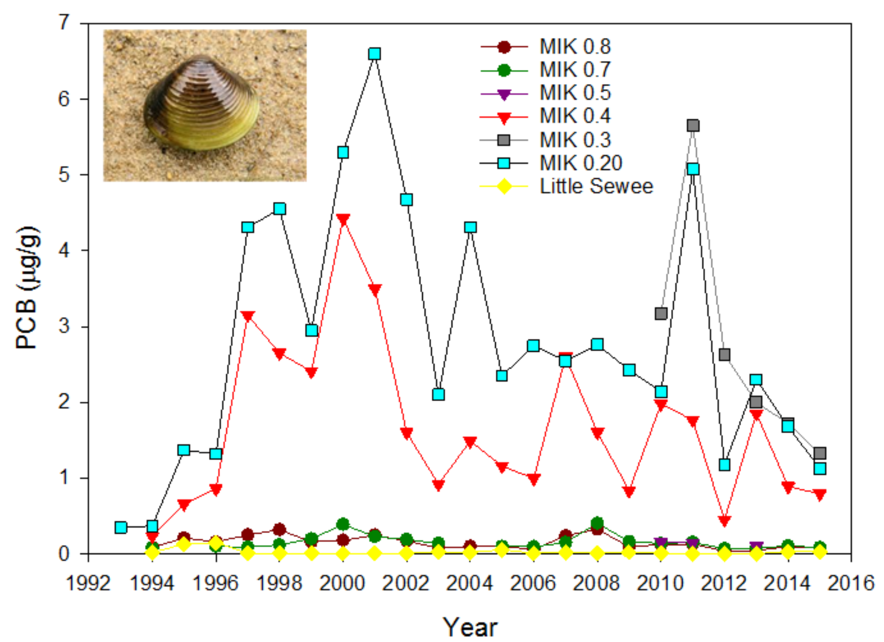

Fig. 3.50. Trend of PCBs in caged clams.
(MIK = Mitchell Branch kilometer and PCBs = polychlorinated biphenyls)

Table 3.44. Compiled data for mercury concentrations in caged Asiatic clams (*Corbicula fluminea*), 2011 to 2015
(ng/g, wet weight)

Location	Basket	2011	2012	2013	2014	2015
MIK 0.8 (above SD 170)	A	37	31.9	33.5	34.4	25
	B	46.9	32.2	32.1	44.1	22
SD 170	A	67.2	88.7	34.2	36.5	28
	B	80.7	62.3	38.9	43.2	38
MIK 0.7 (below SD 170)	A	37.7	46.2	33.5	34.8	28
	B	64.8	48.8	33.3	38	78
SD-180	A					103
	B					106
MIK 0.5 (below SD 180)	A	97.2	51.4	48.7		
	B	154.8	*B*	49.6		
SD 190	A	109.9	127.8	187.8	93.7	58
	B	80.7	270	210.7	103	107
MIK 0.4 (below SD 190)	A	114	85	113.1	46.3	47
	B	102.3	104.8	107.1	56	40
SD 195	A		88.1			
	B		79.5			
MIK 0.3	A		311.7	116.6	148	64
	B		322.6	125.8	132	53
MIK 0.2	A	166.3	115.9	100.1	88.4	38
	B	187.9	136.6	105.9	83.4	---
K-1700	A			87.7		
	B			88.3		
K-1203-10 sump	A	—	472.3	298.8	392	
	B	—	336.2	337.8	455	
P1	A	23	25.6	19	19.5	34

Table 3.44 (continued)

Location	Basket	2011	2012	2013	2014	2015
	B	22.6	14.5	22.4	17	20
K-901-A outfall	A	33.1	17.4	18.9	16.9	19
	B	46.4	27.6	25.8	18.5	67
SD 05A	A		472.3			
	B		336.2			
K-897-E	A					24
	B					22
K-897-J	A					26
	B					31
Little Sewee Creek	A	19.6	25.2	24.4	18.6	21
	B	27.2	19.1	26.7	17.4	26

Acronyms
MIK = Mitchell Branch kilometer
SD = storm water outfall/storm drain

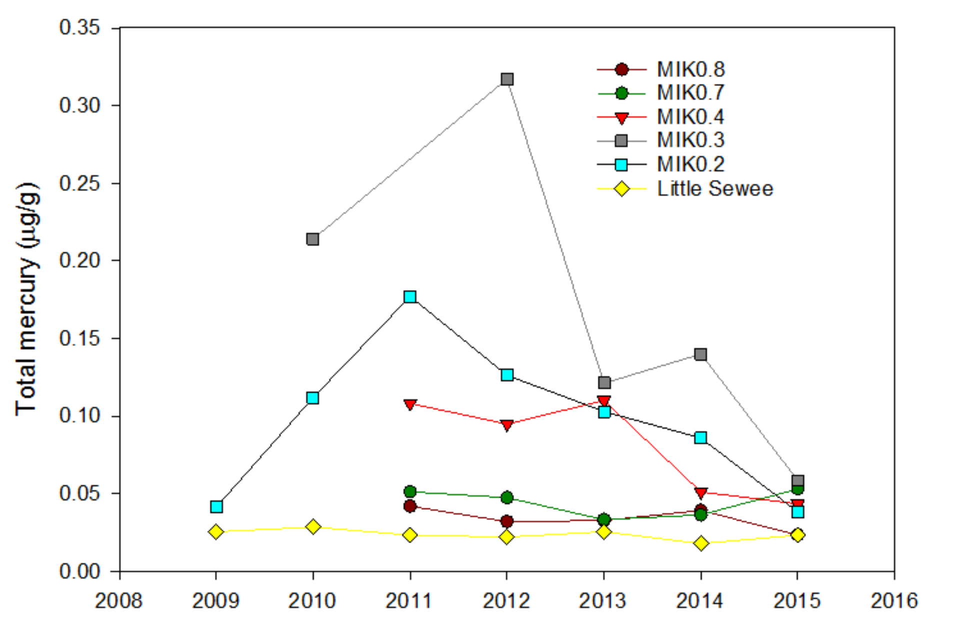

Fig. 3.51. Trend of mercury in caged clams. *(MIK = Mitchell Branch kilometer)*

Clams from the Mitchell Branch watershed, the K-901-A and K-1007-P1 ponds, storm water outfall 710, and the sump at the former K-1203 STP were analyzed for mercury (both total mercury and methyl mercury) in 2015. The highest mean total mercury concentrations were found in the clams from storm water outfall 180 (104.5 ng/g). Clams from the section between K-1700 and storm water outfall SD 190 also had higher levels, with concentrations of total mercury in the caged clam composite samples ranging from a low of 38 ng/g to a high of 107 ng/g. At other sites, mercury concentrations in clams ranged from at or near reference values to fourfold higher (19 to 78 ng/g). Clams were also analyzed for methyl mercury, which typically makes up a small fraction of the total mercury in clams. Levels of methyl mercury in the clams in the 2015 monitoring ranged from a high of 23 ng/g in the clams from the K-1007-P1 pond to a low of 6 ng/g in the clams from MIK 0.8. In most instances, the levels of methyl mercury were very close to the levels seen in the clams from the reference locations (an average of 11 ng/g).

