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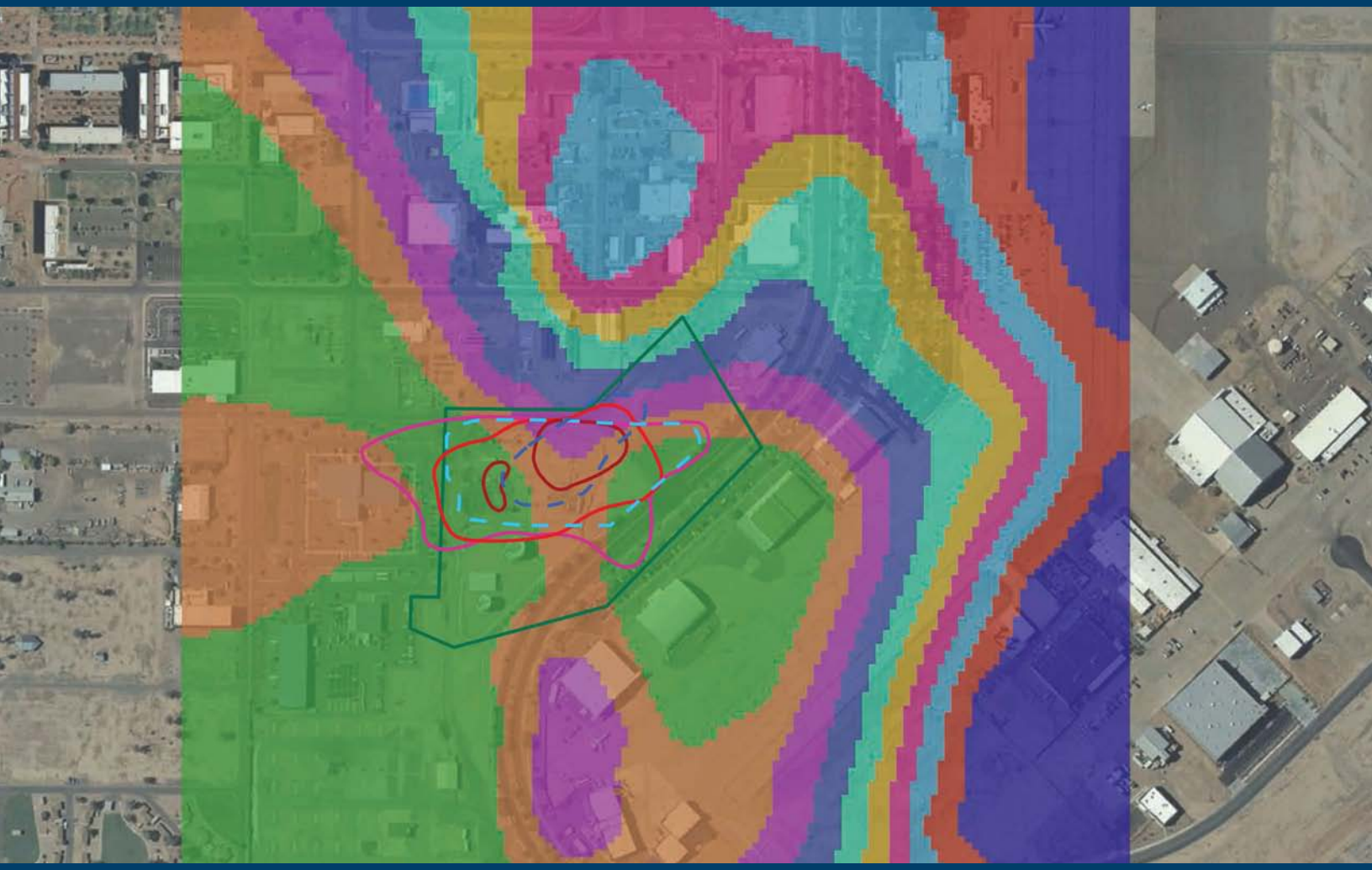
GROUND WATER TECHNICAL SUPPORT CENTER (GWTSC)

ANNUAL REPORT
Fiscal Year 2015 (FY15)

Office of Research and Development
National Risk Management Research Laboratory



Acknowledgements

The Ground Water Technical Support Center (GWTSC) would like to acknowledge the contributions from ORD scientists for their efforts in support of the GWTSC's mission. The GWTSC extends a thank you to our numerous clients in the Office of Science Policy, Office of Land and Emergency Management, Office of Superfund Remediation and Technology Innovation, and the EPA Regions, particularly the Superfund Technology Liaisons (STLs), the On Scene Coordinators (OSCs) and their management for their support. The GWTSC would also like to recognize the exemplary support provided by its contractor, CSS-Dynamac, and their subcontractors and consultants. Finally the GWTSC extends special thanks to everyone that provides document reviews, responds to technical request phone calls, and provides all other manners of assistance.

Abstract

The Ground Water Technical Support Center (GWTSC) is part of the Ground Water and Ecosystems Restoration Division (GWERD), which is based in the Robert S. Kerr Environmental Research Center in Ada, Oklahoma. The GWERD is a research division of U.S. EPA's National Risk Management Research Laboratory (NRMRL). The GWTSC is one of an interlinked group of specialized Technical Support Centers that were established under the Technical Support Project (TSP). The GWTSC provides technical support on issues related to ground water. Specifically, the GWTSC provides technical support to U.S. EPA and State regulators for issues and problems related to:

1. subsurface contamination (contaminants in groundwater, soils and sediments),
2. cross-media transfer (movement of contaminants from the subsurface to other media such as surface water or air), and
3. restoration of impacted ecosystems.

The GWTSC works with Remedial Project Managers (RPMs) and other decision makers to solve specific problems at Superfund, RCRA (Resource Conservation and Recovery Act), Brownfields sites, and ecosystem restoration sites.

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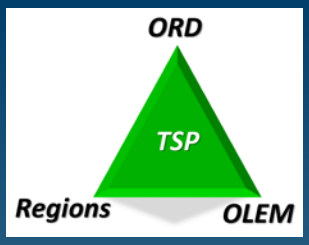
Introduction

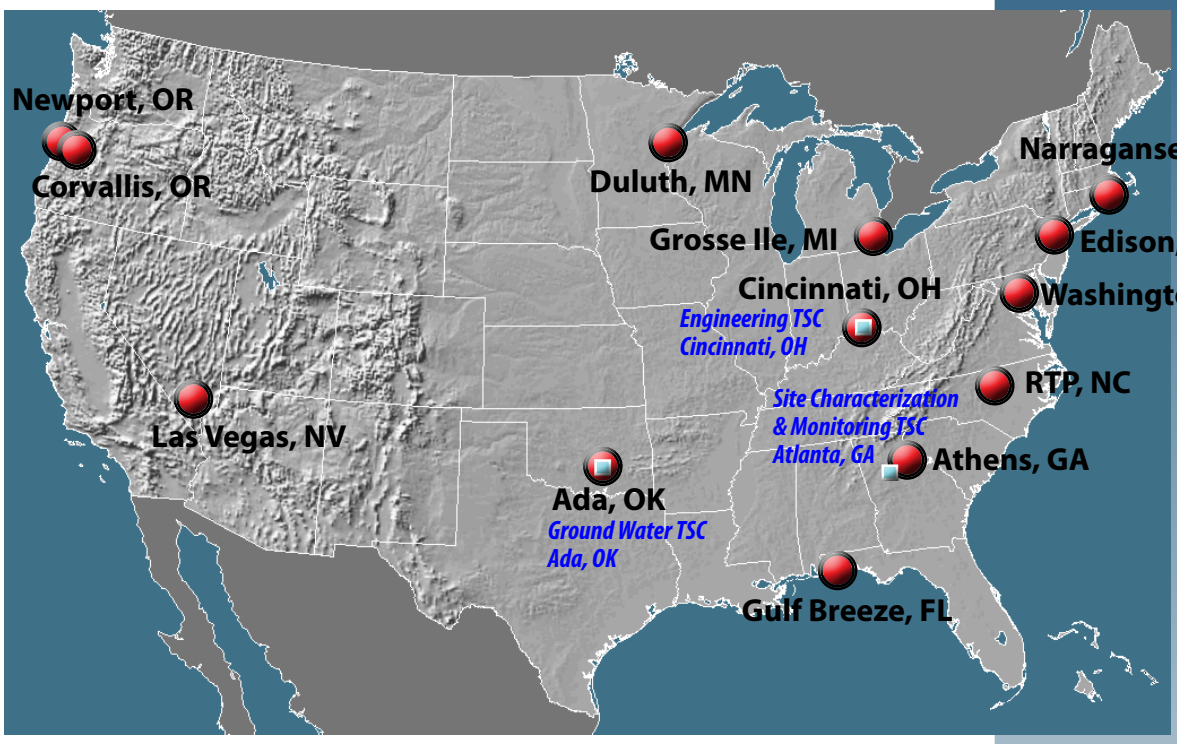


In 1985, an agreement between Office of Research and Development (ORD), Office of Solid Waste and Emergency Response (OSWER; now the Office of Land and Emergency Management (OLEM)), and the US EPA Regional Offices formed the Technical Support Project (TSP) to provide for technical support to USEPA Regions, Offices, and Programs. The Ground Water Technical Support Center (GWTSC) is one of the Technical Support Centers (TSC) established under the TSP to provide support in specific areas of expertise.

Ground Water Technical Support Center (Ada OK)

Engineering Technical Support Center (Cincinnati OH)

Site Characterization & Monitoring Technical Support Center (EPA Region IV)



Locations of ORD Laboratories and ORD Technical Support Centers.
(Base map courtesy of Ray Sterner, Johns Hopkins University Applied Physics Laboratory.)

The GWTSC is a component of the Ground Water and Ecosystems Restoration Division (GWERD), located in the USEPA Robert S. Kerr Environmental Research Center (RSKERC) complex in Ada, Oklahoma.

GWERD is a part of USEPA's National Risk Management Research Laboratory (NRMRL), headquartered in Cincinnati, OH; NRMRL is part of USEPA's Office of Research and Development (ORD).

Dr. Richard Lowrance, RSKERC Director (far right) welcomes local, state and federal dignitaries to the RSKERC 50th Anniversary Celebration, August 3, 2016.

The GWTSC Mission: What Does the GWTSC Do?

GWTSC provides technical support to U.S. EPA and State regulators for issues and problems related to:

- **subsurface contamination** (contaminants in ground water, soils and sediments),
- **cross-media transfer** (movement of contaminants from the subsurface to other media such as surface water or air), and
- **restoration** of impacted ecosystems.

GWTSC Focus Areas:

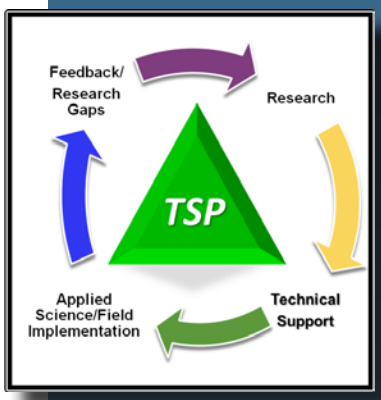
Subsurface contamination

Cross-media transfer of contaminants

Ecosystem restoration

The GWTSC technical support cycle involves three main components:

- Linking ORD research to Agency decisions:
  providing expert technical support personnel to link between ORD scientists and Agency decision-makers so the EPA's operating programs have in-house access to technical expertise and research results
- Moving expertise to the field:
  channeling current scientific understanding and best practices in user-friendly form to managers and field implementers for informed decision-making and practical application
- Moving field results back to researchers:
  taking field implementation results back to the laboratory so researchers are continually oriented toward addressing the most important problems the Agency is facing



The Technical Support Project knowledge cycle drives the GWTSC mission.

GWERD scientists installing monitoring wells.

Implementing the GWTSC Mission

USEPA Program and Regional staff and other decision makers can call on GWTSC to provide technical assistance for CERCLA, RCRA, Brownfields, and ecosystem restoration issues. The GWTSC focuses on these three core remediation and restoration functions:

Technical Assistance for:

CERCLA

RCRA

Brownfields

Ecosystem Restoration

Guidance for Planning Site Activities:

- site characterization
- remedial investigations
- feasibility studies
- identification and selection of remedial alternatives
- remedy performance monitoring

Guidance for Choosing and Applying Models:

- identifying appropriate environmental modeling software and modeling implementation approaches
- critical evaluation of site-specific modeling efforts

Guidance for Use of New and Innovative Technologies:

Oversight assistance and technical support of new/innovative technologies for treatment of contaminated soils/ground water, and restoration of sensitive ecosystems

- design
- testing
- pilot and full-scale implementation
- performance evaluation

The GWTSC Team

The core of the GWTSC technical support team is comprised of members of GWERD's Applied Research and Technical Support Branch (ARTSB). For additional expertise or support GWERD scientists from the Subsurface Remediation Branch (SRB), the Ecosystem and Subsurface Protection Branch (ESPB) and field support staff from the Technical & Administrative Support Staff (TASS), all also located at the RSKERC, are available to the GWTSC as needed.

CSS-Dynamac

CSS-Dynamac, an on-site technical support contractor, provides on- and off-site expertise to address technical support questions, and also provides access to additional expertise via subcontractors, consultants, and academia.

The Center for Subsurface Modeling Support (CSMoS; discussed below), an integral part of the GWTSC, also uses in-house EPA personnel as well as contractors to provide expertise on environmental modeling applications, and support for a suite of publicly available groundwater models.

Technical Expertise from GWTSC

Hydrogeologists
Geochemists
Ecologists
Microbiologists
Environmental Engineers
Mathematical Modelers
Geographical Information Systems (GIS) Specialists
Organic Chemists
Inorganic Chemists
Analytical Chemists
Technical Writing and Training Specialists

Site-specific technical guidance:

Formal or informal interactive approaches related to specific CERCLA, RCRA, Brownfields, or ecosystem restoration sites

Technical transfer:

Training and publications related to specific subsurface or ecosystem restoration issues

GWTSC Technical Support Avenues

GWTSC provides technical support through:

Site-specific Technical Guidance

•site activity review memoranda

•conference calls

•email

•site visits and meetings

Technical Transfer

•training, including workshops, demonstrations, conferences, and expert panels

•publications, such as issue papers, fact sheets, and technical guidance documents

GWTSC Technical Support Concentration Areas

Subsurface Contamination

GWTSC/GWERD is the USEPA technical support and research leader for subsurface processes, characterization, remediation and monitoring.

GWTSC/GWERD areas of expertise for contaminants in ground water, soils and sediments include:

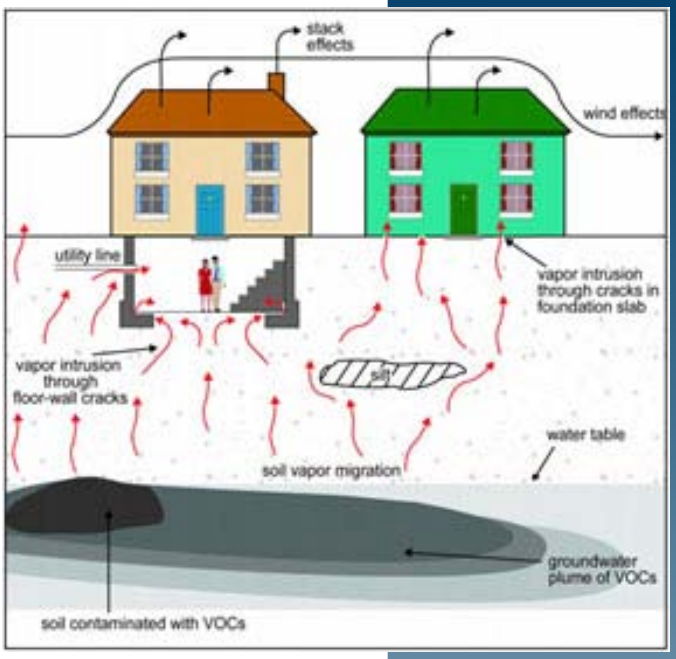
- Contaminant sources
- Plume behavior
- Transport and fate of contaminants
- Subsurface geology and stratigraphy
- Subsurface geochemistry
- Subsurface microorganism populations and processes
- Ground water model suitability and application
- Sampling and analysis tools
- Bench and pilot studies, and scaleup
- Performance monitoring
- Holistic/sustainable approaches

Laying out tubing for a sampling program.

Since 1985, GWTSC/GWERD has produced almost 150 EPA publications directed to technical guidance and understanding of subsurface contamination issues, plus many more journal articles, books, etc. Some of the latest publications are listed under the Scientific and Technical Publications heading later in this Annual Report. Many more publications can be accessed at the USEPA EPA National Library Catalog webpage for searching the various USEPA libraries, including the GWERD library in Ada, OK. (https://www.epa.gov/nscep)

Cross-media Transfer

GWTSC's technical support expertise for cross-media transfer relates to movement of contaminants from groundwater and subsurface media to surface water or air. Vapor intrusion (VI) involving transfer of contaminants from groundwater to subsurface air and then to structures is a common issue at many sites GWTSC works with, particularly where chlorinated solvents are found in shallow groundwater under or near buildings. Also, transfer of contaminants from groundwater to surface water is a common problem.



