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Engineering Technical Support Center

Annual Report Fiscal Year 2015






Office of Research and Development
National Risk Management Research Laboratory

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by

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Office of Research and Development
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Notice/Disclaimer Statement

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

This document received Office of Research and Development (ORD) internal peer review preceding the institutional clearance process.

Disclaimer: Mention of company trade names or products does not constitute endorsement by the U.S. Environmental Protection Agency and are provided as general information only.

Abstract

The United States Environmental Protection Agency (EPA or Agency) Office of Research and Development (ORD) created the Engineering Technical Support Center (ETSC) in 1987, one of several technical support centers created as part of the Technical Support Project (TSP). ETSC provides engineering expertise to Agency program and regional offices and remediation teams working at contaminated sites across the country. The ETSC is operated within ORD's Land Remediation and Pollution Control Division (LRPCD) of the National Risk Management Research Laboratory (NRMRL) in Cincinnati, Ohio.

The ETSC's mission is to provide site-specific scientific and engineering technical support to Remedial Project Managers, On-Scene Coordinators, and other remediation personnel at contaminated sites. This allows local, regional, or national authorities to work more quickly, efficiently, and cost effectively, while also increasing the technical experience of the remediation team. Since its inception, the ETSC has supported countless projects across all EPA Regions in almost all states and territories.

This report highlights significant projects the ETSC supported in fiscal year 2015 (FY15). These projects addressed an array of environmental scenarios, such as remote mining contamination, expansive landfill waste, cumulative impacts from multiple contamination sources, and persistent threats from abandoned industrial sites. Constructing and testing new and innovative treatment technologies through pilot and field research is a major component of meaningful remediation. The ETSC conducts such pilot and field research. For example, ETSC teams spearhead field projects on the cutting edge of remediation research in the areas of bioremediation and groundwater treatment, active sediment capping, in-situ stabilization, and sustainable site cleanup. The ETSC organizes and reports on significant developments in environmental engineering in the form of Engineering Issue Papers (EIPs) and peer-reviewed journal publications. The ETSC has also undertaken newer initiatives that integrate sustainability into community and land use plans.

While ETSC's central focus is to bolster technical expertise for site-specific remediation at contaminated sites, ETSC teams are reaching out to support other efforts in pollution prevention, thereby reducing the Agency's burden from legacy sites in the future.

NRMRL/LRPCD and the ETSC have continually evolved to meet the demand, as well as scientific and engineering needs, of the EPA program offices and regional clients.

Foreword

Congress charges the EPA with protecting the nation's land, air, and water resources. Under a mandate of several national environmental laws, the Agency formulates and implements actions that balance human activities and the ability of natural systems to support and nurture life. To meet this mandate, EPA's research program provides data and technical support to solve current environmental problems while building a science knowledge base necessary to manage our ecological resources, understand how pollutants affect our health, and prevent or reduce environmental risks in the future.

The NRMRL within ORD is the Agency's center for investigating technological and management approaches to prevent and reduce risks from pollution that threatens human health and the environment. The focus of our research is on methods that cost effectively prevent and control pollution to air, land, water, and subsurface resources; protect water quality in public water systems; remediate contaminated soils, sediments and groundwater; prevent and control indoor air pollution; and restore damaged ecosystems. We collaborate with both public and private sector partners to anticipate emerging problems and to foster technologies that reduce the cost of compliance. Our research provides solutions to environmental problems by developing and promoting innovative technologies; advancing scientific and engineering information to support regulatory and policy decisions; and providing the technical support and information transfer to help implement environmental regulations and strategies at the national, state, and community levels.

This report highlights the activities and accomplishments of the ETSC in fiscal year 2015.

Cynthia Sonich-Mullin, Director

National Risk Management and Research Laboratory

Acknowledgements

The ETSC would like to acknowledge the contributions from ORD scientists for supporting ETSC's mission. We extend thanks to our numerous partners in the Office of Science Policy, Office of Land and Emergency Management, Office of Superfund Remediation and Technology Innovation, the EPA Regions (particularly Region 5), the Superfund Technology Liaisons, On-Scene Coordinators. We also thank the management of these partners for their patronage and financial support. The ETSC also recognizes the exemplary support provided by our contractors, Battelle Memorial Institute and RTI International. Finally, the ETSC extends special thanks to everyone that provides document reviews, responds to technical request phone calls, and provides all other manner of assistance.

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List of Acronyms

3PE	3 Point Estimator
As	arsenic
CO_2	carbon dioxide
COC	contaminants of concern
DMA	dimethylarsinic acid
DTS	distributed temperature systems
DTSC	Department of Toxic Substances Control
EIP	Engineering Issue Paper
ERASC	Ecological Risk Assessment Support Center
ET	evapotranspiration
ETSC	Engineering Technology Support Center
ETV	Engineering Technology Verification
FY	fiscal year
GWTSC	Groundwater Technical Support Center
IRODA	interim record of decision amendment
LRPCD	Land Remediation and Pollution Control Division
MOST	Ministry of Science and Technology
NERL	National Exposure Research Libraries
NPL	National Priorities List
NRMRL	National Risk Management Research Laboratory
OITA	Office of International and Tribal Affairs
ORD	Office of Research and Development
OSC	On-Scene Coordinator
OU	operable unit
P4	elemental phosphorus
PCBs	polychlorinated biphenyl
PFC	perfluorocarbon
PRP	potentially responsible party
RCRA	Resource Conservation and Recovery Act
ROD	record of decision
RPM	Remedial Project Manager
SCMTSC	Site Characterization and Monitoring Technical Support Center
SHC	Safe and Healthy Communities
S/S	solidification/stabilization
STARS	Site Technical Assistance Reporting System
STL	Superfund Technology Liaisons
STSC	Superfund Health Risk Assessment Technical Support Center
SWAT	Soil and Water Assessment Tool
TSC	Technical Support Center
TSMD	Tri-State Mining District
TSP	Technical Support Project
VOC	volatile organic compound

1 Introduction

The LRPCD in NRMRL operates the ETSC in Cincinnati, Ohio. Created in 1987, ETSC is part of the TSP, a partnership between ORD and the Office of Land and Emergency Management (formerly the Office of Solid Waste and Emergency Response). The TSP consists of a network of Regional Forums, the Environmental Response Team, and specialized Technical Support Centers (TSCs) that have evolved over time as the Agency's needs have changed. There are currently five active TSCs in the TSP:

- ETSC in Cincinnati, Ohio
- Groundwater Technical Support Center (GWTSC) in Ada, Oklahoma
- Site Characterization and Monitoring Technical Support Center (SCMTSC) in Atlanta, Georgia
- Superfund Health Risk Assessment Technical Support Center (STSC) in Cincinnati, Ohio
- Ecological Risk Assessment Support Center (ERASC) in Cincinnati, Ohio.

Each TSC has a specific focus of expertise and has access to engineers and scientists that are eager to assist on the most difficult matters encountered at contaminated sites. ETSC provides scientific and engineering knowledge and expertise in remediation and technologies for soil, surface waters, sediment, and mine-related contamination issues to program offices and regional clients to help with risk-management decisions. The ETSC provides site-specific assistance, technical support, and targeted research for EPA Regions and program offices. The ETSC also collaborates with international governments to build capacity and share lessons learned in the greater effort of moving towards safe and healthy communities.

The Center 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. Some examples of support provided across EPA Regions include developing, evaluating, and demonstrating bioremediation and groundwater treatment technologies; evaluating capping and beneficial waste reuse technologies; providing engineering review and design assistance; recommending proven, viable technologies; conducting focused research on the sustainability of selected site remedies; and providing on-call technical assistance. In the past several years, ETSC staff have assisted in Superfund Five-year reviews and technology optimization studies, and have completed applied research projects that support research for technical assistance requests.

The ETSC primarily accesses scientists and engineers from ORD/NRMRL/LRPCD. Additional assistance is provided by other ORD Laboratory or Division personnel, Regional personnel, and external contractors and consultants. In FY15, ETSC responded to approximately 357 requests at over 140 contaminated sites in all 10 EPA Regions. Eighty-three percent of the Superfund site technical support requests were National Priority List (NPL) sites.

This report provides an overview of how the ETSC provides technical support, a small selection of its written outputs, a select list of high impact technical support projects, and a visual breakdown of technical support provided in FY15.

2 Receiving Technical Support for Contaminated Sites

ETSC typically addresses technical support requests through the process presented in **Figure 1**. The process typically begins with a problem encountered at a contaminated site. A Remedial Project Manager (RPM), On-Scene Coordinator (OSC), or other decision maker associated with the contaminated site, contacts ETSC through their Regional ORD liaison, or will directly contact the ETSC Director. ETSC logs the request into the ETSC Site Technical Assistance Reporting System (STARS) database and simultaneously consults an EPA subject matter expert. Once ETSC identifies an EPA expert, that expert services the request through three general channels of action: research, identification of a new or existing technology, or the identification of a knowledge gap. Once the expert determines the site needs, he or she undertakes the appropriate actions as indicated in the flow chart to address the contaminated site's needs. The subject matter expert then develops the deliverables related to the request, which are sent to the client and the ETSC Director when completed. If the request is of a sensitive nature, needs peer review, or requires a policy review by the Agency, the ETSC Director receives the product for review before delivery to the client. The feedback arrows between the RPM, OSC, and Superfund Technology Liaisons (STL) and the ETSC Director signify the timeliness and quality of the technical assistance to help the Center evaluate and provide better service to its clients.