Bioaccumulation monitoring in the K-1007-P1 pond, K-901-A pond, K-720 slough, and Mitchell Branch involves sampling of fish (Fig 3.52) and analyzing the tissues for PCB concentrations (Table 3.45 and Fig. 3.53). Typically, fillets of game fish are used as a monitoring tool to assess human health risks, while whole body composites of forage fish are used to assess ecological risks associated with exposure to PCBs. Target species vary from site to site, depending upon the ecological conditions and, thus, the available species. The target species for bioaccumulation monitoring in 2015 in the K-1007-P1 pond was bluegill sunfish (*Lepomis macrochirus*) (Fig. 3.54) and largemouth bass (*Micropterus salmoides*). In Mitchell Branch, the target species was the redbreast sunfish (*Lepomis auritus*). In the K-901-A pond and the K-720 slough, the target species were the gizzard shad (*Dorosoma cepedianum*) and largemouth bass (*Micropterus salmoides*). As there were not enough largemouth bass, carp (*Cyprinus carpio*) and smallmouth buffalo (*Ictiobus bubalus*) were also collected.

Fig. 3.52. Fish bioaccumulation sampling at K-1007-P1 pond.

Table 3.45. Polychlorinated biphenyl levels in fish samples at East Tennessee Technology Park, 2009 to 2015 *(µg/g)*

Fish	Sampling location	2009	2010	2011	2012	2013	2014	2015
Redbreast sunfish	Mitchell Branch	0.99	1.17	1.12	1.67	1.29	1.54	2.71
Stoneroller minnows	Mitchell Branch							7.54
Largemouth bass	K-901-A pond	0.48		0.5	0.72	1.4	0.45	0.66
Common carp	K-901-A pond		0.71	2.06	3.08	2.94	1.41	1.77
Gizzard shad	K-901-A pond				4.82	8.86	6.52	5.41
Largemouth bass	K-1007-P1 pond	14.85	0.3					5.33
Bluegill sunfish	K-1007-P1 pond		2.13	1.85	2.16	0.7	0.62	0.45
Bluegill sunfish (whole body composites)	K-1007-P1 pond				9.25	4.45	3.21	2.03
Redbreast sunfish	Hinds Creek	0.0007	0.09	0.06	0.06	0.06	0.03	0.03
Stoneroller minnows	Hinds Creek							0.03
Largemouth bass	K-720 slough			0.24	0.22	0.14	0.15	0.08
Smallmouth buffalo	K-720 slough			0.77	0.68	0.44	0.14	
Common carp	K-720 slough			0.96	0.31	0.45	0.27	0.35
Gizzard shad (whole body composites)	K-720 slough					0.57	0.29	0.39

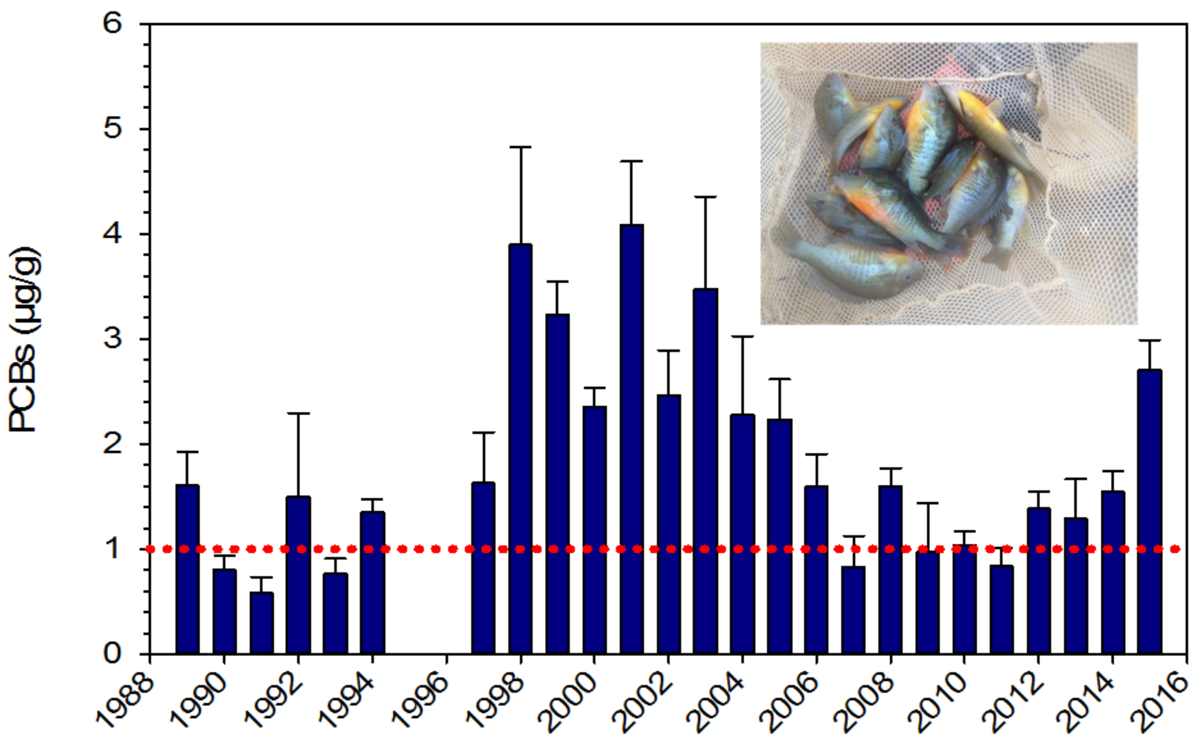

Fig. 3.53. Trend of polychlorinated biphenyls in fish from Mitchell Branch (blue bars show average values, T-bars show the range of results from individual fish).

