Measurement & Monitoring:
29th Quarterly Literature Update & Grant Survey

The references selected for this update have been added to the searchable literature database developed for the Measurement and Monitoring Technologies for the 21st Century ($21M^2$) Web site: www.clu-in.org/programs/21m2/litsearch.cfm

Adaptive Long-Term Monitoring at Environmental Restoration Sites
Harre, K., T. Chaudhry, R. Greenwald, W. Jian, C.B. Davis, M. Zavislak, and B.S. Minsker.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-155, 2008

The recently developed Summit software is intended to reduce costs and improve effectiveness of long-term monitoring, while achieving remediation goals. The software comprises 2 major modules: Sampling Optimizer and Data Tracker. The purpose of Sampling Optimizer is to identify redundant sampling locations and/or frequencies in historical data. The purpose of Data Tracker is to assist users in comparing current monitoring data with historical data to identify cases where current data deviate from expectations based on historical values and patterns. Model Builder, an additional component primarily used by Sampling Optimizer, has two sections: one for model fitting, visualization, and analysis, and another for visualizing relative uncertainty. This presentation discusses the results of application of the Summit monitoring tools at Camp Allen Landfill, Norfolk Naval Base (Norfolk, VA); the Former George Air Force Base (Victorville, CA); and the Former Nebraska Ordnance Plant (Mead, NE). Kriging using quantile transformation qualitatively provided the best representation of the measured data, relative to other combinations of interpolation technique (inverse distance weighting) and data transformation (log or none) options. The Sampling Optimizer provided useful trade-off curves of sampling cost versus the error that results from removing samples. These tradeoff curves allow the user to identify optimal monitoring plans that represent significant reductions in the number of samples with acceptable loss of information. The software allows the user to select a monitoring plan along the tradeoff curve and view a map of the plume generated with the full data set versus the plume generated with the optimized number of samples. The user determines visually if that plan provides an adequate representation of the plume, and if not, the user can select other plans along the tradeoff curve. Data Tracker quickly identified many situations in which current data deviate significantly from historical values and patterns and provided useful displays of concentration versus time for further evaluation and reporting. The software was easy to learn and use for a typical DoD analyst/contractor.
http://www.serdp-estcp.org/Symposium2008/Posters/upload/W131-Harre.pdf

Advances in Rock Core VOC Analyses for High Resolution Characterization of Chlorinated Solvent Contamination in a Dolostone Aquifer
Kennel, Jonathan, Master's thesis, University of Waterloo, ON, Canada. 226 pp, May 2008

To address contamination at fractured rock sites, multiple methods focusing on different aspects of the hydrologic system are required, and particular emphasis needs to be placed on the rock matrix. This thesis shows the further development and utility of the decade-old CORE(tm) method for volatile organic compounds (VOCs) in rock matrices when used in conjunction with multiple high-resolution datasets as it applies to a 100-m thick highly productive dolostone aquifer located in the northwestern quadrant of the municipality of Guelph, Ontario. The research site and surrounding area was a productive zone for water supply until the early 1990s,

when the two closest municipal supply wells (Sacco, Smallfield) were shut down (in 1991 and 1993, respectively) due to VOCs in the ground water. TCE was used as a degreaser at the Guelph site and likely entered the ground water more than 20 years ago. This thesis comprises four chapters. Chapter 1 provides a brief background to the rock-core VOC method and gives the conceptual framework for the investigation. Chapter 2 focuses on the further development of the rock-core VOC method by providing the field validation of a recently adapted extraction method for VOCs in rock cores using microwave-assisted extraction (MAE), demonstrating the importance of rapid field preservation of samples, and comparing to the industry standard purge and trap method for VOCs on solid matrices. Chapter 3 creates high-resolution porosity and bulk density logs by using selected geophysical logging tools in combination with core-derived physical properties for the purpose of calculating porewater concentrations from total contaminant mass concentrations obtained from the rock-core VOC method and sample specific rock properties relevant to the conversion. Chapter 4 is a demonstration of the discrete fracture network approach applied to the Guelph field site with emphasis on the insights gained through high-resolution contaminant profiles generated from cored holes in or near the source area and along a transect. Together, the four chapters present a framework for investigating VOC contamination in fractured sedimentary rocks with emphasis on evaluating recent advances in the rock-core VOC methodology in a field context.
http://uwspace.uwaterloo.ca/handle/10012/3666

Application of Compound-Specific Carbon and Chlorine Stable Isotopes for Fingerprinting Sources of Chlorinated Compounds in Groundwater
Aravena, R., Univ. of Waterloo, Canada.
International Symposium on Advances in Isotope Hydrology and Its Role in Sustainable Water Resources Management, 21-25 May 2007, Vienna (Austria). International Atomic Energy Agency, Report No IAEA-CN-151 (Paper No IAEA-CN-151/24), Vol 2, p 445-452, 2008

Environmental isotopes offer a unique approach for fingerprinting sources of organic contaminants in groundwater. This paper presents the first novel application of the combined use of Cl-37 and C-13 to evaluate the contribution of two sources to TCE contamination. The first source was on site (located in Pleasant Hill, CA), the second an off-site source producing TCE by biodegradation. The contamination is located in unconfined to semi-confined sand stringers within a fairly tight silty clay matrix aquifer and a deeper confined aquifer consisting of sand beds. The stable isotope data showed a very distinct and significantly different isotopic fingerprint for the primary source of TCE compared to the off-site source. The different signatures make it possible to relate downgradient contamination to the respective sources and clearly demonstrate that the off-site source contributes to TCE contamination at the site. These results demonstrate the great potential of the combined use of Cl-37 and C-13 for fingerprinting organic contaminant sources in groundwater.
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1310Vol2_web.pdf

Application of Fluorescence In Situ Hybridization Technique to Detect Simazine-Degrading Bacteria in Soil Samples
Martin, M. (Complutense Univ., Madrid, Spain), A. Gibello, C. Lobo, M. Nande, C. Garbi, C. Fajardo, A. Barra-Caracciolo, P. Grenni, M.J. Martinez-Inigo.
Chemosphere, Vol 71 No 4, p 703-710, 2008

A specific oligonucleotide probe (AtzB1) was designed to evaluate the natural attenuation capacity of soil by using fluorescence in situ hybridization (FISH). The probe was based on the sequence data of the atzB gene involved in the hydrolytic deamination of s-triazines; this gene, located in a multiple copy plasmid was detected by the optimized FISH protocol. Two agricultural soils with a history of simazine treatments and two natural soils without previous simazine exposure were studied. AtzB1 probe-target cells were found only in the agricultural soils. The FISH method used in this study was suitable for the detection of simazine-degrading bacteria and could be a useful indicator of soil bioremediation potential.

Application of Tools to Measure PCB Microbial Dechlorination and Flux into Water during In-Situ Treatment of Sediments
Baker, J. (Univ. of Washington, Tacoma); A. Chang, U. Ghosh, S. Fagervold, P. Paul, B. Kjellerup, and K.R. Sowers (Univ. of Maryland).
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-194, 2008

SERDP research project ER-1502 is quantifying the two most important long-term loss processes of PCBs in sediments: microbial degradation and diffusive and resuspension-related losses to the water column. High-throughput molecular and activity analyses of Grasse River sediment showed an in situ enriched microbial population consisting of Dehalococcoides phylotypes with a high dechlorination potential and a high concentration of congeners containing unflanked chlorine substitutions. In microcosms spiked with Aroclor 1260 congeners were reductively dechlorinated in all samples independent of GAC sequestration. The dominant dechlorination products formed in GAC treated samples were mono and di-chlorinated congeners. In untreated samples the main products were tetra-chlorinated congeners. Aerobic slurries of the sediment showed a significant decrease in the mass of di-, tri-, and tetrachlorobiphenyls as compared to an abiotic control after 60 days of incubation. Activated carbon amended sediment showed slower biodegradation and also a decrease in the volatilization of PCBs. The potential impact of activated carbon addition on both the erodibility of the sediments and the PCB desorption rates is being explored with a sediment-water exchange model. Dynamic partitioning to sediment particles ranging in size from 2 to 1,000 microns suspended in the water and in surficial (0.1 cm) and consolidated (0.1-5 cm) sediments was modeled. A unique feature of this model is that the particles form aggregates and diffusion-controlled exchange of PCBs from these flocs to the surrounding water is simulated. Activated carbon was added as a state variable to this model. Results from the first 2 years of this study are discussed, including initial sediment characterization, initiation of microbial dehalogenation incubations, and model development. http://www.umbi.umd.edu/~sowers/SERDP-CBL.html

Assessing Bioavailability and Bioaccumulation with Field Deployable SPME
Reible, D., D. Lampert, and X.X. Lu, Univ. of Texas, Austin.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-185, 2008

Sediments are often the ultimate sink for many hydrophobic organic contaminants, such as PAHs and PCBs. Recent studies under ESTCP Project ER-0624 have indicated that the bioavailable fraction of these contaminants, as indicated by the fraction leading to toxicity and bioaccumulation, is indicated by the interstitial or pore water concentrations even if the route of uptake is ingestion. Direct analysis of pore water concentrations often is impossible due to the hydrophobic nature of PAHs and PCBs. Solid-phase microextraction (SPME) provides a means of quantifying pore water concentrations at the parts-per-trillion level. Laboratory efforts to characterize the kinetics and equilibrium uptake on fibers were reported previously, as well as studies confirming the ability of fiber uptake to indicate bioaccumulation in benthic organisms. A field SPME sampling device was also developed for quantifying pore water profiles in situ. The current poster report describes efforts to extend and confirm these studies in both lab and field. The emphasis is on the application of the field-deployable SPME sampling device and comparison of the results of field bioassays to porewater concentration measurements. This device has been deployed at several sites with simultaneous deployment of caged benthic organisms.

