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ENGINEERING TECHNICAL SUPPORT CENTER

Annual Report Fiscal Year 2018

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Engineering Technical Support Center Annual Report Fiscal Year 2018

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Notice/Disclaimer Statement

This report is intended to inform the public and U.S. Environmental Protection Agency (EPA) Remedial Project Managers, On-Scene Coordinators, and Superfund Technology Liaisons of progress at the Engineering Technical Support Center (ETSC) project sites, cutting-edge remedial technologies, and ETSC operations.

Disclaimer:

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Foreword

The U.S. Environmental Protection Agency (EPA) is charged by Congress with protecting the nation's land, air, and water resources. Under a mandate of national environmental laws, the Agency strives to formulate and implement actions leading to a compatible balance between human activities and the ability of natural systems to support and nurture life. To meet this mandate, the EPA's research program provides data and technical support for solving environmental problems today and building a science knowledge base necessary to manage our ecological resources wisely, understand how pollutants affect our health, and prevent or reduce future environmental risks.

The Center for Environmental Solutions and Emergency Response (CESER) within the Office of Research and Development (ORD) conducts applied, stakeholder-driven research and provides responsive technical support to help solve the Nation's environmental challenges. The Center's research focuses on innovative approaches to address environmental challenges associated with the built environment. We develop technologies and decision-support tools to help safeguard public water systems and groundwater, guide sustainable materials management, remediate sites from traditional contamination sources and emerging environmental stressors, and address potential threats from terrorism and natural disasters. CESER collaborates with both public and private sector partners to foster technologies that improve the effectiveness and reduce the cost of compliance, while anticipating emerging problems. We provide technical support to EPA regions and programs, states, tribal nations, and federal partners, and serve as the interagency liaison for EPA in homeland security research and technology. The Center is a leader in providing scientific solutions to protect human health and the environment.

Gregory Sayles, Ph.D., Director

Center for Environmental Solutions and Emergency Response

Acknowledgements

The Engineering Technical Support Center (ETSC) would like to acknowledge the contributions from Office of Research and Development scientists for their efforts in support of ETSC's mission. Special recognition goes to a number of our colleagues who have recently retired—their dedication and commitment to the EPA mission has had a positive impact on human health and our environment. ETSC extends thanks to our numerous clients in the Office of Science Policy, Office of Land and Emergency Management, Office of Superfund Remediation and Technology Innovation, the EPA Regions, the Superfund Technology Liaisons, On-Scene Coordinators, and their management for their patronage and support. ETSC would also like to recognize the exemplary support provided by our contractors, Pegasus Technical Services Inc., Battelle Memorial Institute, General Dynamics IT, and RTI International. Finally, ETSC extends special thanks to our dedicated EPA employees who provide document reviews, respond to technical request phone calls, and provide all other manner of assistance.

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List of Acronyms

CESER	Center for Environmental Solutions and Emergency Response
COC	contaminant of concern
DEQ	Department of Environmental Quality
DNAPL	dense non-aqueous phase liquid
EAFB	Ellsworth Air Force Base
EIP	Engineering Issue Paper
EPA	U.S. Environmental Protection Agency
ETSC	Engineering Technical Support Center
FS	feasibility study
FY	fiscal year
ISS	in situ solidification/stabilization
JBMD	Joint Base McGuire-Dix
LRTD	Land Remediation and Technology Division
NAPL	non-aqueous phase liquid
NATO	North Atlantic Treaty Organization
NHDES	New Hampshire Department of Environmental Services
NPL	National Priorities List
OCDD	octachlorodibenzodioxin
OITA	Office of International and Tribal Affairs
ORD	Office of Research and Development
OSC	On-Scene Coordinator
OU	Operable Unit
PAHs	polycyclic aromatic hydrocarbons
PCP	pentachlorophenol
PFC	perfluorocarbon
PFAS	per- and polyfluoroalkyl substances
RI	remedial investigation
RPM	Remedial Project Manager
STL	Superfund and Technology Liaison
SVE	soil vapor extraction
TCE	trichloroethylene
TRIP	Troutdale Reynolds Industrial Park
TPH	total petroleum hydrocarbons
TSC	Technical Support Center
VOC	volatile organic compound

Executive Summary

In 1987, the U.S. Environmental Protection Agency (EPA or Agency) created the Technical Support Project through the Office of Research and Development (ORD) and the Office of Land and Emergency Management (formerly the Office of Solid Waste and Emergency Response). The Technical Support Project consists of a network of EPA Regional Forums, the Environmental Response Team, and five specialized Technical Support Centers (TSCs). The TSCs actively provide support to the EPA's most complex and high-priority cleanup sites by delivering expertise on the latest methods, approaches, and technologies.

The Engineering Technical Support Center (ETSC), one of the five TSCs, is operated by the ORD Center for Environmental Solutions and Emergency Response (CESER), Land Remediation and Technology Division (LRTD) in Cincinnati, Ohio.

ETSC's mission is to provide site-specific scientific and engineering technical support to Remedial Project Managers (RPMs), On-Scene Coordinators (OSCs), and other remediation personnel at contaminated sites. ETSC is primarily staffed with scientists and engineers from ORD/CESER/LRTD with a broad range of skills and technical expertise. ETSC collaborates with EPA programs and other federal agencies to deliver the latest methods, approaches, and technologies needed to characterize, remediate, and manage risk at contaminated sites. Additional assistance is provided by other ORD Laboratory or Division personnel, EPA Regional personnel, and external contractors and consultants as needed. ETSC's combined technical expertise supplements the work performed by responsible local, EPA Regional, and national authorities, allowing them to work more quickly, efficiently, and cost-effectively while also increasing the technical experience of the remediation team.

IMPACTS OF ETSC IN 2018

ETSC provides technical support for soil, sediment, groundwater, and mining-related contamination.

In FY18, ETSC provided support to seven Superfund sites on the Administrator's list of those targeted for immediate and intense action.

ETSC responded to 172 requests for support at 122 sites from all 10 EPA Regions, 8 countries (Argentina, Australia, China, Israel, Peru, Poland, Ukraine, and Vietnam), the United Nations, and other entities. Twenty-one percent of the site-specific requests were associated with Superfund NPL sites.

Technical support requests ranged from site characterization to modeling, monitoring, and remediation of soil and water contamination to ecological effects resulting from chemical exposures. ETSC also provided technical input in the areas of engineering and prototype testing, environmental and human health risk assessment, and groundwater modeling.

ETSC led or contributed to 29 disseminated products, including conference presentations, technical workshops, peer-reviewed journal articles, and other EPA technical reports and products.

In fiscal year 2018 (FY18), ETSC responded to 172 combined technical support requests from 122 sites across the 10 EPA Regions; technical requests from 8 countries (Argentina, Australia, China, Israel, Peru, Poland, Ukraine, and Vietnam) and the United Nations; and 20 other non–site-specific technical requests. In 2018, seven of the sites

to which ETSC provided support were on the Administrator's Emphasis List of Superfund sites targeted for immediate and intense action (US EPA, 2019a):

- Mohawk Tannery (R1),
- L.A. Clarke & Son (R3),
- St. Regis Paper Co. (R5),
- U.S. Smelter and Lead Refinery, Inc. (a.k.a. USS Lead or East Chicago) (R5),
- Tar Creek, Ottawa County (R6),
- Des Moines TCE (R7), and
- Bonita Peak Mining District (R8).

ETSC also provided support to one site on the Superfund Task Force's List of Superfund Redevelopment Opportunity Sites—Bunker Hill Mining & Metallurgical Complex (R10) (US EPA, 2019b).

ETSC's efforts directly supported 35 states, with the most support provided to the following eight states: Missouri, New Jersey, Montana, Oregon, Washington, Michigan, Idaho, and Oklahoma.

Varied interdisciplinary backgrounds and expertise enable ETSC staff to bring creative thinking to life through applying innovative engineering research to real-world scenarios. These innovations have the potential to produce long-lasting dividends and ultimately safer, more sustainable, and healthier communities. The selected projects highlighted in this report provide insight into the unique role that ETSC plays as a bridge between environmental remediation—as applied research—and innovative engineering research in ORD. Several of these support efforts have already generated substantial results (i.e., cost savings, effective/timely remediation results, patents), whereas others are working toward that end.