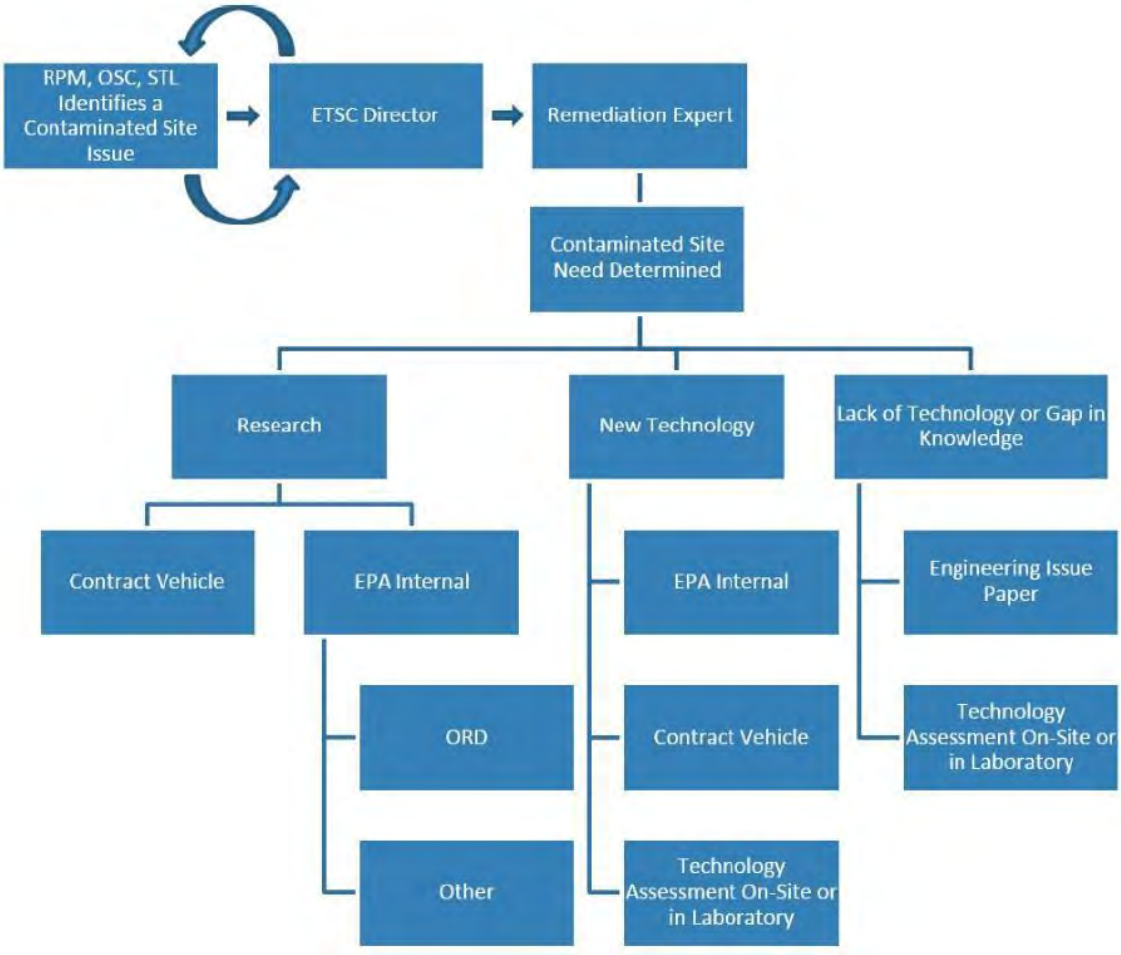

Figure 1. Engineering Technical Support Request Flow Chart

In FY14, ETSC began piloting the TSC's SharePoint site to log in, assign, and track technical support requests for ETSC, GWTSC, and SCMTSC. The pilot period is designed as a tiered process. Initially, ETSC will import into SharePoint technical support requests from the STARS database from past years. Secondly, ETSC will post a request form so RPM's, OSC's and STL's can submit requests directly to the SharePoint site. After a client submits the form to the SharePoint site, ETSC will follow a similar process to that shown in Figure 1. The TSC SharePoint site pilot will continue through FY16. At the end of FY 16, ETSC will evaluate the SharePoint site for efficacy, and continue it in pilot form or finalize the site and make it fully functional.

3 National and Global Impacts of the ETSC

In FY15, ETSC received 357 technical support requests across all 10 Regions and internationally. The technical support requests vary greatly. Approximately 45 percent were expert reviews of feasibility studies, remedy selection, technology reviews, technical document reviews, and the preparation of EIPs. Most other requests involved the application of site-specific technologies; use of development of decision support tools; modeling activities; and analytical support (see **Figure 2**). Approximately 39 percent (145) of support requests fulfilled Superfund-related issues. Most of the Superfund requests (83 percent) were for NPL sites. The ETSC also serviced 11 Resource Conservation and Recovery Act (RCRA) sites and 2 international requests (for the China Ministry of Science and Technology [MOST] project and a site visit to the Rio Tinto Iron and Titanium facility in Québec). The majority of requests originated from Region 5.

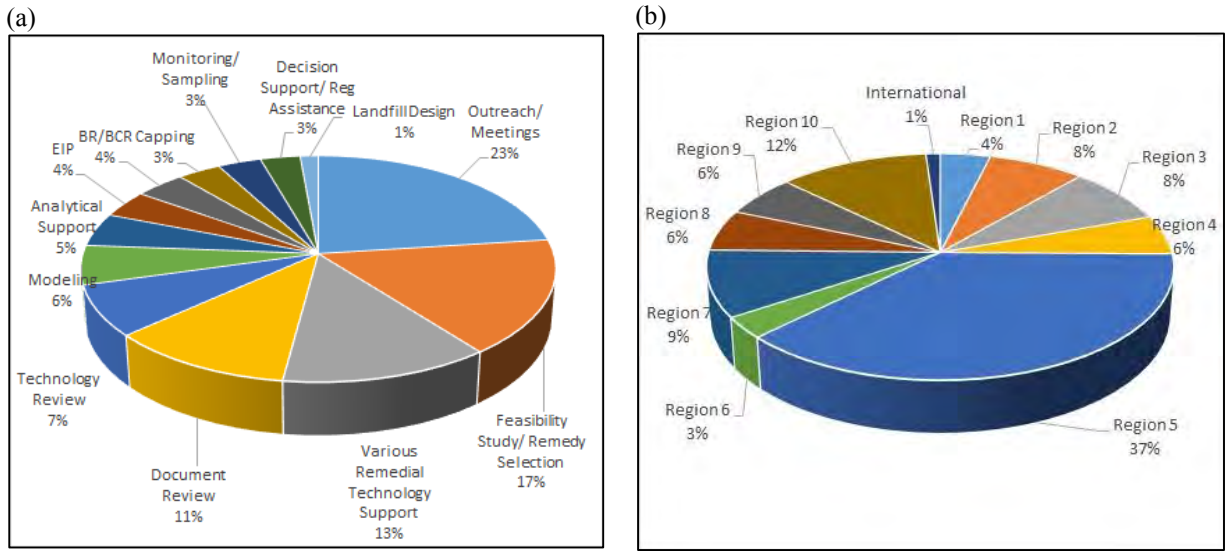

Figure 2. ETSC technical support requests by project category (a) and Region (b) in FY15

Figure Notes: BR/BCR = bioreactor/biochemical reactor; EIP = Engineering Issue Paper.
The category of Various Remedial Technology Support combines numerous technologies that consist of less than 5 percent of the total project requests (e.g., in-situ stabilization, soil vapor intrusion, soil vapor extraction). Outreach and meetings are included in Figure 2b.

Word clouds presented in **Figure 3** highlight the technologies (Figure 3a) that were used or investigated in the technical support requests in FY15 in addition to the contaminants of concern (COCs) the

technologies were intended to address (Figure 3b). The word cloud presented in Figure 3a shows more specificity on technologies addressed compared to Figure 2a. The most frequent types of technical support requests in FY15 were for modeling support and document reviews. The requests most often related to metal, volatile organic compounds (VOC), or polychlorinated biphenyl (PCB) contamination.