ORNL 2011-G00782/chj

Fig. 3.54. Bluegill sunfish (*Lepomis macrochirus).*

Whole body composites (six composites of 10 bluegills per composite) and fillets from 20 individual bluegills were analyzed for PCBs to assess the ecological and human health risks associated with PCB contamination in the K-1007-P1 pond. Average PCB levels in bluegill whole body composites from the K-1007-P1 pond averaged 2.03 µg/g, down from 3.21 µg/g in 2014. Fillets averaged 0.45 µg/g total PCBs, a slight decrease compared to levels seen in 2014 (0.62 µg/g). Fillets of largemouth bass averaged 5.33 µg/g total PCBs (bass were not sampled in 2014). Average PCB concentrations in sunfish fillets collected in Mitchell Branch were 2.71 µg/g, slightly higher than the levels seen in 2014 (1.59 µg/g). The concentrations observed in fillets of largemouth bass from the K-901-A pond (0.66µg/g) increased slightly from the concentrations seen in the 2014 monitoring, 0.45 µg/g. Fillets of carp from the K-901-A pond averaged 1.77µg/g. Gizzard shad whole body composite samples from K-901-A pond (5.41 g/g) decreased from the concentrations seen in the 2014 monitoring (6.52 µg/g). Levels of PCBs in bass, gizzard shad, and carp from the K-720 slough (0.08 µg/g, 0.39 µg/g, and 0.35 µg/g, respectively) were considerably lower than for the same species from the K-901-A pond.

In addition to being analyzed for PCBs, selected species collected from several locations were analyzed for total mercury (Table 3.46 and Fig. 3.55). Previous studies have shown that methyl mercury accounts for more than 95% of the total mercury in fish, so a separate analysis for methyl mercury was not conducted. The EPA’s recommended limit for mercury in fish fillets is 0.3 µg/g. In 2015, whole body composite samples of gizzard shad from the K-720 slough averaged 0.07 µg/g of mercury, while those from the K-901-A pond averaged 0.05 of mercury. The mean mercury concentration in largemouth bass fillets collected from the K-1007-P1 pond was 0.12 µg/g in 2015, while whole body composite samples of bluegill from K-1007-P1 pond averaged 0.08 µg/g of mercury. The mean mercury concentration in sunfish fillets collected at MIK 0.2 was 0.41 µg/g in 2015, little changed from 2014 (0.46 µg/g). However, mercury concentrations in fish in Mitchell Branch in recent years have averaged about 0.3 to 0.5 µg/g, with about 10 to 20% variability within the annual collection (Table 3.45). Fillets of sunfish from the reference site, Hinds Creek, averaged 0.06 µg/g of mercury in 2015, while whole body composite samples of stonerollers (*Campostoma oligolepis*) averaged 0.03 µg/g of mercury.

Table 3.46. Mercury levels in fish fillets and whole body samples at East Tennessee Technology Park, 2009 to 2015
(µg/g)

Fish	Sampling location	2009	2010	2011	2012	2013	2014	2015
Redbreast sunfish	Mitchell Branch	0.49	0.35	0.34	0.37	0.52	0.46	0.41
Stoneroller minnows								0.06
Gizzard shad (whole body)	K-901-A pond		0.086					0.05
Paddlefish (1 sample)	K-1007-P1 pond		0.07					
Largemouth bass	K-1007-P1 pond							0.12
Bluegill sunfish	K-1007-P1 pond		0.085					0.08
Stoneroller minnows	Hinds Creek							0.06
Redbreast sunfish	Hinds Creek		0.08	0.07	0.058	0.07	0.09	0.06
Gizzard shad (whole body)	K-720 slough		0.067					0.07

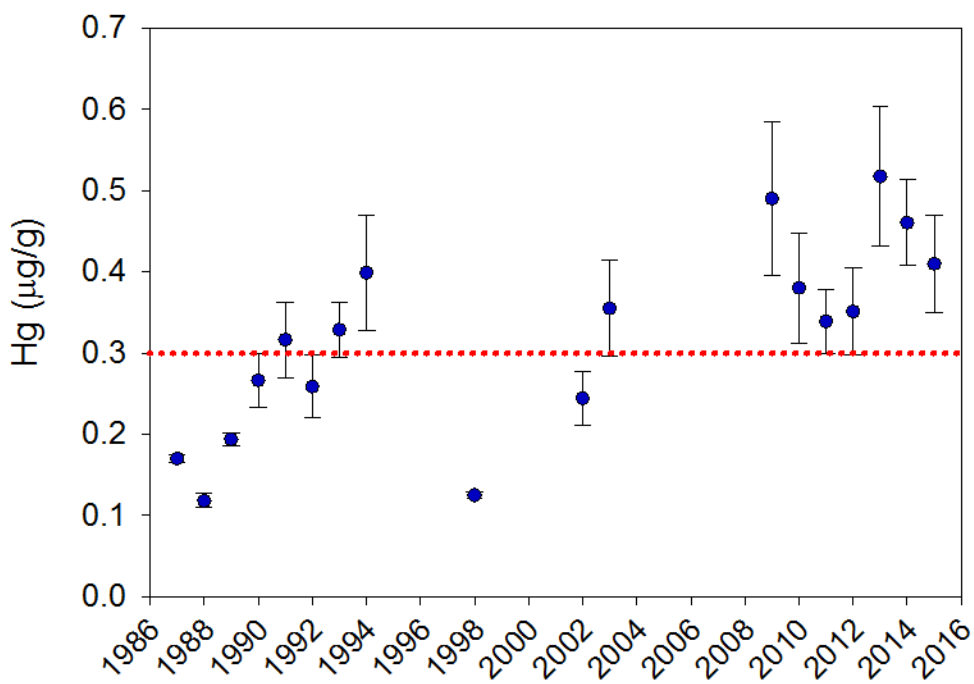

Fig. 3.55. Trend of mercury in fish in Mitchell Branch.