ETSC also convenes meetings and publishes reports on significant developments in environmental engineering in the form of Engineering Issue Papers (EIPs), peer-reviewed journal articles, technical workshops, and conference presentations and posters. In FY18, ETSC contributed to 29 such dissemination products and holds a seat on EPA's Superfund National Remedy Review Board.

INNOVATION

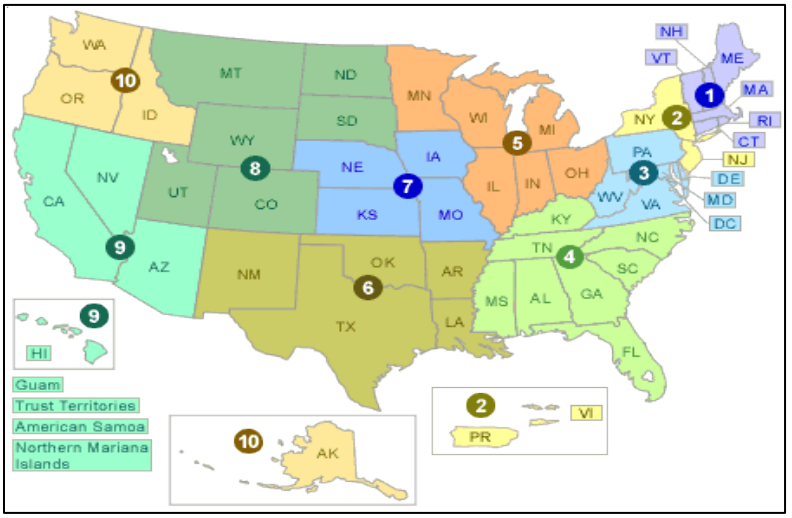
A major component of affecting meaningful remediation lies in constructing and testing new, innovative treatment technologies through pilot and field research. ETSC teams spearhead progressive field research in many areas, including:

- PFAS remediation technologies;
- beneficial reuse of agricultural waste products as biosolids;
- phytoremediation of contaminants;
- risk assessment prioritization;
- containment and treatment methods for coal combustion residue located near sensitive ecosystems;
- permeable reactive barrier technologies to slow or stop groundwater contaminants from escaping sites or reaching receptors;
- groundwater pump-and-treat system design and optimization;
- spatiotemporal fate and transport groundwater modeling to evaluate existing systems or guide remedy selection;
- citizen science tools related to air quality monitoring; and
- engineering plan design reviews to ensure efficacy of selected site treatment(s) or remedy and cost efficiency.

ETSC implements proven technologies when viable, including the application of in situ solidification, thermal desorption, and in situ chemical oxidation.

The National Impact of Our Work

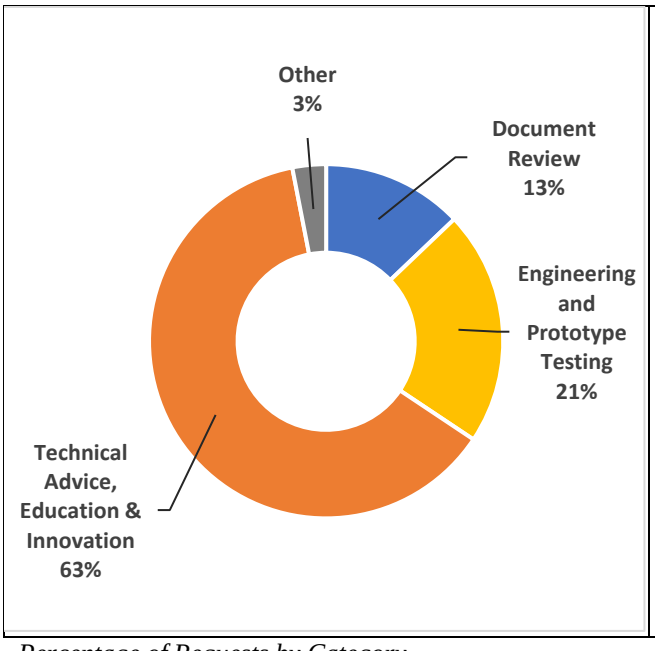
ETSC is helping to accelerate cleanup and advance economic revitalization through provision of expertise in the latest methods, approaches, and technologies for contaminated sites.



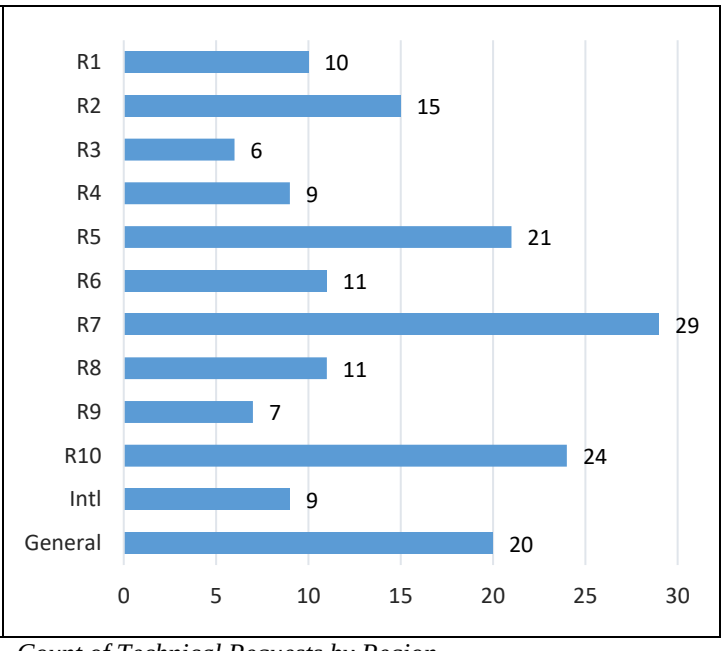
Map of EPA Regions

In FY18, ETSC experts responded to **172 requests for support at 122 sites across all 10 EPA Regions and internationally**. Most requests sought technical input, education, and innovative ideas for site remediation (63 percent); engineering and prototype testing (21 percent); and document review (13 percent). The topics ranged from site characterization to modeling, monitoring, and remediation of soil and water contamination to ecological effects resulting from chemical exposures. For these requests, ETSC conducted technical document reviews, engineering and prototype testing, and developed knowledge products such as EIPs to broadly disseminate information.

ETSC provides long-term, continuous support to many high-priority Superfund sites including aid to 12 of the 21 sites from the EPA Administrator's 2017 Emphasis List that contains sites requiring immediate, intense action, and 4 of the 31 sites on the EPA's list of sites with the greatest expected redevelopment and commercial potential.

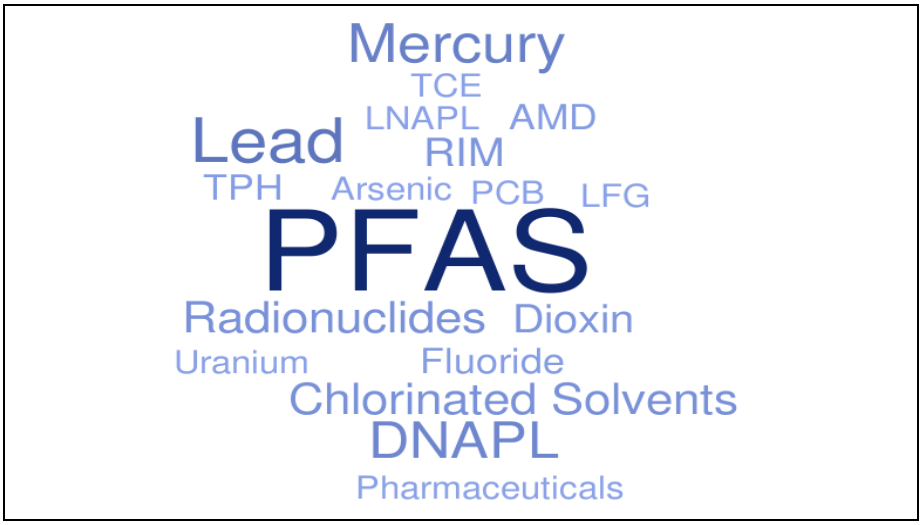


Percentage of Requests by Category



Count of Technical Requests by Region

Most requests originated from Region 7, with multiple requests for the same sites—West Lake Landfill, Oak Village, Madison County Mines Operable Unit (OU) 7, and Bridgeton Landfill. ETSC also provided expert technical support to Region 7 on total petroleum hydrocarbons (TPH) method validation, innovative technologies used to disperse light non-aqueous phase liquids (NAPLs) in the subsurface, and real-time analytical tools for lead in water.