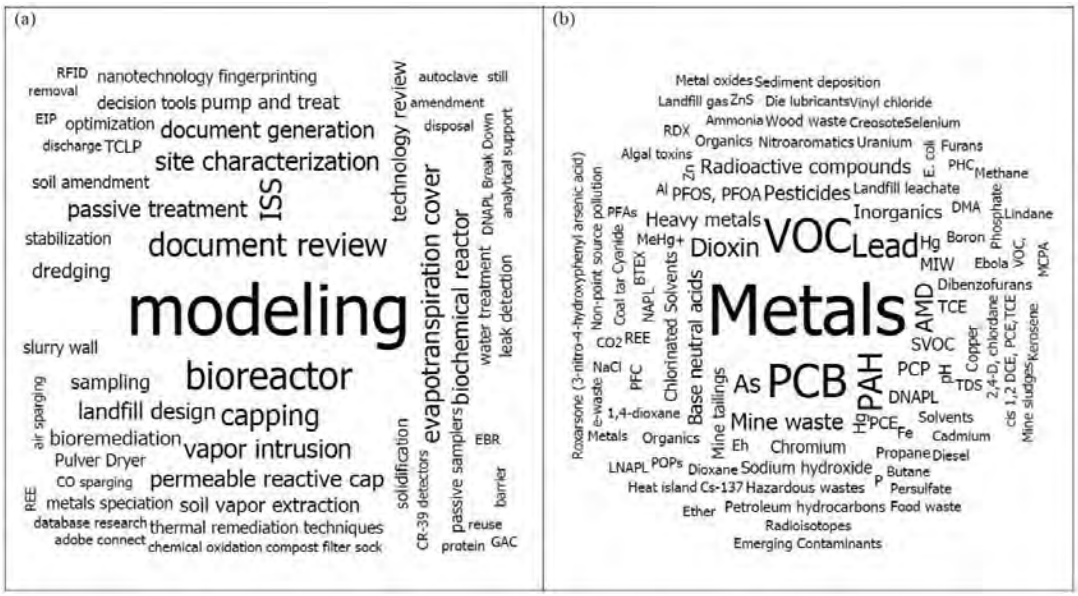

Figure 3. The technologies most used to address technical support requests in fiscal year 2015 and the COCs the technical support requests considered

Figure 4 spatially portrays the sites that the technical support requests were for. Both sites listed on the NPL and those not listed on the NPL are presented.

Figure 4. Location of sites where ETSC provided assistance in fiscal year 2015
Note: NPL = National Priority List.

4 Engineering Issue Papers

ETSC prepares EIPs when there are knowledge gaps on a technical subject. EIPs provide a state-of-the-science review of technologies available for contaminated site cleanup. Once finalized, EIPs are used to support office, RPM, OSC, or 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 forms the basis of the EIPs. ETSC may also seek input from leading engineers and scientists inside the Agency, federal government community, academia, or the contracting community.

ETSC initiated or completed six EIPs in FY15. Three of the EIPs completed in FY15 are relevant to technical support requests addressed in the past fiscal year:

- Passive Samplers for Investigations of Air Quality: Method Description, Implementation, and Comparison to Alternative Sampling Methods (Grosse and McKernan, 2014)
    - Compares passive sampling techniques and devices to active sampling techniques and devices. Presents the basic theory of how passive sampling devices work. Discusses designing and implementing a passive sampling program. Covers data quality objectives and interpreting passive sampling results.
    - The key takeaways are that passive samplers are comparable in accuracy and precision to conventional methods such as evacuated canister samples or pumped sorbent tube samples. The adsorption rate, or 'sampling rate', is the most critical variable for accurately determining air concentrations using passive samplers.
- Biotransformation Pathways of Dimethylarsinic (Cacodylic) Acid in the Environment (McKernan, 2014)
    - Provides an overview of the chemical properties, toxicity, biotransformation, and fate and transport in the environment of dimethylarsenic acid (or DMA(V)).
    - The key takeaways are that maintaining an oxic environment may aid in reducing transport of arsenic. However, under anoxic conditions, DMA(V) is demethylated to inorganic arsenic and both inorganic As(V) and As(III) can be produced. Trivalent arsenic species (both organic and inorganic) are generally more toxic and more mobile than the pentavalent arsenic species (both organic and inorganic).
- Challenges in Bulk Soil Sampling and Analysis for Vapor Intrusion Screening of Soil (Grosse et al., 2015).
    - Discusses using bulk soil samples to assess vapor intrusion risks from soil containing VOCs.
    - Analyses show that while bulk soil sampling and analysis may help delineate and determine the gross mass of contamination present in a source area, they cannot adequately assess potential vapor intrusion exposures for most VOCs in undisturbed soil or in soil remaining after excavation. To address this information gap, ETSC provides alternatives for monitoring soil VOCs and for enhancing remedies where soil excavation is necessary to address VOC-contaminated soils.

Three other EIPs initiated in FY15 are relevant to the projects highlighted in this report:

- Perfluorocarbon (PFC) in Region 4 (being developed in collaboration with the Engineering Forum)
- Soil vapor extraction and vapor intrusion, and
- Bioremediation techniques for dioxin.

5 Lessons Learned Research Summary for Fiscal Year 2014

EPA's TSCs, included in ORD's Sustainable and Healthy Communities (SHC) Research Action Plan, fill the need for supplying subject matter experts to continually assess state-of-the-science research and practices, and channeling this information to users in both direct applications (i.e., site-specific technical support) and general applications (i.e., technical transfer activities such as technical guidance documents, conferences, or workshops). The user community for the TSCs is large and diverse. Their needs range from basic explanations and demonstrations of concepts, tools, and approaches for characterization, remedy implementation, and monitoring, to highly complex analyses and model development for guiding remediation of heterogeneous sites and complex contaminant distributions.

As an example of the variety of technical support requests, the *EPA Technical Support Centers: FY14 Lessons Learned* document (Burden et al., 2015) presents six case studies, two from each of the three TSCs—GWTSC, ETSC, and SCTSC—to illustrate the variety of TSC approaches. This research summary is one of the few documents that groups the three TSCs together and in addition to summarizing the type of support provided, may also introduce those in need of support to new concepts and products. The document highlights the following case studies:

- The GWTSC summarizes issues related to analyzing binary mixtures of groundwater samples after in situ chemical oxidation treatment, that lead to the publishing of *Groundwater Sample Preservation at In-Situ Chemical Oxidation Sites – Recommended Guidelines* (EPA/600/R-12/049).
- GWTSC also presented a groundwater flow spreadsheet tool, 3 Point Estimator (3PE). This tool provides a simple and quick method to calculate groundwater flow directions and velocities. groundwater
- ETSC highlighted two EIPs: One on DMA (McKernan, 2014) and the other on passive samplers for vapor intrusion (Grosse and McKernan, 2014). The key points of these EIPs are provided in Section 4 of this report.
- The SCMTSC presented an overview of the ProUCL software, a user friendly and free statistical software model for data analysis to support site remediation decision making.
- SCMTSC also discussed their investigation of Distributed Temperature Systems (DTS), which has potential for surveying and monitoring relatively large areas of a streambed or lake bed to determine when and where groundwater contaminants are transferred from groundwater to surface water.

6 Selected Fiscal Year 2015 Technical Support Projects

In FY15, the ETSC received 357 technical support requests from over 140 contaminated sites across the United States. With so many requests, not all of them can be highlighted in this report. The projects

presented are organized by three categories of support: mining, landfill remediation, and materials management.

6.1 ETSC Support at Mining Sites

6.1.1 Tri-State Mining District (Region 7)

ETSC provided technical support on the Tar Creek Site in the Oklahoma region of the Tri-State Mining District (TSMD). The TSMD consists of several distinct sites covering 1.6 million acres (2,500 square miles) within Kansas, Missouri and Oklahoma as shown in **Figure 5**. Historic operations in the TSMD included a lead smelter in Galena, Kansas; a zinc smelter in Henryetta, Oklahoma; and a central mill in Picher, Oklahoma. Processing activities began in the area in the 1850s and from the early 1900s to the 1970s, the northeastern region of Oklahoma was also extensively mined for lead and zinc ore (U.S. DOI NRDAR Program, 2016; Isabella Indian Reservation, no date). These mining, milling, and smelting activities generated large quantities of mining and milling wastes (referred to in the region as 'chat') that were disposed of in above-ground piles, or in flotation or tailing ponds. Some of the chat piles are up to 200 feet tall and cover several acres. **Figure 6** shows a large chat pile at TSMD.