Assessment of Chromium Biostabilization in Contaminated Soils Using Standard Leaching and Sequential Extraction Techniques
Papassiopi, N., A. Kontoyianni, K. Vaxevanidou, and A. Xenidis, National Technical Univ. of Athens, Greece.
Science of the Total Environment, Vol 407 No 2, p 925-936, 2009

The efficiency of biostabilization treatment of soils spiked with chromate at 200 and 500 mg/kg was evaluated by applying several standard extraction techniques--the EN12457 standard leaching test, the USEPA 3060A alkaline digestion method, and the BCR sequential extraction procedure--on the soil samples before and after treatment. According to the EN leaching test results, the water-soluble chromium decreased after the biostabilization treatment from 13 to less than 0.5 mg/kg and from 120 to 5.6 mg/kg for samples spiked with 200 and 500 mg Cr(VI) per kg soil, respectively. Although the BCR sequential extraction scheme did not provide accurate estimates about the initial chromium speciation in contaminated soils, the test proved to be a useful tool for monitoring the relative changes in element partitioning as a consequence of the stabilization treatment. After bioreduction, the percentage of chromium retained in the two least soluble BCR fractions (i.e., the oxidizable and residual fractions) increased from 54 and 73% to more than 96% in both soils.

Bacterial Communities Analysis with Q-PCR in PCB-Contaminated Sediment Core
Xu, Y., Y. Yu, K. Gregory, and J. VanBriesen, Carnegie Mellon Univ., Pittsburgh, PA.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-199, 2008

To characterize the bacterial communities in a PCB-contaminated river, a sediment core was collected from the Grasse River (Massena, NY) in 2006. Quantitative polymerase chain reaction (Q-PCR) was applied to quantify total bacteria and some specific microbial populations related to anaerobic reductive dechlorination of PCBs. For each of 14 segments selected from the core, 16S rRNA gene copy numbers of bacteria (BAC), Chloroflexi group (CHL), Dehalococcoides group (DHC), PCB dechlorinators (o-17 /DF-1 clade) and three sulfate-reducing bacteria groups [Desulfovibrionales (DSV), Desulfobacterales (DSB) and Desulfuromonales (DSM)] were obtained. In brief, all bacterial groups were detected in the sediment core and the concentrations ranged from 2.77x104 copy/gram wet sediment to

1.16x1010 copy/gram wet sediment. Sulfur reducing bacteria were much more abundant than PCB dechlorinators, which indicated the existence of other electron acceptors in this sediment core. Together with PCB congener identification and total organic carbon (TOC) analysis, relatively extensive dechlorination was observed in older (deeper) sediments.

Bioelectrochemical Immunoassay of Polychlorinated Biphenyl
Lin, Y.Y., G. Liu, C.M. Wai, and Y. Lin.
Analytica Chimica Acta, Vol 612 No 1, 23-28, 2008

A simple, quick, and highly sensitive bioelectrochemical immunoassay method based on magnetic beads (MBs) and disposable screen-printed electrodes (SPE) has been developed to detect PCBs. The principle of this bioassay is based on a direct competitive enzyme-linked immunosorbent assay using PCB-antibody-coated MBs and horseradish peroxidase (HRP)-labeled PCB (HRP/PCB). A magnetic process platform was used to mix and shake the samples during the immunoreactions and to separate free and unbound reagents after the liquid-phase competitive immunoreactions among PCB-antibody-coated MBs, PCB analyte, and HRP/PCB. After a complete immunoassay, the HRP tracers attached to MBs were transferred to a substrate solution containing o-aminophenol and hydrogen peroxide for electrochemical detection. The different parameters, including the amount of HRP/PCB conjugates, immunoreaction time, and the concentration of substrate that governs the analytical performance of the immunoassay have been studied in detail and optimized. A detection limit of 10 pg/mL was obtained under optimum experimental conditions. The performance of this bioelectrochemical immunoassay was successfully evaluated with PCB-spiked river water, and the results were validated by a commercial PCB enzyme-linked immunosorbent assay kit, indicating that this convenient and sensitive technique offers great promise for decentralized environmental application and trace monitoring of PCBs.

Case Study: Application of Stable Isotopes to Site Characterization
Vlassopoulos, D., S.S. Papadopulos & Associates, Inc.
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 33 pp, 2008

Compound-specific isotope analysis (CSIA) is used as one of multiple lines of evidence to understand sources, degradation, and mixing of contaminants. The C-13/C-12 ratio was used to help differentiate three sources of chlorinated solvents in commingled plumes at the Port of Vancouver site in Washington State. The isotopic ratio for oxygen also was measured to trace the ground-water flow paths and refine the ground-water transport model.
http://www.epa.gov/tio/tsp/meetings.htm

Case Study: Evaluation of Groundwater/Surface Water Interactions, IMC Site, Spartanburg, SC
Canova, J., South Carolina DHEC
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 29 pp, 2008

This presentation describes an investigation to find possible discharges of contaminated ground water to local streams. Based on indicator parameters (pH, temperature, conductivity) measured in regularly spaced sediment pore water samples, targeted samples were collected and analyzed for total and dissolved metals. Surface water samples (targeting low pH areas) were analyzed, and elevated levels of metals, TNT, and fluoride/nitrate were detected. The results indicate that the streams are impacted on the side of the stream adjacent to the site, but not in the center. The concentrations measured in pore water were 2 to 5 times higher than those measured in surface water. http://www.epa.gov/tio/tsp/meetings.htm

Case Study: NW Natural, Former "Gasco" MGP Site: Investigative Methods to Assess DNAPL and Dissolved-Phase Transport to the Willamette River
Bayuk, D., Oregon DEQ.
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 46 pp, 2008

A multi-technique approach was used to 1) track the movement of ground-water plumes from a former MGP and into transition zone water (TZW) and surface water; 2) understand how contamination may be related to direct disposal of MGP waste in the river; and 3) assess TZW and surface water concentration trends and tidal fluctuations. The data were used to upgrade the shoreline groundwater monitoring network, evaluate distribution of DNAPL, estimate contaminant mass flux to the river, and support source control measures. The recommended upland source control measure combines a vertical barrier with hydraulic control near the shoreline and DNAPL removal in the uplands.
http://www.epa.gov/tio/tsp/meetings.htm

Case Study: Use of Stable Isotopes at the Palermo Well Field, Tumwater, Washington
Zavala, B., U.S. EPA Region 10.
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 19 pp, 2008

This presentation illustrated how the use of compound-specific isotope analysis (CSIA) was used to gain better understanding of the conceptual site model and to identify the source of VOCs that were impacting the Palermo Well Field. The C-13/C-12 ratio of the TCE was shown to be the same as the TCE at a nearby Department of Transportation laboratory. Thus, degradation of PCE used at a nearby drycleaner was not the source of TCE.
http://www.epa.gov/tio/tsp/meetings.htm

Challenges for Ethanol Fuels Contaminated Sites Assessment
de Freitas, J.G., J.F. Barker, and I. Chatzis, Univ. of Waterloo, Waterloo, ON, Canada.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The use of ethanol as an additive in gasoline raises concerns when monitoring the subsurface for groundwater contamination due to the effect of ethanol on contaminant distribution in the source zone. Ethanol can change important properties of the system, which can result in an unexpected distribution of the gasoline contaminants. Ethanol also can enhance the solubility of aromatic hydrocarbons, such as benzene. In 2D visualization experiments, gasoline was injected in the top of the unsaturated zone and then ethanol was injected in the same position. Ethanol was observed to mobilize the gasoline and alter its distribution significantly. The visualization experiments also indicated that ethanol stays mainly in the capillary fringe and is transported above the water table along with cosolubilized hydrocarbons. Typical monitoring techniques applied at fuel-contaminated sites are not intended to sample the capillary fringe. Under some conditions, a typical monitoring well might draw in some ethanol-contaminated water, providing an indication of contamination, but the sample will be diluted and the measured concentration likely will be significantly smaller than the actual concentration in the capillary fringe. The horizontal transport of high concentrations of hydrocarbons and ethanol in the capillary fringe at field scale therefore presents significant challenges for monitoring. For example, volatile losses are more likely to happen when sampling water from the vadose zone because that sampling requires suction. Laboratory experiments showed that the use of ceramic suction samplers can result in loss of up to 30% VOCs, depending on the pressure applied and compound properties. The concentration of ethanol in the aqueous phase also can interfere with the sample bias.

Characterization of the Vadose Zone for Chlorinated Contaminated Sites in Japan and in Switzerland via In Situ Flux Measurement

Tartre, A., S. Koenigsberg, and D. Sarr.

Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Research has been conducted in Canada to develop an innovative sampling technique for organic vapors in soil. This new method quantifies the rate at which vapors or gases are produced during a particular period of time under specific conditions of ventilation with nitrogen within the vadose zone. Traditional soil-gas surveys evaluate concentrations of specific vapors that are in chemical equilibrium with dissolved, sorbed, or free product in the subsurface. The proposed sampling technique involves purging the soil with an inert gas, such as nitrogen, in the vicinity of a sample probe for few minutes. The soil-gas purge affects the gas/liquid/soil equilibrium, causing sorbed and dissolved vapors to transfer to the gas phase. During a period when the static equilibrium is unbalanced, the rate at which vapor contaminants are transferred to the soil-gas phase is estimated. After a stabilization period, the purge is reduced or stopped altogether. Rebounds after the purging period indicate whether sources of organic vapors are present beside the sampling point. This method constitutes a major improvement for plume delineation at low cost. It delivers results on site within 10 minutes, thus offering the ability to investigate the site fully by iteration in real time. The production of investigation-derived waste is almost eliminated. This soil-gas sampling approach has been carried out recently for PCE contamination at an electronics plant in Japan and a former chemical plant in Switzerland. Findings from both sites are presented. In Japan, the vadose zone was suspected of contributing to a rebound of PCE in the saturated zone, but sampling confirmed the absence of a contaminated area in the vadose zone. In Switzerland, a highly contaminated area in the vadose zone was discovered and delineated, which allowed fine-tuning of the remediation work plan.

Characterizing a 1,4-Dioxane Groundwater Plume Upwelling into Wetlands Using the Triad Approach
Kiker, J., A. Easterday, and J. Donovan (ECC, Marlborough, MA); M. Rossi and D. Crosby (Stone Environmental, Montpelier, VT).
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Due to 1,4-dioxane's hydrophilic and low soil-partitioning properties, this compound can migrate ahead of other CVOCs in a plume. A studied plume previously defined by CVOC extent required timely re-characterization to determine the extent of 1,4-dioxane within and potentially beyond the previously established downgradient plume extent. This 1,4-dioxane assessment was focused within an area where discharge of the plume into two surface water bodies was likely. Piezometers were installed using Geoprobe(r) methods to intercept 1,4-dioxane. The geology within the wetland and floodplain of this site comprises sand/silt layers atop a marine clay unit, which overlies an undulating bedrock surface. Atop the clay layer, a deep transmissive sand layer (the lower sand unit) is the preferential contaminant pathway for the CVOC and 1,4-dioxane plume. Within the wetland and floodplain area, the bedrock, clay, and sand/silt layers rise sharply toward the surface, forcing the groundwater to well up and discharge to the surface waters of the wetland area. Utilizing an innovative real-time field technique like headspace solid-phase micro-extraction with gas chromatography/mass spectrometry (HS/SPME/GC/MS), allowed for characterization of the extent of 1,4-dioxane following a Triad dynamic work strategy. This sampling approach supported a cost-effective plume characterization that was completed during a single field mobilization.

Characterizing Hydraulic Properties and Ground-Water Chemistry in Fractured-Rock Aquifers: A User's Manual for the Multifunction Bedrock-Aquifer Transportable Testing Tool (BAT3)
Shapiro, A.M.
U.S. Geological Survey Open-File Report 2007-1134, 136 pp, 2007

A borehole testing apparatus has been designed to isolate discrete intervals of a bedrock borehole and conduct hydraulic tests or collect water samples for geochemical analyses. This borehole testing apparatus, referred to as the Multifunction Bedrock-Aquifer Transportable Testing Tool (BAT3), contains two borehole packers, which when inflated can form a pressure-tight seal against smooth borehole walls; a pump apparatus to withdraw water from between the two packers; a fluid-injection apparatus to inject water between the two packers; pressure transducers to monitor fluid pressure between the two packers, as well as above and below them; flowmeters to monitor rates of fluid withdrawal or fluid injection; and data-acquisition equipment to record and store digital records from the pressure transducers and flowmeters. The generic design of this apparatus originally was discussed in U.S. Patent 6,761,062 (Shapiro 2004). The prototype of the apparatus is designed for boreholes that are about 6 inches in diameter and can be used to depths of 300 feet below land surface. The apparatus is designed to fit in five hard plastic boxes for easy shipment. The equipment can be assembled rapidly, and the length of the test interval (the distance between the two packers) can be adjusted to account for different borehole conditions without reconfiguring the downhole components. The Multifunction BAT3 is configured to conduct both fluid-injection and fluid-withdrawal tests. Fluid-injection tests are used to estimate the hydraulic properties of low-permeability fractures intersecting the borehole. The lower limit of the transmissivity that can be estimated using the

configuration of the present Multifunction BAT3 is approximately 10(-3) square ft per day. Fluid-withdrawal tests are used to collect water samples for geochemical analyses and estimate the hydraulic properties of high-permeability fractures intersecting the borehole. The Multifunction BAT3 is configured with a submersible pump that can support pumping rates ranging from approximately 0.05 to 2.5 gallons per minute.
http://pubs.usgs.gov/of/2007/1134/

Characterization of Multiple Chlorinated Solvent Plumes Due to the Impact of TCE Screening Level Reduction

Dickson, J.R., A. Lonergan, R. Stenson, and C. Winklejohn, CTI and Associates Inc.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The reduction in the TCE vapor-phase screening level by USEPA in 2004 prompted a reevaluation of groundwater contaminant source areas, transport mechanisms, and commingling of multiple CVOC plumes within a complex river basin. A USEPA Administrative Order on Consent (AOC) dictated the subject manufacturing facility to investigate and perform a residential and commercial vapor-phase removal action to the revised indoor air and subslab action levels without regard for contaminant source area, transport, or commingled contaminants. In response, a comprehensive reevaluation of the river basin hydrogeology and groundwater CVOC distribution was completed by the manufacturer to facilitate demarcation of the AOC vapor phase removal action boundary and thus to minimize investigation of contaminants not attributable to the facility. In 2007, data collected during an integrated investigation and review of other data sources were evaluated to identify additional CVOC source areas, map known CVOC plumes, establish groundwater flow transport pathways, and determine the potential for commingled CVOC plumes. Understanding the complex groundwater flow regime, which was strongly influenced by river stages, flood control structures, municipal well-field production, and engineered recharge basins, was critical to resolving the migration pathway of multiple CVOC plumes. All data collected were compiled into a series of CVOC overlay maps to provide a working river basin model of CVOC distribution and migration based on groundwater flow. The resulting distribution of CVOC source areas and migration pathways resulted in numerous instances of CVOC plumes becoming commingled due to the groundwater flow patterns. As a result, the manufacturer recommended the reduction of the AOC vapor-phase removal action boundary area by over 60%, thus limiting the action area to that immediately downgradient of the facility.

Coal Tar Detection and Mobility Assessment at Manufactured Gas Plant Sites: Refining the Res-SAT(r) Tool Protocol

Electric Power Research Institute (EPRI), Inc., Palo Alto, CA. Product 1018271, Oct 2008

EPRI has revisited the baseline data used to develop and validate the original Res-SAT(r) Tool designed in 2004 for determining coal tar mobility using a field screening approach. After reevaluating that data, it was determined that developing a broader data set would further validate the Res-SAT(r) Tool operating protocol and allow it to serve as a complement to other in situ or onsite field assessment tools for use during investigations. This study suggests that a protocol is necessary for performing a second field demonstration. Such a demonstration would refine the tool's performance characteristics in measuring coal tar mobility in saturated soils and identify key opportunities for incorporating tool test results into a conceptual site model and assessment of remedial options to address coal tar in subsurface soils. One project objective was to identify appropriate Res-SAT(r) Tool operating conditions that can be used to measure the potential for mobility of dense nonaqueous-phase liquids (DNAPLs) in fine, medium, and coarse-grained soils. Another objective was to evaluate using the tool in the field without the need for site-specific laboratory calibration. Previous Res-SAT(r) Tool research had only tested a limited range of coal tar and soil characteristics. This work tested two heavier coal tars from MGP sites on two finer-grained soils. Four coal tar samples were analyzed from which two tars with a specific gravity between 1.05 and 1.07 were selected for evaluation by a third-party laboratory with expertise in the science of residual saturation testing. This project has developed a broader data set of Res-SAT(r) Tool performance data on soils and coal tars typically encountered at former MGP sites. The project also has demonstrated the Res-SAT(r) Tool can be used in the field for coal tar mobility screening without prior site-specific laboratory calibration to identify a site-specific critical pressure.

Combination of Radon and Stable Isotope Analysis as a Tool for Decision Support Concerning the Remediation of NAPL-Contaminated Sites
Schubert, M. (UFZ, Leipzig, Germany), M. Balcazar, A. Lopez, P. Pena, J.H. Flores, and K. Knoller.
Isotopes in Environmental and Health Studies, Vol 43 No 3, p 215-226, 2007

A nonaqueous-phase liquid (NAPL)-contaminated aquifer was investigated at a major refinery site in Mexico. Owing to the depth of the NAPL source zone over 100 m below ground surface, the actual aquifer material was not accessible for sampling. Information on the residual NAPL contamination of the aquifer could be obtained only indirectly by analyzing groundwater samples from a few wells at the site. An alternative approach to conventional groundwater analysis for dissolved NAPL was chosen for evaluating the recent contamination and estimating its probable future development. The radioisotope radon-222 was used as partitioning tracer for the approximate localization and semi-quantitative assessment of the NAPL source zone. The stable isotopes C-13, S-34, and O-18 were used as naturally occurring contamination tracers and as indicators for naturally occurring biodegradation processes, which could have potential utility in future remediation schemes.