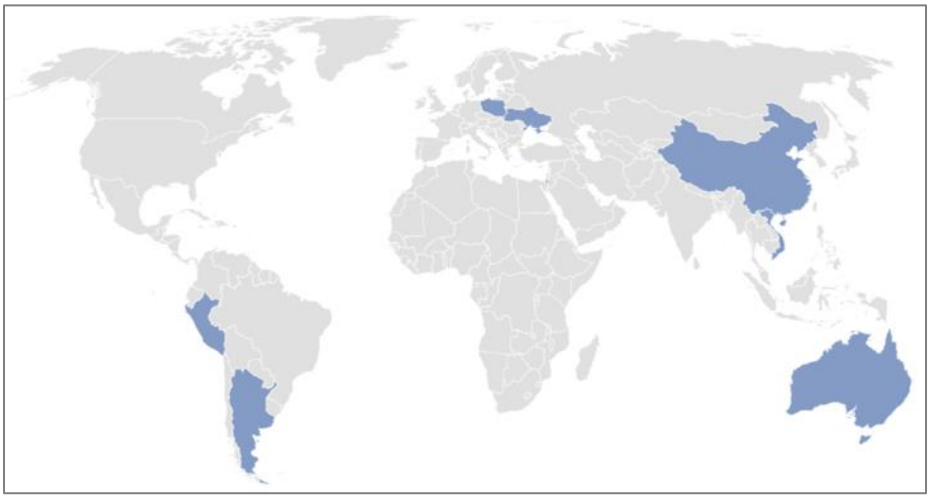
The most frequently identified contaminants of concern (COCs) among the more than 40 COCs referenced in FY18 ETSC requests for support.

Most frequently applied and/or referenced methods and technologies involved in the technical support requests from FY18.

ETSC provides support for many Superfund sites across the country, many of which are on the National Priorities List (NPL). These sites include, among others, abandoned mines and legacy contamination from smelters, chemical manufacturing facilities, paper manufacturing facilities, and more. Nearly 100 different technologies were referenced, reviewed, or used by ETSC to provide support in FY18.

International Partnerships

ETSC continues to serve as a world leader in remediation. In FY18, several international partnerships were developed or strengthened by providing technical assistance to Argentina, Australia, China, Israel, Peru, Poland, Ukraine, Vietnam, and the United Nations. A brief description of the support provided to each of these partners follows.



International countries (highlighted in dark blue) where ETSC provided support in FY18 – Argentina, Australia, China, Israel, Peru, Poland, Ukraine, and Vietnam.

Argentina—The Ministry of Environment and Sustainable Development requested ETSC support on determining the effectiveness of, and impact to, benthic fauna associated with the application of limestone rock on the beds of contaminated site lagoons to remedy acid mine drainage contamination at a former mining facility. ETSC shared their knowledge and an article coauthored by an ETSC expert (Al Abed, 2002).

Australia—An expert on per- and polyfluoroalkyl substances (PFAS) from Australia contacted ETSC to discuss soil washing and immobilization technologies, two emerging treatment solutions for PFAS contamination. A private company also requested a meeting with ETSC to discuss an immobilization product manufactured in Australia that is available on the U.S. market.

China—ETSC experts met with Chinese scientists regarding a collaboration request from Anew Global Consulting LLC and ETSC's Chinese counterpart, the Ministry of Ecology and Environment.

Israel—ETSC supported Region 3 in providing assistance on sampling, analytical, and remediation methods for military waste on two former military sites being redeveloped for commercial and residential uses.

Peru—Population growth in Latin America has significantly increased in recent years, particularly in coastal areas where increasing water stress has been observed. Most of Peru's freshwater resources originate in the Amazonian region, and river/tributary diversions and activities decrease the quantity and quality of water that reaches the most populous regions. The EPA Office of International and Tribal Affairs (OITA) for Latin America and the Caribbean requested ETSC expertise on water modeling to demonstrate specifically how modeling scenarios could inform the country's monitoring and environmental enforcement efforts. The modeling support requested included general movement of materials (e.g., sediment, contaminants) in waterways, groundwater, physical systems, and watersheds and their impacts on water quality in lakes, estuaries, and other hydrological systems.

Poland—EPA personnel participated in the Central Eastern European Conference on Health and the Environment Workshop in Krakow, Poland on June 10–14, 2018. A senior EPA researcher served as a co-organizer for this

conference with other scientists from Poland, Romania, and other Eastern European countries. The EPA co-organizer was also the lead organizer for the water quality management session and presented case studies on mine-influenced water remediation and nanotechnology remediation of recalcitrant contaminants in the environment. Other EPA staff served as the session co-chair for the site remediation and thermal treatment session and an instructor for the "Chemical Mixtures and Epidemiologic Fundamentals for Risk Assessment Applications" workshop. The focus of the conference was air pollution, persistent organic pollutants, and site remediation of mining and military sites in Eastern European countries. In addition, the conference highlighted research on environmental toxicology and mechanistic biology studies, disease risks, and intervention approaches to improve health.

Ukraine—ETSC received an invitation from the National University of Life and Environmental Sciences in Ukraine to participate in several educational, scientific, and outreach events in the country in support of an ongoing North Atlantic Treaty Organization (NATO) project.

Vietnam—Pesticide and dioxin contamination issues have been encountered at historic U.S. military installations in Vietnam. Since FY14, ETSC has collaborated with the Joint Advisory Committee for Vietnam, U.S. State Department, U.S. Department of Health and Human Services, the Centers for Disease Control and Prevention, and internal EPA entities, including other Centers and Laboratories in ORD, and OITA to provide input on evaluating and selecting the best remedial solutions for these legacy military sites. In FY18, ETSC provided technical guidance on evaluating the effectiveness of in situ solidification and stabilization technologies.

United Nations—ETSC conducted an expert review of the United Nations Stockholm Convention on Persistent Organic Pollutants titled "Draft risk profile: Perfluorohexane sulfonic acid (CAS No: 355 46-4, PFHxS), its salts and PFHxS-related compounds" (Persistent Organic Pollutants Review Committee, 2018).

RISK ASSESSMENT & DECISION ANALYSIS

ETSC routinely provides guidance on site-specific information to assess risks and support decision making through decision trees, remedy selection, cleanup plans, models, and other decision support tools. Examples of support provided by ETSC in FY18 related to risk assessment and decision analysis include:

- Vo-Toys, New Jersey, Region 2—At this industrial site, ETSC evaluated the worst-case exposure scenario of mercury being released in a potential warehouse fire.
- Quanta Resources, New Jersey, Region 2—ETSC evaluated risk assessment assumptions for organic exposure in conjunction with the EPA's National Center for Environmental Assessment at this industrial site.
- B.F. Goodrich, Kentucky, Region 4—ETSC provided technical assistance for consideration of applying an adaptive management approach to begin action based on available data at this industrial site.
- Bunker Hill Mining & Metallurgical Complex, Idaho, Region 10—ETSC used the Decision Analysis for a Sustainable Environment, Economy, and Society (DASEES) decision support tool to assist Region 10 in prioritizing the areas to be sampled and to assist in the process of structured decision making for adaptive site management at this mining complex.
- Hanford Department of Energy, Washington, Region 10—At this military base, ETSC provided support on the inhalation exposure factor for radiological compounds used for Soil Screening Level Guidance.