Metals (lead, cadmium, zinc) and acid mine drainage have contaminated soils, surface water, groundwater, and biota in the 2,500-square mile site. Two major rivers, the Spring River and Neosho

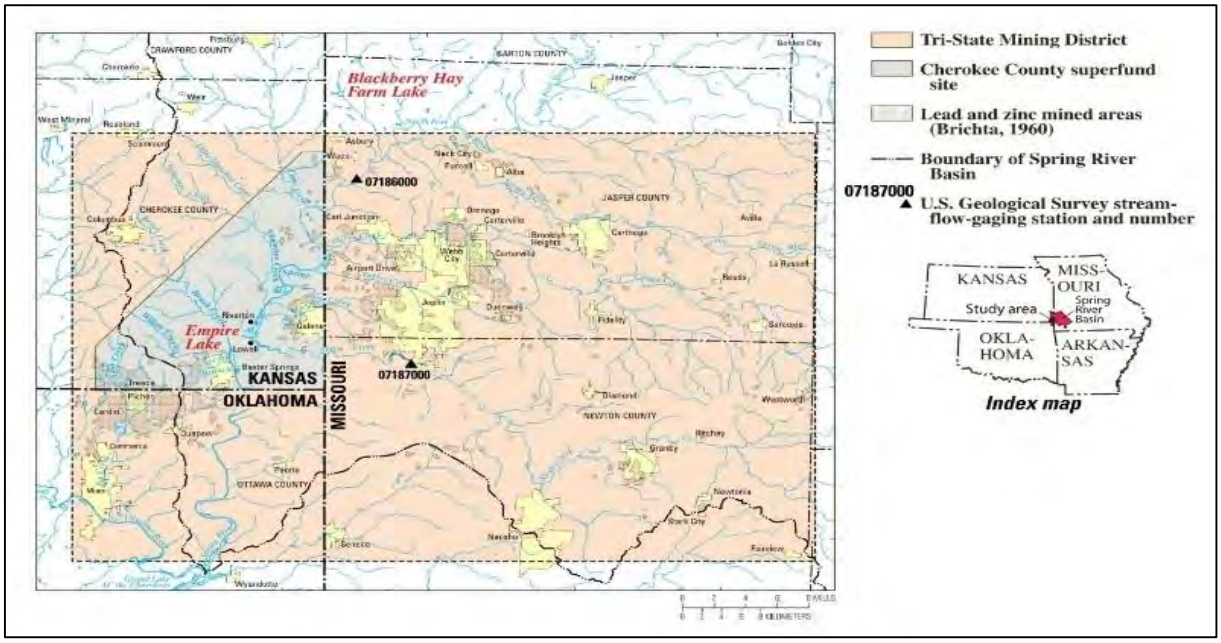

Figure 5. Location of the Tri-State Mining District
(USGS, 2015)

River, and their watersheds combine to form the Grand River, which drains the entire TSMD into Empire Lake and the Grand Lake O' the Cherokees. The releases from the mine waste tailings, and acid mine drainage, are a source of human, ecological, and environmental exposure that have impacted the natural resources of eight separate Indian and Tribal allotted resources, including federally listed threatened and endangered species, migratory birds, fish, and other treaty protected biota (U.S. DOI NRDAR Program, 2016).

The Oklahoma region of TSMD is the Tar Creek Superfund Site, which EPA added to the National Priorities List (NPL) in 1983 groundwater (OK DEQ, 2016). Activities during the 1980s and 1990s focused on surface water remediation of Tar Creek. In 2000, the governor of Oklahoma commissioned a study to develop a comprehensive remediation plan for the area, and in 2002 the Oklahoma Department of Environmental Quality issued fish consumption advisories after studying metals concentrations in fish from waters impacted by TSMD (OK DEQ, 2016). In 2005, the State of Oklahoma restored 329 acres of land for reuse. A year later, the state passed legislation allowing the voluntary buyout of citizens' homes with children in highly impacted areas.

Figure 6. A large chat pile in the Tri-State Mining District
(Isabella Indian Reservation, no date)

ETSC provided support to Operable Unit (OU) 5 where EPA Regions 6 and 7 are working together to characterize suspended sediment loads and surface water throughout the Spring and Neosho River basins. ETSC provided technical support for an engineering review of remedial design documents focusing on stream remediation in Cherokee County; compiled information to inform a watershed model of surface flow and metal and sediment transport; and calibrated the watershed model to estimate deposition rates for the Spring and Neosho River basins (Niazi and Hantush, 2015). ETSC staff also authored a research document on the hydrologic modeling in the TSMD using the Soil and Water Assessment Tool (SWAT)[1] (Niazi and Hantush, 2015).

6.1.2 Eastern Michaud Flats Contamination (Region 8)

ETSC scientists and engineers provided support to remedial activities at the Eastern Michaud Flats Superfund site (FMC plant area) in FY15. The Eastern Michaud Flats Superfund site covers approximately 2,530 acres northwest of Pocatello, Idaho and includes two adjacent phosphate ore processing facilities. (US EPA, 2016b; see **Figure 7**). FMC Corporation manufactured elemental phosphorus (called P4) from 1940 until December 2001 and the J.R. Simplot Company Don Plant still actively produces phosphoric acid. In addition to the two plant areas, there are eight RCRA ponds, which range from 3-13 acres in size, containing wastes from P4 production. In 2009, EPA found residual P4 from historical spills and process leaks at the FMC plant down to a depth of 85 feet below ground surface and approximately 500 feet laterally on the FMC property (US EPA, 2009). Surface and groundwater at the Simplot plant was investigated in the late 2000's. In 2015, the EPA conducted the first five-year review to assess whether the soil and groundwater activities identified in the ROD and interim record of decision amendments (IRODAs) will, when fully implemented, be protective of human health and the environment. The IRODA was issued for the Simplot portion of the site in 2010 and the FMC potion in 2012. Remedial activities are ongoing at both portions (US EPA, 2015).

ETSC staff provided technical guidance for the evapotranspiration (ET) covers that will be placed over the contaminated soils to minimize the percolation of rainfall and snowmelt into the soil that would eventually contaminate groundwater. The caps are scheduled for completion in December 2015. The

[1] See http://swat.tamu.edu/ for more information.

cleanup plan also requires the groundwater to be treated to protect the local springs and the Portneuf River. FMC performed treatability testing prior to EPA approval and required an in-depth review for suitability. ETSC reviewed the treatability test results, and identified anion exchange resins and iron-based media that can selectively remove phosphorus and arsenic in the groundwater. EPA expects installation of the treatment system in 2016. ETSC staff also reviewed and provided comments on excavation and treatment technologies, including a proposed mud still process to treat the 'phossy' sludge in waste ponds at the FMC site (US EPA, 2015).

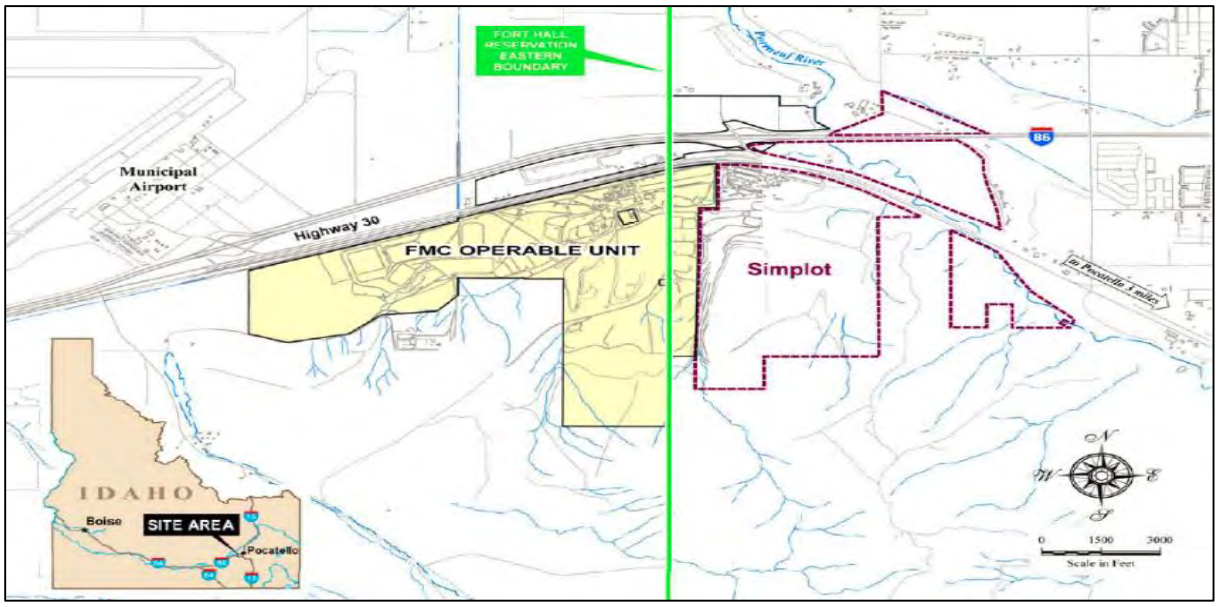

Figure 7. Location of the Eastern Michaud Flats Contamination site
(US EPA, 2009)

6.1.3 Argonaut Mine (Region 9)

ETSC evaluated the environmental and public health impact that a potential dam failure would have on the community living near the Argonaut Mine site in Jackson, California. The Argonaut Mine site is a historic hard rock gold mine that operated from the 1850s to 1942 (see **Figure 8**). Soil throughout the northwest side of present-day Jackson, California is contaminated with arsenic, lead and mercury from disposal of mine tailings. The contamination at this site is an acute hazard, and is time sensitive because an estimated 1 million cubic yards of contaminated materials are being held back by the 46 feet tall 100-year-old concrete Eastwood Multiple Arch Dam. (US EPA, 2016c). In 2015, the U.S. Army Corps of Engineers determined the dam to be structurally unsound and at risk of failure. The concrete dam was constructed to retain mine tailings and waste, and is at greatest risk of failure during heavy rainfall events. Using accepted modeling techniques for debris flow, the ETSC found that if the concrete dam fails in wet conditions, the contamination would quickly spread downstream and pose a significant public health threat to nearby communities. The California Department of Toxic Substances Control (DTSC) is evaluating options to stabilize the dam and has built a storm water diversion system to prevent water from collecting in the tailings behind the dam. In concert, ETSC has been reviewing sample results and assisting in the dam safety investigation by modeling a potential dam failure using the FLO-2D debris model.