Comparison of Four Extraction Methods for the Analysis of 24 Pesticides in Soil Samples with Gas Chromatography-Mass Spectrometry and Liquid Chromatography-Ion Trap-Mass Spectrometry
Lesueur, C., M. Gartner, A. Mentler, and M. Fuerhacker, BOKU-Univ. of Natural Resources and Applied Life Sciences, Vienna, Austria.
Talanta, Vol 75 No 1, p 284-293, 2008

To analyze multiple residues of pesticides in soil samples, 4 extraction methods were compared: a new ultrasonic solvent extraction (USE) was compared to the European Norm DIN 12393 for foodstuff (extraction with acetone, partitioning with ethylacetate/cyclohexane and cleanup with gel permeation chromatography (GPC)), the QuECheRS method, and a pressurized liquid extraction (PLE) method. Pesticides were analyzed with both GC-MS and HPLC-MS/MS.

The reference materials were the EUROSOIL 7 and its subsoil SO26, as well as a sea sand. All the substances were observed to be linear in the range of 4-800 ng/g for the European Norm DIN 12393, 7-1,400 ng/g for the USE method, and 20-4,000 ng/g for the QueCheRS and the PLE methods. Limits of detection (LOD) and limits of quantification (LOQ) were with HPLC between 0.006 and 0.23 ng/g and between 0.022 and 0.77 ng/g, respectively, with the exception of diuron (LOD up to 11.8 ng/g; LOQ up to 39.2 ng/g). With GC, they ranged from 3.0 to 87.5 ng/g and from 10 to 292 ng/g, respectively. All substances could be recovered with USE as well as with the QuEChеRS method; the European Norm DIN 12393 could not recover carbendazim and metamitron; the PLE could not recover carbendazim, metamitron, and monolinuron. For the remaining substances, recoveries at a 500 ng/g fortification level ranged from 10.9 to 96.3% with the USE. In comparison, the QuEChеRS method was the most efficient extraction method with recoveries from 27.3 to 120.9%. It was followed by the European Norm DIN 12393 with recoveries between 6.8 and 108.1% and the PLE with recoveries from 12.2 to 153.2%. Recoveries were higher from the EUROSOIL 7 than from the SO26. The repeatability expressed in term of standard deviation was below 20% for all substances and all materials. http://www.eng.jcu.edu.au/research/water/Pesticize/Lesu%202008%20Diuron.pdf

Comparison of Pumped and Diffusion Sampling Methods to Monitor Concentrations of Perchlorate and Explosive Compounds in Ground Water, Camp Edwards, Cape Cod, Massachusetts, 2004-05
LeBlanc, D.R. and D.A. Vroblesky.
U.S. Geological Survey Scientific Investigations Report 2008-5109, 26 pp, Dec 2008

Lab and field tests were conducted at Camp Edwards on the Massachusetts Military Reservation on Cape Cod to examine the utility of passive diffusion sampling for long-term monitoring of concentrations of perchlorate and explosive compounds in ground water. The diffusion samplers were constructed of 1-inch-diameter rigid, porous polyethylene tubing. Lab test results in which diffusion samplers were submerged in containers filled with ground water containing perchlorate, RDX, and HMX indicate that concentrations inside the diffusion samplers equilibrated with concentrations in the containers within the 19 days of the test period. Field tests of the diffusion samplers were conducted in 15 wells. Comparison of the concentrations of perchlorate, RDX, and HMX in the diffusion samplers placed in the wells against concentrations in samples collected by low-flow pumped sampling indicate generally good agreement between the pumped and diffusion samples for concentrations of the subject contaminants. The concentration differences indicate no systematic bias related to contaminant type or concentration level. http://pubs.usgs.gov/sir/2008/5109/

Comparison of TO-15, TO-17 and a Modified NIOSH Sampling Method for Investigating Indoor Air at Sites Outside the United States
Desrosiers, J. (ERM, Raleigh, NC); P. Valle; E. Anderson.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

In the Unites States, EPA Method TO-15 is the method generally accepted for investigating vapor intrusion impacts for chlorinated volatile organic compounds (CVOCs), other methods are commonly used outside the United States because of an absence of laboratories certified in TO-15 and because of the increased expense of shipping sample media internationally. As a result, some multinationals struggle to decide what sampling method to use at sites outside the United States. Work was conducted to compare 3 analytical sampling methods and provide guidance for future sampling events. As part of an investigation at an active manufacturing site in Belgium, indoor air samples were collected for CVOCs by TO-15, TO-17, and a modified NIOSH method recognized by the local regulatory authority. Samples were collected using each of the 3 methods simultaneously from 4 sampling stations in the facility and 1 outdoor location. One duplicate sample was collected for each method to evaluate analytical precision. CVOCs had not been used at the facility in over 10 years, so it was expected that any compounds of concern detected in indoor air would be the result of vapor intrusion from contaminated groundwater beneath the facility. After completion of the investigation, the 3 methods were evaluated based on several parameters including achievable detection limits, analytical results, precision, cost, and implementation. No CVOCs were detected in the modified NIOSH samples, so the evaluation of analytical results focused on the comparison of TO-15 and TO-17. This paper presents the findings of the study and a discussion of indoor air sampling methods at sites outside the United States.

Compound-Specific Stable Isotope Ratio Analysis of Explosives
Vanderford, M. (GSI Environmental, Inc., Houston, TX); R.P. Philp and M. Derda (Univ. of Oklahoma). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-190, 2008

The analytical technique of compound-specific stable isotope analysis (CSIA) using gas chromatography with isotope ratio mass spectrometry (GC/IRMS) has been proposed as a tool to demonstrate destructive chemical processes for munitions in affected groundwater. The overall objective of ESTCP Project ER-0706 is to establish a strong tertiary line of evidence for explosives contaminant transformation by utilizing a methodology that focuses on the analysis of reactants rather than the products. The project goal is to demonstrate and validate the utilization of C-13/C-12 and N-15/N-14 isotope ratios, determined by GC-IRMS, as a tool for documenting the fate of various nitroaromatic residues. The optimization of the GC/IRMS analytical method to determine 13C/12C stable isotope ratios of various nitroaromatic compounds included a concentration method using solid-phase extraction (SPE) and a gas chromatography with electron-capture detector (GC-ECD) method used for quantification of compound concentrations. An SPE-GC/IRMS method was used to reduce detection limits in the determination the deltaC-13 isotope signatures of nitroaromatic compounds. Because relatively high constituent concentrations are required to evaluate isotope ratios in specific compounds and because relatively low environmental concentrations are anticipated at the demonstration sites, an SPE method was developed to concentrate munitions constituents from groundwater. Optimization of the GC-ECD protocol for determination of total concentration of constituents in the sample included optimization of the column, temperature ramp, and linear velocity of the carrier gas. Detection limits for the GC-ECD method were between 40 to 50 ug/L without preconcentration for selected constituents. With preconcentration, samples as low as 0.04 to 0.05 ug/L can be quantified by GC-ECD. Analytical parameters determined for the GC-ECD were applied to the GC-IRMS method. Determination of isotopic signatures has a higher initial mass requirement than GC-ECD. The mass of carbon necessary for the IRMS step ranges between 16 and 92.5 ng for the compounds tested. Final limits of detection for deltaC-13 isotope signatures of nitroaromatic compounds for the GC-IRMS method using the 1000X preconcentration step were between 30 and 500 ug/L. Limits of detection can be improved by using larger sample volumes (5 L) and preconcentrating to much lower volumes. The authors estimate that preconcentration of large volumes can reduce the detection limit for carbon isotope ratios to 10 ug/L for RDX and 5 ug/L for TNT.

Congener Tracker-Pair Analysis for Evaluation of Reductive Dechlorination of Polychlorinated Biphenyls (PCBS) in River Sediments
Vanbriesen, J.M., M.J. Small, G. Lowry, K. Gregory, E. Minkley, and S. Karcher, Carnegie Mellon Univ., Pittsburgh, PA
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-200, 2008

"Tracker pairs" are pairs of PCB congeners that maintain the same ratio across multiple Aroclor mixtures and lots. Under SERDP Project ER-1495, the authors used published data to elucidate a set of tracker pairs that can be used to determine if an environmental sample from a sediment is aroclor-like or has changed from the relative concentrations that originally were deposited to the river. The method was used to evaluate the likelihood of dechlorination in the Hudson River using data from the Hudson River low-resolution sediment coring project. To assess the transferability of the method, the authors used datasets from the comprehensive characterization of the Grasse to evaluate a method developed on a distinctly different sediment system (255 samples were available). Evaluation of these Grasse River data show strong statistical support for the conclusion that the sediments experienced ongoing reductive dechlorination during the time period evaluated: 255 of 272 tracker pairs showed shifts away from Aroclor-like relationships, while 17 pairs did not show significant changes. This analysis provides strong support that the tracker pair method developed by Karcher et al. (2004) is applicable to sediments systems beyond the original application in the Hudson River. Further, this field-based analysis provides significant information as it considers only what has happened in the environment rather than what can happen in the laboratory under ideal conditions. Weathered PCBs in this system are undergoing predictable reductions in chlorination level, very likely through biological activity.
http://www.serdp-estcp.org/Symposium2008/Posters/upload/W220-VanBriesen.pdf