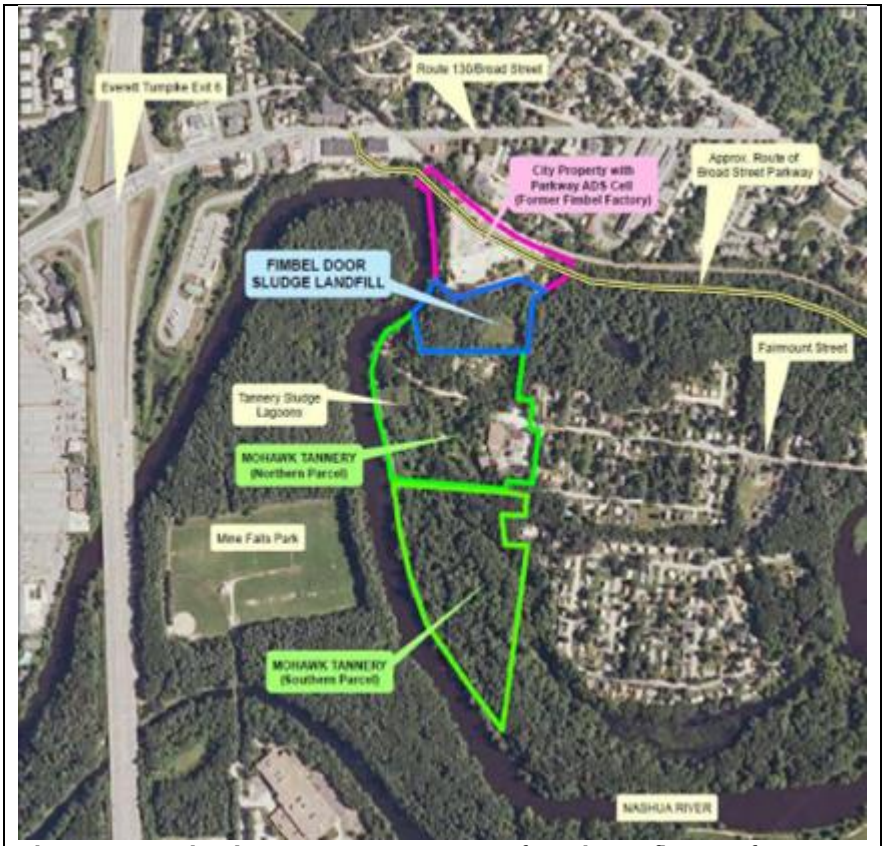
The Impact of Our Work at Select Sites

In FY18, the ETSC received 172 technical support requests for contaminated sites across the United States and internationally. The project and technical support request summaries presented here highlight a few of the many responses to technical support requests and illustrate the wide range of technical issues for which ETSC is asked to support, including sampling methodologies and approaches, emerging contaminants, and advances in remediation and mining sites. They are organized by highly complex sites, mining operations, NAPL-contaminated sites, and PFAS-contaminated sites. Each summary describes the site and ETSC's contribution to the technical support request.

Highly Complex Sites

Mohawk Tannery (Region 1)

The former Mohawk Tannery facility poses potential risks to ground- and surface water from the estimated 60,000 cubic yards of sludge remaining in unlined disposal areas. The 30-acre site is 3.5 miles upstream from the confluence of the Nashua and the Merrimack Rivers and surrounding wetlands in Nashua, New Hampshire. The facility produced leather-tanned hides between 1924 and 1984. During its operation, the facility discharged wastewater containing hazardous substances like chromium, zinc, and phenol directly into the Nashua River and disposed of sludge containing hazardous substances like chromium (e.g., trivalent), pentachlorophenol (PCP), phenol, and 2,4,6-trichloropehenol into several on-site, unlined disposal areas. Approximately 5,000 people obtain drinking water from groundwater wells within a 4-mile radius of the site, which is on the Administrator's Emphasis List (US EPA, 2018a).



The 30-acre Mohawk Tannery site is upstream from the confluence of two rivers and surrounding wetlands in Nashua, New Hampshire. A local developer is working with the EPA and NHDES on a remediation and redevelopment plan. The facility discharged contaminated wastewater, impacting nearby drinking water wells within a 4-mile radius of the site (US EPA, 2018b).

Only limited investigations have been undertaken at the site since June 2005 (other than a 2009 treatability study of the sludge lagoons) pending a resolution of the funding mechanism (e.g., private developer or finalization of the site

on the NPL) for site cleanup. In June 2012, the city of Nashua funded the complete demolition and asbestos abatement needed to remove the remaining former tannery buildings (excluding the slabs). These buildings had become a visible nuisance and had been suspiciously burned on several occasions prior to demolition in 2012. The EPA and the New Hampshire Department of Environmental Services (NHDES) conducted several field investigations in the southernmost 15-acre parcel of the site to evaluate which portion of the undeveloped area could be considered for delisting from the NPL (US EPA, 2018a).

A local developer who is exploring the option of acquiring the site for redevelopment completed a solidification/ stabilization bench-scale treatability study in 2009 to evaluate Portland cement and various additives for the contaminated soils and sludges and, later, a draft Remedial Action Plan to the EPA (including ETSC) and NHDES. In 2018, ETSC assisted with the review of public comments to the remedial action plan and evaluated potential issues with the proposed containment alternatives (e.g., land disposal design requirements), chemical deterioration of sheet pile seals, and reactive barrier interception trenches. The EPA and NHDES are working together with the developer and the city of Nashua regarding cleanup strategies and redevelopment potential (NHDES, n.d.; US EPA, 2018a).

Bay Road Holdings (Region 9)

Bay Road Holdings LLC (formerly Romic Environmental Technologies Corporation, or Romic) is a closed hazardous waste management facility in East Palo Alto, California, near the San Francisco Bay. Romic operated the 12.6-acre facility from approximately 1964 to 2007, conducting solvent recycling, fuel blending, wastewater treatment, and hazardous waste storage and treatment. Because of past operations dating to the 1950s, soil and groundwater beneath the site became contaminated with volatile organic compounds (VOCs). Typical VOCs found at the site are solvents used in the dry cleaning and automotive industries. The groundwater contamination extends across most of the site to a depth of at least 80 feet below ground surface. The groundwater is not a drinking water source (US EPA, 2018c).

After the facility ceased operations in 2007, all of the surface structures, including distillation towers, storage tanks, and hazardous waste drum storage buildings were demolished in 2009 as part of the closure process (US EPA, 2018c).

The Bay Road Holdings site in 2008 (left) and after demolition in 2017 (right). (US EPA, 2018c). Remediation of subsurface solvent contamination is ongoing via a groundwater recirculation system with horizontal injection of a sugar-based substrate.

EPA selected biological treatment options to remediate the solvent contamination in the soil and groundwater by using a groundwater recirculation system with horizontal injection wells that delivers a substrate, consisting mainly of sugar, into the subsurface. The substrate acts as a food source for the natural bacteria that live on the subsurface, and these bacteria then break down the solvents into less toxic end products. This remedy allows for flexibility during redevelopment, such as allowing the cleanup to proceed underground while not interfering with the redevelopment

construction. Approximately 40 percent of the full-scale biological treatment system was constructed and underwent testing in 2017. The full-scale treatment system is expected to begin operation by 2020 (US EPA, 2018c).

In 2018, the California Department of Toxic Substances Control communicated concerns to ETSC that the substrate may act negatively on native microbial populations and suggested that a passive bio-trap device be placed in groundwater wells for 60 days to evaluate the condition of microbes. ETSC provided guidance to the Region on whether in situ bioremediation was performing as expected and is working with the Department of Toxic Substances Control to determine whether a passive bio-trap is necessary or beneficial.

Reynolds Metals (Region 10)

The 800-acre Reynolds Metals Company site in Troutdale, Oregon, is the former location of the Reynolds/Alcoa aluminum smelter which operated an aluminum reduction plant from 1941 to 2000. Historical facility operations contaminated soil, sediment, and groundwater. EPA investigations of contaminated waste disposal areas began in 1993, and in 1994 the EPA placed the site on the NPL. A remedial investigation (RI)/feasibility study (FS) conducted from 1996 to 2000 identified arsenic, beryllium, chromium, cyanide, fluoride, lead, 1,1-dichloroethene, and tetrachloroethylene in groundwater, and fluoride and polycyclic aromatic hydrocarbons (PAHs) in soil, process waste, and lake sediment (US EPA, 2018d).

The Reynolds Metals Superfund site is now the Troutdale Reynolds Industrial Park (TRIP), with dedicated areas for infrastructure, open space, wetlands, and trails. TRIP is a major community asset, attracting companies (e.g., FedEx, Amazon) and thousands of workers to the region. In 2018, the Port of Portland was presented with EPA Region 10's Howard Orlean Excellence in Site Reuse Award in recognition of its efforts as part of a diverse group of stakeholders who made the redevelopment possible.