In April 2015, the benthic macroinvertebrate community at four Mitchell Branch locations (MIKs 0.4, 0.7, 0.8, and 1.4) was sampled using standard quantitative techniques (Fig. 3.56); MIK 1.4 was the reference location. Results of monitoring in 2015 using the ORNL protocols show little change at the three uppermost locations (MIKs 1.4, 0.8, and 0.7). The number of pollution-intolerant species is highest at MIK 1.4 (Fig. 3.57). The number of pollution-tolerant species makes up a much larger percentage of the total fauna at MIK 0.4 than at any of the other locations. Otherwise, except for the period from 2010-2012, trends in change at MIK 0.4 have generally mirrored those at MIKs 0.7 and 0.8. In recent years, the benthic macroinvertebrate community at MIK 0.7 and MIK 0.8 has shown no major persistent change in trends of either the mean number of taxa (taxonomic richness of all taxa) or the mean number of pollution-intolerant taxa [i.e., the taxonomic richness of the Ephemeroptera, Plecoptera, and Trichoptera (EPT)]. These results show that the benthic community at MIK 0.4 continues to be negatively impacted while the results for MIKs 0.7 and 0.8 suggest that the macroinvertebrate community at those sites is also impacted to a lesser degree.

Fig. 3.56. Benthic macroinvertebrate sampling in Mitchell Branch.

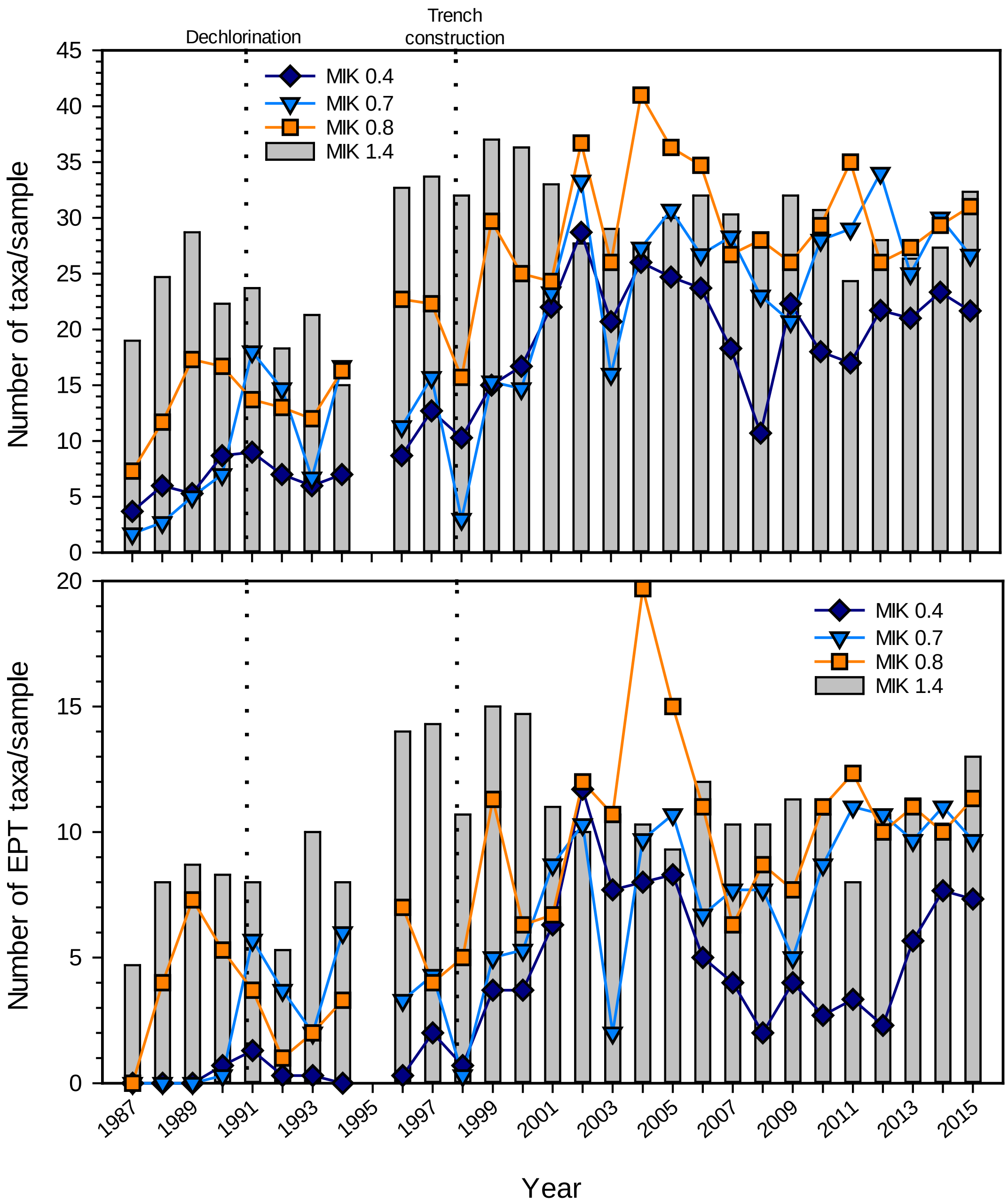

Fig. 3.57. Mean taxonomic richness in Mitchell Branch, 1987–2015*:*
(a) number of all taxa, and (b) number of pollution-intolerant Ephemeroptera, Plecoptera, and Trichoptera (mayflies, stoneflies, and caddisflies, or EPT) taxa per sample. Samples were not collected in April 1995, as indicated by the gap in the lines. (MIK = Mitchell Branch kilometer)

Since August 2008, TDEC protocols, which assess both community and habitat characteristics, have also been used at the MIK 0.4, 0.7, and 0.8 monitoring locations. Beginning in August 2009, the use of TDEC protocols was expanded to include MIK 1.4 as well (Fig. 3.58). The biotic index indicated that the community at MIK 0.4 was slightly impaired, and the communities at MIKs 0.7, 0.8, and 1.4 were unimpaired. The habitat assessment (which primarily considers the physical aspects of the stream to