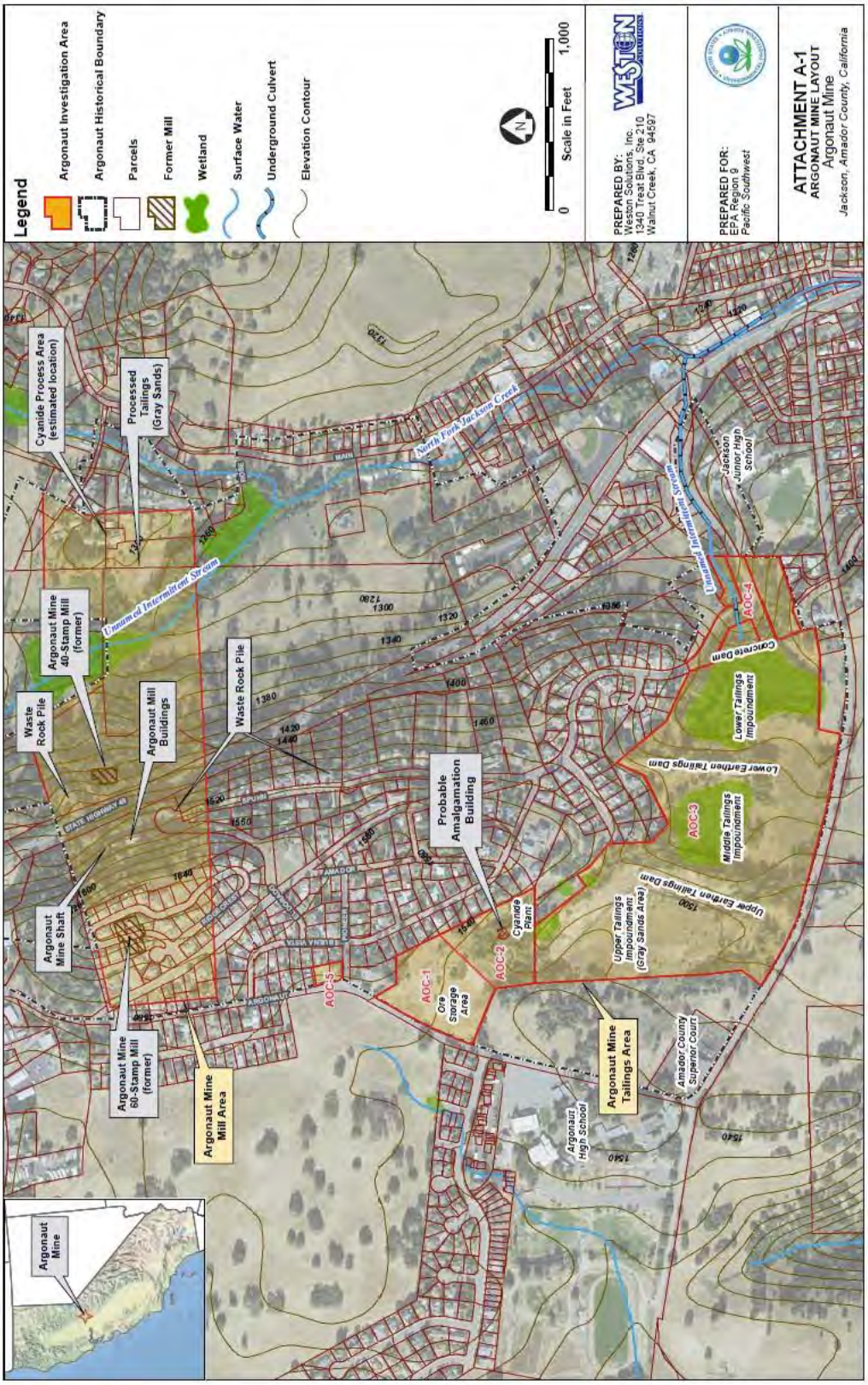

Figure 8. Layout of the Argonaut Mine site in California
(US EPA, 2016c)

6.2 ETSC Impacts at Landfill Remediation Sites

6.2.1 Fort Devens (Region 1)

ETSC can provide modeling to evaluate cleanup rates for pump and treat systems to determine if a technology will meet cleanup levels or if the system needs to be optimized. The former Fort Devens Army Base is 35 miles west of Boston in the towns of Ayer, Shirley, Lancaster and Harvard, Massachusetts.

Investigation and cleanup are active at five sites on the former base. At one of these sites, the Shepley's Hill Landfill, ETSC provided assistance related to arsenic contamination in the groundwater. This 84-acre landfill operated from 1917 to 1992. During cleanup, a pump-and-treat system was installed to extract and treat the arsenic-contaminated groundwater. Long-term monitoring and five-year site review findings recommended further evaluation of the groundwater contamination. ETSC scientists reviewed the groundwater sampling plan and modeled the cleanup rate for arsenic. The sampling plan provided for a range of background arsenic concentrations in groundwater for the aquifer impacted by plume migration from the landfill. The Army and EPA continue with long-term monitoring efforts to properly manage the groundwater contamination at this site.

6.2.2 Lower Darby Creek Area (Region 3)

ETSC provides expertise for innovative cover systems at landfills, such as an ET cover at the Lower Darby Creek Area Superfund site. The LDCA site expands over two counties in southeast Pennsylvania (Delaware County and Philadelphia County - see **Figure 9**). The site consists of two separate landfills, (Clearview and Folcroft). Portions of the Lower Darby Creek Area site are within the John Heinz National Wildlife Refuge near the Philadelphia International Airport. Both landfills operated from the 1950s to the 1970s and closed in the mid-1970s. Poor waste disposal practices contaminated the soil, groundwater, surface waters and fish tissue with hazardous chemicals such as PCBs.

The EPA selected the final cleanup plan for Clearview Landfill (US EPA, 2014a). The Clearview plan consists of constructing an ET cover for about 50 acres to contain the landfill waste and contaminants, excavating contaminated soils currently outside the planned cover area, and placing them under the ET cover,

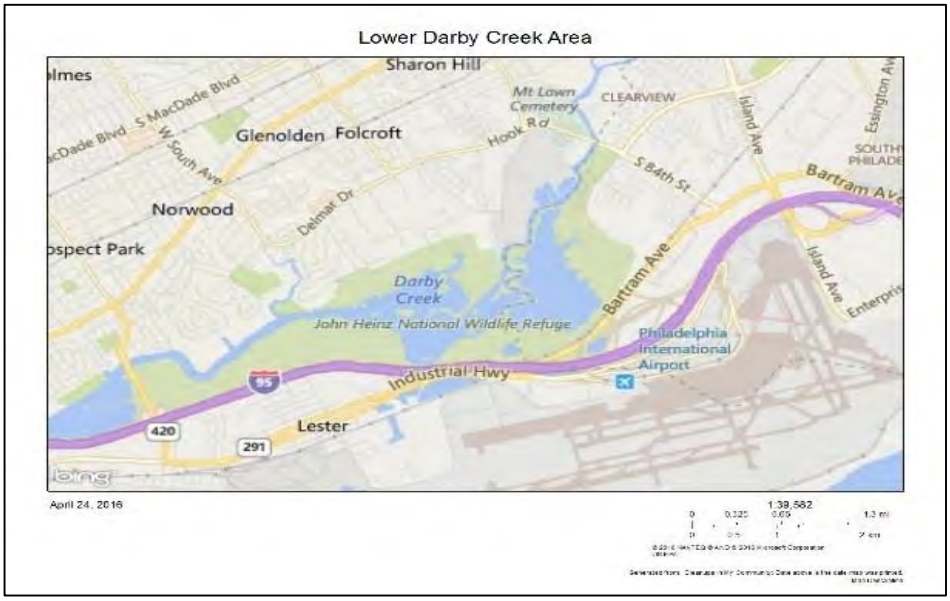

Figure 9. Location of the Lower Darby Creek Area in Pennsylvania
(US EPA, 2016f)

and collecting and treating the leachate (US EPA, 2016f). In the summer of 2015, EPA began the cleanup plan and site design for the contaminated waste and soils. ETSC has provided technical input on the ET cover, tree selection, climate mitigation, and ecological functions. ETSC is also providing hydrologic modeling support for the Clearview watershed (specifically on the HED-HMS model).