Several removal and remedial actions have been performed since the RI/FS, including:

- removing 60,000 tons of visible waste and contaminated soil between 1995 and 2002;
- installing a geotextile and rock cap at the west end of the lake and a soil cap at the east end to cover the sediments that could not be removed in 2003 and 2004;
- capping a landfill with rock cover to prevent direct contact and to provide flood protection in 2003 and 2004;
- installing a focused extraction well system to remove and contain the groundwater fluoride contamination in 2005; and
- undertaking additional remedial actions like groundwater monitoring and engineering and institutional controls to limit future use of groundwater and portions of the property.

In 2005, the soils were confirmed to be within both the EPA's and the Oregon Department of Environmental Quality's (DEQ's) acceptable risk range for all carcinogenic contaminants except for a minor exceedance for benzo(a)pyrene in the east area. No ecological concerns were identified (US EPA, 2018d). Final remedial action objectives were then implemented to further reduce human exposure to contaminated soil and groundwater and reduce and control the spread of fluoride and other contaminants of concern (COCs) in ground and surface water.

In 2018, ETSC experts supported EPA Region 10 in finalizing an optimization review of the site's remediation approach. ETSC provided technical support in the area of surface and groundwater interactions to inform decisions for reducing the fluoride contamination, and provided ecosystem risk evaluations for fluoride exposure, specifically related to groundwater flux into the Sandy River that could potentially harm aquatic life (US EPA, 2018d).

Mining Operations

Tar Creek (Ottawa County) (Region 6)

The 25,600-acre (40-square-mile) Tar Creek site, near Picher, in Ottawa County, Oklahoma, covers a portion of the 100-square-mile Tri-State Mining District that extends into Missouri and Kansas. The area produced substantial quantities of iron and zinc in the 1920s and 1930s (US EPA, 2018e). Mining operations used room and pillar techniques, and groundwater accumulated in the rooms and horizontal tunnels after mining operations ceased in the 1970s. In 1979, acid mine water with high concentrations of heavy metals began to discharge to the surface, contaminating surface water and threatening the regional water supply beneath the mining area (US EPA, 2018f).

In 1980, the governor of Oklahoma established the Tar Creek Task Force to investigate the effects of mine drainage onto the area's surface water, and based on the investigation's results, the site was added to the NPL in 1983. Five Operable Units (OUs) were established at the site (US EPA, 2018f):

- **OU1–Surface Water and Groundwater** addresses the surface water degradation by the discharge of acid mine water and the threat of contamination of the Roubidoux Aquifer, the regional water supply (US EPA, 2018f).
- **OU2–Residential Areas** addresses contaminated soil in residential areas.
- **OU3–Eagle-Picher Office Complex–Abandoned Mining Chemicals** addressed a former office and laboratory complex. No further action is necessary in this OU (US EPA, 2018f).
- **OU4–Chat Piles, Other Mine and Mill Waste, and Smelter Waste** addresses the undeveloped rural and urban areas of the site where mine and mill residues and smelter wastes have been placed, deposited, stored, and disposed.
- **OU5–Surface Water and Sediments** addresses contamination in seven watersheds, covering approximately 437 square miles and 119 river miles within Oklahoma, Kansas, Missouri, and eight tribal areas.

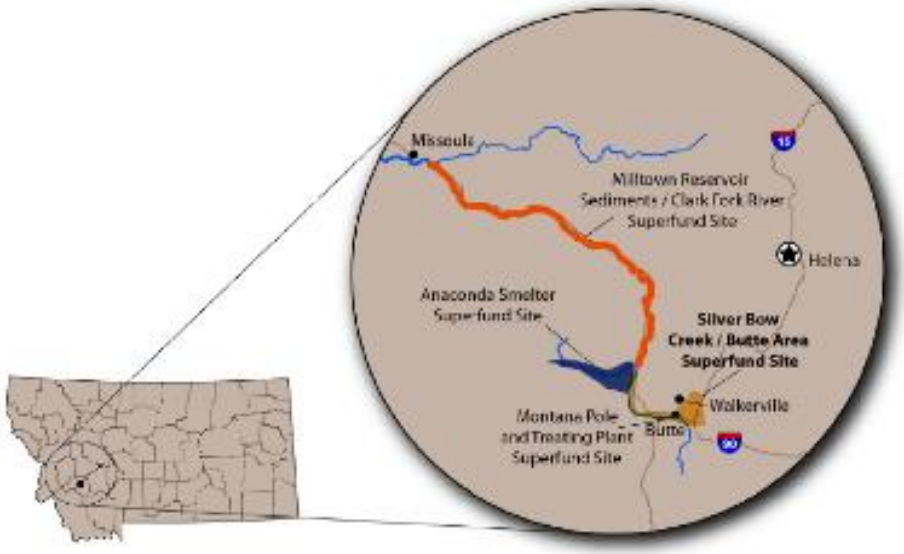
Weathered Chat Pile (ODEQ, 2017).

In FY18, ETSC responded to multiple requests related to the evaluation and use of soil amendments to the "chat" piles of contaminated rock, which have left the countryside bare and unable to support revegetation. ETSC recommended strategic soil amendments (using locally available materials) to remediate transition zone soil that would (1) restore ecosystem services to the new topsoil to reduce metals bioavailability to acceptable levels in transition zone soils; (2) retain and enhance topsoil and its function based on property-specific land use; and (3) limit excavation and disposal of transition zone soil (as a cost-saving measure) to only

those soils that cannot be addressed through amendments, deep mixing, or another on-site or in situ measure. ETSC investigated the pros and cons of soil amendments such as chicken litter and arranged for laboratory analysis of the amendment/sediment mixtures samples for metal speciation.

Silver Bow Creek/Butte Area (Region 8)

The Silver Bow Creek/Butte Area site in Butte, Montana, includes 26 miles of stream and streamside habitat. Wastes from nearby mining activities were dumped into streams and wetlands since the late 1800s, contaminating groundwater and surface water with heavy metals. Silver Bow Creek was listed as a Superfund site in 1983 and the Butte Area was listed in 1987.



The Silver Bow Creek/Butte Area Superfund site in western Montana is part of a larger regional cleanup effort addressing much of the Clark Fork River watershed. The Silver Bow Creek/Butte Area site includes a large portion of Butte and nearby Walkerville.

Over the past three decades, the EPA has removed contaminated soil from waste dumps, residential areas and properties, and railroad beds, rail yards and reclaimed rail yards. A waste dump was capped, and cement channels and sedimentation ponds have been installed throughout Butte to address stormwater contamination. The EPA also removed contamination from stream sides and channels and has been treating local area groundwater (US EPA, 2018g). Removal and cleanup actions have been completed to address immediate threats to human health and the environment in Butte.

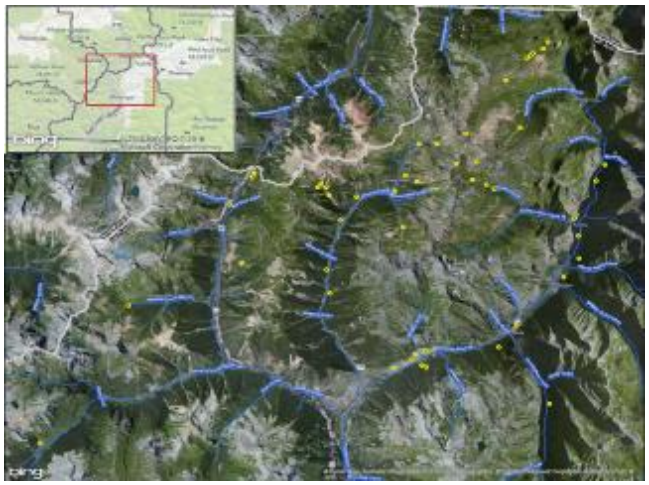
Additional cleanup activities, operation and maintenance, sampling, and monitoring actions are underway. Further actions include (1) removing lead- and arsenic-contaminated soil and attic dust in homes and yards; (2) removing and disposing of contaminated soil, sediment, and tailings from around Butte; (3) managing remaining wastes left in place; (4) installing institutional controls; (5) implementing long-term operation and maintenance; (6) treating contaminated surface and groundwater; and finally (7) performing long-term environmental monitoring (US EPA, 2018g).

In FY18, ETSC reviewed and provided suggestions to improve the Butte Mine Draft Field Sampling Plan for the Butte Mine Flooding OU on behalf of the Montana Resources LLP and Atlantic Richfield Company. The Draft Field Sampling Plan includes an EPA Region 8 QA Document Review Crosswalk form to assist document review, a Sampling and Analysis Plan, and a Quality Assurance Project Plan.