Continuous Profiling of Subsurface Pollutants
Robbat, A. and Thomas Considine, Tufts Univ., Medford, MA.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Two different probes capable of extracting organic pollutants from subsurface soil and groundwater have been developed. The probes are connected on one end to a flexible, heated (300 degrees C) transfer line, and on the other end, to a heated six-port valve. Organic vapors are swept from the collection port through the transfer line into a valve connected to a photoionization detector (PID) for rapid subsurface profiling. When the PID signal increases over baseline, detector response indicates the magnitude of pollutants present at that location. When the valve is switched from the PID to an external freeze-trap, organics are trapped inside an empty glass sleeve, which is brought to a thermal desorption gas chromatography/mass spectrometry (GC/MS) instrument for on-site analysis. When moisture content is < 15%, organics are desorbed from soil and collected directly into the transfer line or through a hydrophobic membrane. The membrane allows the passage of organics and excludes the passage of water into the transfer line. For SVOCs, extraction efficiencies of 70 to 90% are achievable with the direct inlet probe because soil temperatures can reach 300 degrees C. In contrast, soil only reaches 120 degrees C with the membrane inlet probe, and much lower extraction efficiencies are obtained. The same technology can be used to profile soil-to-water or water-to-sediment interfaces in a continuum. Data are presented from a coal tar site in which PAHs are profiled continuously by PID as the probe is advanced into the subsurface. PID response is compared against GC/MS results at the same exact location, with the overall correlation coefficient > 0.92. When the heated transfer line is connected directly to an online freeze trap in series with the GC column, correlation coefficients increase. Organic compounds of low molecular weight and low boiling point--benzene, naphthalene, and their alkylated analogs--are captured much more efficiently than what was obtainable using the external freeze-trap. To match sample collection and analysis speeds, a 5-min GC/MS analysis was performed using the ion signature deconvolution algorithms to quantify target compounds. Combining these technologies will facilitate onsite sample collection and analysis using modified SW-846 GC/MS methods optimized to meet field conditions.

Continuous, Wireless Monitoring of Sediment Flux at Multiple Low-Water Stream Crossings on Tank Trails

Grimm, G. (U.S. Army Aberdeen Test Center, MD), N. Zhang, J. Steichen, and N. Wang.

Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-48, 2008

Kansas State University (KSU) has developed a prototype suspended sediment concentration (SSC) sensor that continuously measures SSC in situ in surface water. Limited tests of the sensor have been performed successfully in several studies, including a joint study between the U.S. Army Aberdeen Test Center (ATC) and KSU in which the sensor was tested at a low-water stream crossing site at an Army installation. KSU also has developed and tested several wireless sensor networks (WSN) to transmit SSC data remotely. ATC has partnered with KSU and Oklahoma State University (OSU) in ESTCP project SI-0817 to develop and demonstrate the sensor and the WSN technologies. When complete, this effort will provide an SSC sensor and WSN technology that will enable more effective monitoring of SSC loads in streams. Field demonstration testing of the SSC sensor and WSN will be performed at Aberdeen Proving Ground, Fort Benning, and Fort Riley when the development effort is complete. The technology, preliminary results, and testing plans are discussed.

A Cost Effective Solution for Collecting Groundwater and Soil Gas Data for Vapor Intrusion Studies

Ensign, M.C. and R. Siegener, GEI Consultants, Inc., Woburn, MA.

Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

A vapor intrusion investigation typically proceeds separately with groundwater and vapor sampling. Groundwater monitoring wells are installed and screened at the water table, and soil gas sampling points are taken independently to collect the data. This paper presents an alternative and more cost-effective method of collecting both groundwater and soil gas samples from a monitoring well. The methodology starts with the proper installation of a dual-purpose well. The screen interval of the groundwater monitoring wells was adjusted during installation so that they include both saturated and unsaturated portions. The monitoring wells also were constructed with a gas-tight seal and a sampling port at the surface. Prior to soil gas sampling, gas present in the well was purged to minimize the effects of off-gassing from the groundwater in the well and to obtain a representative soil gas sample. The combined well system provides reliable data that represent soil gas concentrations in the unsaturated zone; results in significant time and cost savings, particularly on projects with a large study area; and is less intrusive and disruptive due to the reduction in the number of sampling points needed.

A Critical Examination of Some Common Field Tests to Assess the Acid-Sulphate Condition in Soils

Vegas-Vilarrubia, T., F. Baritto, and G.T. Melean.

Soil Use and Management, Vol 24 No 1, p 60-68, 2008

This paper evaluates the usefulness of four easy-to-apply field survey tests for potential acid-sulfate diagnosis in some Histosols and Entisols in wetlands. Comparison of incomplete oxidation by fast air-drying, incubation, fast oxidation with hydrogen peroxide, and the indirect determination of sulfide with lead acetate were applied to samples of 227 surface-organic and underlying mineral soils of poorly drained Histosols and Entisols. Interpretation of the results obtained from the acid-sulfate soil tests may be misleading for highly organic samples because they cannot be related unambiguously to the production of sulfuric acid derived from pyrite oxidation. Mineral samples yielded more reliable results. Incomplete oxidation by the fast air-drying test did not induce significant acidification in either organic or in mineral samples; the final pH values were dependent on the original pH values. Fast oxidation with hydrogen peroxide test was effective with mineral samples. During the incubation test, the slower rate of pH decrease and the final values obtained with the organic samples suggested retardation in the rate and amount of acid generation by pyrite oxidation because of the concurrent oxygen consumption by organic matter and bacterial activity. The indirect determination of sulfide with lead acetate yielded only qualitative results in organic samples, but worked well in mineral samples, indicating a higher content of pyrite intermediates.

Demonstration and Validation of a Fractured Rock Passive Flux Meter (FRPFM)

Newman, M., K. Hatfield, M. Annable, and J. Cho (Univ. of Florida); H. Klammler (Federal Univ. of Bahia); B. Parker (Univ. of Guelph); J. Cherry (Univ. of Waterloo); W. Pedler (RAS, Inc.). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-125 2008

The objective of ESTCP Project ER-0831 project is to demonstrate and validate the fractured rock passive flux meter (FRPFM) as new technology for measuring the magnitudes and directions of cumulative water and contaminant fluxes in fractured rock aquifers. The sensor consists of an inflatable core that compresses a reactive fabric against the wall of a borehole and to any water-filled fractures intersected by a borehole. The reactive fabric is designed to intercept and retain target groundwater contaminants (e.g., TCE, DCE, VC); in addition, the fabric releases non-toxic tracers, some of which visibly indicate active fracture location, aperture, orientation, and direction of fracture flow along a borehole, while others quantify cumulative groundwater discharge within the fractures. Initial work (Year 1) will consist of lab-scale demonstration, followed by 2 years of field-scale testing. Demonstration and validation studies will be conducted at two sites in Canada where available field facilities will permit FRPFM testing in well-characterized rock wells and under controlled flows. Demonstration studies then will be performed at two DoD installations where the underlying fractured rock aquifer is contaminated with chlorinated solvents. Direct FRPFM measures of active fracture location and magnitude of water and contaminant flux will be compared to results generated using competing technologies (e.g., borehole imaging tools, heat-pulse flow meter [Model 40 GEOFLO], temperature logging, and borehole dilution).

Demonstration/Validation of the Snap Sampler Passive Ground Water Sampling Device at the Former McClellan AFB

Parker, L. and N. Mulherin (ERDC-CRREL); W. Major (NFESC); R. Willey (U.S. EPA, Region 1); T. Imbrigiotta and J. Gibs (NJ USGS); D. Gronstal (AFRPA). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-171, 2008

Where the use of passive (no-purge) sampling technology is appropriate, data-quality improvements and cost reductions can be achieved; however, most passive diffusion samplers have limitations. For example, the passive diffusion bag sampler can be used only for selected VOCs, and the dialysis (or regenerated cellulose [RGC]) membrane sampler cannot be used for long deployments because the membrane can biodegrade. In contrast, equilibrated-grab passive samplers, such as the Snap Sampler, can be used to sample for a wide spectrum of analyte types, and unlike diffusion-based passive samplers, can provide a sample in real time. The Snap Sampler collects a whole water sample from the screened portion of the well under in situ conditions. The objectives ESTCP project ER-0630 are to demonstrate that passive sampling, and especially the Snap Sampler, can provide technically defensible analytical data for a wide spectrum of analytes, and to demonstrate the utility and potential cost savings of the technology. Our approach was to collect samples at five sites with (1) the Snap Sampler, (2) low-flow purging and sampling (EPA Region 1, 1996), and (3) other passive diffusion samplers (as appropriate). This poster presents the results from the second test site, the former McClellan AFB in Sacramento, CA. Ten 4-inch-diameter monitoring wells were sampled using the Snap Sampler, low-flow purging and sampling, and the RGC passive diffusion sampler. Each well contained a 1.7-inch diameter bladder pump, five Snap Samplers, and one or two RGC samplers. The Snap Samplers and the RGC samplers were deployed so that the samplers straddled the depth of the pump intake. Analytes included VOCs, metals (filtered and unfiltered), and natural attenuation parameters, including iron, chloride, and sulfate. Using several sampling technologies allows comparison of dissolved and colloid-borne contaminants. Also, this site's relatively deep groundwater enabled the testing of the newly developed electric trigger for the Snap Sampler. The field work has been successfully completed and the analytical results are summarized in the poster presentation.
http://www.serdp-estcp.org/Symposium2008/Posters/upload/T170-Parker.pdf

Design and Operation of a Borehole Straddle Packer for Ground-Water Sampling and Hydraulic Testing of Discrete Intervals at U.S. Air Force Plant 6, Marietta, Georgia
Holloway, O.G. and J.P. Waddell
U.S. Geological Survey Open-File Report 2008-1349, 32 pp, Dec 2008