Example of cross-media contaminant transfer.

Ecosystem Restoration

Ecological restoration originates or expedites recovery of ecosystems with respect to health, integrity and sustainability. Ecosystem restoration involves restoration of impacted ecosystems such as riparian zones and streams, and wetlands.

Severely contaminated stream needing restoration.

Cross-media Contaminant Transfer from Groundwater to Surface Water

In FY'15, Dr. Richard Wilkin, a GWERD environmental geochemist, provided assistance to Project Manager Lily Lee regarding methods to determine the spatially resolved mass flux of mercury into San Francisco Bay from the Hunters Point Naval Shipyard site.

Center for Subsurface Modeling Support (CSMoS)

The Center for Subsurface Modeling Support (CSMoS), distributes public domain groundwater and vadose zone modeling software to government agencies and the public. In addition to providing links for downloading the models and associated documentation such as manuals, CSMoS provides direct technical support to EPA and State decision makers for applications of the subsurface models.

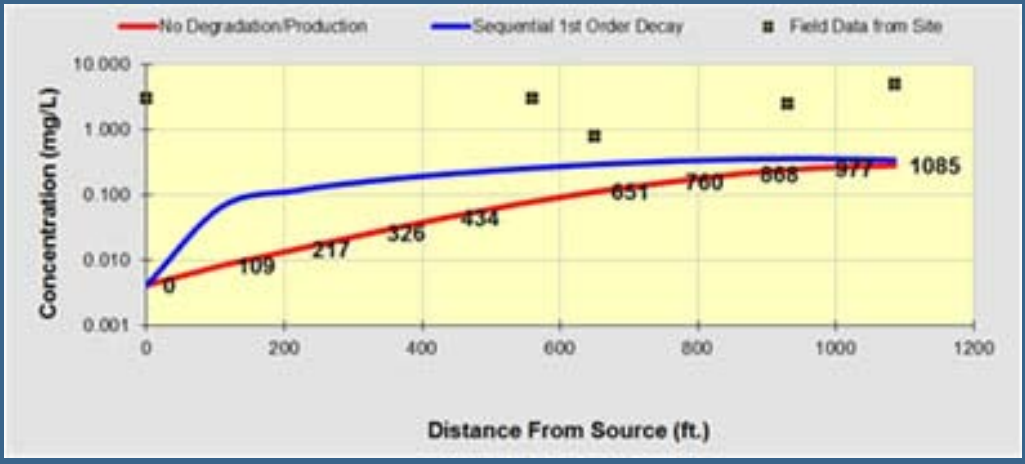
CSMoS models currently available can be downloaded at the USEPA Methods, Models, Tools, and Databases for Water Research webpage under the Models tab. (https://www.epa.gov/water-research/methods-models-tools-and-databases-water-research)

The relatively simple, user-friendly screening models Biochlor, Bioscreen, REMFuel, and Bioplume III are among the most popular downloads. These screening models are easy to learn and apply, providing means to quickly examine site data, get an overview of contaminant transport and fate, and output tabular and graphic results for ease of understanding and for facilitating presentations to stakeholders.

Other models, as listed in the table below, include additional user-friendly models such as:

- FOOTPRINT (used to evaluate the 2-D transport of BTEX and ethanol, which are commonly found together in the ethanol/gasoline mixtures sold for motor vehicle fuel)
- REMChlor, a screening model for chlorinated solvents transport and fate
- OWL, a screening model to evaluate locations for monitoring wells

BIOCHLOR simulates degradation (first-order decay by reductive dechlorination) of dissolved solvents.



BIOPLUME III is used to model fate and transport under aerobic and anaerobic conditions of hydrocarbons; the electron acceptors oxygen, nitrate, sulfate, iron (III), and carbon dioxide; and iron (II).

BIOSCREEN simulates biodegradation of dissolved hydrocarbons by aerobic and anaerobic reactions.

REMFuel (Remediation Evaluation Model for Fuel hydrocarbons) simulates transient effects of groundwater source and plume remediation for fuel hydrocarbons.

Description of Models Distributed by CSMoS

Model Name	Model Name and Version	Model Description
2DFATMIC	2DFATMIC 1 .0	2-D subsurface flow/transport
3DFATMIC	3DFATMIC 1 .0	3-D subsurface flow/transport
BIOCHLOR	BIOCHLOR 2 .2	1-D Domenico screening model
BIOPLUME II	BIOPLUME II 1 .1	2-D USGS MOC transport
BIOPLUME III	BIOPLUME III 1 .0	2-D USGS MOC transport with Windows GUI
BIOSCREEN	BIOSCREEN 1 .4	3-D Domenico transport
CHEMFLO	CHEMFLO 1 .3	1-D vadose zone numerical transport
CZAEM	Capture Zone Analytic Element Model	Estimates Capture Zones
FOOTPRINT	FOOTPRINT 1 .0	2-D transport of BTEX and ethanol
GEOEAS	GEOEAS 1 .2 .1	Geostatistical analysis
GEOPACK	GEOPACK 1 .0 .e	Geostatistical analysis
HSSM-DOS	HSSM-DOS 1 .1	Multiphase LNAPL flow/transport
HSSM-SPN	HSSM en Espanol 1 .2 .e	Multiphase LNAPL flow/transport (Spanish version)
HSSM-WIN	HSSM-Windows 1 .2 .e	Multiphase LNAPL flow/transport
MDFL MAN	MODFLOW Manuals	MODFLOW practice problems
MOFAT	MOFAT 2 .0 .a	2-D multiphase transport
MT3D	MT3D 1 .11	3-D numerical transport
OWL	OWL 1 .2	Monitoring well locator
PESTAN	PESTAN 4 .0	Simulate leaching of pesticides
REMChlor	REMChlor 1 .0	Simulate transient plume remediation
REMFuel	REMFuel v 1.0	Simulates the transient effects of groundwater source and plume remediation for fuel hydrocarbons
RETC	RETC 1 .1	Estimate soil model parameters
RITZ	RITZ 2 .12	Simulate vadose zone transport
STF	Soil Transport and Fate Database 2 .0	Database of behavior of organic and inorganic chemicals in soil
UTCHEM-PC	UTCHEM-PC 9 .0	3-D multiphase flow/transport
UTCHEM-UNIX	UTCHEM-UNIX	3-D multiphase flow/transport
VIRULO	Virulo 1 .0	Probabilistic virus leaching model
VLEACH	VLEACH 2 .2 .a	1-D vadose zone leaching model
WhAEM	WhaEM	Analytical element capture zone model
WhAEM 2000	WhAEM2000 3 .2	Analytical element capture zone model
WHPA	WHPA 2 .2	Finite-difference capture zone model

Contact Information for Requesting Technical Support

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Chief, Applied Research and Technical Support Branch (ARTSB)

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How to Request Technical Support

Define the specific questions you need answered. "Does the Enhanced Bioremediation Work Plan call for measuring the appropriate geochemical parameters?" is a good, specific question. "What does GWTSC think about the Enhanced Bioremediation Work Plan?" is difficult to answer, and the answer may not narrow it down to the answers you really need. Provide questions that help GWTSC experts focus on those specific issues that are important to you for your site.

Second, gather the site documents needed to help GWTSC understand the hydrogeology, contaminants, plumes, and geochemistry/microbiology at the site. Site characterization data, monitoring reports, work plans, site maps and cross sections are almost always needed. Electronic copies are best except for large maps. Spreadsheets of monitoring data (i.e., in addition to tables in pdf files) are often helpful to allow GWTSC experts to slice and dice the data for analysis.

Finally, contact David Burden by phone, email, or through the ORD TSC SharePoint site (https://usepa.sharepoint.com/sites/ORD_Work/ETSC/_layouts/15/start.aspx#/default.aspx) to initiate a technical support request.

Technical Support Activity Examples

Bioremediation

In FY'15, GWTSC provided technical support to 12 sites where bioremediation is used or proposed. Examples of this support are below.

Demmer Properties LLC/Former Motor Wheel Facility Site

Dr. David Burden (GWERD) and Dr. Daniel Pope (CSS-Dynamac) advised USEPA Project Manager Don Heller on a proposed pilot scale study for evaluating the use of enhanced reductive dechlorination (ERD) for remediation of chlorinated alkenes trichloroethene (TCE), 1, 2-dichloroethene (1, 2-DCE), and vinyl chloride (VC) at the Demmer Properties LLC/Former Motor Wheel Facility Site in USEPA Region V. GWTSC recommendations for revising the pilot study plan included providing details of the calculations for the amount of electron donor to be injected, including specific provisions for dealing with adverse changes in aquifer chemistry such as pH excursions or excessive methane generation, and enhancing the monitoring plan to cover gaps in the monitoring network.

Radiation Technology Inc. Superfund Site

Dr. David Burden (GWERD), Dr. John T. Wilson, and Dr. Daniel Pope (CSS-Dynamac) advised USEPA Project Manager Brian Quinn on evaluation of results of a pilot study for biodegradation of perchlorate at the Radiation Technology Inc. Superfund Site. Perchlorate contamination at the site occurs in groundwater in granite bed rock and the overlying weathered granite (saprolite). The pilot study involved injection of a commercial reagent containing a suspension of emulsified vegetable oil; biodegradation of the vegetable oil was intended to provide fatty acids and other metabolic products that would support biodegradation of the perchlorate in the groundwater. GWTSC conclusions and recommendations included:

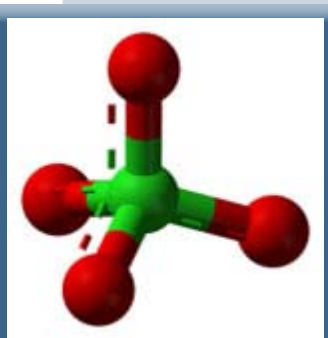
- most of the monitoring wells used during the pilot test were outside the radius of influence of the oil injection, so the actual radius of influence of the reagent injections is not known
- the reagent used has a large particle size, which may have plugged the aquifer flow paths that distributed water; this could be evaluated by examining the field log that compared injection flow to back pressure to see how the total amount of fluid injected affected the back pressure, and to compare that back pressure to the pressure head that would be expected from injecting water alone
- a minimum of 100 milligrams per liter (mg/L) total organic carbon (TOC) in the groundwater should be used as the definition of useful concentrations of the reagent and the reagent's degradation products such as fatty acids

FY'15 Technical Support for Bioremediation Remedies

- Caldwell Trucking Superfund Site
- Demmer Properties LLC/Former Motor Wheel Facility Site, No. 4
- DuPont Pompton Lakes Works, No. 5
- Eli Lilly & Company/Evonik Deguss Corp., No. 4
- England AFB
- Former Medallic Arts Facility
- Iowa Army Ammunition Plant, No. 2
- Libby Ground Water Contamination Site
- Occidental Chemical
- Picillo Farms Superfund Site, No. 8
- Savage Well Municipal Water Supply Superfund Site, No. 7
- South Municipal Water Supply

Perchlorate

Perchlorate is relatively chemically stable, highly water-soluble, and highly mobile in groundwater. A perchlorate plume at the Olin Flare Facility (a former safety flare site) extends more than 9 miles.



Perchlorate; chlorine atom is green and oxygen atoms are red.

In Situ Chemical Oxidation (ISCO)

FY'15 Technical Support for ISCO Remedies

- DuPont Chambers Works Superfund Site
- Eli Lilly & Company/Evonik Deguss Corp., No. 4
- General Electric 220 South Dawson Street Facility
- Kearsarge Metallurgical Corp. Superfund Site, No. 2
- Occidental Chemical
- Resolve Superfund Site
- South Adams 1,4-Dioxane in Groundwater Superfund Site
- Wells G&H Superfund Site - New England Plastics Subsite, No. 2
- Wells G&H Superfund Site - Olympia Sub Subsite, No. 3

In FY'15, GWTSC provided technical support to 9 sites where ISCO is used or proposed. Examples of this support are below.

Wells G&H Superfund Site - Olympia Sub Subsite, No. 3

Dr. Scott Huling (GWERD) provided support to USEPA Project Manager for the Wells G&H Superfund Site - Olympia Sub Subsite, No. 3, where permanganate is being used to oxidize tetrachlorethene (PCE). High contaminant concentrations and low permeability of the soil and aquifer material limit contaminant and oxidant mass transport. GWTSC conclusions and recommendations included:

- continuation of the use of larger volumes of oxidant and lower concentrations, because this approach allows greater opportunity for contact between the oxidant solution and the contaminants in the porous media
- binary mixtures, where MnO4- and TCE are present in the same ground water sample, suggest that the oxidant and contaminated ground water are entering into the well screen from different intervals, and/or that there is heavy contamination in close proximity to the well that has limited contact with the oxidant
- focused delivery of the permanganate ISCO reagent at known contamination hotspots, delivered in the same vertical intervals where high TCE concentrations have been noted, should help to address persistent or rebounding TCE concentrations

Common Oxidants for ISCO

- permanganate (MnO^{4-})
- hydrogen peroxide (H_2O_2) and iron (Fenton's reagent)
- persulfate ($S_2O_8^{2-}$)
- ozone (O_3)

Eli Lilly & Company/Evonik Degussa Corp. No. 4 Site

Dr. David Burden (GWERD) and Dr. Bruce Pivetz (CSS-Dynamac) advised USEPA Project Manager Don Heller on results of a pilot scale study of ISCO conducted using a commercial ISCO reagent containing sodium persulfate, powdered activated carbon, and calcium peroxide. Also, GWTSC evaluated a proposed full-scale remedial design based on the results of the pilot study. At the Eli Lilly & Company/Evonik Degussa Corp. No. 4 site, groundwater and saturated soil in the source areas are contaminated by a variety of volatile organic chemicals (VOCs), primarily benzene, chlorobenzene (CB), p-chlorobenzotrifluoride (pCBT), tetrahydrofuran (THF), and n,n-diethylaniline (n,n-DEA). GWTSC recommendations included:

- providing a justification of the use of a presumably average contaminant concentration in calculating the required sodium persulfate mass for all the injection locations within each source area. It was recommended that injection-location-specific concentrations be used for calculations of required sodium persulfate mass rather than one concentration for each source area

- undertaking additional investigation of the issue of contaminant sorption on the activated carbon component of the ISCO reagent, providing a discussion of the possible influence of the injected activated carbon on the sorbed- and dissolved-phase contaminants

- designing closer spacing between injection wells, closer spacing between injection and monitoring wells, and longer-term or multiple injections to ensure reagent contact with contaminants

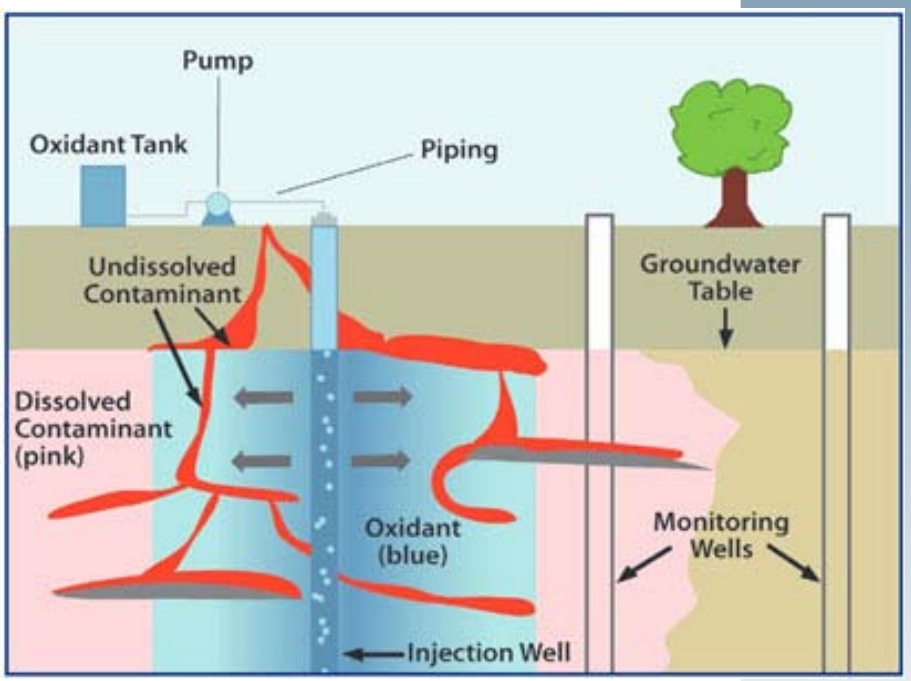


Diagram of ISCO implementation.

Modeling, Screening

Characterization and remediation of most groundwater contamination sites involve modeling of groundwater flow and contaminant transport, and so GWTSC support for most sites involves support for modeling activities from time to time. For FY'15, GWTSC provided detailed comments on modeling efforts for eight sites. Examples of this support are below.