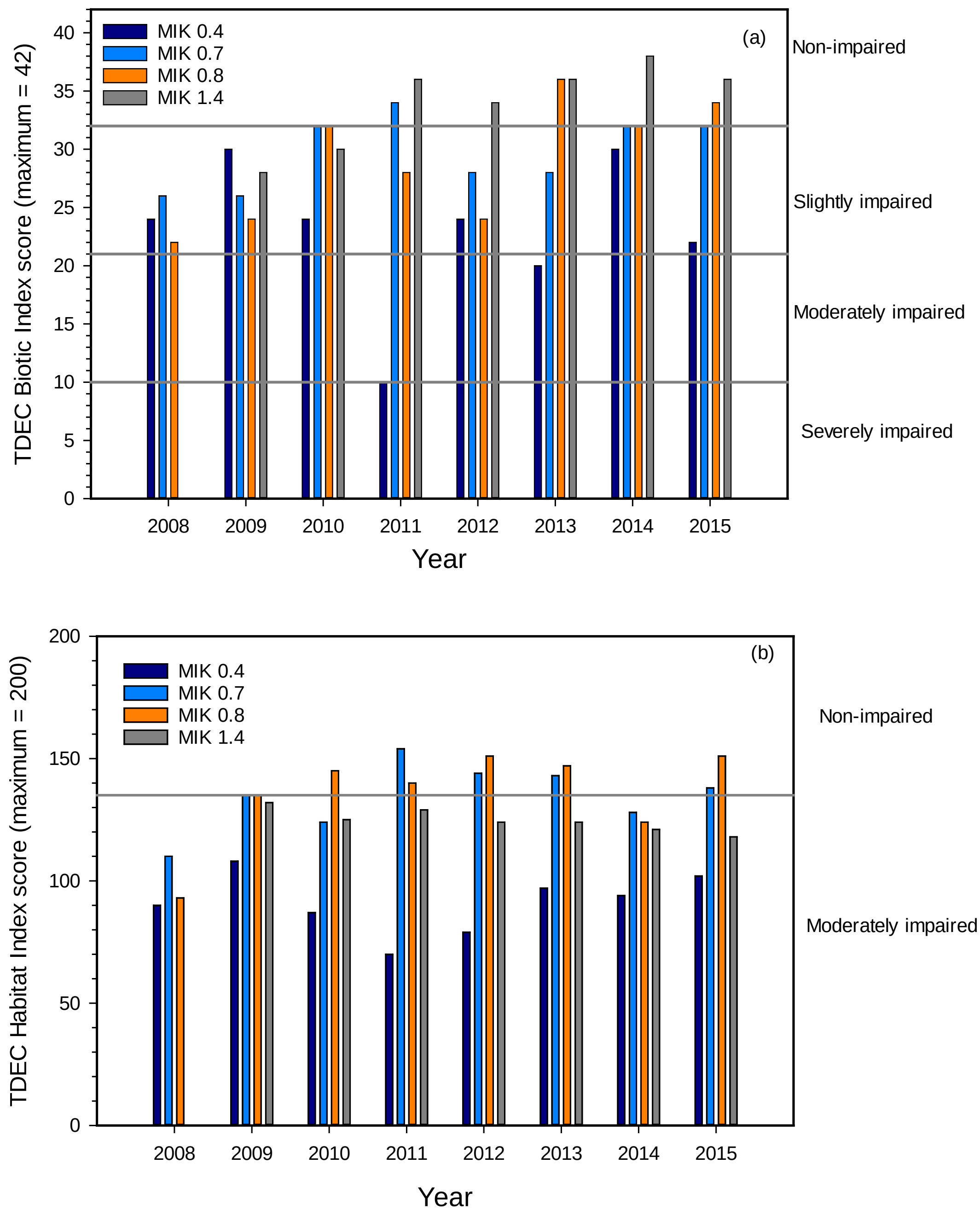

Fig. 3.58. Temporal trends in Tennessee Department of Environment and Conservation (TDEC) Benthic Macroinvertebrate Biotic Index (a) and Stream Habitat Index (b) scores for Mitchell Branch, August 2008 to 2015.

Horizontal lines in both graphs show the lower thresholds for narrative index ratings; respective narrative ratings for each threshold are shown on the right side of each graph.
(MIK = Mitchell Branch kilometer)

determine its suitability to support biological communities) in 2015 indicated habitat impairment at MIKs 0.4 and 1.4, while the habitat at MIKs 0.7 and 0.8 were rated as unimpaired. Overall, results using TDEC's semiquantitative protocols and ORNL's quantitative protocols since 2008 have been in general agreement that the macroinvertebrate community at MIK 0.4 scores from slightly to moderately impaired, and the communities at MIKs 0.7 and 0.8 score from slightly impaired to unimpaired. Habitat assessments show evidence of some impairment at all sites.

Fish communities in Mitchell Branch (MIKs 0.4 and 0.7) and at local reference sites were sampled in 2015. In Mitchell Branch, species richness (number of species), density (fish/m²) (Figs. 3.59 and 3.60), and biomass were assessed for comparison with area reference streams. Results for 2015 showed changes within the normal range of variation for species richness. However, most of the species found during the community studies sampling tend to be more tolerant of less than optimal conditions. At the most downstream site (MIK 0.4), all three metrics [species richness (Fig. 3.59), density (Fig. 3.60), and biomass] increased with a noticeable increase in biomass and density. MIK 0.7 had a slight decrease in species richness, while biomass and density still remain over two times higher than in the other reference streams. Overall, variations in these three parameters are typical of streams that have been severely impacted and are still recovering. While the condition of the fish communities over the last several years has been relatively stable, they have yet to reach conditions typical of less impacted streams in the area, and the stream is still dominated by more tolerant fish species.