A borehole straddle packer was developed and tested by the U.S. Geological Survey to characterize the vertical distribution of contaminants, head, and hydraulic properties in open-borehole wells as part of an ongoing investigation of ground-water contamination at U.S. Air Force Plant 6 (AFP6) in Marietta, Georgia. To gain a better understanding of contaminant fate and transport in a crystalline bedrock setting and to support remedial activities at AFP6, numerous wells have been constructed that include long open-hole intervals in the crystalline bedrock. These wells can include several discontinuities that produce water, which may contain contaminants. Because of the complexity of ground-water flow and contaminant movement in the crystalline bedrock, it is important to characterize the hydraulic and water-quality characteristics of discrete intervals in these wells. The straddle packer facilitates ground-water sampling and hydraulic testing of discrete intervals, as well as delivery of fluids (i.e., tracer suites and remedial agents) into these discontinuities. The straddle packer consists of two inflatable packers, a dual-pump system, a pressure-sensing system, and an aqueous injection system. Tests were conducted to assess the accuracy of the pressure-sensing systems, and water samples were collected for analysis of volatile organic compound (VOC) concentrations. Pressure-transducer readings matched computed water-column height, with a coefficient of determination of greater than 0.99. The straddle packer incorporates both an air-driven piston pump and a variable-frequency, electronic, submersible pump. Only slight differences were observed between VOC concentrations in samples collected using the two different types of sampling pumps during two sampling events in July and August 2005. A test conducted to assess the effect of stagnation on VOC concentrations in water trapped in the system's pump-tubing reel showed that concentrations were not affected. A comparison was conducted to assess differences between three water-sampling methods: collecting samples from the well by (1) pumping a packer-isolated zone using a submersible pump, (2) using a grab sampler, and (3) using a passive diffusion sampler. Concentrations of tetrachloroethene, trichloroethene, and 1,2-dichloropropane were greatest for samples collected using the submersible pump in the packed-isolated interval, suggesting that the straddle packer yielded the least dilute sample.
http://pubs.usgs.gov/of/2008/1349/

Detailed Hydraulic Assessment Using a High-Resolution Piezocone Coupled to the GeoVIS: Cost & Performance Report
Environmental Security Technology Certification Program, ESTCP Project ER-0421, 69 pp, July 2008

Based on the results from a full-scale demonstration of the use of two innovative direct-push sensor probes (the high-resolution piezocone and GeoVIS) deployed with a standard cone penetrometer system, this report breaks out the costs involved and the performance observed during the demonstration. A piezocone is a direct push sensor probe consisting of a porous element connected to a customized transducer that converts pore pressure to water level. A high-resolution piezocone (HRP) (U.S. Patents 6,208,940 and 6,236,941) is a sensor probe capable of generating highly resolved hydraulic head values (plus or minus 1-inch of water level) while simultaneously collecting critical soil type information. The GeoVIS (U.S. Patent 6,115,061) is a

Navy/SERDP-developed video microscope sensor probe capable of yielding real-time soil and contaminant images that can render effective porosity estimates. The probes were applied to the determination of direction and rate of ground-water flow in three dimensions at the National Environmental Technology Test Site (NETTS) in Port Hueneme, CA. While the GeoVIS did not provide accurate effective porosity values in the silty soils encountered, the HRP provided representative hydraulic head, hydraulic conductivity, soil type, and effective porosity data, enabling users to develop highly resolved 3-D models and predictions of contaminant flux distributions that compared favorably to short screen well-based methods. Project results were incorporated into ITRC guidance and ASTM standard 6067, and the HRP technology was licensed to the private sector.
http://www.estcp.org/Technology/upload/ER-0421-C&P.pdf

Detection of Low Volatility Organic Analytes on Soils Using Infrared Reflection Spectroscopy
Gallagher, N.B., P.L. Gassman, and T.A. Blake.
Journal of Near Infrared Spectroscopy, Vol 16 No 3, p 179-187, 2008

Detection algorithms that might be useful for rapid standoff detection of organics compounds on soil are being tested in the laboratory. Six signal processing methods--including Savitzky-Golay second derivatives, extended multiplicative scatter correction (EMSC), and a novel alternative to piece-wise EMSC--are designed to minimize irrelevant variability in the recorded soil reflection-absorption spectra while enhancing signal from analyte compounds possibly present on soil. The preprocessed signal was used for detection. Previous work utilized principal components analysis (PCA)-based multivariate statistical process control methodologies for detection. Six alternative anomaly detection statistics were examined here that were based on the preprocessed signal, weighted signal, and generalized weighted signal. Two tests corresponding to different monitoring strategies were examined: test data 'local' and 'non-local' to the calibration data. The generalized weighted approach worked extremely well for the local detection test but less well for the non-local test. Results suggest that good characterization of analyte-free soil prior to monitoring will lead to the best detection performance. Second derivative preprocessing showed the best results on receiver operator characteristic curves and its ease of application is a distinct advantage, although it may not be universally successful for all bands to be considered in the future.

Determination of Cyanide in Process Water of the Steel Industry
Metrohm Information Issue 1, 2008

The determination of the cyanide content in process water with ProcessLab is based on the standard addition method using an ion-selective cyanide electrode (cyanide ISE). ProcessLab automatically transfers a defined amount of water sample into the titration vessel and then takes an aliquot in a sample loop. The remaining sample is discharged and the titration vessel rinsed. The sample is transferred from the loop back to the rinsed titration vessel and treated with TISAB solution (NaOH, 0.1 mol/L) as auxiliary reagent. The cyanide content of the water sample is calculated by the standard addition method from the potential measurements performed after each addition of cyanide standard solution.
http://metrohm.biz/company/metrohminfo/2008/e/MI-2008e-1-12.pdf

The Determination of Sediment Polycyclic Aromatic Hydrocarbon (PAH) Bioavailability Using Direct Pore Water Analysis by Solid-phase Microextraction (SPME)

Nakles, D. (ENSR, Monroeville, PA); A. Hawkins (NFESC); S. Hawthorne (Energy and Environment Research Center); T. Bridges and J.D. Farrar (U.S. Army ERDC); U. Ghosh (Univ. of Maryland); D. Thal (Test America). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-187, 2008

Recent data have shown that PAHs in sediments from urban and industrial sites are often much less toxic than is generally assumed by generic bulk sediment screening values, and toxicity is often not related to the concentration of total extractable PAHs using EPA standard methods. To increase the scientific understanding of what governs chemical exposure in sediments and how to measure it, the Sediment Contaminant Bioavailability Alliance (SCBA) initiated a program to develop a comprehensive database evaluating the bioavailability of hydrophobic organic compounds in aquatic sediments. To date, the SCBA has completed 16 case studies, with measurements of PAH bioavailability on over 200 sediment samples. In a recent publication, the SCBA demonstrated that 73 of 97 (75%) of sediment samples analyzed exceeded the probable effect concentration (PEC) value for total PAHs (22.8 mg/kg); however, only 23 (32%) resulted in reduced survival to the aquatic amphipod Hyalella azteca. Concurrent with this effort, the SCBA has supported the development of a new analytical technique for estimating PAH bioavailability that involves the measurement of dissolved PAHs in sediment pore water using solid phase microextraction (SPME). ASTM and EPA approval of this method is being pursued with the conduct of interlaboratory validation studies. A provisional ASTM standard (D7363-07) and an EPA method (SW846 Method SW-8272) are presently in place. ESTCP Project ER-0709 used the SCBA methodology to assess the bioavailability of PAHs in sediments from the Anacostia River, proximate to the Washington Navy Yard. The results of the study indicated that the use of PAH sediment screening levels, as well as the EPA equilibrium partitioning method, did not predict toxicity and non-toxicity to a benthic test organism (Hyalella azteca) adequately, and that their use would vastly overstate the volume of sediment requiring further action. The direct measurement of PAHs in sediment porewater corresponded to toxicity to H. azteca, and provided an accurate assessment of the potential effect of sediment PAHs on toxicity to benthic organisms.

Determining the Origin of Perchlorate Using Stable Isotope Analysis

Hatzinger, P., N. Sturchio, A. Beloso, Jr., J.K. Boehlke, B. Gu, W.A. Jackson, and G. Harvey. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-143, 2008

Perchlorate has both natural and synthetic sources. Perchlorate has long been known to co-occur with nitrate and other anions in caliche deposits in the Atacama Desert of Chile. These deposits were imported into the U.S. as an agricultural fertilizer in the past. In addition to Chilean caliche, natural perchlorate has been detected in mineral deposits and in surface soils throughout arid regions of the western U.S. The key objective of ESTCP project ER-0509 is to distinguish natural from man-made perchlorate using isotope-ratio mass spectrometry, as well as to understand the extent and origin of variations in the isotopic compositions of synthetic and natural perchlorate. Techniques have been developed to collect, purify, and measure the isotopic composition of perchlorate (deltaCl-37, deltaO-18, and DO-17) in both source materials and environmental samples. Consistent differences have been observed between natural perchlorate derived from Chilean caliche (and fertilizers prepared from this material) and all synthetic sources tested to date. The deltaCl-37 values in the synthetic samples are higher than the Chilean perchlorate, while the deltaO-18 values average lower. The natural perchlorate is also characterized by a distinctive O-17 excess that readily differentiates it from man-made perchlorate and suggests an atmospheric origin with ozone as a reactant. Isotopic analyses of perchlorate in groundwater have been performed at locations across the U.S., and both synthetic and natural signatures have been observed, as have signatures indicating local mixtures of these sources. The data suggest that perchlorate originating from past agricultural practices contributes significantly to groundwater contamination in some regions, such as southern California and Long Island, New York. Stable isotope ratios of naturally occurring perchlorate in groundwater at several sites in the western U.S. (Texas, New Mexico, and Oregon) deviate from those of Chilean-derived perchlorate, indicating that such perchlorate was formed by a different mechanism or that it may have been modified by biological, physical, or geochemical processes after deposition. Additional studies are ongoing to explain the genesis of isotopic variations in natural perchlorate.