6.2.3 Malone Service Co. – Swan Lake Plant (Region 4)

ETSC can assist regions with design specifications and requirements for landfill construction. For example at the Malone Service Co. Swan Lake Plant in Texas City, Texas (see **Figure 10**), ETSC provided Region 6 with landfill design specifications and requirements for a geosynthetic clay liner in the Subtitle C landfill cell shortly after remedial construction activities began in 2015. From 1964 to 1997, a reclamation, storage and disposal facility for waste oils and chemicals operated at the Swan Lake Plant. Galveston Bay is a National Estuary and a major fishery for the area.

During active operations, the facility handled waste from acid and caustic compounds, solvents, gasoline, and crude oil tank bottoms, resulting in surface water, groundwater and soil contamination. The selected remedy for soil and sediment sludges includes solidification of the sludge and placement of the solidified waste and unsolidified contaminated soil into an on-site RCRA Subtitle C equivalent landfill cell. Approximately 215,000 cubic yards of sludge and 16,000 cubic yards of contaminated soil are targeted for remediation. In FY15, ETSC provided landfill design specifications and requirements for the geosynthetic clay liner of the Subtitle C landfill cell shortly after remedial construction activities began in 2015. All remedial activities should be completed by December 2017, after which, the land may be transferred to an environmental nonprofit organization for natural preservation or conservation.

Figure 10. Location of the Malone Service Co. – Swan Lake Plant site in Texas
(US EPA, 2016g)

6.3 ETSC Impacts at Materials Management Sites

6.3.1 American Cyanamid Co. (Region 2)

ETSC can conduct treatability tests to evaluate treatment technologies before, during or after remedy implementation. At the 435-acre American Cyanamid Superfund Site in Bridgewater Township, New Jersey (see **Figure 11**), the facility manufactured rubber, rubber chemicals, dyes, pigments, fungicides, petroleum-based products, and pharmaceuticals for nearly 100 years, until all manufacturing stopped at the site in 1999 (NJ DEQ, 2011). Over that time, the soil became contaminated with VOCs, cyanide, PCBs, and metals, while the shallow and deep groundwater aquifers became contaminated with metals and VOCs. Four hazardous waste lagoons and 16 surface storage impoundments containing tars, wastewater sludges, iron oxide and general plant debris were on-site when remedial activities began in the early 1980s. EPA is selecting final remedies to address six impoundments (numbers 3, 4, 5, 13, 17, and 24). In FY15, ETSC provided technical support for the remedial activities of three of these impoundments (3, 4, and 5), specifically for the evaluation of solidification/stabilization (S/S) treatability test results being carried out for site soils and sludges.

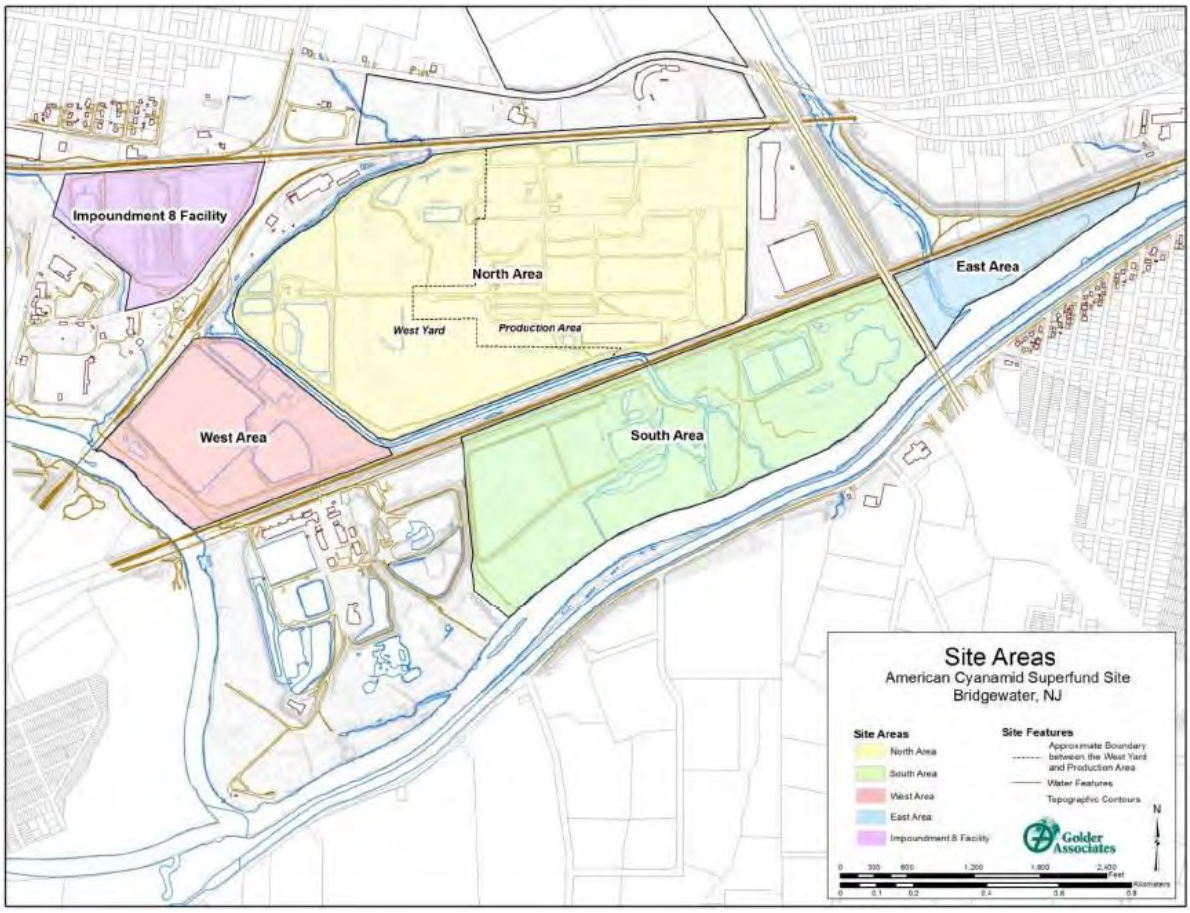

Figure 11. Location of the American Cyanamid Co. site in New Jersey
(US EPA, 2014b)

6.3.2 Allied Paper, Inc. / Portage Creek / Kalamazoo River (Region 5)

Sometimes RPMs need an objective review of treatment technologies to fairly assess the capabilities and limitations of the technology. ETSC can perform those reviews. For example, at the Allied Paper Inc./ Portage Creek / Kalamazoo River Superfund site in southwestern Michigan (see **Figure 12**), ETSC provided the RPM with technical guidance on the use of two proprietary technologies (PulverDryer and Biotech Restorations) being considered for PCB remediation.

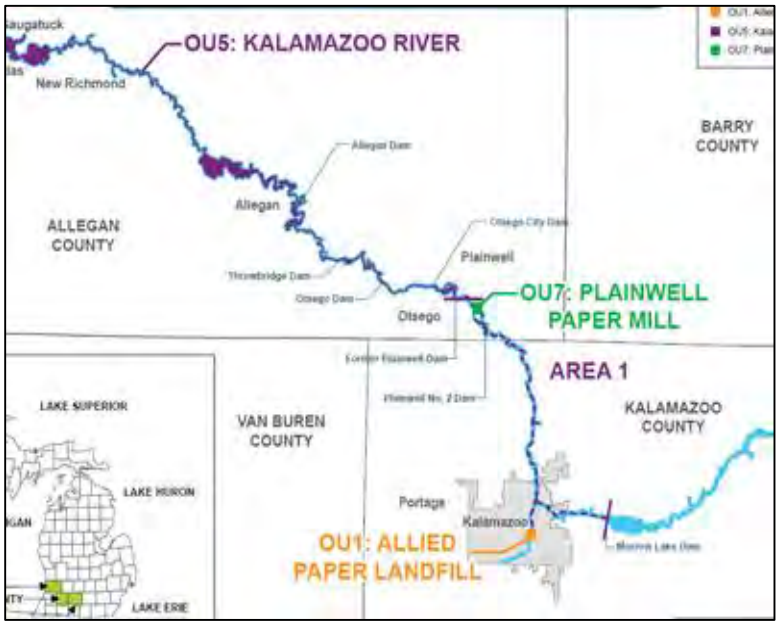

Figure 12. Location of the Allied Paper Inc. / Portage Creek / Kalamazoo River Site in Michigan
(US EPA, 2016i)

The site includes five disposal areas, six paper mill properties, an 80-mile stretch of the Kalamazoo River (a tributary of Lake Michigan) and a 3-mile stretch of Portage Creek (a tributary of the Kalamazoo River). Various paper manufacturing and disposal operations occurred at the site until all paper manufacturing operations ceased in the early 1980s. The primary COCs are PCBs resulting from accidental introduction of carbonless copy paper in the recycled paper stream.

Cleanup started upstream on the Kalamazoo River with the removal of PCB sources. Cleanup focus is currently on three OUs: Allied Paper Landfill, Plainwell Paper Mill, and Kalamazoo River as identified in Figure 12. As part of the EPA's outreach efforts, ETSC staff participated with follow-up discussions with the mayor's staff on cleanup technologies and conducted a thorough review of vendor claims for the PulverDryer and Biotech Restoration technologies.