Bonita Peak Mining District (Region 8)

The Bonita Peak Mining District in San Juan County, Colorado, consists of 48 historic mines or mining-related sources that release metals from acid mine drainage into the water and sediments of the Mineral Creek, Cement Creek, and Upper Animas River drainage areas (US EPA, 2018h). Various remedial activities have been performed at the site since 2005. This site is on the EPA Administrator's Emphasis List.

From 2015 to 2016, the EPA Superfund Removal Program installed an engineered concrete bulkhead in the adit of the Red and Bonita Mine, and conducted an investigation and assessment of the Gold King Mine. An interim water treatment plant was installed at the Gold King Mine to treat ongoing acid mine drainage being discharged from the mine as part of an emergency removal action following the 2015 accidental release of 3 million gallons of mine tunnel water (US EPA, 2017 and 2018h).



The Bonita Peak Mining District site consists of 48 historic mines or mining-related sources where ongoing releases of metal-laden water and sediments occur within the Mineral Creek, Cement Creek, and Upper Animas River drainages in San Juan County, Colorado. This figure illustrates the size and complexity of the drainage area from the ridgeline of the mountain peaks (US EPA, 2017).

In 2017, EPA Region 8 requested technical assistance to assess which contaminants to address at the site, to what levels, and associated technological approaches to remediate contamination. ETSC assisted with the development of a remedial decision tree and in the design of the RI/FS. ETSC also provided Region 8 with support to help evaluate various technology vendors and remedial approaches at the site. ETSC compiled a list of technologies that were reviewed for the site along with a description of each technology to assist with knowledge management and later requests for support at this site. In addition, the EPA, U.S. Forest Service, Bureau of Land Mines, and Colorado Department of Public Health and Environment conducted an RI/FS inclusive of a human health risk assessment, ecological risk assessment, and a hydrologic study of the Bonita Peak groundwater system. The results from the collaborative study will support decisions regarding future site cleanup options (US EPA, 2018h).

In 2018, ETSC continued to provide technical support and expertise regarding various innovative remediation technologies for potential applicability at the Bonita Peak Mining District. In particular, ETSC evaluated a type of solidification process with mine water treatment sludge (metal hydroxides), mine tailings, and lime as part of the larger FS for this extensive site. ETSC also supported and evaluated bench-scale work plans, leaching test methods, and test results.

NAPL-contaminated Sites

L.A. Clarke & Son (Region 3)

The 44-acre L.A. Clarke & Son site is in Spotsylvania County, Virginia, approximately 4.5 miles southeast of Fredericksburg. With only a one-year interruption from 1979 to 1980, wood preservation operations occurred at the site from 1937 until 1988. L.A. Clarke and Son, Inc. operated the facility from 1937 until 1980 when the facility was sold to the Curtas family who operated it until it closed in 1988. During operations, railroad ties, telephone poles, and fence posts were preserved at the wood treatment plant through injection of a creosote and coal tar mixture, resulting in contamination of site surface soils and sediment with PAHs and benzene, COCs typical of creosote wood treating. In 1986, the EPA listed the site on the NPL.

In 1988, the EPA issued a Record of Decision to address surface soil contamination and sediments. In 1992, the site was acquired by RF&P and subsequently sold to Commonwealth-Atlantic-Spotsylvania Inc. (CASI) (US EPA, 2018i). CASI entered into an agreement with the EPA to clean up the site and is currently working under the EPA's oversight (US EPA, 2018i).

Assessment and remedial activities have been ongoing since the late 1980s. In 2012, groundwater contamination including dense NAPLs (DNAPLs) was identified on the south side of Massaponax Creek. In 2015, the EPA determined that the human health and ecological risk assessments had to be revised to properly evaluate all site-related contaminants and, furthermore, determined that groundwater monitoring is necessary at a minimum of four times per year. The EPA, in coordination with the Virginia DEQ, is overseeing CASI's investigations and studies leading to cleanup actions. Long-term remedial alternatives include excavation and biological treatment of some contaminated soil and sediment through landfarming, backfilling excavated areas, off-site disposal of contaminated wastewater and associated sludge, and groundwater monitoring.

In 2018, ETSC evaluated DNAPL mobility in site soils and developed a list of technology options for remediation. The ETSC also evaluated both ex situ and in situ treatment methods for minimizing DNAPL migration, including in situ thermal heating methods.

Kerr-McGee Chemical Corp–Navassa (Region 4)

The Kerr-McGee Chemical Corp–Navassa site is in Navassa, North Carolina, near the Brunswick River which discharges to an estuary. The 234-acre site includes the area where Kerr-McGee Chemical Corporation operated a wood-treating plant from 1936 to 1980. The EPA placed the site on the NPL in 2010 because of creosote-contaminated groundwater, soil, and sediment caused by facility operations and wastewater that was disposed of in on-site ponds and discharged into the marsh on the south end of the facility. Creosote is a likely human carcinogen, and the site contamination is impacting groundwater at and near the site; however, a public water line conveys potable water to local residences and businesses.

In 2010, the Kerr-McGee site was added to the NPL because of contamination in groundwater, soil, and sediment resulting from wood-treating activities (Talton, 2018).

Most of the contamination is located within the southwestern portion of the former facility, in the former process area, and in the wetlands south of the former process area. The adjacent property to the north is a former fertilizer plant and boat factory. Residential properties are across North Navassa Road to the west. Sturgeon Creek borders the site to the south. The Brunswick River borders the site to the east (US EPA, 2018j). The site is physically stable and vegetation protects against erosion.

The EPA and the North Carolina DEQ are working with the Greenfield Environmental Multistate Trust LLC (owners of a portion of the site) to investigate the site and plan the cleanup. The RI field investigation is currently complete; the RI Report was finalized in August 2019. The EPA and North Carolina DEQ will propose the cleanup strategy for the former wood storage areas in 2019.

In FY18, ETSC performed an ex situ pilot study using a green and sustainable synergistic mechanism of phytoremediation, rhizoremediation, and bioremediation to remove the COCs. ETSC also evaluated potential remediation technology options as part of the RI.

St. Regis Paper Co. (Region 5)

The St. Regis Paper Co. Superfund site is within the boundaries of the Leech Lake Band of the Ojibwe Indian Reservation in Cass Lake, Minnesota. This site was placed on the NPL in 1984 because of soil and groundwater contamination from wood treatment operations. In FY18, ETSC provided critical reviews of the partition coefficients of PCP and OCDD and the results of modeling of pump-and-treat effluent discharge to improve dioxin removal.

The 125-acre St. Regis Paper Company site is home to a former wood treatment facility that used creosote and PCP and operated from the 1950s to the 1980s. The site is within the boundaries of the Leech Lake Band of the Ojibwe Indian Reservation in Cass Lake, Minnesota. The site's operations included pressure-treating wood with creosote, PCP, and chromated copper arsenate. Wastewater from these processes was discharged into several disposal ponds at the site, and between 1957 and 1960, wastewater and sludges were hauled to a pit within the former Cass Lake city dump and burned. The disposal from the ponds occurred almost daily at an estimated rate of 500 gallons per day for a total of 547,500 gallons over the 3-year period (US DOI, 2019). From 1960 to 1975, unknown quantities of sludge were hauled to the city dump pit.

In 1984, the EPA placed the site on the NPL, and it is now on the EPA Administrator's 2018 Emphasis List of sites requiring immediate, intense action. Remedial activities began in 1986 with guidance from the Minnesota Pollution Control Agency until 1995 when the EPA became the lead agency for the site. Cleanup continues for soil and groundwater contamination.

Much work has been done to control soil contaminated with dioxin since it was first identified in 2000. After a Human Health and Ecological Risk Assessment was completed, several thousand tons of contaminated soil were removed from several site areas and replaced with clean soil or covered or fenced to reduce exposure. Activities to control the spread of dioxin from the contaminated soils included comprehensive cleaning of all area residences, supplemental periodic cleaning of homes, clean soil yard covers, and dust suppression for unpaved roads in 2006. Cleaning of residences and dust suppression will continue until a final remedy for surface soil is completed (US EPA, 2018k).