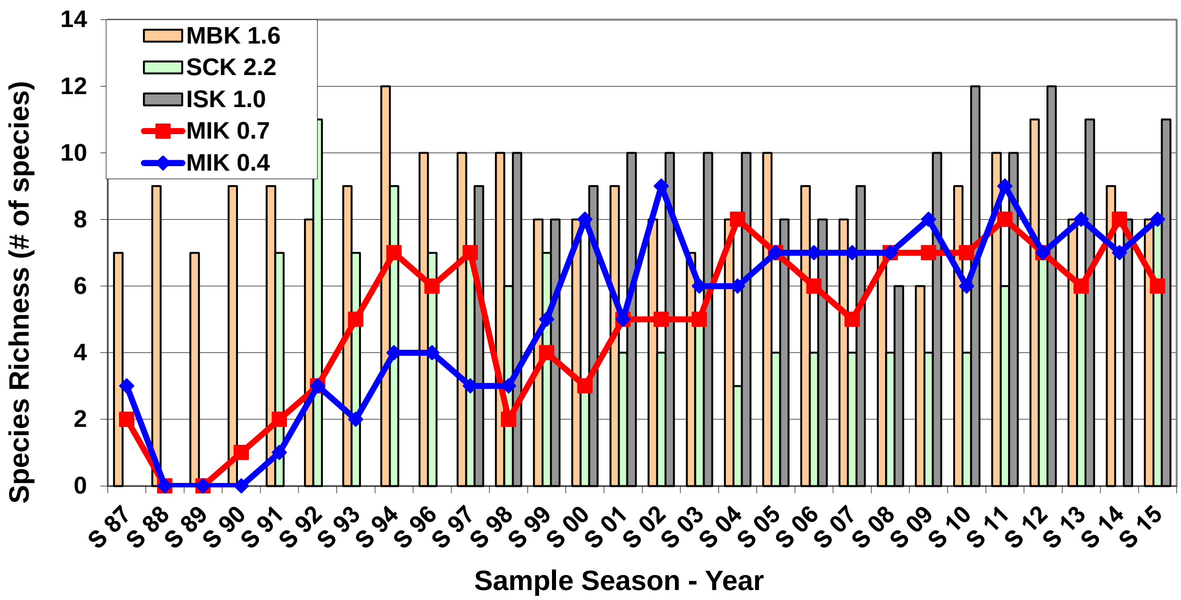

Fig. 3.59. Species richness for fish communities at sites in Mitchell Branch and in reference streams. *(ISK = Ish Creek kilometer, MBK = Mill Branch kilometer, MIK = Mitchell Branch kilometer, and SCK = Scarboro Creek kilometer)*

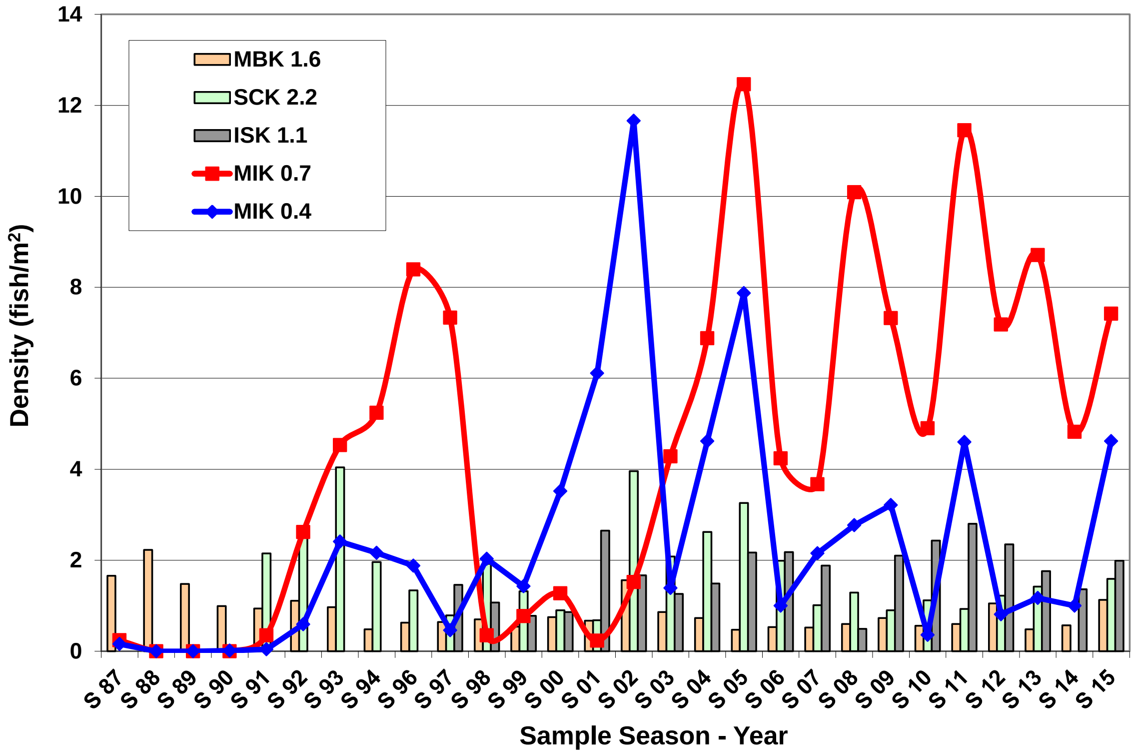

Fig. 3.60. Density for fish communities at sites in Mitchell Branch, and in reference streams.
(ISK = Ish Creek kilometer, MBK = Mill Branch kilometer, MIK = Mitchell Branch kilometer, and SCK = Scarboro Creek kilometer)

Similar to stream sampling, the K-1007-P1 pond is sampled annually to assess the diversity and density of resident fish populations. The pond is isolated from Poplar Creek by a weir grate at the outfall, preventing migration of fish into or out of the pond. Remediation efforts in 2007 focused on creating a fish community dominated by short-lived sunfish. Before remediation activities, the fish community contained high densities of predatory fish, as well as grazers, which fed on phytoplankton. In 2015, the fish community was comprised of sunfish (~50%), grazers (~40%), and predators (~7%). These numbers continue to vary from year to year, indicating that the population has not reached a state of balance yet, but they do continue to indicate a movement towards the goal of a sunfish-dominated community.

3.8 Environmental Management and Waste Management Activities

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 smaller water treatment unit for chromium-contaminated groundwater that sits within the existing CNF 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 CNF discharge line. Section 3.6.2.14 provides a more detailed discussion of CWTS operations.

3.8.1 Environmental Remediation Activities

EM continued remediation activities to reduce ETTP soil contamination in 2015. 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.