6.3.3 San Jacinto River Waste Pits (Region 6)

The 14-acre San Jacinto River Waste Pits site consists of a set of impoundments on the western bank of the San Jacinto River in Harris County, Texas (see **Figure 13**). The pits were constructed in the 1960s to dispose of pulp and paper mill wastes. The site contains contaminated soil, sediment and fish tissue. During operation, chlorine was used as a bleaching agent and sampling events indicate the presence of polychlorinated dibenzo-p-dioxins, polychlorinated furans (dioxins and furans) and some metals in the impoundments. The principal constituents of concern are dioxins, although PCBs and arsenic are also present. EPA placed the site on the NPL in 2008 because of the dioxin contamination, and its high presence in fish and shellfish in the San Jacinto River.

In 2011, an armored cap consisting of three layers of protective geotextile and geomembrane and covered with rocks was installed over the waste pits to isolate the dioxin. In FY15, ETSC conducted a technical

review for dioxin/polycyclic aromatic hydrocarbon relative bioavailability values reported through sampling events at the site. Sample results found that the waste material containing dioxins were exposed because of the cap damage, but that surrounding undisturbed areas around the cap did not show elevated levels of waste materials containing dioxins (US EPA, 2016j). An EPA inspection team discovered a 25-foot by 22-foot area of possible damage to the cap in FY15. As a preventive measure, the Region required the potentially responsible parties (PRPs) to add 24-hour/7-day-a-week surveillance and warning buoys around the perimeter of the site (US EPA, 2016j) to prevent watercraft and swimmers from getting too close to the cap. The lighted warning buoys and barrier floats are in place and EPA has conducted several rounds of inspections. Several small areas (approximately a few square feet) of missing or deficient cap thickness on both the eastern and western cell were identified, and later repaired.

A sampling event in the spring of 2016 tested pore water samplers at 14 locations within the cap, wells in the area, and dioxin screening for the first time in surface water, ground water, sediments, and fish tissue (US EPA, 2016k). EPA will evaluate data from this sampling event to determine whether the cap continues to isolate the dioxin in the impoundments and will recommend improvements as needed.

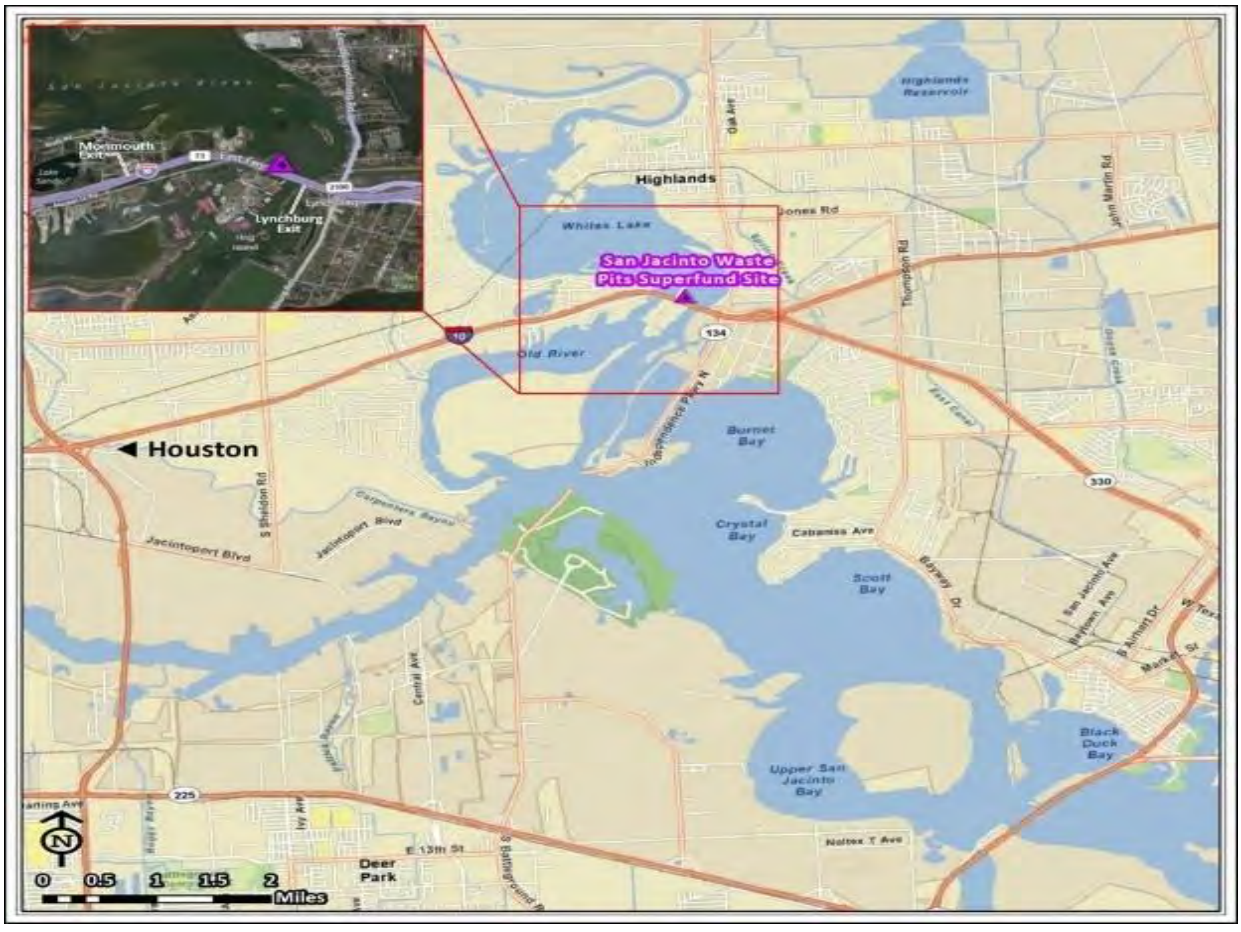

Figure 13. Location of the San Jacinto River Waste Pits site in Texas
(Galveston Bay Foundation, 2016)

6.3.4 Ward Transformer (Region 4)

In FY15, ETSC reviewed PCB remedial technologies and cleanup activities proposed by the site PRPs at the Ward Transformer Company. From 1964 to 2006, Ward Transformer operated a facility that handled transformers, switchgear and other types of electrical equipment near the Raleigh-Durham International Airport in North Carolina (see **Figure 14**). EPA placed the 11-acre site on the NPL in 2003 because of PCB-contaminated fish tissue, sediment and soil resulting from the company's operations. The site itself does not contain any creeks or streams, but the contamination has affected several bodies of water southwest of the site, including creeks, streams, and Lake Crabtree where subsistence fishing occurs.

Current activities focus on two areas. Operable unit 1 (OU-1) consists of contaminated surface water and sediment downstream from the site, while OU-2 consists of contamination at the site, surrounding properties, and nearby drainage paths uphill from one of the reaches (US EPA, 2016l). The cleanup will involve conducting streambed tests that will dictate either leaving portions of soil and sediment undisturbed, or excavating and treating the contaminated sediment between the Ward site and Lake Crabtree.

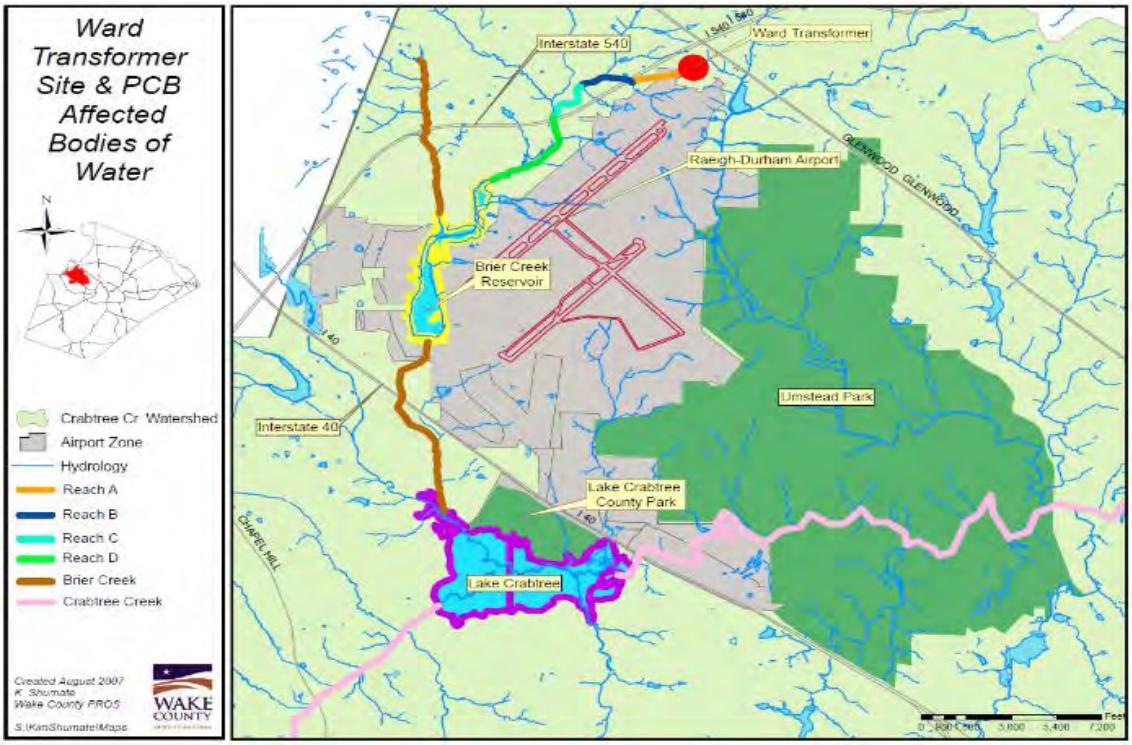

Figure 14. Location of the Ward Transformer site and PCB affected bodies of water in North Carolina (UNC, 2016)

6.3.5 Commencement Bay – Nearshore Tideflats (Region 10)

ETSC provided valuable input for technology evaluations in the Feasibility Study phase of the remedial process at the Commencement Bay Nearshore Tideflats site located in the city of Tacoma and the town of Ruston at the southern end of the Puget Sound in Washington. The Puyallup River, which starts at Mt.