FY'15 Technical Support for Groundwater Flow and Contaminant Transport Modeling

- Bailly Generating Station
- Chem-Dyne Superfund Site, No. 6
- Cyprus Tohono Mine Superfund Site, No. 2
- Eastern Michaud Flats, FMC OU, No. 4
- Frontier Fertilizer SF Site
- Picillo Farms Superfund Site, No. 8
- US Steel - Minntac Site Assessment
- Yerington Mine Site, No. 8

Yerington Mine Site

Dr. Randall Ross (GWERD) and Dr. Milovan Beljin (CSS-Dynamac) provided USEPA Project Manager David Seter with an analysis of the Groundwater Flow Model Supplemental Materials document for the Yerington Mine Site, where uranium and sulfate related to previous copper ore mining and processing contributed to groundwater contamination.

Hydrology at the Yerington Mine Site is complex and subject to significant uncertainty, particularly with respect to the effects of local agriculture on long-term contaminant migration. The primary goal foreseen for the Yerington groundwater flow model is to provide a management tool that can be used to evaluate possible remediation options.

GWTSC conclusions and recommendations included:

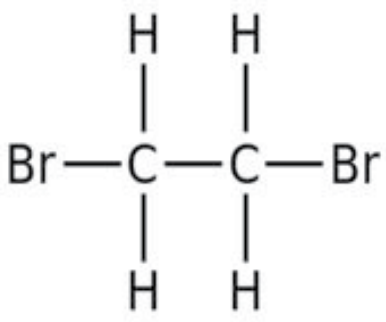
- the greatest value for the groundwater flow model is in allowing short-term comparisons of remedial designs and possible effectiveness of different remediation scenarios using a common tool; the model appears to be adequate for that purpose
- the groundwater flow model is likely to have less value for predicting long-term migration of contaminants
- the groundwater flow model should continue to be modified as new data are collected, such as the data that are becoming available from the area east of West Campbell Ditch
- the next step in the development of the model should be to develop a solute transport component that can simulate transport processes that will impact concentrations of chemicals in groundwater
- groundwater modeling may provide a useful tool for better understanding current conditions and potential remedial options, but the performance of any selected remediation strategy should ultimately be determined by a properly designed performance monitoring network

Yerington Mine (Anaconda Copper Mine), Yerington, NV.

Frontier Fertilizer Superfund Site

Dr. Randall Ross (GWERD) and Dr. Milovan Beljin (CSS-Dynamac) provided USEPA Project Manager Bonnie Arthur with a review of the Frontier Fertilizer Groundwater Model Update and Capture Zone Analysis, for the Frontier Fertilizer Superfund Site. Groundwater at the site is contaminated with pesticides including ethylene dibromide (EDB), 1,2-dichloropropane (DCP), 1,2,3-trichloropropane (TCP), and 1,2-dibromo-3-chloropropane (DBCP). A revised version of the groundwater flow model for the site, as discussed in the Update, included numerous improvements (e.g., simulates transient rather than steady state conditions, increased number of layers, finer grid spacing, different aquifer parameters). GWTSC conclusions and recommendations included:

- the overall improvements to the model, while significant, have not resulted in an adequately calibrated model capable of achieving the original objectives for the model
- many of the calibration hydrographs show very good agreement between simulated and measured water levels, but not for the potentiometric surface maps, specifically for layers 2 and 3. A properly calibrated flow model should be able to approximate not only the hydraulic heads, but also the direction and the magnitude of hydraulic gradients across a site
- specific yield and specific storage were each estimated as a single value for all the layers in the model domain, though it was not clear why all the layers would have the same values; a sensitivity analysis of the model to the storage coefficient values was recommended
- a major drainage ditch is located just north of the site. It is unclear if this a lined ditch and whether it is included in the model
- the capture zone analysis is based on the assumption that the model is calibrated, but water level maps of the simulated heads are in a poor agreement with the water level maps based on the measured heads; the flow direction and the magnitude of the hydraulic gradient vectors should also be criteria in the model calibration



Ethylene dibromide (EDB), a fumigant and anti-knock fuel additive.

Center for Subsurface Modeling Support (CSMoS)

Technical support for modeling applications is also provided through CSMoS. CSMoS technical support is largely oriented to answering basic questions regarding the availability, installation and use of the free models provided through CSMoS (listed in the CSMoS model table under the Center for Subsurface Modeling Support (CSMoS) section heading. Most of the inquiries are by email.

Examples of modeling support questions	
Examples of Modeling Issues/Questions Answered by CSMoS	**Summary of Response to Questions**
Wanted software to show hydrologic cycle in the vadose zone	Provided link to NASA water movement simulation http://www.youtube.com/watch?v=Az2xdNu0ZRk Also sent USGS water cycle graphic
Numerous inquiries asked how to run some of the CSMoS software (e.g., Virulo, VLEACH 2.2, REMFuel) on Windows 7; Biochlor on Windows 8	Provided link to "Virtual XP" http://windows.microsoft.com/en-us/windows7/install-and-use-windows-xp-mode-in-windows-7
Where to download REMFuel?	Provided the new USEPA web link to the REMFuel model https://www.epa.gov/water-research/remediation-evaluation-model-fuel-hydrocarbons-remfuel
Source data file for NAPL Simulator	Provided link to the model download page and example problems https://www.epa.gov/water-research/non-aqueous-phase-liquid-napl-simulator
Can BIOSCREEN be used to model degradation of total petroleum hydrocarbons (TPH)?	No. TPH is a mixture of compounds with different rate constants for degradation and different retardation factors. As the TPH degrades the composition changes, and so does the rate constant for the residual TPH and the retardation factor for the residual TPH.
Where to download HSSM?	Provided new link to HSSM model http://www2.epa.gov/water-research/hydrocarbon-spill-screening-model-hssm-dos
Will an update to HSSM be released?	No new updates are planned

Thermal Treatment

In FY'15, GWTSC provided technical support to 9 sites where thermal treatment is used or proposed. Examples of this support are below.

Savage Municipal Water Supply Superfund Site

Dr. Eva Davis (GWERD) analyzed the Draft Feasibility Study Report for the bedrock contamination at the Savage Municipal Water Supply Superfund Site (USEPA Project Manager Richard Hull), focusing on the thermal remediation evaluation portions. The site has chlorinated solvent DNAPL and groundwater contamination, with a groundwater plume moving toward municipal water supply wells. GWTSC conclusions and recommendations included:

- it appears that thermal treatment of the bedrock is technically feasible, but costly, having significantly greater costs than the other alternatives that were evaluated; however, the remediation time would be significantly shorter than other remedial approaches considered
- the proposed "potential DNAPL zone" (i.e., where thermal treatment would be applied) is based on relatively low PCE groundwater concentrations that are more appropriately applied to porous media, not bedrock fractures; therefore the potential DNAPL zone is probably much larger than necessary, increasing the estimated cost of thermal remediation
- also, the potential DNAPL zone reaches to 600 feet below ground surface, but there is no evidence that DNAPL is at that depth, again increasing the estimated cost of thermal treatment
- recommendations included re-evaluating the potential DNAPL zone to focus on particular subsurface volumes where high PCE concentrations indicate DNAPL, and where thermal treatment would be cost-effective

FY'15 Technical Support for Thermal Treatment Remedies

- Atlantic Water Supply
- Beede Waste Oil Superfund Site, No. 5
- Hunter's Point Naval Shipyard, No. 5
- Iowa Army Ammunition Plant, No. 2
- Letterkenny Army Depot Superfund Site, No.3
- Libby Ground Water Contamination Site
- Lindsay Manufacturing, No. 2
- Resolve Superfund Site
- Savage Well Municipal Water Supply Superfund Site

Hunter's Point Naval Shipyard, No. 5 Site

Dr. Eva Davis (GWERD) reviewed the Draft NAPL Treatment Pilot Study Work Plan Addendum for the Hunter's Point Naval Shipyard, No. 5 site (USEPA Project Manager Yvonne Fong), which provides details of a sampling plan to close perceived data gaps, including:

- giving better delineation of the NAPL area
- providing a detailed understanding of the NAPL properties (e.g. density and viscosity measurements will be made on the NAPL, which is composed of motor oil, aryl phosphate, and other materials)
- correlating hydraulic conductivity to NAPL mobility
- providing a detailed understanding of vertical stratification of horizontal hydraulic conductivities of the fill within the Southwest pond footprint

Dr. Davis' GWTSC conclusions and recommendations included:

- in order to correlate hydraulic conductivity with NAPL mobility, soil borings must be co-located with HPT borings, and NAPL mobility testing must be included for all hydraulic conductivity ranges
- in the Work Plan, the spacing between the Tier 3 samples was greater than 100 feet; a spacing of approximately 50 to 75 feet should be used to give better delineation of the NAPL area
- because the NAPL could change from a DNAPL to an LNAPL or from an LNAPL to a DNAPL during thermal treatment depending on its density response to temperature change relative to that of water, density and viscosity measurements should be made as a function of temperature to aid in designing an effective NAPL recovery and treatment system

An electrical resistance heating (ERH) thermal treatment installation.

Monitored Natural Attenuation (MNA)

In FY'15, GWTSC provided technical support to 16 sites where MNA is used or proposed.

Chem-Dyne Superfund Site, No. 6

Dr. Randall Ross (GWERD), Dr. Daniel Pope, and Dr. Milovan Beljin (CSS-Dynamac) reviewed the Monitored Natural Attenuation Pilot Test Work Plan for the Chem-Dyne Superfund Site (USEPA Project Manager Lolita Hill), where MNA is proposed for part of the remedy for chlorinated solvent-contaminated groundwater.

GWTSC conclusions and recommendations included:

- part of the proposed approach to evaluating the results of the pilot test involved plume stability analysis, which is a widely used approach to helping determine plume behavior. However, the particular plume stability analysis approach proposed had several serious deficiencies, including reliance on a relatively arbitrary value for contaminant concentration changes with depth, and vertically-discrete contaminant concentration data were not used
- trend analyses for contaminant concentrations were poorly correlated with the data
- contaminant concentration decreases appeared to be driven by source removal rather than natural attenuation mechanisms, so extrapolation based on current trends would be highly uncertain
- contaminant concentration trends appeared to be confounded by earlier activities at the site which were not representative of current conditions
- hydrogeologic parameters to be monitored were not specified in the Workplan
- important MNA assessment parameters (nitrate, sulfate, sulfide, alkalinity, total organic carbon [TOC], and dissolved gases [methane, ethane, ethene]) would only be collected once yearly, and only at a few sampling points
- the sources of electron donor and their availability and longevity should be evaluated, particularly if changes in the groundwater flow regime are expected (e.g., cessation of extraction), and if any of the carbon source materials are anthropogenic

FY'15 Technical Support for Monitored Natural Attenuation Remedies

- Armour Road Site
- Bailly Generating Station
- Chem-Dyne Superfund Site, No. 6
- Demmer Properties LLC/Former Motor Wheel Facility Site
- DuPont Pompton Lakes Works, No. 5
- East Mount Zion Landfill
- Eli Lilly & Company/Evonik Deguss Corp., No. 4
- England AFB
- Frontier Fertilizer SF Site
- GM Component Holdings
- Iowa Army Ammunition Plant, No. 2
- Kirtland Air Force Base, No. X
- Occidental Chemical
- Savage Well Municipal Water Supply Superfund Site
- West KL Avenue Landfill, No. 2
- Yerington Mine Site, No. 8

Permeable Reactive Barriers (PRB)

GWTSC provided support to three sites where PRBs are in use.

FY'15 Technical Support for Permeable Reactive Barrier Remedies

- Olean Well Field Superfund Site - AVX Source Area, No. 2
- Savage Well Municipal Water Supply Superfund Site, No. 7
- Somersworth Landfill, No.8

Olean Well Field Superfund Site

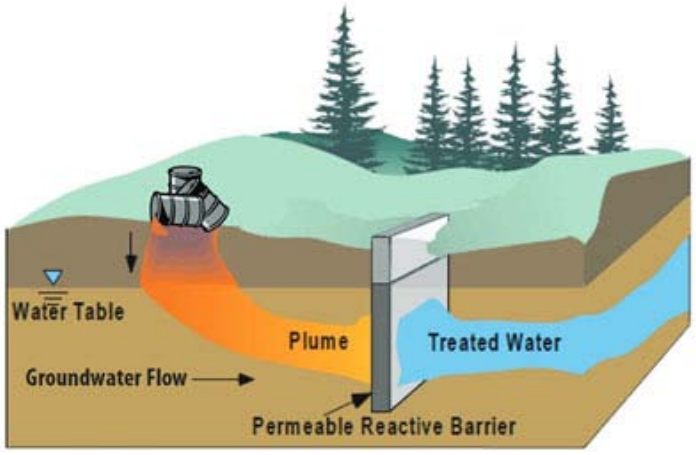
Dr. Ralph D. Ludwig (GWERD) reviewed the Feasibility Study Report for the Olean Well Field Superfund Site (USEPA Project Manager Lorenzo Thantu). This report presented hydraulic containment (trench-based hydraulic containment with above-ground treatment) and permeable reactive barrier (PRB; a zero-valent-iron [ZVI] PRB was proposed) alternatives for remediation of groundwater contaminants including PCE, 1,2-dichloroethane (1,2-DCA), BTEX, and acetone. GWTSC conclusions and recommendations included:

- the trench-based hydraulic containment with above-ground treatment alternative was recommended, primarily because 1,2-DCA, toluene, xylenes, and acetone are not treatable with the proposed ZVI PRB
- design and installation of a PRB capable of treating both the ZVI-treatable and non-ZVI treatable contaminants at the site would be challenging and potentially infeasible

Somersworth Sanitary Landfill Superfund Site

Dr. Richard Wilkin (GWERD) reviewed the Draft Annual Monitoring and Demonstration of Compliance Report for 2014 for the Somersworth Sanitary Landfill Superfund Site (USEPA Project Manager Gerardo Millán-Ramos). Groundwater contaminants include PCE, trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), vinyl chloride (VC), dichloromethane (DCM), and benzene. Remediation efforts at the site include a granular iron chemical treatment wall (CTW). GWTSC conclusions and recommendations included:

- generally, the report's data analysis indicates that the CTW performance meets the compliance requirement at most of the compliance monitoring locations and over most of the sampling rounds
- recurring exceptions include contaminant detections that show up at some locations; the reason(s) as to why these detections occur remains unclear, and additional effort is recommended to identify possible causes and possible ways of verifying the causes
- the analysis of mineral precipitation presented in the report shows no anomalous results; normal geochemical behavior is indicated in the CTW
- the report's analysis of potential underflow, overflow, and lateral bypass of the CTW is reasonable; it is recommended that these potential problems be examined with respect to the recurring detections that show up at some locations

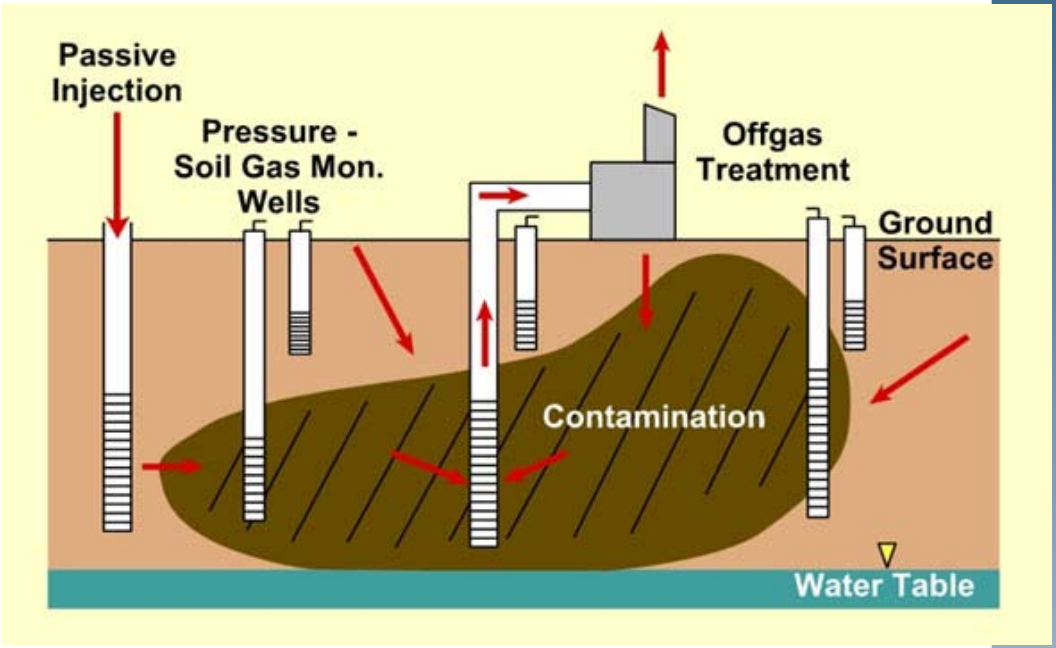


PRB treats a plume of groundwater contaminants.

GWTSC Technical Transfer Special Projects

Is Vacuum Radius of Influence (ROI) Appropriate for Design of Soil Vacuum Extraction Systems?