3.8.1.1 Zone 1

The interim ROD, which documents the cleanup method for the site, required Environmental Management (EM) to remediate soil to a depth of 10 ft (suitable for the protection of an industrial work force) and remove sources of groundwater contamination. EM prepared a remedial investigation/feasibility study (RI/FS) to address groundwater, surface water, ecological protection, and final LUCs. EPA and TDEC provided comments on the RI/FS, and the agencies reached an agreement to initiate a Zone 1 final soils ROD and defer Zone 1 surface water and groundwater to a future decision. In FY 2014, TDEC prepared and approved a revised RI/FS. The initial draft of the Zone 1 final soils proposed plan was also prepared and transmitted to EPA and TDEC for review. Upcoming work includes addressing EPA and TDEC comments and finalizing the Zone 1 final soils proposed plan, conducting a public meeting on the proposed plan, and preparing the Zone 1 final soils ROD.

3.8.1.2 Zone 2

Remediating Zone 2 involves removing some contaminated soil so that the site is safe for industrial use and removing sources of groundwater contamination.

In FY 2015, EM completed characterization of the footprints of Building K-25 and Building K-31. In 2016, this characterization data will be evaluated to determine if remediation is required under the Zone 2 Soils ROD. The roughly 40-acre footprint of Building K-25 has been declared the K-25 Preservation Footprint and is designated for historical commemoration and interpretation activities. The characterization results are also being used to support preservation of the area and evaluation of potential end states of the slab.

3.8.1.3 Tc-99 GW Investigation

Elevated levels of ^{99}Tc, a slowly decaying isotope, were observed in groundwater, storm water, and sanitary sewage during the demolition of the K-25 building. In 2014, an RmSE was prepared to assess the potential threat to human health and the environment from the elevated ^{99}Tc levels, discuss mitigative measures taken, and determine if further action was needed. The evaluation concluded that the levels of ^{99}Tc do not pose a threat to human health and the environment and recommended a shallow groundwater investigation south of the K-25 building slab to evaluate the potential migration of ^{99}Tc.

In 2015, the shallow groundwater investigation was implemented in phases. The results of Phase 1 and Phase 2 are documented in *Addendum to the Technetium-99 Removal Site Evaluation of the East Tennessee Technology Park, Oak Ridge, Tennessee* (DOE/OR/01-2663&D1/A1, DOE 2015b). This document was submitted to DOE on December 21, 2015. The RmSE document will be revised to update the results of the Phase 3 investigation, which are scheduled to be completed in 2016.

3.8.1.4 Building K-31 Demolition

Demolition of the K-31 building at ETTP was completed in June 2015, marking the removal of the fourth of five gaseous diffusion buildings at the former uranium enrichment site. ETTP—once called the Oak

Ridge Gaseous Diffusion Plant (ORGDP), as well as the K-25 Site—was built as part of the Manhattan Project in the 1940s to enrich uranium for the atomic bombs that would end World War II. The site later produced enriched uranium for commercial and defense purposes. Operations ceased in 1985 and the site was permanently shut down in 1987. DOE then began cleanup operations, which included demolition of many of the buildings at the site.

The 750,000 ft^2 K-31 building was built in 1951. As part of a cleanup project in 2005, most of the hazardous materials were removed from the facility, leaving its shell to be demolished. UCOR, DOEs cleanup contractor, began demolishing the building in October 2014 and completed demolition ahead of schedule and under budget.

3.8.1.5 Building K-27 Demolition

Demolition of the K-27 building will mark the first-ever complete cleanup of a gaseous diffusion complex.

In FY 2015, transite paneling on the structure's outer skin was removed. Building demolition began and is expected to be completed in 2016.

The building is one of EMs highest priorities at the site due to its risk and deteriorated state. The K-27 building is similar in structure to the already demolished K-25 building. It spans more than 8 acres and is approximately 900-ft long, 400-ft wide, and 58-ft in height.

Characterization of the building structure, equipment, and piping was completed for the purposes of waste disposal. A total of 105 samples of the building structure and 184 samples of equipment and piping were collected. Oil and other fluids were drained from various equipment. The application of polyurethane foam in process gas equipment, the off-site shipment of sodium fluoride (NaF) traps, the removal of ^{99}Tc-contaminated cylinders, and the removal of high risk equipment were completed. Removal of process gas equipment from the cell floor in two units of the building was completed. Other project activities completed in FY 2015 included sealing slab penetrations, installing storm water berms, and preparing waste disposal documents.

3.8.1.6 Buildings K-31 and K-33 Ancillary Facilities Demolition

In addition to completing the K-31 building demolition, buildings that supported the gaseous diffusion operations at K-31 and K-33 were also removed, creating an additional 200-acre tract of land for use by the private sector.

Demolition of four support pedestals remaining from the tear down of Building K-791 in the late 1990s was safely completed in February 2015. The pedestals were built as part of Building K-791 in the early 1950s to support equipment that regulated power to the K-33 building during gaseous diffusion operations. The pedestals were constructed of formed concrete and rebar. Each pedestal was 30 ft × 18 ft × 18 ft with a wall thickness varying from 40 to 52 in.

Demolition was completed on the K-761 Switch House, which was the power distribution and electrical switching station for the K-31 gaseous diffusion building at ETTP. The 14,640 ft^2, five-story building was built in the early 1950s, and after K-31 ceased operations in 1985, K-761 was shut down. Activities were then limited to routine S&M, storage of various types of waste containers, and the occasional removal of process equipment items for shipment to other gaseous diffusion plants.

Other ancillary buildings that were demolished included the K-892 fire and raw cooling water pumphouse and the K-892-Y RCW sludge softener.

3.8.1.7 Building K-1037 Demolition Preparation Begins

After almost 10 years of being placed in standby condition, the K-1037 Building has had revised security measures approved by DOE to allow for the removal of materials in preparation for deactivation and demolition of the facility. The building was used to produce barrier material for the gaseous diffusion process.

Initial planning walkdowns for the building have been conducted, which identified issues with the building's electrical service and combustibles storage. The original electrical distribution has been isolated, and a new temporary lighting service has been installed. Workers also began removing combustibles from the building.

Preliminary planning and engineering walkdowns have been conducted to allow for future asbestos and hazardous materials abatement.

3.8.1.8 Commemoration of the K-25 Site

Historic preservation of the K-25 Site continued in FY 2015 with the completion of the conceptual design of the Equipment Building, Viewing Tower, K-25 History Center, Wayside Exhibits, and K-25 slab delineation. A consultation meeting was held in January 2015, where representative from the Professional Site Design Team and Museum Professional (Smee and Busby Architects and Hilferty and Associates) presented the conceptual design to a group of 12 consulting parties, made up of historic preservation agencies and other interested agencies. Following review of the conceptual design documents, preliminary design activities started in 2015.