Groundwater remediation has occurred since 2005, and as of 2016, substantial amounts of PCP and PAHs have been removed from the groundwater (US EPA, 2018k). The 2015 Five-Year Review Report described occasional exceedances of dioxin/furan congeners in the pump-and-treat system discharge effluent. In response, the responsible parties submitted theoretical and modeling information based on partition coefficients of PCP and octachlorodibenzodioxin (OCDD). Contrary to model predictions that PCP would break through at effluent limits years sooner than OCDD, occasional incidents of early OCDD breakthrough have been observed.

In 2018, ETSC responded to a request to review the partition coefficient and modeling results for PCP and dioxin, evaluate how the results could be extrapolated to other dioxin/furan congeners, and identify viable measures to improve dioxin removal from the effluent of the pump-and-treat system.

Des Moines TCE (Region 7)

The 200-acre Des Moines TCE Superfund site, located in south-central Des Moines, Iowa, on the east side of the Raccoon River, is also on the EPA Administrator's 2018 Emphasis List. Today, the site contains empty warehouses, but for approximately 40 years, Dico, Inc. owned and operated steel wheel manufacturing and chemical and pesticide formulation facilities there. Operations resulted in the release of trichloroethylene (TCE), 1,2-dichloroethene, and vinyl chloride to the groundwater; residual pesticides and metals to shallow soils; and pesticides to buildings and soils on the southern end of the site and drainage areas (US EPA, 2018l). From the mid-1950s through the early 1970s, pesticide and herbicide formulation operations were conducted on-site, and chemicals were stored in several buildings.

Empty buildings on the Dico property (top) and a section of Raccoon River along the Dico property border (bottom) (EPA Region 7, 2007).

EPA placed the site on the NPL in 1983 and established four OUs:

- **OU1** addresses the groundwater TCE plume on the Dico property.
- **OU2** originated as source soils associated with TCE groundwater contamination but later focused on residual pesticides and metals in shallow soils.
- **OU3** is the source area of trichloroethylene groundwater contamination north of the Dico property.
- **OU4** addresses pesticides in buildings and soil on the southern end of the Dico property and in drainage areas of the Dico property.

A groundwater extraction and treatment system was first installed in 1987 to treat contaminated groundwater and contain the contamination to protect the nearby public water supply system. The EPA is working with stakeholders to conduct an optimization study to assess whether changes to the existing pump-and-treat system are warranted or if a different remedy may be more effective (US EPA, 2018l).

To prevent human contact with contaminated soils and building materials, Dico initially cleaned and encapsulated contaminated buildings and covered much of the property with an asphalt cap to reduce migration of surface soils and COCs. The EPA is now evaluating how to address the deteriorating contaminated buildings (US EPA, 2018l).

In 2018, ETSC provided assistance in evaluating remediation options and associated testing methods for a stormwater drainage lake and the identification of non-removal, in situ remediation technologies.

PFAS-Contaminated Sites

Naval Air Engineering Station at the Joint Base McGuire-Dix at Lakehurst, New Jersey (Region 2)

The 7,382-acre Naval Air Engineering Station–Lakehurst site is part of the Joint Base McGuire-Dix (JBMD) Lakehurst and is located in Lakehurst, New Jersey. The site has been used since the 1920s for research, maintenance, firefighter training, testing, and disposal activities by the U.S. Navy. The size of the Lakehurst facility and its operations have changed over the years; however, its major function has remained the development and testing of fleet support systems (US EPA, 2018m).

Laboratory analyses of samples at JBMD-Lakehurst (JBMD-Lakehurst, 2017).

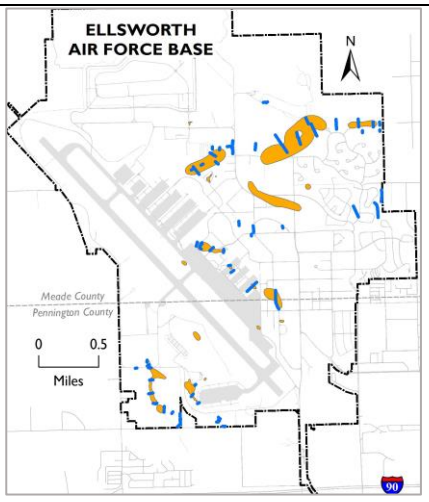
The Navy identified 44 potentially contaminated areas at the site in the 1980s, including landfills, open pits, unlined lagoons, and drainage ditches. RIs of most contaminated areas were conducted by the early 1990s, and long-term remedies were implemented. In 2016, perfluorooctanoic acid and perfluorooctane sulfonate were identified throughout the Lakehurst site. These two chemicals have been detected off-site as well; however, they were not detected in the main public drinking water systems. The chemicals are components of a type of fire-fighting foam used by the Air Force since 1970 to extinguish petroleum fires (US EPA, 2018m).

The ETSC support team evaluated a solidification/stabilization treatability study to represent an in situ solidification/stabilization (ISS) field process, where the effects of sorbents and cement as a solidification binder are being evaluated for reducing leaching of chemicals from site soils to groundwater and surface water.

Ellsworth Air Force Base (Region 8)

Ellsworth Air Force Base (EAFB) is a 4,858-acre U.S. Air Force Air Combat Command base situated six miles east of Rapid City, South Dakota (US EPA, 2018n). EAFB began operating in 1942, and the site includes petroleum storage tanks, landfills, fire-training areas, explosive ordnance disposal areas, and radioactive waste sites. Military activities have contaminated soil, sediment, surface water, and groundwater primarily with petroleum products and waste solvents on the base and on adjacent private land. The EPA placed the site on the NPL in 1990 (SD DENR, 2018).

The EPA established 12 OUs, including landfills, a fire protection training area, spill sites, industrial areas, and an explosive ordnance disposal area. Remedies have been selected and are being implemented at all OUs (US EPA, 2018n). The Air Force is performing all cleanup



In situ reductive treatment walls (in blue) and 2016 groundwater contamination plumes (in gold) at EAFB (EAFB, 2017).

activities with the EPA and South Dakota providing regulatory oversight. Long-term remedies include groundwater pump-and-treat systems, which were replaced by in-place reductive treatment systems beginning in 2007, and bio-dechlorination, landfill covers, soil treatment systems, excavation activities, natural attenuation, and institutional controls.

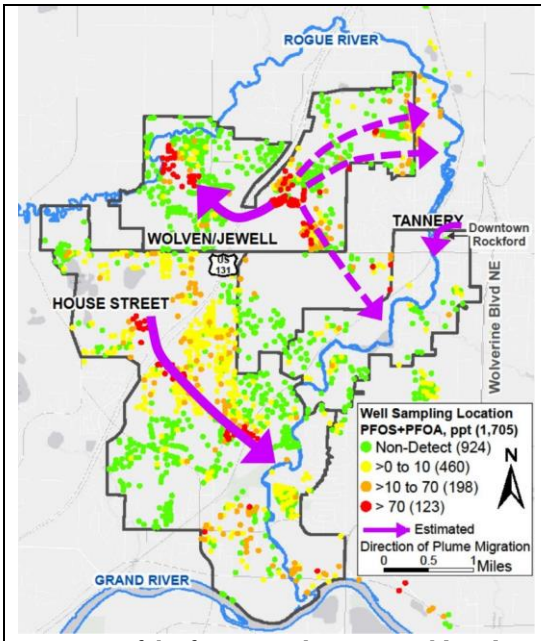
Base water supply wells were abandoned for off-base residents. Those on the east side are serviced by a water supply line from the city of Box Elder. Further cleanup for the groundwater is warranted, and the 2015 draft Five-Year Review identified four on-base areas that need further investigation to determine whether new OUs need to be established or if they belong in an existing OU. These areas include munitions, vapor intrusion, perfluorocarbons (PFCs) from multiple potential sources, and buried concrete monoliths near OU 2 (US EPA, 2018n).

In 2018, the ETSC support team evaluated a solidification/stabilization treatability study to represent an ISS field process, where the effects of sorbents and cement as a solidification binder are being evaluated for reducing soils leaching to groundwater and surface water.

Wolverine (Region 5)

The Wolverine World Wide site consists of two facilities in Kent County, Michigan—an inactive tannery facility at the northern end of downtown Rockford and a former disposal facility on House Street in Belmont. Wolverine conducted leather tanning activities for shoe production from the late 1800s until 2009. In the late 1950s, leather waterproofing with Scotchgard®, a product that then contained high levels of several PFAS compounds (US EPA, 2018o), was performed. Only one tannery structure remains on the site; all other structures were demolished in 2011.