Problem: The Nevada Division of Environmental Protection (NDEP), Bureau of Corrective Actions (BAC), was developing guidance to "...clarify requirements and assist Certified Environmental Managers (CEMs), case officers, and supervisors with understanding the requirements for the testing, design, installation and operation of effective soil vapor extraction (SVE) systems." A radius of influence (ROI) vacuum of 0.5" water was proposed to be required in soil as a basis of SVE design.



Example of a soil vacuum extraction system.

Question: Is Vacuum Radius of Influence (ROI), commonly used to design SVE systems, an appropriate parameter for design of SVE systems?

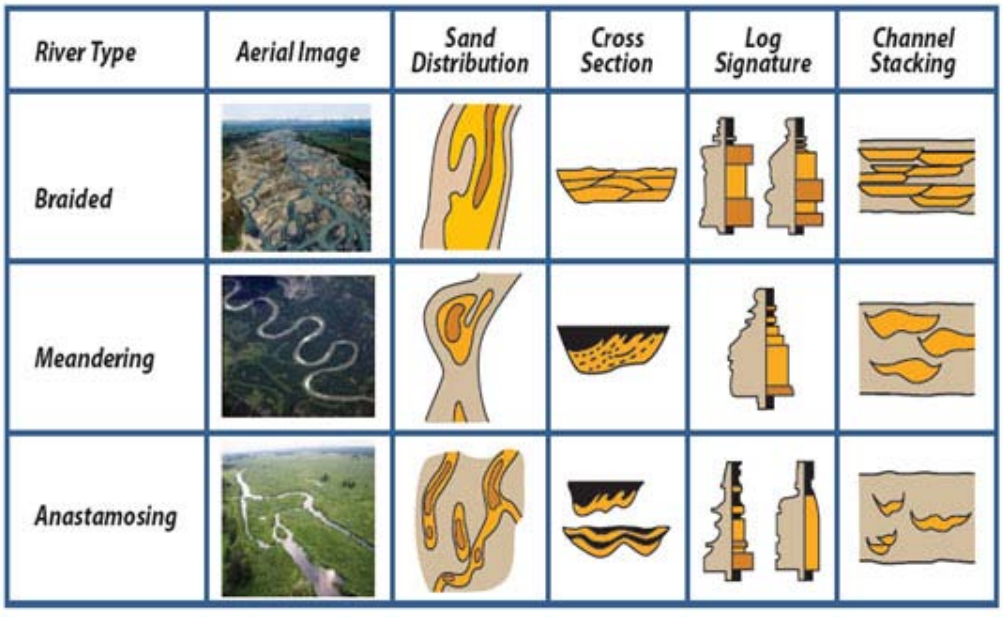
Solution: GWTSC, in collaboration with CSS-Dynamac/subcontractor's SVE technical expert, determined that ROI is not an appropriate parameter on which to base SVE design, because ROI based designs generally do not guarantee sufficient subsurface gas flow to ensure timely remediation. Under some specific (and likely rare) conditions (e.g., an isotropic subsurface domain where radial permeability is equal to vertical permeability, fully open to the atmosphere), the guidance-proposed vacuum of 0.5" could possibly ensure sufficient gas exchange. However, the presence of a semi-confining layer and anisotropy (radial permeability greater than vertical permeability), quite common in subsurface media, would make it likely that a vacuum of 0.5" would not ensure sufficient gas exchange. Therefore GWTSC recommended that ROI-based design approaches should not be used. Rather, more technically defensible criteria based on pore-gas velocity or travel time should be incorporated in the proposed guidance for SVE.

Characterizing the Lithologic Framework in a Depositional Environment

Problem: It is well known that the primary control of groundwater flow and contaminant pathways is the geology of the site. But in the complex environment of sedimentary deposits, the conceptual site models (CSMs) used to guide site characterization, remedy choice/implementation, and performance monitoring, often fail to adequately describe the lithologic heterogeneity in a practically useful manner.

Question: Can a practical, user-friendly CSM elaboration method be created so site project managers can systematically characterize sedimentary environments in detail?

Solution: GWTSC, in collaboration with the USEPA Groundwater Forum and CSS-Dynamac/subcontractors, took insights and approaches developed by the petroleum industry to apply sequence stratigraphy methods for understanding and predicting the permeability architecture of sedimentary deposits. Sediments are organized into repeated, predictable patterns (i.e, sequences) which control permeability architecture in the subsurface. An Issue Paper was developed to provide practical guidance to remediation project teams on proven methods to integrate site geologic information so as to address lithologic heterogeneity at the appropriate scale to select successful remedies.



General classification of fluvial systems and their deposits (modified from http://www.beg.utexas.edu/agi/mod03/graphics/9180.gif). Courtesy of the Bureau of Economic Geology, University of Texas at Austin).

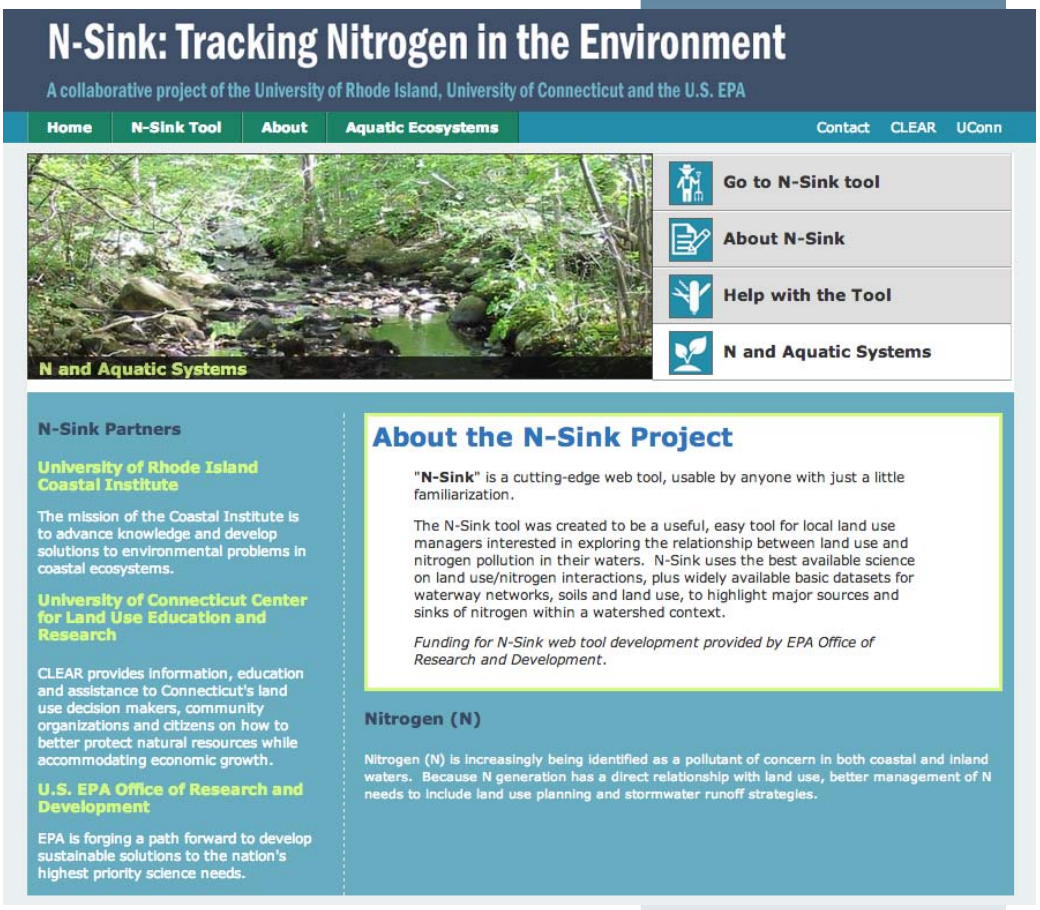
Controlling Nitrogen Sources in Watersheds

Problem: Land use planners, such as town/local planners, county commissioners, residential/commercial developers, and regulators at all levels, must incorporate an understanding of nitrogen sources and sinks in the land use planning process in order to properly provide and design for nitrogen control in land usage. However, the available tools and methods for tracing nitrogen sources, transport and impact are often difficult to understand and use without extensive professional training and experience.

Question: Can a simple decision support tool be developed that will allow land use planners to simply and easily predict nitrogen attenuation and removal due to denitrification and other nitrogen retentive processes by wetlands, streams, riparian zones, and other landscape features in a watershed?

Solution: GWTSC, in collaboration with GWERD researcher Dr. Ken Forshay and CSS-Dynamac/subcontractor the University of Connecticut, built on previous work by the University of Connecticut and collaborators to develop to develop an extended version of the N-Sink Decision Support Tool. N-Sink is a quantitative and spatially explicit model that can be used to

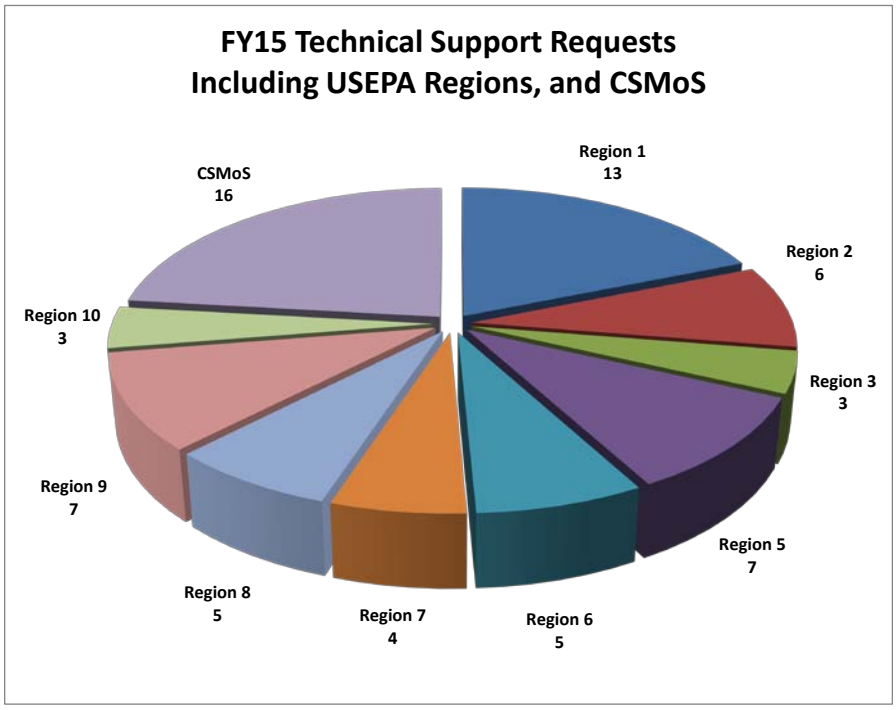
- identify class, type, and locations of nitrogen sources that may be controlled and/or potentially limited by regulators
- identify specific landscape features that act as sinks for nitrogen under current or recent historic conditions
- identify alternate scenarios for different local watershed management schemes based on the results of nitrogen source and sink features identified with the model



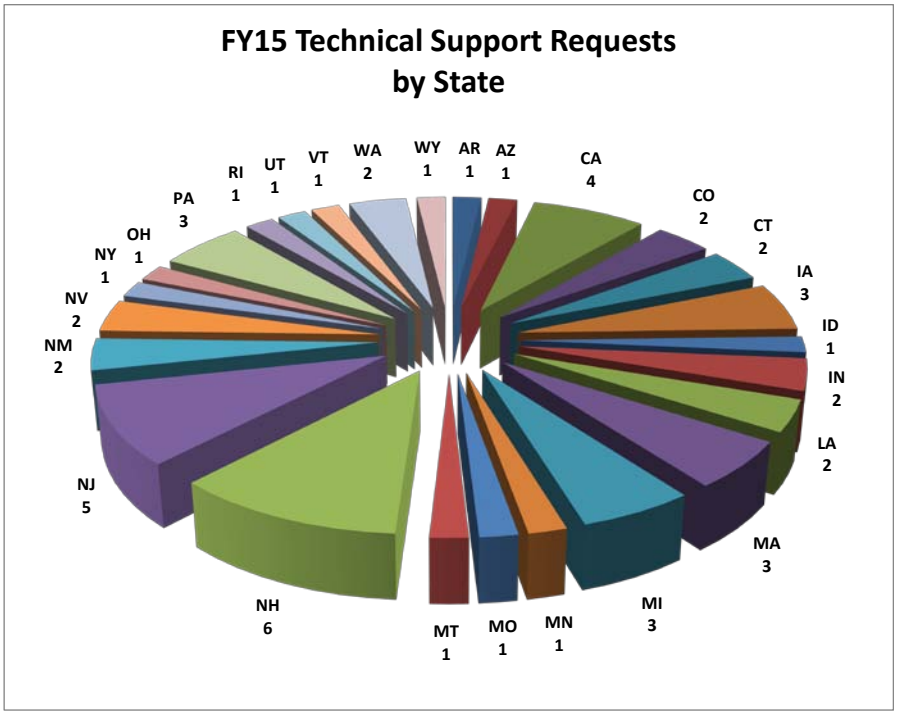
Screen capture of N-Sink web portal, currently residing on the UConn CLEAR server.

GWTSC Technical Support by the Numbers

Most technical support requests come to GWTSC through the USEPA Regional offices or USEPA Headquarters; in some cases such technical support requests can involve direct GWTSC support to states (e.g., state environmental agencies), US Territories, or even foreign countries. GWTSC support is fairly evenly distributed across all USEPA Regions and States over the years, but Regions and States with greater populations, larger historical industrial bases (and therefore usually more Superfund and RCRA sites) generate more technical support requests. Most technical support requests generate several GWTSC responses (i.e., emails, conference calls, review memoranda, meetings, site visits), and support often continues for several years as GWTSC advises on site activities from characterization to remedy evaluation, selection, implementation, and performance monitoring. Note that technical support requests coming into CSMoS are charted separately from Regions/States, because it's not always clear whether a particular CSMoS support request is directly related to a Region or State, and also CSMoS technical support requests are often from individuals (i.e., not federal or state regulators).



Technical support requests including Regions and CSMoS.



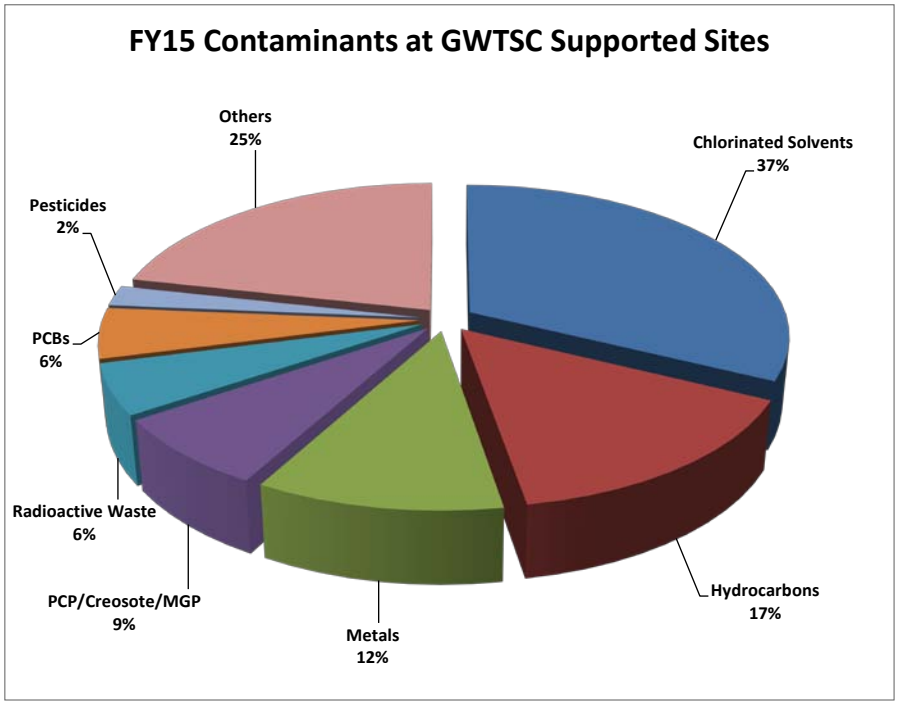
Technical support requests by State.