Development of the K-25 Virtual Museum website proceeded throughout FY 2015, and the website was previewed by the consulting parties in May 2015. Their comments were incorporated into the website, which is now available online at www.K-25virtualmuseum.org. The designer of the web-based K-25 Virtual Museum is Westside Media; historical content was provided by UCOR staff.

The National Defense Authorization Act of 2015, passed by Congress and signed into law December 19, 2014, by President Barak Obama, included provisions authorizing a Manhattan Project National Historical Park. Although the historic preservation activities at the K-25 Site are being implemented separately and independently of the National Historical Park, the passage of the Park legislation may provide opportunities to benefit from the experience of the National Park Service (NPS).

In August 2015, NPS officials, accompanied by an interpretive team from the NPS Harpers Ferry Center, toured Oak Ridge historic properties and held preliminary discussions with DOE headquarters and local officials about launching the park. The visit included a tour of the K-25 Site and discussions on the status of K-25 historic preservation activities.

3.8.2 Reindustrialization

As cleanup has progressed extensively at ETTP, more large parcels are becoming available for transfer (Fig. 3.61). The completion of K-31 demolition allows for the first parcel of over 200 contiguous acres that can be developed for large-scale, heavy industrial projects at Heritage Center Industrial Park. This area has been approved for transfer by the EPA and TDEC. Transfer of the land is expected to take place in 2016. This will be the second largest transfer in the history of the program. 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 airport project. The general aviation airport runway will accommodate small corporate jets, private airplanes, and EMS aircraft. DOE completed an Environmental Assessment to support the property transfer and potential construction and operation of the airport. In 2015, DOE began draft documentation for future property transfers of large industrial parcels at the former Powerhouse area and Duct Island, both located at the western end of the site.

In the past year, three new businesses have begun operations at ETTP. This year also saw the construction of the Powerhouse 6 Solar Farm, the third and largest solar array on-site. Powerhouse 6 is a 1-MW solar array on five acres of former DOE land, providing electricity to TVA through the City of Oak Ridge. Heritage Center has also established numerous greenway areas, as well as an arboretum certified by the Tennessee Urban Forestry Council.

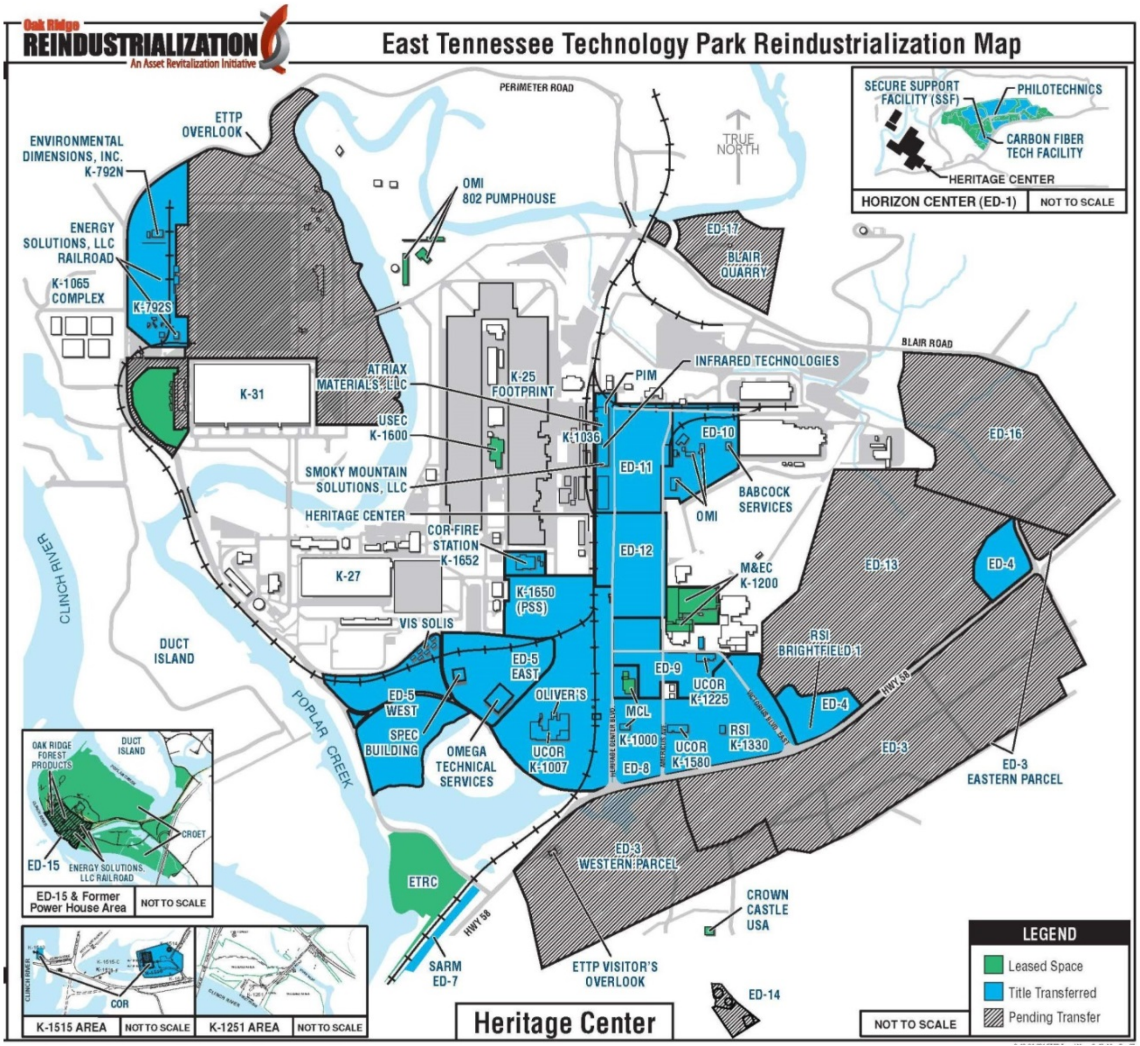

Fig. 3.61. East Tennessee Technology Park reindustrialization status, 2015.

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