In 2017, investigations identified groundwater contaminated with PFAS, heavy metals, VOCs, and semivolatile organic compounds at the tannery site. A waste dump known as the House Street Disposal Area in Belmont has also been identified as a contamination source. This dump was used exclusively by Wolverine for waste disposal of lime-sludge waste from tanning treatments and lime slurry waste disposal in trenches dug across the property. The waste dump area also contained seepage pits, which were used for disposing of lime liquor and other liquid waste. The third potential source of contamination is the Wolven/Jewell source area, where Wolverine may have used an old gravel mining operation site to dispose of tanning process waste (US EPA, 2018o). Nearby residents are being supplied with water filters and bottled water.



Location of the former Wolverine World Wide tannery, House Street Disposal Area, and the Wolven/Jewell source in Michigan. Groundwater is contaminated with PFAS, with the extent of contamination shown as non-detect (green) to high (red) (US EPA, 2018o).

The Michigan DEQ is the lead agency investigating the PFAS contamination in ground-, surface, and drinking water. The EPA is directing the investigation of other contamination that may be associated with Wolverine's former tannery

and the House Street Disposal Area. In 2018, Wolverine was ordered by the EPA to perform soil, sediment, soil gas, surface water, and groundwater sampling, and monitoring wells were installed to delineate the extent of the plumes. The Wolven/Jewell area was not included in the EPA's order because it is currently being investigated by DEQ.

The plumes are up to 200 feet deep at both the House Street Disposal site and the Wolven/Jewell source area. Both sites are located on high ground, and the groundwater plumes flow in multiple directions toward the Rogue River, making for a highly complex site investigation. As next steps, the EPA will analyze investigation and sampling results and determine appropriate cleanup actions for the PFAS-contaminated groundwater plumes.

In 2018, ETSC provided support, including research of PFAS and guidance for analytical approaches. ETSC also began work on delineating groundwater impacts downgradient of the two site areas, collecting groundwater samples at an impacted former fire-training area for PFAS analysis, and evaluating PFAS analytical methods (US EPA, 2018o).

SAMPLING ASSISTANCE & ANALYSIS

A well-designed sampling plan is critical to properly characterize, assess, and monitor contaminated sites. ETSC staff help design and review sampling plans to ensure the collected data are representative and sufficient to make evidence-based decisions. ETSC also assists with selecting field methods and procedures and analyzing sampling results.

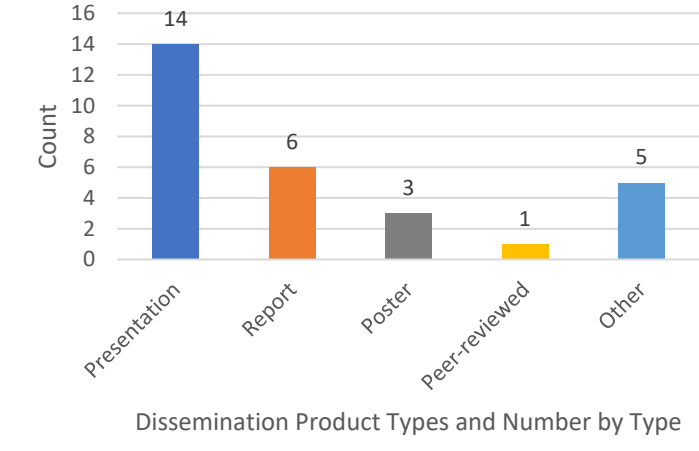
In FY18, ETSC fielded more than 14 requests related to sampling assistance and analysis for a variety of sites covering soil, surface water, and groundwater:

Landfills	• Deschutes Landfill, Oregon, Region 10 (2 requests) • Forest Waste Site, Michigan, Region 5
Mining Sites	• Carpenter's Creek/Barker/Danny T, Montana, Region 8 • Coeur d'Alene, Idaho, Region 10
Industrial Sites	• Central Chemical, Maryland, Region 3 • DuPont Pompton Lakes, New Jersey, Region 2 • San Jacinto, Texas, Region 6
Military Bases	• DFSP Melville Newport Naval Station, Rhode Island, Region 1 • Fort Devens, Massachusetts, Region 1 • Wurtsmith Air Force Base, Michigan, Region 5
Other	• Lake Michigan, Michigan, Region 5 – natural area • Los Alamos National Laboratory, New Mexico, Region 9 – other • Brownfields Site, Oregon, Region 10 – other (subsurface heating event)

Dissemination and Knowledge Sharing

ETSC shares the results of its work in a variety of formats to broaden its reach. In FY18, 29 scientific communication products in collaboration with various researchers were produced, many of which are listed below.

- Select general reports:
    - Evaluating the Protectiveness of Texas Site-Specific Dissolved Oxygen Criteria for Oso Bay and Laguna Madre in Corpus Christi, TX
    - Analysis of Temperature, Gas Quality and Settlement Trends at the Bridgeton Sanitary Landfill in 2016
- Peer-reviewed journal article: Darlington, R., Barth, E., and McKernan, J. 2018. The Challenges of PFAS Remediation. Mil Eng. 110(712): 58–60. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5954436/.
- Presentations and posters:
    - Sustainable and Healthy Communities Project 3.61: Contaminated Sites and Task 2 – Contaminated Groundwater Research
    - Sustainable and Healthy Communities Project 3.61: Contaminated Sites
    - Contaminated Groundwater Research and Technical Support at the US EPA's Groundwater, Watershed, and Ecosystem Restoration Division, Ada, OK, USA
    - ORD's Contaminated Sites Research and Technical Support Program
    - Developing Solutions for Environmental Decision Making
    - HHRA Science Assessment Translation and Support
    - ORD Technical Support Centers Presentation
    - SCMTSC: Assessing Environmental and Human Health Exposures Through Technical Support
    - ORD Engineering Technical Support at the West Lake Landfill Superfund Site, EPA Region 7, St. Louis, MO
    - ORD Engineering Technical Support Center (ETSC): RARPM Training Meeting 2018
    - Using Models to Assist with Clean-up Decisions at Contaminated Sites
    - EPA ORD Research to Support Site Characterization and Remediation/Treatment
    - Water Treatment and Infrastructure Research
    - SCMTSC Case Study Webinar



  - Aquifer Storage & Recovery: ORD Pilot Study
  - Risk Reduction Strategies for Dioxin in Soils
  - ORD Superfund and Technology Liaison (STL) Program Presentation
- Other: Scientific and Technical Advisory Committee Peer Review of Revised James River Chlorophyll-a Criteria and Assessment

EIPs are prepared when knowledge gaps on a technical subject are identified. EIPs provide a state-of-the-science review of technologies available for contaminated site cleanup. Once finalized, EIPs are used to support office, Remedial Project Manager, OSC, or EPA Regional decisions. ETSC conducts an extensive literature review on the current understanding of the theory, design, and implementation of various remedial or treatment technologies that form the basis of the EIPs. Leading engineers and scientists inside the EPA, federal government, academia, or contracting community may also be consulted for input.

KEY RESEARCH PRODUCTS FROM FY18

Key disseminated products from FY18 include the following:

- **Soil Vapor Extraction (SVE) Technology—**ETSC finalized and published an EIP summarizing the state of the science regarding the widespread use of SVE as a major treatment technology for removing VOCs from soil. SVE can be applied alone or as an integral component of more complex remedial technologies that volatilize subsurface contaminants (e.g., thermal remediation, air sparging). This EIP also provides information describing SVE and its applicability and limitations; site characterization; design and construction; performance monitoring, evaluation, optimization, and shutdown; complementary technologies; costs; case studies; and references for further information. https://cfpub.epa.gov/si/si_public_record_Report.cfm?dirEntryId=345171&Lab=NRMRL
- **Assessment of Sediment Cleanup Level for Dioxin Based on a Two-Carbon Partitioning Model—**ETSC drafted a journal article on the use of a two-compartment partitioning model for a site containing dioxin-contaminated sediment, using pore water as the water quality criterion.
- **Evaluation of In-situ Solidification/Stabilization (ISS) of PFAS-contaminated Soils—**ETSC drafted a report on evaluating the effectiveness of various sorbents to stabilize two different PFAS-contaminated soils, then mixing such soils with cement to decrease the hydraulic conductivity of the contaminated soils to minimize further PFAS leaching. Pre- and postleaching analyses were performed to measure whether cement further reduced leachability.

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