For sites where GWTSC technical support was provided in FY'15, chlorinated solvents, hydrocarbons (BTEX and other fuel hydrocarbons), various polynuclear aromatics [PAHs]), and metals or metalloids such as arsenic, lead and mercury were the most common contaminants, as shown in the chart below. Wood treating wastes containing pentachlorophenol (PCP) or creosote, radioactive materials such as uranium, and pesticides such as DDT, 1,2-dibromoethane, 1,2-dichloropropane, 1,2,3-trichloropropane, and 1,2-dibromo-3-chloropropane were also problems found at GWTSC-supported sites. The "Other" category includes contaminants such as:

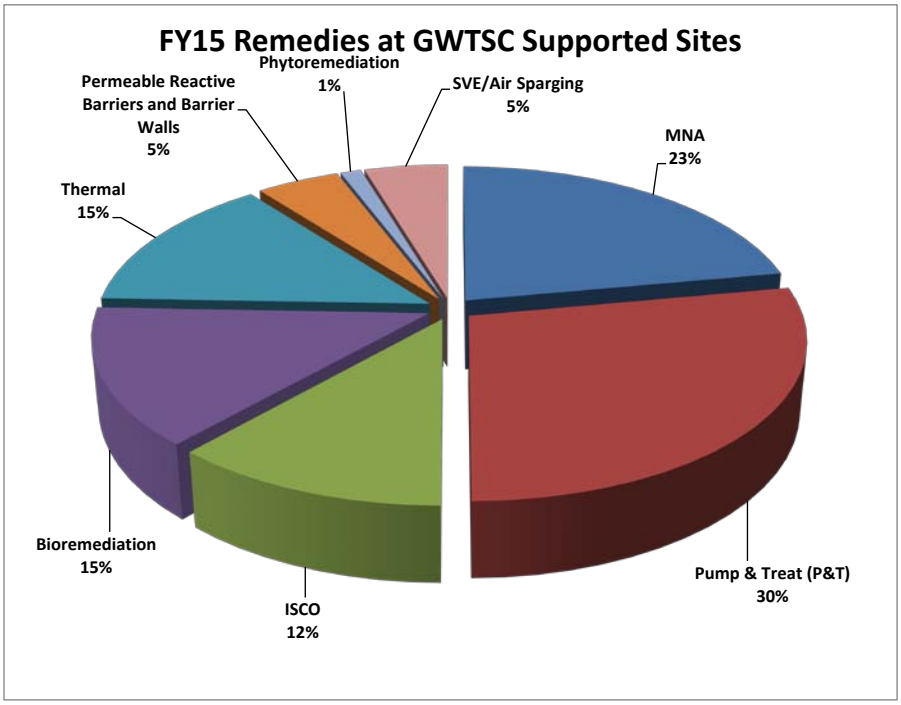
- 1,2-dibromo-3-chloropropane
- 1,2-dibromoethane
- 1,2-dichloropropane
- 1,2,3-trichloropropane
- 1,4-dichlorobenzene
- 1,4-dioxane
- acetone
- acid mine drainage
- bis(2-chloroethyl)ether
- bis(2-ethylhexyl)phthalate
- boron
- brine
- carbon tetrachloride
- chlorobenzene
- dioxins
- furans
- n,n-diethylaniline
- p-chlorobenzotrifluoride
- phosphate
- Royal demolition explosive
- sulfate
- tetrahydrofuran

Many of the "Other" contaminants listed are rarely encountered, and require extensive investigation by GWTSC to determine their environmental transport properties, susceptibility to biotic and abiotic degradation, interactions with other contaminants, appropriate sampling and analysis techniques, etc., in order to properly evaluate characterization, remediation, and monitoring approaches.

Remedies proposed, in testing, or implemented at GWTSC-supported sites in FY'15 include pump & treat (P&T), MNA, bioremediation, ISCO, thermal, and permeable reactive barriers or passive barrier walls, and SVE/air sparging, as shown on the chart below. Most sites have more than one remedy in place or proposed, and remedies may be simultaneous or sequential, as the site progresses from initial remedy implementation to final remedial efforts. For example, P&T (for plume capture and hydraulic control) is often combined with other remedies, such as thermal treatment for source control, MNA/bioremediation for dilute plume remediation, etc.

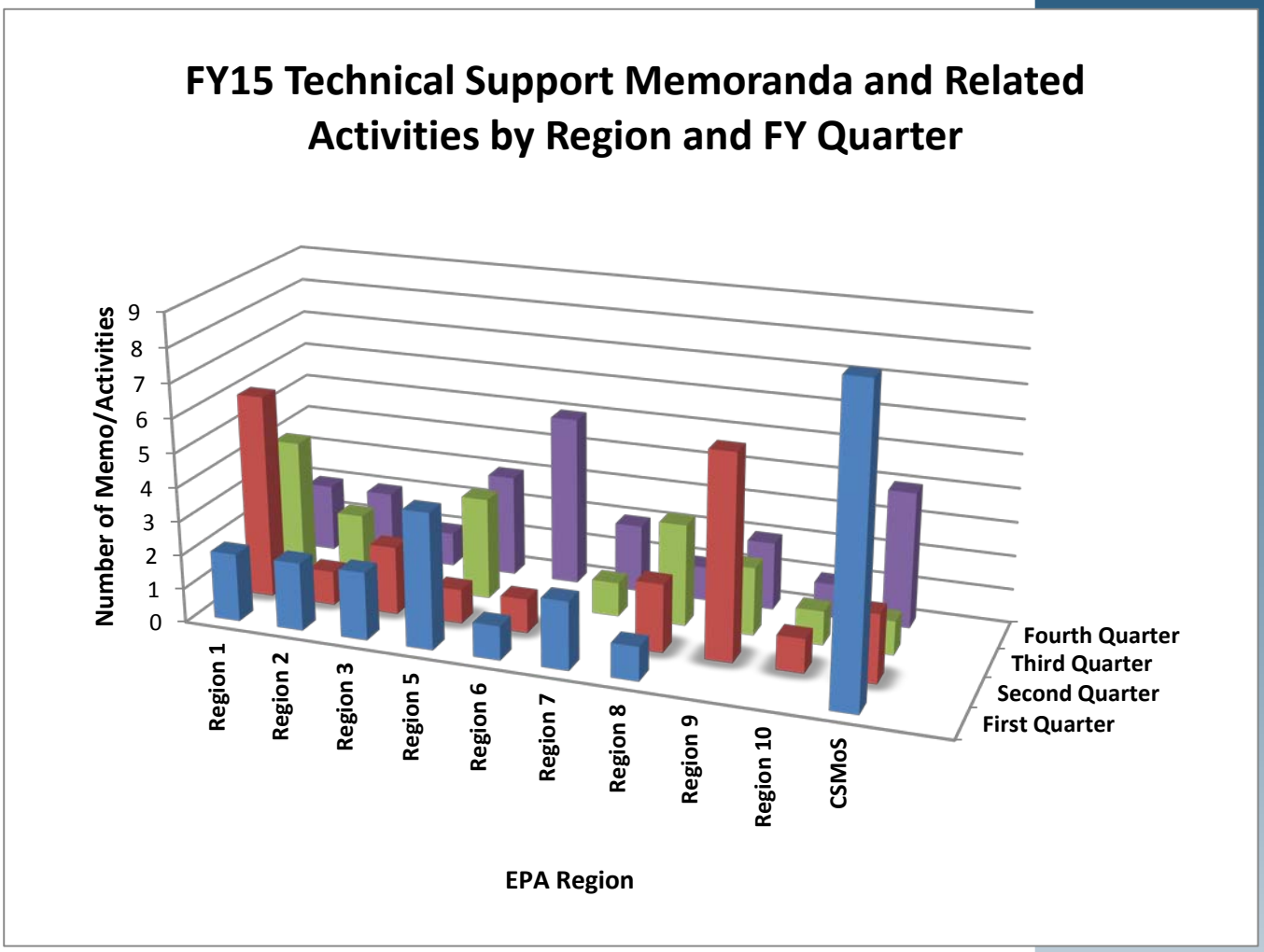


Contaminants at GWTSC supported sites.



Remedies at GWTSC supported sites.

FY'15 technical support memoranda and related activities by USEPA Region and fiscal year quarter are shown in the chart below. However, for almost all GWTSC technical support requests, there are many conference calls and emails provided in addition to formal memoranda for each technical support request, as GWTSC subject-matter experts interact with Regional personnel to assess their technical support needs.



Technical support memoranda and related activities.

Technical Assistance Region III: On October 7, 2014, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Debra Rossi for documents from the Supplemental Site Characterization - Revision 1 (the SSCR), March 2014, for the Delaware Sand and Gravel (DS&G) Site, New Castle, Delaware. A review of the available data and information from data from the SSCR indicates that it is likely that dissolved manganese is being contributed to the plume from both the DS&G Site and the Army Creek Landfill Site. There are locations of detected manganese immediately downgradient of each Site. The contoured manganese concentrations use relatively sparse location data; and not all monitoring wells are "included in current monitoring." It is recommended that a synoptic round of groundwater analyses be conducted if it is desired to have a better definition of the manganese plume(s). There do not appear to be many (or any) data points in the Upper Potomac Confining Unit Transition Zone farther downgradient away from the DS&G Site. This unit may act as a contaminant migration pathway. It is recommended that additional scrutiny of this unit is warranted. It is likely that As and Co in the plume are present as anthropogenic contaminants from the DS&G landfill. If further examination of As and Co is desired, it is recommended that dissolved As and Co concentrations be provided and plotted on cross-section and in map view.

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Technical Assistance Region V: On October 7, 2014, Dr. Daniel Pope (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Donald Heller for the Enhanced Reductive Dechlorination (ERD) Pilot Scale Study Workplan, August 28, 2014, for the Demmer Properties LCC/Former Motor Wheel Facility (Site) located in Lansing, Michigan. In general, a pilot study of ERD for the Site is appropriate, given that the Site conditions appear to be appropriate for successful use of ERD as part of the Site remedial activities for groundwater. As is usually the case for studies of groundwater remediation, there are uncertainties involved in interpreting the data likely to be derived from the study. These problems (uncertainty about groundwater flow direction and the orientation of the treatment zone, incomplete transect coverage across the treatment zone, incomplete depth monitoring, long-screened monitoring wells, etc.) can cause difficulties with interpretation of treatment effectiveness, contamination attenuation rates, treatment timeframes, etc. Therefore, it is recommended that the monitoring well transects be extended to reach all the way across the anticipated treatment zones to define the boundaries of the treatment zone, and three wells within each treatment zone to monitor the "core" of the zone and the fringes, for each transect. Also, we recommend that each treatment zone be monitored with at least one transect that includes vertical monitoring to define the variations (contaminant, geochemistry, reagents) by depth for the zone.

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Technical Assistance Region VIII: On October 30, 2014, Mr. Frank Beodray and Dr. Daniel Pope (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Sam Garcia on groundwater monitoring data reports and documents for the Bountiful/Woods Cross 5th South PCE Plume Superfund Site (the Site), Bountiful and Woods Cross, Utah. The review comments addressed questions posed by EPA Region 8. The PCE plume originated from a former dry cleaner facility founded in the early 1940s that released wastewater from their operation to the subsurface through an underground sump and possibly a former septic system. As indicated in the Site documentation, section, a SVE system was initially proposed and then removed from the Treatment Pilot Study Record of Decision (ROD) objectives. In summary, five years ago SVE was considered and found not to be an effective remedial option based on low concentrations of VOCs. Despite not identifying remaining source material at Bountiful Cleaners Incorporated (BCI), soil gas contaminant concentrations

were elevated and groundwater contamination appears to still originate from the BCI property, suggesting that tetrachloroethene (PCE) contamination remains at the BCI property. It is assumed that the PCE concentrations have decreased in the vadose zone since 2008 but re-evaluation of potential PCE sources may be warranted in lieu of waiting for remaining PCE to enter groundwater for treatment by the GWTS. Investing in a pilot program to evaluate an SVE system does not seem appropriate until such time that the source of groundwater contamination is better identified and defined. Two wells appear to be out of the radius of influence of the extraction well, and the concentration of PCE in one well has actually increased slightly based on the 2013 data. Since well one well has been destroyed, a minimum of two additional wells are recommended for this area to better understand the horizontal and vertical plume migration to the south. Again it is recommended that soil samples be collected from each permeable unit in the unsaturated vadose zone during installation to gain a better understanding of what concentration of PCE remains in each unit.

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Technical Assistance Region VII: On November 5, 2014, Dr. Ralph Ludwig (GWERD) provided technical review comments to RPM Hoai Tran on the "Armour Road Site MNA option for groundwater, North Kansas City, Missouri." Clearly, very extensive and exhaustive site characterization work has already been conducted at the site. The only possible weakness with the work done is the apparent limited information on groundwater redox conditions at the site. In order to defend monitored natural attenuation (MNA) as a viable option for addressing groundwater impacts at the site, a solid conceptual model is needed to demonstrate a good understanding of the geochemical and hydrogeological processes in play at the site and how these processes will act to support the MNA option. Most of this work has certainly been done. Redox characterization would be important in understanding the fate and transport of redox-sensitive constituents such as arsenic. Reduction of arsenic concentrations in groundwater over the short term may or may not be indicative of success. Sufficient time should be allowed for re-establishment of equilibrium conditions in the subsurface. As conditions eventually revert back to the original more reducing conditions (if these were the original conditions). This may explain why a rebound is currently being observed.

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Technical Assistance Region I: On November 25, 2014, Dr. Randall Ross (GWERD) and Dr. Milovan Beljin (CSS-Dynamac) provided technical review comments to RPM Anna Krasko on the "Groundwater Flow and Solute Transport Modeling Report, Picillo Pig Farm Superfund Site, Coventry, Rhode Island." The report focuses on the refinement of the existing model using the shutdown test results and the tracer study results. The flow and solute transport has been and will continue to be a useful management tool at the Site. However, some of the latest model modifications should be re-examined. Most modifications to the current model are based on data collected during the tracer study and the shut-down test. While some model input data were clearly described as the results of the latest investigation, it is not always obvious whether the model parameters were modified, and if so, what the previous model parameter values were. Future modeling efforts should clearly identify which input parameters were modified and provide a list the new input values along the list of the values being replaced.

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Technical Assistance Region V: On November 26, 2014, Dr. Bruce Pivetz and Dr. Daniel Pope (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to Corrective Action Project Manager Donald Heller on the "Treatability Study Report and Remedial Design for the Eli Lilly & Co. - Evonik Corporation Tippecanoe Laboratories, Lafayette, Tippecanoe County, Indiana." The

purpose of the review was to identify any design or scientific problems or issues associated with the pilot-scale treatability study or the full-scale remedial design. Overall, the Report appears satisfactory in that it provides sufficient discussion regarding the results of the pilot-scale study. Its discussions and conclusions appear reasonable. The Remedial Design (RD) recommendations for full-scale remediation and monitoring within each source area appear reasonable and conservative and are supported by adequate and satisfactory discussion. It is recommended that the issues discussed in this technical review be addressed as the RD process continues. An explanation and justification of the use of a presumably average contaminant concentration in calculating the required sodium persulfate mass for all the injection locations within each source area is recommended. It is also recommended additional investigation and discussion of the issue of contaminant sorption, and the possible influence of the injected activated carbon on the sorbed- and dissolved-phase contaminants be provided. Overall, it appears that the enhanced bioremediation component of the pilot study had relatively little effect on subsurface geochemistry and contaminant concentrations. It is recommended that a strong emphasis be placed on use of in-situ chemical oxidation (ISCO) to meet remedial goals, and that the ISCO component be considered the more effective and primary remedial component. The enhanced bioremediation component (if any) could possibly be delayed and ISCO be continued until the remedial goals are met.

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Technical Assistance Region I: On December 1, 2014, Dr. Eva Davis (GWERD) provided technical review comments to RPM Cheryl Sprague on the "100% Pre-Final Thermal Design Report – Phase 1, Beede Waste Oil Superfund Site, Plaistow, New Hampshire." In general, the report presents a complete remedial design for the Phase 1Steam Enhanced Extraction (SEE) for the former Lagoon area of the site, and adequately responds to previous comments. It may be advisable to obtain both PID and FID measurements on the vapor streams, and compare them to the summa canister results to determine which measurement more accurately reflects the contaminant concentration in the vapor phase. Additional information should be provided to explain the contingencies for treating effluent vapors if the thermal oxidizer is down for an extended period of time. Also, clarification should be provided concerning where effluent water from Weir Tank T-109 will be discharged.

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Technical Assistance Region II: On December 8, 2014, Dr. Scott Huling (GWERD) provided technical review comments to RPM Sin-Kie Tjho, and Region 2 Hydrogeologist, Sharissa Singh, on the "Pilot Test Workplan, AOC 1 – Fluoroproducts Area, DuPont Chambers Works, Deepwater, New Jersey." This draft pilot study workplan proposes to use an emerging technology that has had limited application and documentation. Based on technical deficiencies, unclear treatment objectives, and ambiguous ISCO design details, the feasibility of proposed remedial activities is questionable. There are risks and uncertainties associated with the proposed ISCO activities in terms of contaminant fate and transport, the ability to assess treatment performance, the impact of releasing large quantities of chlorofluorocarbon greenhouse gases and VOCs. The proposed design appears to involve a DNAPL mobilization strategy to be deployed in the DNAPL source area. The lack of hydraulic control of ground water contaminants from the source area and the potential for volatile emissions are unacceptable. Proof of concept demonstration of this emerging technology has not been provided, and limited data and information will be provided in proposed pilot scale activities that can differentiate between degradation and non-degradation loss mechanisms. It is recommended that the feasibility of other DNAPL removal technologies be further investigated, including thermal remediation.