Determination of Rates and Extent of Dechlorination in PCB-Contaminated Sediments during Monitored Natural Recovery: Sediment Issue
U.S. EPA, National Risk Management Research Laboratory, Cincinnati, OH.
EPA 600-S-08-012, 8 pp, Aug 2008

U.S. EPA's National Risk Management Research Laboratory (NRMRL) conducted studies to evaluate the long-term recovery of polychlorinated biphenyl (PCB)-contaminated sediments via reductive dechlorination, including the magnitude, extent, and rates of ortho and meta plus para dechlorination reactions with sediment depth and time. The data summarized were generated during field studies conducted by NRMRL in cooperation with U.S. EPA Region 4 at the Sangamo-Weston/Twelvemile Creek/Lake Hartwell Superfund Site in Pickens County, South Carolina. At PCB-contaminated sediment sites, dechlorination can be an important component of the natural recovery of the sediments when anaerobic conditions exist and the source(s) of PCBs in sediment remain unchanged. Under anaerobic conditions, the primary metabolic pathway for PCBs is reductive dechlorination in which chlorine removal and substitution with hydrogen by bacteria result in a reduced organic compound with fewer chlorine molecules. Reductive dechlorination of PCBs preferentially removes chlorines from the meta and para positions, which has been shown to lead to the conservation of biphenyl rings and ortho chlorines in laboratory dechlorinating enrichment cultures. Generally, higher-chlorinated biphenyls are dechlorinated preferentially over lower-chlorinated congeners, resulting in the accumulation of mono-, di-, and trichlorobiphenyls. Thus, reductive dechlorination can be identified by the historical transformation of higher-chlorinated PCB congeners with sediment depth and time, and through the preferential loss of meta and para chlorines and the conservation of ortho chlorines. Determination of dechlorination rates is useful for predicting the number of years for chlorine loss to occur (i.e., for predicting when positive impacts of dechlorination could be observed). PCB congener fingerprinting and multivariate receptor modeling can be used as exploratory data analysis tools to characterize PCB sources and alteration patterns. Utilization of PCB dechlorination to assess the extent of natural recovery can be a valuable tool; however, challenges associated with this tool may be encountered, some of which have been summarized in this issue paper to enable site managers to account for them in their research design and interpretation of results. This summary is intended to be used as a reference for site managers and EPA decision makers who may be considering monitored natural recovery as a contaminated sediments management strategy. http://www.epa.gov/nrmrl/pubs/600s08012/600s08012.pdf

Development of a Portable Fiberoptic Surface Enhanced Raman Sensor
Gu, B. (ORNL); P.A. Mosier-Boss (SPAWAR Pacific); P. Hatzinger (Shaw Environmental).
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008.
Program Abstracts, p G-173, 2008

Current techniques for monitoring energetics in groundwater are expensive, and analytical results often are not available for several weeks after samples are collected. The goal of SERDP Project ER-1602 is to develop a new, cost-effective technique for in situ quantification and monitoring of energetics such as perchlorate, TNT, and RDX in groundwater via fiberoptic surface-enhanced Raman spectroscopy (SERS). The specific objectives are to develop and fabricate sensitive and selective SERS substrates that can be used for detection of trace quantities of energetics, to construct a prototype fiberoptic SERS sensor that can be interfaced with a handheld Raman spectrometer, and ultimately to determine the performance and cost effectiveness of SERS technique for in situ field screening and monitoring of contaminant energetics. To date, highly ordered SERS substrates have been fabricated using electron beam lithographic techniques, as well as wet chemical synthesis techniques. These SERS substrates were found to be sensitive to detect TNT at concentrations as low as about 10(-8) M (~2.3 ug/L) and about 10(-9) M (~0.1 ug/L) for perchlorate by using wet-chemical self-assembly techniques. A SERS probe is also being interfaced with a portable Raman spectrometer for initial laboratory testing. This project builds upon recent advances in large-scale nanofabrication of highly ordered SERS substrates and our understanding of surface modifications for improved selectivity and sensitivity of SERS. The technology has the potential to reduce long-term monitoring costs significantly due to decreased labor and analytical costs.
http://www.serdp-estcp.org/Symposium2008/Posters/upload/W178-Gu.pdf

Development of a Protocol and Screening Tool for Selection of DNAPL Source Area Remediation
Lebron, C.A., J. Konzuk, D. Major, C. Carrara, M. Duhamel, G. Grant, B. Kueper, M. West, J. Gerhard, and T. Pang. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-103, 2008

A DNAPL remediation screening tool is currently being developed under ESTCP Project ER-0424. The tool will provide users with observed performance for various technologies applied at statistically similar sites and thus aid in determining the remedial approach most likely to meet site-specific remedial goals. This screening tool has as its basis a comprehensive database of case studies of DNAPL remediation compiled from remedial performance data from site applications, lab experiments, and numerical simulation studies. The screening tool will allow users to access a large volume of performance data quickly while filtering the output to show only the results relevant to the particular site under study. Users can also filter the output by study type or other parameters. The numerical simulations of the template sites provide information that cannot be determined from field applications, i.e., more detailed information on remedial performance such as total mass removed and mass remaining, improved understanding of the critical factors impacting technology performance through sensitivity studies, and direct comparison between technology performance and specific site characteristics. For example, the numerical modeling completed to date has shown that chemical oxidation using permanganate can reduce downgradient mass flux from a DNAPL source zone within weeks to months from treatment initiation and is capable of achieving partial removal of the DNAPL phase; however, permanganate consumption is often inefficient (~8 to 10 times more permanganate reacts with natural organic matter than contaminant in simulations with typical levels of organic matter), and the rate of DNAPL removal can become diffusion-limited due to the formation of manganese dioxide precipitate rind surrounding the DNAPL phase, prolonging necessary treatment time. The screening tool protocol was developed using multivariate regression analyses to identify key parameters affecting each performance metric for each DNAPL remediation technology. Results of the numerical simulations and case study review are presented.

Development of Biomarkers for Assessing In Situ RDX Biodegradation Potential
Cupples, A.M., I. Jayamani, and M.P. Manzella, Michigan State Univ. East Lansing.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-188, 2008

The most cost effective remediation approach for RDX used in munitions is likely to be bioremediation, but it is not yet possible to predict the effectiveness and reliability of this cleanup strategy. To address this deficiency, a novel molecular method, DNA stable isotope probing (SIP), is being used to identify microorganisms able to transform RDX in the mixed community of an environmental sample. SIP enables function to be linked with identity without the need to culture the bacteria involved. The approach involves the exposure of environmental samples to labeled target compounds, followed by nucleic acid extraction and the identification of organisms able to assimilate the target compound via 16S rRNA gene sequencing of the labeled DNA. The final goal of SERDP project ER-1606 will be to develop molecular tools toward the identified organisms so that their presence and abundance can be investigated at different contaminated sites. A variety of soils were screened for their ability to transform RDX. For each soil, microcosms were constructed with a mineral salts medium, soil inoculum, carbon source, and RDX as the sole nitrogen source. Both sample and autoclaved control microcosms were set up in triplicate and incubated, shaking at room temperature, in the dark. RDX was extracted (sonication for 18 hrs at 15 degrees C) and analyzed (HPLC-UV) at various time points during the study. Preliminary results indicate that microcosm samples from at least two soil types showed significant RDX removal, while the controls did not, suggesting a biological removal process. The SIP methodology is being integrated into these studies to identify the effective organisms. Labeled (C-13- and/or N-15-labeled RDX) or unlabelled RDX will be added to sample microcosms, DNA will be extracted then subjected to ultracentrifugation to identify the microorganisms capable of label uptake, and thus RDX transformation. Subsequently, biomarkers will be developed to investigate the presence and activity of these organisms at contaminated sites.

Development of More Cost-Effective Methods for Long-Term Monitoring of Soil Vapor Intrusion to Indoor Air Using Quantitative Passive Diffusive-Adsorptive Sampling Techniques

Groenevelt, H., T. McAlary, T. Gorecki, S. Seethapathy, D. Crump, B. Schumacher (EPA); P. Johnson, M. Tuday, P. Sacco. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-141, 2008

ESTCP project ER-0830 is designed to demonstrate the applicability of lower-cost alternatives for sampling and analysis of VOCs in indoor air and soil gas during investigation of subsurface vapor intrusion to indoor air. Lab analysis of indoor air, outdoor air or soil gas samples by EPA Method TO-15 is currently the most common method used for vapor intrusion assessments, but it typically costs $250 to $400 per sample, depending on the reporting limit required. Passive diffusive sampling and analysis can be 30 to 50% less expensive. The passive samplers also have at least three technical benefits: (1) they can be used consistently by different operators with minimal training, (2) they can be deployed over relatively long periods of time, which would provide a long-term average concentration more suitable for assessing risks over long exposure periods and minimizing temporal variability inherent in shorter-term samples, and (3) they are significantly smaller and less obtrusive than Summa canisters and thus less disruptive to building occupants. Four distinct types of passive diffusive samplers will be tested against two active gas sampling methods under controlled laboratory conditions and under field conditions at a DoD site. Each of the passive diffusive samplers contains adsorbent media that trap VOCs over time during exposure of the sampler to indoor air or soil gas. Each sampler has different materials of construction and geometries that makes it sufficiently different to justify comparative testing. None was specifically designed for soil gas monitoring, although the benefit of having data from both soil gas and indoor air is very attractive for vapor intrusion assessments, so the proposed research is designed to test applicability to soil gas as well.