Rainier, flows into Commencement Bay and creates a large delta area, or tideflats. The nearby area is heavily developed (as shown in **Figure 15**) and includes a commercial seaport, shoreline and many industrial facilities. Cleanup activities have been ongoing for decades. Two sites where cleanup is beginning include those owned by Occidental Chemical Corp. and Rhone-Poulenc Inc.

The Occidental site is situated off an inlet of Commencement Bay. Toxic plumes of dry cleaning solvents, chlorine, and other wastes from the chemical manufacturing facility contaminated the soil, sediment and, surface waters (WA DoE, 2016a, b). Because of the uncertainty surrounding this particular site, Region 10 asked ETSC to develop an optimization of remedial techniques for the feasibility study, and specifically reviewed site-specific documentation to provide a high-level evaluation of site-specific considerations and limitations to apply in situ chemical oxidation and in situ thermal remediation at the site. ETSC also evaluated other possible chemical technologies that may be applicable at the site. EPA expects actual cleanup activities at the Occidental site to begin in 2018.

Figure 15. Location of the Puget Sound and Commencement Bay Nearshore Tideflats Superfund Site in Washington
(WA DoE, 2016a)

The Rhone-Poulenc site is approximately 14 acres and consists of a paved upland area, a shoreline, and a tidal flat that extends into the Duwamish Waterway. The complex nature of the COCs at the site will likely require a treatment train approach consisting of multiple technologies to achieve remedial goals. Carbon dioxide (CO_2) sparging appears to be a promising technology to neutralize the pH plume and potentially reduce the concentrations of various metals in groundwater by reducing the solubility of the metal ions. Other technologies, such as biologically mediated stabilization also may be effective. In FY15, ETSC reviewed the draft corrective measures study work plan, which provides the framework for selecting a suitable remedy for the site in accordance with RCRA. A pilot test, consisting of sparging CO_2 into a portion of the aquifer, was proposed by ETSC to evaluate the ability of CO_2 to treat high pH groundwater at the Rhone-Poulenc site. ETSC later provided a review of the CO_2 injection pilot study implementation and results.

7 Additional Reports and Publications Prepared in FY15

In addition to the EIPs and the Lessons Learned research document highlighted in earlier sections of this report, ETSC also published two ASTM methods (one for water and one for sediment), the ETSC annual report for FY14, and several other reports and publications.

ETSC provided support to the development of the following ASTM methods led by Region 5's Laboratory in Chicago, IL:

ASTM International, 2015. ASTM D7968-14, Standard Test Method for Determination of Perfluorinated Compounds in Soil by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS). ASTM International, West Conshohocken, PA. Available at http://www.astm.org/Standards/D7968.htm.

ASTM International, 2015. ASTM D7979-15-e1, Standard Test Method for Determination of Perfluorinated Compounds in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS). ASTM International, West Conshohocken, PA. Available at http://www.astm.org/Standards/D7979.htm.

Two documents were also prepared in collaboration with the EPA's Engineering Technology Verification (ETV) Program, one on black carbon and the other on leak detection:

McKernan, J., J. Enriquez, A. Dindal, and S. Bessler. Report: Suitability of Leak Detection Technology for Use In Ethanol-Blended Fuel Service. EPA/600/R-15/254. September 2015.

Grosse, D., J. Enriquez, J. McKernan, S. Bessler, and A. Dindal. Environmental Technology Verification Program Advanced Monitoring Systems Center, Quality Assurance Project Plan for Verification of Black Carbon Monitors. EPA/600/R-16/032. April 2016.

Full references for the additional reports and publications are provided (in alphabetical order) below:

Bessler, S. and J. L. McKernan, 2015. Engineering Technical Support Center Annual Report for Fiscal Year 2014. EPA/600/R-15/132. August, 2015.

Bless, D. and D. Grosse, 2015. Abstracts from the 2014 National Conference on Mining-Influenced Waters: Approaches for Characterization, Source Control and Treatment. Presentation at the 2014 National Conference on Mining-Influenced Waters, Albuquerque, NM, August 2014. EPA/600/R-15/088. August, 2015.

Eckley, C. S., T. P. Luxton, J. L. McKernan, J. Goetz and J. Goulet, 2015. Influence of reservoir water level fluctuations on sediment methylmercury concentrations downstream of the historical Black Butte Mercury Mine, OR, *Applied Geochemistry*, Volume 61, October 2015, Pages 284-293, ISSN 0883-2927.

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Patricio, P., S. Al-Abed, C. Holder, R. Warner, J. McKernan, S. Fulton and E. Somerville, 2015. Assessing the Impact of Overburden Materials Selection from an Appalachian Region Coal Mine in Mine Water Quality Using a Standard Columns Leaching Test. Journal Submission. September, 2015.

Truesdale, R., M. Eom and J. McKernan, 2015. Flow Modeling and Damage Estimated for the Argonaut Mine Dam Failure Study Report. EPA/600/X-15/167. July, 2015.

8 International Endeavors

In addition to the invaluable national support that ETSC provides, they also engage with international governments to build capacity and share lessons learned. ETSC provided technical assistance to three countries in FY15: China, Vietnam, and Romania.

For the China MOST, EPA and Chinese officials are working on a collaborative effort to identify and solve parallel environmental issues in both countries. The ETSC collaboration for this effort will provide the latest research on metal uptake and bioavailability in sediment and soil.

In Vietnam, historic U.S. military installations have encountered pesticide and dioxin contamination. In FY14, ETSC provided valuable input on evaluating and selecting the best remedial solutions for these military sites. In FY15, ETSC is helping to evaluate remedial solutions is providing the Office of International and Tribal Affairs (OITA) support with presentations and documents. For this effort, ETSC collaborates 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 ORD/National Exposure Research Laboratory (NERL) and OITA.

ETSC is also collaborating with the Environmental Health Center and the Romanian government to build analytical capabilities for soil, water, and indoor dust to assess the impacts on metals contamination in mining communities in Romania. ETSC is also discussing options for large-scale decontamination and cleanup.

9 Summary

The technical support requests summarized in this report are a selected sample of those undertaken by the ETSC. Several of these investigations have generated substantial results, while others are working toward that end. The selected investigations provide insight into the unique role that ETSC plays as a bridge between environmental remediation conducted by our program and regional customers, and innovative engineering research performed in ORD. Examples of the impact and contributions the ETSC provides to clients in EPA Programs and the Regions are described below.

1) ETSC developed, evaluated and demonstrated bioremediation technologies, including
    - Technologies such as biochemical reactors for potential treatment options at metal-rich acid mine drainage sites, and the
    - Design and implementation of ET covers for landfills and Superfund sites to assist in remediating VOCs and other compounds from soil.
2) ETSC developed, evaluated and demonstrated groundwater treatment technologies, including
    - Permeable reactive barrier technologies to slow or stop groundwater contaminants from escaping sites
    - State-of-the-art spatiotemporal fate and transport groundwater modeling to evaluate existing systems or guide remedy selection, and
    - Groundwater pump and treat system design and optimization
3) ETSC evaluated sediment capping efficacy, environmental impacts, and long-term sustainability.
4) ETSC determined potential for reuse of waste materials.

5) ETSC completed engineering plan design reviews to
    - Ensure efficacy of site treatment or remedy, and cost efficiency, and
    - Implement proven technologies (when viable), including application of in situ solidification, thermal desorption, and in situ chemical oxidation.
6) ETSC provided timely and relevant technical support to contaminated sites through
    - Research, evaluation, or demonstration of new and innovative treatment technologies, and
    - By providing expert assistance in a broad range of topics including life-cycle analyses.

ETSC's interdisciplinary staff use creative thinking to apply innovative engineering research in real-world scenarios with the potential to produce long-lasting dividends, and ultimately safer and healthier communities.

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