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Technical Assistance Region II: On December 10, 2014, Dr. Ralph Ludwig provided technical review comments to RPM Lorenzo Thantu on the "AVX Corporation Feasibility Study Report for the Olean Well Field Superfund Site, Olean, New York." The technical review included the subject report and other available documentation pertinent to evaluation of the hydraulic containment and permeable reactive barrier (PRB) alternatives for the AVX Corporation property associated with the Olean Well Field Superfund Site in Olean, New York. While both alternatives appear to be technically sound and appropriate options for treatment of groundwater in the till unit, the trench-based hydraulic containment alternative with above-ground treatment appears to be the better and more reliable choice. This is primarily because there are some contaminants that have been released on the AVX property (or that are otherwise present on the AVX property) that are not amenable to treatment with a ZVI-based permeable reactive barrier — this being the type of PRB being proposed for implementation at the site under the PRB alternative. Other issues include some uncertainty with regard to the longevity of a PRB and the fact that a PRB would be less amenable to alteration/modification should the contaminant plume geometry or direction change over time. The significantly higher costs of the hydraulic containment alternative including the need for an above-ground treatment system that will need to be maintained and secured for decades, however, would be strong factors in favor of the PRB alternative were it not for the presence of the ZVI non-treatable contaminants on site.

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Technical Assistance Region V: On December 11, 2014, Dr. David Burden (GWERD), and Dr. Daniel Pope (CSS-Dynamac) provided Donald Heller, Region 5, a summary of the conference call on the PM Environmental Response to Comments on the Enhanced Reductive Dechlorination (ERD) Pilot Scale Study Workplan, August 28, 2014 Demmer Properties for the Demmer Properties, LLC/Former Motor Wheel Facility, Lansing, Michigan. The vadose and saturated subsurface zones at the Site are contaminated with contaminants including the chlorinated alkenes trichloroethene, 1, 2-dichloroethene, and vinyl chloride. The Workplan provided a proposed approach to a pilot-scale study of ERD as part of the remediation effort for the Site. A pilot study for the Site is appropriate, with some additional clarification of the proposed approach. Enhancement of the proposed monitoring system - including the three additional monitoring wells proposed in the Response, and one additional monitoring well located on the west end of the E transect, downgradient of the PSMW-C4 monitoring well – would be desirable to reduce uncertainty (e.g., about changes in geochemistry, rates of degradation, etc.).

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Technical Assistance Region VIII: On January 12, 2015, Dr. Eva Davis (GWERD), provided technical review comments to Andrew Schmidt, Regional Hydrogeologist, and RPM Kathryn Hernandez, on the "Draft Work Plan for the Pilot Test for Steam Enhanced Extraction followed by Biosparging" for the Libby Groundwater Site, in Libby, Montana, dated November 21, 2014. In general, the planned Steam Enhanced Extraction (SEE) pilot test should be able to provide data and other information specific to the objectives listed in the Work Plan, however, it may not be possible to collect definitive data on all objectives. It is less clear that the biosparging portion of the pilot study will produce useable data for the design of a full scale system. Aspects of the Steam Injection System that should be addressed include: Energy Balance, Low permeability zone, Groundwater Modeling, Wellfield layout, Vapor Extraction and Monitoring Wells, Steam Injection Pressures, Steam Injection Screens, and Vapor Extraction. Also, the

operational plan should be described in the Work Plan, including criteria for moving from one phase of the pilot study to another. It is not recommended that the pilot study be operated by the calendar, but by achieving the stated goal of each phase of operation. Concerning the above-ground treatment system, recommendations include reviewing all of the specified materials to ensure that they are compatible with creosote and the temperatures they will encounter at their point of use.

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Technical Assistance Region I: On January 14, 2015, Dr. Scott Huling (GWERD) provided technical review comments to RPM Richard Hull on the "Draft Feasibility Study Report Savage Municipal Water Supply Superfund Site: Bedrock Contamination" (621 Elm Street Milford, New Hampshire). Prior to the deployment of the proposed pilot study where additional field data and information will be obtained on oxidant transport, distribution, and persistence, it is recommended that one of the objectives of the pilot study involve establishing a spatial correlation between the volume of oxidant injected and the transport distance of the oxidant from the injection location. In general, this is referred to as the radius of influence (ROI). Currently, it has been proposed that the ROI will range from 20-35 feet or 10-15 feet, depending on the injection system and targeted zone. The Authors have assumed the volume of oxidant proposed to be injected will achieve the design ROI. However, no calculations or scientific basis was provided to validate the design. There are several factors that could be taken into consideration that will play a role in this relationship but may be difficult to quantify or to definitively evaluate in a critical analysis. The spatial correlation between oxidant volume and ROI could be evaluated empirically during field scale deployment. Such information could be used to more definitively design the injection volume for full scale deployment appropriate for specific depth intervals, targeted zones, and contaminated areas.

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Technical Assistance Region I: On January 15, 2015, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Mr. Steven Acree (GWERD), provided technical review comments to RPM Karen Lumino on the Spring 2014 Compliance Monitoring Report for the Pine Street Canal Superfund Site. In addition, the report entitled Completion of Work Report, Pine Street Canal Superfund Site, Vertical Barrier, July 2014 (the Completion Report) was reviewed as background material to support review of the current and future compliance monitoring reports. The technical review indicated that the conditions (extent and magnitude of contamination) do not appear to have changed significantly from previous monitoring periods. Further, there does not appear to be any evidence of non-performance of the vertical barrier to date. Continued monitoring is recommended. Additional NAPL observations and measurements (i.e., in wells where they are not to be made during future monitoring events) could be useful to fully understand and confirm the extent of NAPL. The comments below provide discussion of this point.

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Technical Assistance Region I: On January 20, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Cheryl Sprague on the "Updated Demonstration of Compliance Plan (DCP), Phase 1 Thermal Remediation, Beede Waste Oil Superfund Site, Plaistow, New Hampshire." In general, the Updated DCP responds adequately to previous comments. However, additional clarification on 'diminishing returns,' groundwater sampling, and interim soil sampling is warranted. If the operation of the thermal remediation is to continue past 150 days, additional groundwater data would provide a valuable line of evidence in determining if the system is approaching diminishing returns. It is recommended that interim soil sampling be

used to determine if additional remedial treatment is needed. The Plan indicates that the thermal remediation system would be shut down if sufficient natural gas is not available for operation. Other fuel types should be considered for producing steam before resorting to shutting off the steam injection system before the soil cleanup goals or diminishing returns are met.

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Technical Assistance Region II: On February 5, 2015, Dr. John Wilson and Dr. Daniel Pope (CSS-Dynamac) under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Brian Quinn, on the "Bio-Injection Pilot Study Conducted for Groundwater Operable Unit 1 (OU-1) at the Radiation Technology Inc. (RTI) Superfund Site in Rockaway Township, New Jersey." At the Site, perchlorate contamination occurs in groundwater in granite bed rock and the overlying weathered granite (saprolite). Comments were incorporated into letters provided by EPA, the New Jersey Department of Environmental Protection (NJDEP), Alliant Techsystems Inc. (ATK), and contractor Conestoga-Rovers & Associates. EPA and NJDEP believe that the results from the pilot test do not provide sufficient evidence to confirm that emulsified soy lactate can be effectively injected into the groundwater system. It is the Agencies' decision that the pilot test be rerun as specified in the previously approved work plan or a new work plan needs to be submitted for approval. Conestoga-Rovers respectfully disagree with the EPA and NJDEP general comment. The bench scale study and the pilot study have shown that the injection of vegetable oil into the groundwater system was accomplished and has biodegraded perchlorate. It is acknowledged that adjustments are needed to optimize the delivery of vegetable oil into the aquifer. CSS-Dynamac addressed concerns whether it would be possible to deliver the vegetable oil to mix with perchlorate contamination in the groundwater, in particular to perchlorate contamination in the fractured granitic bedrock. The Conestoga-Rovers response acknowledges that the conditions used in the pilot test were not adequate to deliver the vegetable oil to the fractured granitic bedrock, and offers one alternative approach. Whether the Pilot Test is considered a success or failure, the next reasonable step to selecting a remedy is to identify and validate approaches that will successfully deliver vegetable oil to the contaminated groundwater in the fractured granitic bedrock, or to consider other approaches to manage the risk associated with the perchlorate contamination at the site.

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Technical Assistance Region IX: On February 12, 2015, Mr. Steven Acree (GWERD) and Dr. Robert Ford (LRPCD) provided technical review comments to RPM David Seter, on the "Groundwater Geochemical Characterization Data Summary Report (DSR)," Yerington Mine Site, Yerington, Nevada. The report presents the results of groundwater sampling performed in August 2014, including data from wells recently installed east of West Campbell Ditch. Results for several of the constituents useful in understanding contaminant distribution and transport were plotted on depth-specific site maps. The report also contained analyses of the correlation between various parameters. Although this information will be useful in the assessment of geochemical conditions and contaminant mobility, the DSR did not fully address the content envisioned in the remedial investigation work plan, as noted in the cover letter submitted with the report. The cover letter requests that additional technical discussions regarding the thermodynamic database take place prior to completing the evaluation of contaminant mobilization/attenuation processes. It is recommended that these discussions take place as expeditiously as possible to mitigate further delays. In addition, specific suggestions for data presentation and evaluations to support the

assessment of geochemical mobilization/attenuation processes were provided for consideration

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Technical Assistance Region I: On February 17, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Richard Hull on the "Draft Feasibility Study (FS) Report for the Bedrock Contamination at the Savage Municipal Water Supply Superfund Site in Milford, New Hampshire." The Remedial Action Objectives (RAOs) for the site, as well as EPA's Technical Impracticability (TI) Wavier Guidance, requires treatment of principal threat waste (commonly defined as dense nonaqueous phase liquid (DNAPL)) to the extent practicable. From the discussion provided in the Draft FS, it appears that thermal treatment of the bedrock is technically feasible, but costly, having significantly greater costs than the other alternatives that were evaluated. In light of the fact that thermal remediation has the greatest potential for achieving RAOs, and will achieve them more quickly than any of the other technologies evaluated, it is recommended that there be an evaluation of the potential benefits of treating smaller, less costly areas with thermal remediation. The Draft FS includes the costs to treat different sized areas, however, the cost/benefits of treating the smaller sized areas is never evaluated. This evaluation should take into account the exposure pathways that are most probable to be complete in the future, to determine the extent of thermal treatment needed to ensure that the exposure pathways cannot be completed.

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Technical Assistance Region I: On February 25, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Cheryl Sprague on the "Updated Construction Quality Assurance Project Plan (CQAPP), the Draft Site Management Plan (SMP), the Draft Remedial Action Work Plan (RAWP), and the Draft Health and Safety Plans (HASP) for Beede Waste Oil Superfund Site in Plaistow, New Hampshire." There were no comments on the HASP or SMP. There were only minor comments on the CQAPP and RAWP that were in the interest of maintaining consistency between the documents.

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Technical Assistance Region III: On March 5, 2015, Dr. Daniel Pope and Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Sharon Fang on the "Monitored Natural Attenuation (MNA) at the North Penn Area 5 Superfund Site, Colmar, Pennsylvania." Several documents were included in this review. It appears that the NA mechanisms that would play a significant part in an MNA remedy for the Site would be mostly non-destructive mechanisms. Note that especially where non-destructive NA processes are the most significant part of an MNA remedy, plume control may be desirable even if remediation is likely to be difficult. To the extent that the data available for this review indicate that destructive NA mechanisms are operating at the Site. The question to be considered at this point is if MNA is feasible under the current site conditions. Reviewing the data that appear to indicate that destructive NA processes are not significant at the Site, it appears that achievement of the desired downgradient ground-water contaminant concentrations by an MNA remedy will likely be a very long-term process.

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Technical Assistance Region IX: On March 9, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Yvonne Fong on the "Draft NAPL Treatment Pilot Study Work Plan Addendum for the Former Installation Restoration Site 03, Former Waste Oil Ponds, Parcel E, at Hunters Point Naval Shipyard in San Francisco, California." The work plan (WP) states that effective implementation of the activities requires the flexibility to make dynamic decisions while performing field work and that meetings

will be held after the collection of the Tier 1 and Tier 2 soil samples to determine how to proceed with the soil sampling. A flow chart may be very helpful to show how the data collected will affect future field work. The WP also states that density and viscosity measurements will be made on the NAPL. Because thermal treatment is being considered for at least part of the area, it is recommended that density and viscosity measurements be made as a function of temperature. The density of the NAPLs already measured are mostly close to the density of water. It is possible that NAPL could change from a DNAPL to an LNAPL or from an LNAPL to a DNAPL during thermal treatment, depending on its density response to temperature change relative to that of water. Knowledge of the density change in response to temperature would aid in designing an effective NAPL recovery and treatment system. It is recommended that clarification be provided for the area for which hydraulic conductivity profiles are required.

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Technical Assistance Region IX: On March 9, 2015, Dr. Milovan Beljin (CSS-Dynamac), under the direction of Dr. Randall Ross and Mr. Steven Acree (GWERD), provided technical review comments to RPM David Seter to supplement responses to previous comments on the "Groundwater Flow Model Supplemental Materials, Yerington Mine Site, Yerington, Nevada." The primary goal foreseen for the Yerington groundwater model is to provide a management tool that can be used to evaluate possible remediation options. As noted in the model calibration report, the groundwater flow model should continue to be modified as new data are collected. Because the reviewed model is only a groundwater flow model, the next step of developing a solute transport component that can simulate transport processes that will impact concentrations of chemicals in groundwater should proceed. It appears appropriate to move forward with the modeling process with the understanding that certain aspects of the flow model and its assumptions may need to be revisited during the development of the solute transport model and evaluation of the modeling results. While groundwater modeling may provide a useful tool for better understanding current conditions and potential remedial options, the performance of any selected remediation strategy should ultimately be determined by a properly designed performance monitoring network.

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Technical Assistance Region I: On March 13, 2015, Dr. Daniel Pope (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Juan Perez on the "Proposed In-Situ Enhancements for the Former Medallic Arts RCRA Facility, Danbury, CT." Enhanced anaerobic bioremediation (EAB) is a remedial approach commonly used as part of site remedies for sites with tetrachlorethene (PCE-), trichloroethene (TCE-), dichloroethene (DCE-), and vinyl chloride (VC-) contaminated groundwater. It seems likely that EAB could be useful for part of the Site remedial activities. However, it is not clear from the EAB Memo which groundwater parameters are planned to be monitored to evaluate EAB effectiveness. Also, it is not clear how the amount of reagent to be injected was determined. Calculations should be shown for this determination. The proposed EAB program is directed to only a small part of the Site. It is not clear that remediation of this small portion would be sufficient to meet Site remedial goals. Perhaps this initial effort is a pilot-scale test to determine the efficacy of EAB, and then EAB will be extended to the rest of the Site, but this is not stated in the EAB Memo. A discussion of the Site remedial goals in relation to the scope and extent of the proposed EAB program should be provided.

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Technical Assistance Region IX: On March 13, 2015, Dr. Milovan Beljin (CSS-Dynamac), under the direction of Dr. Randall Ross (GWERD), provided technical

review comments to RPM Andrea Benner on the "RI Report Appendix L, Groundwater Model Documentation Memorandum, Cyprus Tohono Mine Site, Tohono O'odam Nation, Arizona." It should be noted that the current groundwater model simulates only groundwater flow. It is anticipated that the model will be adapted in the future to include contaminant transport to support the evaluation of potential remedial alternatives as part of the Feasibility Study. The groundwater flow model encompasses the entire CTC Mine Site. Considering the existing sulfate, uranium, and perchlorate plumes at the Site, the focus of the model should be the basin-fill aquifer. The model limitations should be recognized, particularly regarding the bedrock aquifer. In spite of its limitations, the model will play important role in evaluating remedial alternatives. The Report should include two additional sections: (1) model sensitivity, and (2) water budget. In addition, particle-tracking scenarios would be useful for the model calibration. The visualization of the complex three-dimensional system is a challenge. Additional cross-sections, particularly in the plume area, are recommended, several additional tables were also suggested.

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Technical Assistance Region I: On March 16, 2015, Dr. Richard Wilkin (GWERD), provided technical review comments to Gerardo Millán-Ramos on "DRAFT Annual Monitoring and Demonstration of Compliance Report for 2014; Somersworth Sanitary Landfill Superfund Site, Somersworth, New Hampshire," dated February 20, 2015. The comments focus on the performance of the granular iron chemical treatment wall (CTW). It is recommended that the report include some additional explanation describing results of monitoring well sampling results. Overall, the data analysis indicates that the CTW performance meets the compliance requirement at most of the compliance monitoring locations and over most of the sampling rounds. There seem to be spurious detections that show up at some locations, and the reason(s) as to why these detections occur remains unclear. It would be helpful if the report were to specifically call out the locations where detections >ICL have been noted and list possible causes and possible ways of identifying the cause(s). It is also recommended that a specific figure be constructed to show the important trends that lead to conclusions stated in the report.

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Technical Assistance Region X: On March 18, 2015, Dr. Scott Huling (GWERD), provided technical review comments to Dean Yasuda, Washington State Department of Ecology, on "Persulfate In-Situ Chemical Oxidation Bench Test Work Plan GE 220 South Dawson St. Facility (Draft)." In general, the proposed testing will provide useful information regarding the technical feasibility of In-Situ Chemical Oxidation (ISCO) at the site. In the Study Design and Procedures, it was reported that iron activation was selected as the most appropriate activator. It was proposed that iron will be added to select vials as ferrous sulfate and will be chelated with citric acid to enhance the iron solubility in the vial. The results from these tests may provide some insight regarding what may occur at field scale under similar conditions. Since this test will involve a complete mix test condition, the role of citrate may not fully represent the extent to which it plays a role in Fe transport assuming the citrate-Fe complex is eventually injected into saturated porous media. Other recommendations include an alternate, easier method be considered to measure persulfate anion that the use of ascorbic acid be considered to preserve samples prior to CVOC analysis.

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Technical Assistance Region III: On March 19, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Rashmi Mathur on the "Draft-Final 35% Remedial Design for Electrical Resistance Heating (ERH) of Groundwater at the Property

Disposal Office (PDO) Area Oil Burn Pit (OBP), PDO Operable Unit 4, at the Letterkenny Army Depot in Chambersburg, Pennsylvania. There are several concerns with the expectations of the Technical Evaluation Group (TEG) laid out in this document. First, while it should be a goal for the TEG to reach consensus on the technical issues pertaining to the thermal remediation, it cannot be guaranteed that a consensus will be reached on all issues. It would be more appropriate to ask the TEG for recommendations on various issues. If the TEG's recommendations are accepted, then the TEG would endorse the system as being – in their opinion - adequate to determine changes in groundwater quality related to the operation of the remediation system. In addition, the TEG should have input on the monitoring network and the sampling frequency to demonstrate that these operational goals are met. There are three thermal remediation technologies that are commonly used today, and there is considerable overlap in the applicability of these technologies. For this site, Thermal Conductive Heating (TCH) may be a better technical fit if the resistivity of the bedrock is not compatible with ERH. Generally, a 35% Design for a thermal remediation system is conceptual in nature, and lays out the Basis of Design for a thermal vendor. This document does not provide a Basis of Design, but provides very specific design details that would likely have the effect of eliminating some vendors from bidding on the project. It is recommended that, in order to increase the number of bids received and to obtain the best price for the remediation, the detailed design information in this 35% Design be taken out.

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Technical Assistance Region IX: On March 23, 2015, Dr. Richard Wilkin (GWERD) provided technical review comments to CPM Lily Lee on "Mercury Evaluation at Parcel B, Installation Restoration Site 26 Work Plan, Hunters Point Naval Shipyard, San Francisco, California," dated February 2015. An evaluation of the mass discharge of mercury to the bay near high-concentration wells was recommended as a follow-up action in the third 5-year review of remedial actions for this site. Comparison levels of mass discharge will be needed in order use the information collected in this new effort. The work plan indicates that samples for mercury concentrations will be collected 2 feet below the water table and at an unspecified location near the bottom of aquifer, close to the surface of bedrock. It is recommended that: 1) the sample collected 2 feet below the water table is referenced to the maximum water level as expressed by tidal influences at the site, and 2) additional sampling points in the vertical direction be added between specific locations. It is important that the work plan clearly describe how mass discharge of mercury will be calculated at various points in the aquifer. The work plan should also be revised to indicate how the hydraulic gradient will be determined and how variability in the hydraulic gradient will be handled in the mass flux estimates. Also, it would be useful to map the proposed locations of wells that will be equipped with pressure transducers.

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Technical Assistance Region II: On March 30, 2015, Dr. Scott Huling (GWERD), provided technical review comments to RPM Sin-Kie Tjho and Sharissa Singh on the "Pilot Test Workplan, AOC 1 – Fluoroproducts Area, DuPont Chambers Works, Deepwater, New Jersey." An experimental technology involving a combination of hydrogen peroxide (H_2O_2) and permanganate are proposed to oxidize and reduce a complex mixture of contaminants including chlorofluorocarbons (CFCs). Calculations were provided projecting that the mass of H_2O_2 to be injected into the DNAPL pilot study area would result in many pore volumes of O_2 (g) that would sparge the DNAPL zone. Subsurface pressurization and O_2 (g) migration in heterogeneously distributed gas channels in the subsurface, and transport of contaminants in a direction of decreasing energy were also projected. Inducing widespread vacuum and capture of volatile emissions by the SVE system in the 3-4 ft unsaturated zone would be challenging under

pressurized conditions from O2 (g) sparging. The proposed performance evaluation period (30 days) would represent transient conditions and insufficient time for chemical equilibrium of time-dependent mass transfer and transport mechanisms. The supporting bench scale tests permitted volatile emissions to escape during the testing period. Given the volatile nature of the contaminants in the test reactors, conclusions regarding the test results are uncertain. The global warming potential (GWP) for a gas is a measure of the total energy that a gas absorbs over a particular period of time. Chlorofluorocarbons, such as CFC-11, exhibit a GWP of 5350, this means that the CFCs will cause 5350 times as much warming as an equivalent mass of carbon dioxide and therefore much greater impact on greenhouse warming. Given the uncertainties with the bench test results, the basic treatment process, the ISCO deployment system, the role of non-degradation fate mechanisms, the capture of volatile emissions, and the sensitive nature of CFC releases, it was recommended that the technology not be deployed and that other technologies be evaluated.

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Technical Assistance Region I: On April 1, 2015, Mr. Steven Acree (GWERD), and Dr. Bruce Pivetz (CSS-Dynamac), provided technical review comments to RPM Joseph LeMay on the "Deeper Bedrock Investigation Work Plan, New England Plastics (NEP) Subsite, Wells G&H Superfund Site." The investigation proposed in the Work Plan for identification of transmissive features in existing deeper bedrock wells and for characterization of water quality in those zones appears to be sound in technical aspects and should satisfy the characterization objectives. No additional studies appear to be necessary to satisfy the characterization objectives. In general, the phased approach proposed in the Work Plan appears appropriate, in that it will provide time for analysis and review of the geophysical data collected from the wells, and identification of key fracture zones prior to collection of groundwater samples from those fracture zones. However, it does mean that there will be two mobilizations to the site (one for geophysical logging and the second for sample collection). Thus, timely analysis and review of the data and selection of proposed key fracture zones will be necessary to have all work completed in one field season.

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Technical Assistance Region V: On April 4, 2015, Dr. Randall Ross (GWERD), Drs. Daniel Pope and Milovan Beljin (CSS-Dynamac), provided technical review comments to RPM Lolita Hill on the "Monitored Natural Attenuation (MNA) Pilot Test Work Plan, Chem-Dyne Superfund Site, Hamilton, Ohio." MNA has been widely used at chlorinated solvents sites since the 1990s, and has been shown to be capable of making substantial contributions to meeting remedial goals for such sites. The general outlines of the degradative processes of major importance for control of the chlorinated solvents and their daughter products are well established, and numerous tools for their characterization and evaluation have been developed. However, because MNA is not in itself an active, engineered remedial approach, it is generally understood that MNA may require more intensive site characterization and monitoring than other remedial approaches. Further, MNA is not viewed as a viable remedial option for areas impacted by residual source material, which may be present in the vicinity of MW-15, as indicated by persistent elevated VOC concentrations. It is important to choose carefully the data set to be used in a trend analysis. For the MNA evaluation of contaminant trends, it is important to use only data taken during the MNA evaluation period, so that the analysis considers only the trends occurring while the MNA evaluation is being conducted, and confounding influences are minimized. It is important to obtain a complete hydrologic data set during the MNA evaluation because the proposed termination of the extraction system will change the groundwater flow regime at the Site, and because seasonal changes in groundwater flow may occur. The Workplan indicates that the current extraction system. However, given that the extraction system

is pumping at relatively small rates from a highly productive aquifer, it is not clear that stopping the extraction system would make any significant change related to enhancing biotic degradation.

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Technical Assistance to Region IV: On April 21, 2015, Dr. Scott Huling, (GWERD) provided a presentation to RPM Lila Llamas, and staff from the US Navy, US Marine Corp, South Carolina Department of Health and Environmental Control, TetraTech Inc., and EnSafe Inc. The presentation was a summary of in-situ chemical oxidation (ISCO) research activities at the Parris Island Marine Corp Recruit Depot, Site 45, Beaufort, South Carolina. Site characterization activities included pre- and post-oxidation collection and analysis of soil cores, and installation of micro-wells and pre- and post-oxidation ground water sample collection and analysis. The ISCO pilot scale demonstration study involved three rounds of sodium permanganate oxidant injection utilizing various injection methods. A low cost, mobile, injection system was designed, built, and deployed, and oxidant injections occurred over a 10 month period in a PCE source area where numerous subsurface and surface utility impediments were present. The oxidant injection design involved heavy oxidant loading (mass, volume), and the injection strategy included short vertical injection intervals, narrow ROI's, low injection pressure, top-down/outside-in injection to minimize the role of heterogeneities and to achieve greater probability of oxidant delivery to targeted zones. While significant destruction of CVOCs was achieved, post-pilot study oxidant injection was recommended to further achieve treatment objectives.

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Technical Assistance Region X: On April 22, 2015, Dr. Scott Huling (GWERD), provided technical review comments to Kira Lynch (Superfund Technical Liaison) regarding various documents involving the potential use of in-situ chemical oxidation (ISCO) at the Occidental Chemical site in Tacoma, Washington. In-situ chemical oxidation (ISCO) in the heavily industrialized and contaminated marine environment at the Occidental Chemical facility presents several potential technical challenges. Technical issues include oxidant toxicity to marine life, the impact of tidal influences and subsurface utilities on oxidant transport, the impact of large quantities of DNAPL, the potential need for a pump and treat system in conjunction with a deep barrier wall, oxidant selection, the upwelling discharge of oxidant residuals, and the potential use of a combined remedy approach.

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Technical Assistance Region VIII: On April 22, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Kathryn Hernandez on the "Draft Final Workplan (WP) for the Pilot Test for Steam Enhanced Extraction (SEE) followed by Biosparging for the Libby Groundwater Site in Libby, Montana," and the response to comments provided by International Paper. In general, the responses address previous concerns raised on the November 21, 2014 Draft WP. However, some significant concerns remain on the energy balance for the SEE, and additional questions are raised by some of the responses to comments received. The WP should provide an energy balance which includes a table which quantifies the amount of energy needed to heat the target treatment zone from ambient temperature to the target temperature, the energy input rate as steam during the planned 20 day heatup period, the extraction rate of energy as hot water and as steam, and heat losses to the overburden and underburden. The table should show that the planned energy input is sufficient to heat the target treatment area in 20 days, as called for in the design of the SEE pilot. All calculations should also be included. Additionally, the WP should clarify that the SEE pilot will not be terminated before at least three pressure cycles have been completed even if NAPL recovery ends before pressure cycling is initiated.

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Technical Assistance Region I: On April 23, 2015, Dr. Scott Huling (GWERD), provided technical review comments to RPM Darryl Luce on the "Technical Specifications for In-Situ Chemical Oxidation (ISCO) via Soil Mixing (Draft, 15 April 2015)," Kearsarge Metallurgical Corp. Superfund Site, Conway, New Hampshire. Comments and recommendations address several technical issues. Consideration of these matters in subsequent revisions to the technical specifications report could be useful in the development of this ISCO-related remedy. There are various requirements that have been specified in the report, but oxidant volume is not included. Since the persulfate solution is colorless, it will be difficult to assess the extent to which the persulfate oxidant is adequately mixed into each treatment cell. Additionally, there are no field methods that are proposed to assess and confirm oxidant distribution in the aquifer. It is recommended that a quantitative descriptor be developed that establishes a correlation between the volume of oxidant injected relative to the targeted zone of each treatment cell. The objective is to establish a general guideline in the volume of oxidant required to be injected into each cell, in conjunction with soil mixing, to establish sufficient oxidant coverage.

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Technical Assistance Region II: On April 24, 2015, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Mr. Steven Acree (GWERD), provided technical review comments to RPM Clifford Ng on the "Draft Onsite Groundwater Interim Remedial Measures (IRM) Pilot Study Work Plan, DuPont Pompton Lakes Works, Pompton Lakes, New Jersey." This technical review evaluated the IRMWP for selection of treatment area locations, dimensions, and depths; technical validity of the treatment technology evaluations and selection of a technology; and process and performance monitoring plans. This technical review evaluated the IRMWP for selection of treatment area locations, dimensions, and depths; technical validity of the treatment technology evaluations and selection of a technology; and process and performance monitoring plans. The IRMWP appears to be well-written and accurate in technical aspects. In general, the delineation of the treatment zones (laterally and vertically), and the proposed methods, appear to be appropriate. The selection of ISCO as the treatment technology, rather than horizontal sparging or soil mixing, is appropriate. The process and performance monitoring approach appears acceptable. However, consideration could be given to establishing a baseline against which to conduct the performance monitoring. One recommendation is to consider establishing a baseline against which to compare the performance monitoring results. Another recommendation is to conduct the injections in a "top-down" manner, that is, injecting at progressively deeper depths rather than injecting while extracting the probe from a borehole.

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Technical Assistance Region VI: On April 29, 2015, Dr. Scott Huling (GWERD), provided technical review comments to RPM Stephen Tzhone regarding the document entitled, "Supplemental Groundwater Tracing Summary Report Arkwood, Inc. Superfund Site, Omaha, Arkansas", prepared by Ozark Underground Laboratory (March, 2015). It was proposed in the tracer study report that New Cricket Spring captured all the injected tracer and that any uncaptured tracer residuals were likely detained within the immobile porosity associated with the porous media. An additional fate mechanism not evaluated nor considered in the fate and transport assessment was that some of the tracer in the ground water could have migrated laterally, and bypassed the capture zone created by the naturally occurring spring. Multiple lines of evidence presented in this report and in previous reports, indicate that a ground water flow divide exists on site resulting in multi-directional ground water flow. Consequently, multiple contaminated ground water flow directions away from on-site waste management

areas would occur and complete capture by the New Cricket Spring was projected to be unlikely. Ground water flowing beneath the waste management area located on the north side of the property, adjacent to the train tracks, would be particularly vulnerable in avoiding capture given that it flows in nearly the opposite direction of the spring. It was recommended to re-evaluate the feasibility of the New Cricket Spring ground water treatment system to fully capture all of the contaminated ground water emanating from the area encompassed by the Arkwood Superfund site.

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Technical Assistance Region I: On May 4, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Cheryl Sprague on the "Updated Operations and Maintenance Plan (OMP) for the Beede Waste Oil Superfund Site, Plaistow, New Hampshire," dated April 2015. In general, the Updated OMP responds to the concerns on the March 2014 Draft OMP. Recommendations include the identifying the perimeter air monitoring locations, and identifying the size and boundaries of the exclusion zone, the contaminant reduction zone, and the support zone. This information should be shown on figures in the OMP. Also, the OMP should ensure that the Standard Operating Guidelines contain the appropriate information for the Beede Oil site.

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Technical Assistance Region I: On May 15, 2015, Dr. Scott Huling (GWERD), provided technical review comments to RPM Joseph LeMay and Alex Sherrin, On-Scene Coordinator, on the figures and tables provided in the Focused Review of Environmental Status of 60 Olympia Avenue Woburn, Massachusetts (April 21, 2015). This transmittal involved an update on the in-situ chemical oxidation (ISCO) associated with remediation at Wells G&H Superfund Site, Olympia Nominee Trust Property, and was prepared by GeoInsight, Inc. The data and information presented indicate that long term contact between the permanganate and TCE is resulting in contaminant oxidation. Originally it was projected that remediation would involve a long term and slow treatment process. Examination of Table 2 indicates that larger volumes of oxidant and lower concentrations have generally been carried out from 2008-2014. This is a good shift in the ISCO design and implementation as it allows greater opportunity for contact between the oxidant solution and the contaminants in the porous media. The comments provided generally recommend that whenever [TCE] is rebounding or persisting, to assure there is sufficient oxidant in the general vicinity of the monitoring location by injecting oxidant nearby using either the injection wells or direct push.

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Technical Assistance Region IX: On May 26, 2015, Dr. Randall Ross (GWERD) and Dr. Milovan Beljin (CSS-Dynamac) provided technical review comments to RPM Bonnie Arthur on the "Frontier Fertilizer Groundwater Model Update and Capture Zone Analysis, Frontier Fertilizer Superfund Site, Davis, CA." The current groundwater flow model differs from the previous version (CH2M HILL, 2003) as it includes numerous changes (e.g., simulates transient rather than steady state conditions, increased number of layers, finer grid spacing, different aquifer parameters). However, the overall improvements to the model, while significant, have not resulted in an adequately calibrated model capable of achieving the original objectives. While many of the calibration hydrographs show very good agreement between simulated and measured water levels, the same cannot be said for the potentiometric surface maps, specifically for layers 2 and 3. A properly calibrated flow model should be able to approximate not only the hydraulic heads, but also the direction and the magnitude of hydraulic gradients across a site.

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Technical Assistance Region II: On June 1, 2015, Dr. John T. Wilson and Dr. Daniel Pope (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided a summary of comments to RPM Brian Quinn following the May 5, 2015 conference call with EPA Region 2 related to the Bio-Injection Pilot Study Conducted for Groundwater Operable Unit 1 (OU-1) at the Radiation Technology Inc. (RTI) Superfund Site in Rockaway Township, NJ. The purpose of the call was to discuss possible paths forward at the Site, as related to the bioremediation pilot study. The main topic of concern was the performance of an existing bioremediation pilot test, and implications of the test results for the path forward. During the pilot test, a suspension of emulsified vegetable oil was pumped into an injection well. Natural biodegradation of the vegetable oil was intended to provide fatty acids and other metabolic products that would support biodegradation of the perchlorate contamination in the groundwater. Sampling results from the pilot test indicated that although concentrations of perchlorate were reduced in some of the monitoring wells near the injection well, there was no direct evidence that the vegetable oil or degradation products of the vegetable oil reached the monitoring wells. As a result, the reduction in concentrations of perchlorate could not be directly attributed to the bioremediation of the perchlorate.

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Technical Assistance Region VII: On June 10, 2015, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Sandeep on the Draft OU-3 Off-site Annual Groundwater Monitoring Report and Sampling & Analysis Plan, Environmental Remedial Action Services, Iowa Army Ammunition Plant, Burlington, Iowa, April 2015. The Site has a groundwater plume containing royal demolition explosive (RDX), with a core area that has been defined by concentrations greater than 50 micrograms per liter (µg/L) and a larger more diffuse plume with RDX concentrations above 2 µg/L. The Record of Decision (ROD) selected the injection of an electron donor (sodium acetate) into the core area to create reducing conditions that would allow enhanced (anaerobic) biodegradation of the RDX. The larger diffuse plume was to be treated using Monitored Natural Attenuation (MNA) to reduce RDX concentrations. The GW Report/SAP discusses the current conditions at the Site, after a series of sodium acetate injections that started in 2007. RDX concentrations in the core area of the plume have not yet reached the goal, and RDX concentrations have increased in three wells in the core area of the plume. Continuing the injections of sodium acetate in locations where RDX is above 50 µg/L is recommended. The natural attenuation processes/mechanisms in the lower-concentration portion of the plume appear to be primarily dilution and dispersion, rather than biodegradation. It is recommended that the proposed additional sodium acetate injections inject a greater sodium acetate mass into the subsurface, to both address the core area, and to determine if there is any downgradient transport of electron donor that might enhance the biodegradation in the more diffuse area of the plume downgradient. It is also recommended that MNA monitoring continue to include RDX and its breakdown products (for each annual sampling), as well as the geochemical MNA parameters after an injection event and at each 5-year review.

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Technical Assistance Region II: On July 9, 2015, Dr. Rick Wilkin (GWERD), provided technical review comments to RPM Ray Klimcsak regarding the Sherwin-Williams United States Avenue Burn Site Characterization Summary Report, and some text from the Hilliards Creek Site Characterization Report regarding arsenic in groundwater. One general comment that seems to come up often is the lack of filtered and unfiltered metals data from groundwater and surface water. In any future sampling, both filtered and unfiltered data should be collected. It would be worthwhile to have a figure

showing the key water level elevations through time that lead to the conclusion that upward vertical gradients are predominant at the site. It is suggested that elevated concentrations of aluminum, arsenic, barium, copper, iron, lead, mercury, and vanadium may be linked to entrainment of solids in the samples. This should be further documented with filtered and unfiltered sample pairs. It is stated that aluminum, iron, manganese, and sodium are present at naturally occurring levels. It is further stated that arsenic and lead are likely the result of constituents in soil in the Burn Site Fenced Area. It is not clear what this means – are the arsenic and lead levels derived from dissolution of solids in the soils or are solids in the soils appearing in the unfiltered samples and being digested? As it is now, the data are not conclusive. The Hilliards Report notes that arsenic is present as a result of the dissolution of naturally-occurring arsenic in soil. While natural arsenic may indeed be the source, reducing conditions created by LNAPL contamination establish the geochemical conditions that enable arsenic mobilization. In other words, if there was no LNAPL contamination, then it is unlikely that there would be arsenic appearing in groundwater.

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Technical Assistance Region VI: On July 31, 2015, Mr. Steven Acree (GWERD) and Dr. Bruce Pivetz (Dynamac Corp.) provided technical review comments to RPM Nancy Fagan on the most recent Annual Monitoring Reports for both the Colfax Treating Company site in Alexandria, Louisiana. The review focused on specific aspects of site characterization and the effectiveness of ongoing groundwater remediation. The Alexandria Site is an active creosoting operation where railroad ties are treated. The Pineville Site is an active creosoting operation where telephone poles and pilings are treated. The aqueous plume at the Alexandria Site appears to be generally defined for the Upper Aquifer. The capture zones of the recovery wells may extend over a significant portion of the plume, based on a screening-level capture zone width calculation. However, the available data are not sufficient to support a detailed assessment of the capture zone of this recovery system. Insufficient information was available in the Alexandria Report to fully evaluate the extent and distribution of DNAPL, and potential downward migration pathways. Additional data may be available from previous investigations.

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Technical Assistance Region VII: On August 17, 2015, Dr. Eva Davis (GWERD) provided technical review comments to Susan Fisher, On-Scene Coordinator, on the "Removal Reassessment Report (Revision 01)" for the former Atlantic Water Supply Site, now called PCE Former Dry Cleaner, Atlantic, Iowa. The purpose of my review of the characterization data was to determine if, in my opinion, the source area is completely delineated to define the area to be treated using Electrical Resistance Heating (ERH). It is recommended that a soil sample be obtained for laboratory analysis from at least one of these locations to determine if any of these PID responses indicate PCE soil concentrations above the soil cleanup criteria. Field screening for soil contamination should be completed at the time the sample is obtained. It is also recommended that soil samples be obtained from some of these peaks for laboratory analysis to confirm the southern boundary of the contamination. It is of significant concern that the total depth of the contamination above cleanup criteria does not appear to be defined. For the purpose of determining whether additional vapor intrusion monitoring may be warranted above the dissolved phase plume, it is recommended that the western extent of the dissolved phase plume be determined by permanent monitoring wells.

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Technical Assistance Region VIII: On September 1, 2015, Dr. Junqi Huang (GWERD) and Dr. Chunming Su (GWERD), provided technical review comments and

recommendations on the report "Performance and Influence of the Marlin 29-21 Water Disposal Well on the Madison Formation in Fremont County, Wyoming", conducted by Tetra Tech and Wyoming Oil and Gas Conservation Commission (WOGCC) to U.S EPA Region 8. The primary recommendations include: 1) aquifer draw down test data to inform sustained yield, 2) an updated aquifer exemption request based on revised modeling (i.e., applicant did not request any increase or change in the ¼-mile radius originally requested), 3) a report on future water supply demand or use by an independent expert, 4) information regarding the relationship of the Marlin well to the overall Moneta Divide Project, associated projected injection well counts (i.e. no injection and production wells proposed) and projected produced water volumes for disposal. The EPA review team identified a number of most critical technical concerns that should be brought to the attention of WOGCC and discussed UIC, EPR and ORD perspectives. The EPA anticipates additional discussion with the WOGCC and the applicant regarding the modeling and water quality reports provided.

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Technical Assistance Region V: On September 10, 2015, Dr. Chunming Su (GWERD) and Dr. Junqi Huang (GWERD), provided technical review comments and recommendations to U.S. EPA Region 5 (Shari Kolak) on the report "Contingent Remedial Alternatives Evaluation Update and Preliminary Evaluation of MNA". The report prepared by Golder Associates Inc. in accordance with the revised Work Plan – "Request for Additional Work", dated February 10, 2015, approved by USEPA. The report summarized the evaluation and implement additional source control/contingent remedies to reduce 1,4-dioxane and THF concentrations in groundwater and to prevent further migration of the plume into Van Buren County. The primary recommendations are: 1) Aerobic bacterial degradation of the contaminants is likely the main mechanism of natural attenuation. More detailed microbial investigations should be helpful in this evaluation of the biological degradation. Active remediation may be necessary in some locations where contaminants are persistent. Injection of aerated water or oxygen releasing compounds may be used to create more favorable conditions for microbial degradation; 2) The fate and transport in vadose zone is the fundamental process for mass delivery. It is suggested to simultaneously simulate the fate and transport in the vadose zone for the volatile organic compound (benzene); 3) The leaching of concerned compounds from the landfill site (source area) is a key factor in evaluating the natural attenuation process. The leaching kinetics is worth investigating if fate and transport model in the vadose zone needs to be implemented. The mass flux generated from the leaching process in the source area (top of vadose zone) would provide a reliable boundary condition for the development of a full 3D saturated/unsaturated flow and transport model.

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Technical Assistance Region IX: On September 16, 2015, Dr. Dominic DiGiulio (CSS-Dynamac), under the direction of Dr. Scott Huling (GWERD), provided technical review comments and recommendations on the draft guidance document Guidance for the Design and Operations of Soil Vapor Extraction (SVE) Systems Internal Draft - July, 2015 (NDEP SVE Guidance), developed by the Nevada Division of Environmental Protection (NDEP), Bureau of Corrective Actions (BAC). It is apparent from reading the NDEP SVE Guidance that the State of Nevada has struggled with poorly designed SVE systems. Thus, their effort in developing a NDEP SVE Guidance is commendable. There is a substantial amount of information available from EPA and the U.S Army Corps of Engineers which could be used to improve the NDEP SVE Guidance. Additional discussion should be provided in the NDEP SVE Guidance on any applicable requirements for treatment of extracted soil vapors, in order to properly design SVE systems. Also, a considerable amount of research has been conducted since

publication of these guidance documents; this research should be considered during continued development of the NDEP SVE Guidance.

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Technical Assistance Region I: On September 24, 2015, Dr. Eva Davis (GWERD) provided technical review comments to RPM Jim Brown on the "Draft Surface Design Electrical Resistance Heating, South Municipal Water Supply Well Superfund Site, Peterborough, New Hampshire. In general, the Draft Design does not present the level of detail required for every remedial design. The Design should demonstrate to the Environmental Protection Agency (EPA) and other stakeholders that the system is adequate to meet the needs of the remedial action. The design should describe the site characteristics that are important for the remedial system, an overview of the remedial technology, a summary of any design calculations and/or modeling that were performed, a description of the operation and operational stages of the remediation including the estimated time for each of these stages, treatment performance evaluation, details on the utility requirements, and descriptions of the major equipment, including tanks and pumps. For a thermal remediation system such as this, an energy balance is also required. Permit requirements for air and water discharge should be presented, and how these requirements will be met should be discussed. Additional comments on the Subsurface Design were discussed during a conference call held on September 21, 2015, between Hull & Associates, TRS, EPA, and New Hampshire Department of Environmental Protection (NHDEP).

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Technical Assistance Region VII: On September 28, 2015, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RPM Sandeep Mehta on the *Draft Final OU-3 Off-site Annual Groundwater Monitoring Report and Sampling & Analysis Plan* (GWMR/SAP), *Environmental Remedial Action Services, Iowa Army Ammunition Plant, Burlington, Iowa, August 2015, the Response to Comments on the Draft OU-3 Offsite Annual Groundwater Monitoring Report and Sampling & Analysis Plan Dated April 2015, and Draft Annual Surface Water Monitoring Report* (SWMR) f*or Brush Creek, Environmental Remedial Action Services, Iowa Army Ammunition Plant, Burlington, Iowa, August 2015*. The GWMR/SAP appears to have been appropriately revised to address the issues raised in the previous technical review comments prepared by the EPA reviewers in June 2015. No additional changes appear to be necessary. This technical review concurs with the findings of the SWMR that "*there is insufficient information to draw conclusions regarding the impact of surface water RDX concentrations on MW-123 groundwater RDX concentrations.*" It is recommended that the surface water hydrology be investigated for a better understanding of the "reported...losing stream" portion of Brush Creek. The discharge at the upper and lower ends of the supposed losing stream reach could be measured to determine if surface water is being lost to the groundwater. Only when this losing reach is firmly established hydrologically, can there be an attempt to quantify any potential contribution of RDX in surface water to the groundwater.

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Technical Assistance Region I: On September 29, 2015, Dr. Bruce Pivetz (CSS-Dynamac), under the direction of Dr. David Burden (GWERD), provided technical review comments to RCRA Facility Manager, Aaron Gilbert, on the Memorandum: *Review of Potential Impacts to Biological Receptors Resulting from the Proposed Downsizing the Groundwater Remedial Effort at the Hamilton Sundstrand Facility, Windsor Locks, CT*. The documents reviewed relate to a proposal to deactivate extraction wells (EWs) at the Site. Groundwater at the Site is contaminated primarily by trichloroethene and hexavalent chromium which are co-located in a plume that has migrated toward seeps and surface

water bodies. A groundwater extraction and treatment system has been operating since 1995 to protect Rainbow Brook, other downgradient water bodies, and a number of seeps. The RSE provides recommendations to deactivate a large fraction of the EWs, and to decrease the extent and frequency of groundwater monitoring. Region 1 indicates that "*HS believes with the reclassified groundwater, off-site Seep Collection System, and continued monitoring that they could comply with the applicable State Remediation Standards even if they were to shut down select wells within their pump and treat system (P&T). However, because of the 1994 Consent Order, HS is required to seek EPA concurrence before taking such action*".

Scientific and Technical Publications

Bell, James M. (Civil Engineering, 607th Support Squadron, Osan AB, Korea), John A. Christ (Commander's Action Group, U.S. Air Force Academy, CO), Junqi Huang (GWERD), Mark N. Goltz (Air Force Institute of Technology, AFIT/ENV, Wright Patterson AFB, OH), Avery H. Demond (Univ. of Michigan, Ann Arbor, MI). 2015. "Remediation Complications: Subsurface Cracking at Hazardous Waste Sites." The Military Engineer (TME). Vol. 107, No. 693, January-February 2015.

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Harrison, Melanie D., (National Oceanic and Atmospheric Administration, Southwest Region, Protected Resources Division, Santa Rosa, CA. (formerly PhD Student from Univ. of Maryland-Baltimore County at GWERD)), Andrew J. Miller (Univ. of Maryland-Baltimore County, Baltimore, MD), Peter M. Groffman, (Cary Institute of Ecosystem Studies, Millbrook, New York City, NY), Paul M. Mayer (USEPA, Corvallis, OR (formerly GWERD)), Sujay S. Kaushal (Univ. of Maryland, College Park, MD). 2014. Hydrologic Controls on Nitrogen and Phosphorous Dynamics in Relict Oxbow Wetlands Adjacent to an Urban Restored Stream. Journal of American Water Resources Association (JAWRA) 1-18. Volume 50, Issue 6, Pages 1365-1382, December 2014.

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Huang, Junqi (GWERD), Mark N. Goltz (Department of Systems Engineering and Management, Air Force Institute of Technology, Dayton, OH). 2015. Semianalytical solutions for transport in aquifer and fractured clay matrix system. Water Resources Research, 51, doi: 10.1002/2014WR016073.

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9-3/9-4-15 Jim Weaver (SRB), Chicago, IL. Conference p.pt. presentation for Brownfields 2015, Chicago, IL.

9-14/9-16-15 Jim Weaver, Ken Jewell (SRB), Kristie Hargrove (ARTS), Phoenix, AZ. Conference p.pt. presentation (Jim Weaver) at the 25th Tanks Conference, Phoenix, AZ.

9-21/9-22-15 Jim Weaver (SRB), Norman, OK. Conference p.pt. presentation at the University of Oklahoma, International Water Center Conference.

9-28/9-29-15 Jim Weaver (SRB), Oklahoma City, OK. Conference p.pt. presentation at the Groundwater Protection Conference.

About the Robert S. Kerr Environmental Research Center

The Ground Water and Ecosystems Restoration Division (GWERD), under the leadership of Division Director Dr. Richard Lowrance, pursues areas of investigation that are part of the Office of Research and Development's (ORD) Strategic Plan and the mission of the National Risk Management Research Laboratory. GWERD is EPA's center of expertise for investigation of the soil and subsurface environment and ecosystem restoration. To carry out its mission, the division is divided into four branches: Subsurface Remediation Branch, Ecosystem and Subsurface Protection Branch, Applied Research and Technical Support Branch, and Technical and Administrative Support Staff. In addition, GWERD's Science Research Council oversees and guides the scientific focus of the division and is supported by individual research teams and principal investigators who provide direction for approved projects and specific efforts

The Division's research programs include basic studies to enhance understanding of the physical, chemical, and biological processes that control the transport of mass and energy in surface and subsurface ecosystems through the movement of water; the impact of these processes on surface and subsurface ecosystems; and, the application of this process understanding to protect and restore water quality throughout a watershed. A broad range of expertise and scientific disciplines are represented at GWERD, with professionals who are microbiologists, chemists, hydrologists, ecologists, environmental scientists, geochemists, soil scientists, chemical and environmental engineers, and modelers.

Photograph of the R.S. Kerr Environmental Research Center, Ada, OK.

Photograph by: David S. Burden
Drone Operator: Ken Jewell