DNAPL Source Zone Characterization by the Fusion of Hydraulic and Tracer Tomography Tests

Illman, W.A., K. Lorenzetti, and S. Berg (Univ. of Waterloo); J. Zhu and T.-C.J. Yeh (Univ. of Arizona); A. Craig (Univ. of Iowa). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-133, 2008

Modeling and experimental results are presented of a cost-effective technology that images DNAPL source zones in 3-D without extensive invasive sampling. Based on stochastic methods, this new technology assimilates results of hydraulic and partitioning tracer tomography surveys to derive the best estimate of the DNAPL distribution and its uncertainty. Specifically, it first analyzes the information derived from hydraulic tomography (HT) to identify the 3-D hydraulic heterogeneity of the aquifer. The knowledge of heterogeneity is then used to design partitioning tracer tomography (PTT) tests to accurately depict the spatial distribution of DNAPL residual saturation in the source zone. Results show that the accurate characterization of hydraulic heterogeneity, especially hydraulic conductivity is of paramount importance in mapping the distribution of DNAPLs. Funded under SERDP Project ER-1365, the proposed technology is superior to traditional characterization techniques as it requires less invasive sampling and far fewer boreholes, leading to substantial cost savings to obtain the same level of accuracy. The cost savings increases in larger and deeper DNAPL source zones where drilling is very expensive. The new technology is also non-destructive, can be applied repeatedly pre- and post-remediation, provides the means for real-time monitoring and forecasting of the fate of

DNAPLs during remediation, and provides uncertainty estimates that can facilitate better decision making. http://www.serdp-estcp.org/Symposium2008/Posters/upload/T110-Illman.pdf

The Effects of Meteorological Conditions on Residential Vapor Intrusion at Hill Air Force Base, Utah
Steinmacher, S.J., R. Hanover, P.A. EerNisse, J.P. Miller, and J.D. Case.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

Recent guidance for residential vapor intrusion risk analysis includes recommendations for multiple sampling events, with samples collected under conservative conditions (e.g., appropriate weather conditions and reasonable indoor air exchange rates). At Hill AFB, contractors have noted that a significantly greater proportion of detections for TCE occurs in winter versus summer indoor air sampling. This experience suggests significant differences between winter and summer detection rates, but the pattern of influence of individual meteorological conditions--temperature, barometric pressure, wind speed--on this observed difference is unclear. A detailed data analysis was conducted to determine the influence of meteorological conditions on the probability of volatile organic compound (VOC) detections. Data were collected during ongoing indoor air sampling at residences in one neighborhood at OU-8 near Hill AFB, with over 400 indoor air sampling events between winter 2003 and winter 2008. Of the residences tested, 37.6% had detectable levels of TCE. Of the residences sampled at least once during winter and once during summer, 69% had winter-only detections, compared with 0% summer-only detections, and 31% both-season detections. Despite the seasonality findings, neither average and median daily temperatures nor minimum and maximum daily temperatures were associated with probability of detection. Barometric pressures recorded at the beginning and end of each 24-hour sampling event showed no difference between average pressures for non-detections and detections. Wind speed varied by 22 knots but was not associated with probability of detection. Many factors influence the concentrations of VOCs in indoor air sampled for vapor intrusion, and additional potential factors are discussed. Temperature, barometric pressure, and wind speed alone, however, do not appear to influence detection rates strongly at residences in OU-8. A similar analysis of data across additional OUs near Hill AFB is presented for comparison.

Electrical Root Mapping: A Scoping Study for Rapid Determination of the Spatial Distribution of Tree Roots
Ellis, T.W., W. Murray, J. Brophy, C. Williams, S. Maunder, and P. Hairsine.
Commonwealth of Australia, Rural Industries Research and Development Corporation. RIRDC Publication 08/041, 43 pp, 2008

The measurement of plant root systems by conventional methods is a slow and laborious procedure, particularly under field conditions. This report describes pot and field experiments conducted to assess the use of electricity as a rapid, non-destructive method for the measurement of the spatial distribution of roots of trees and smaller plants. The researchers found that conventional capacitance techniques can be used on trees and applied a new technique to increase the accuracy and repeatability of the measurements. The new technique also eliminated most of the error associated with electrical resistance between the tree stem and the electric probes. By altering the conceptual model of roots as electrical components within a soil medium, and undertaking measurements at high frequency, the presence of shallow individual tree roots was detected successfully via remote methods under laboratory and field conditions. This technique was adapted for use with a ground probe and used to measure the electric field associated with the roots of different plants in pots. The electric field measurements varied according to root mass density and root length density in both vertical and horizontal directions, and were able to detect fine roots (< 1 mm diameter) and with relatively low root length densities. If an electrical technique can be developed into a reliable method for field conditions, it would have immediate and widespread applications for agronomy, forestry, plant breeding, and hydrology, as well as for estimating the zone of influence of plants used for hydraulic control or phytoremediation. The preliminary work undertaken in this study justifies a structured and detailed appraisal of these techniques to determine their potential for rapid root investigations under field conditions. http://www.rirdc.gov.au/reports/AFT/08-041sum.html

Electrical Measurement of Root Mass and Root Location
Ellis, T.W., K. Feher, W. Murray, K. Paul, J. Brophy, K. Jacobsen, V. Koul, P. Leppert, and J. Smith. Commonwealth of Australia, Rural Industries Research and Development Corporation. RIRDC Publication 08/042, 32 pp, 2008

Two electrical methods for the measurement of roots have previously shown promise for the development of rapid non-destructive techniques for measurement of root mass and root location. This report describes additional research conducted to (1) evaluate the low-frequency (kHz range) electrical capacitance method for the measurement of tree root mass and root length, and (2) determine the governing principles and limits for the transmission of electromagnetic signals through a root system. The results provide evidence that low frequency capacitance (C) measurements can be related to root mass and possibly to root length of plantation eucalypts. Trees at three mature plantation sites produced similar relationships between C and root mass. The one younger site showed a different relationship between C and root mass, but the results from the four sites produced a relatively unified relationship between C and root length, although the latter was inferred and not measured directly. This finding is consistent with root capacitance theory. The younger site likely had a greater proportion of fine (<2mm diameter) roots and therefore a greater total root length. In the high-frequency measurement of root location, signals could be transmitted from plant stems to roots, which tended to act as underground antennas, emitting electromagnetic fields that can be detected remotely; however, it appears that the relative dielectric properties of roots and soils are such that signals will travel only relatively short distances (2 to 3 m) along large-diameter (10 to 20 mm) roots, before becoming too small to detect. The methods tested will require additional work to develop them to the point where they are likely to be directly useful for determining the zone of influence of root systems. http://www.rirdc.gov.au/reports/EFM/08-042sum.html

Emerging High-Throughput Approaches to Analyze Bioremediation of Sites Contaminated with Hazardous and/or Recalcitrant Wastes
Stenuit, B., L. Eyers, L. Schuler, S.N. Agathos, and I. George.
Biotechnology Advances, Vol 26 No 6, p 561-575, Nov-Dec 2008

To perform a comprehensive assessment of the biodegradative potential of a contaminated site and monitor efficiently changes in the structure and activities of microbial communities involved in bioremediation processes, sensitive, fast and large-scale methods are needed. The reviewers discuss various genomic high-throughput techniques and their potential or demonstrated application to assessing biotreatment of contaminated environments.

Environmental Technology Verification (ETV) Testing of Four Mercury Emission Sampling Systems: Apex Instruments, Environmental Supply Company, Tekran Instruments Corporation, and Thermo Electron
Kelly, T., J. Satola, Z. Willenberg, and A. Dindal, Battelle, Columbus, OH.
EPA 600-R-07-052 (NTIS: PB2007-108680), 144 pp, 2007

CEMs-Tekran Instrument Corp. Series 3300 and Thermo Electron's Mercury Freedom System Continuous Emission Monitors (CEMs) for mercury are designed to determine total and/or chemically speciated vapor-phase mercury in combustion emissions. Performance for mercury CEMs are contained in Chapter 40 of the Code of Federal Regulations, Part 75 and Part 60 (40 CFR Parts 75 and 60) and require assessment of the performance of newly installed mercury CEMs only for their determination of HgT. This total is the sum of vapor-phase mercury in all chemical forms in the combustion gas, including Hg(0) and HgOX. The CEMs tested claim to measure HgT, Hg(0), and HgOX. They both use atomic fluorescence for detection. Appendix K of 40CFR Part 75 established sorbent-based sampling systems as an acceptable approach for determining mercury in the stack of utility generating stations. Apex Instruments and Environmental Supply Co. both have sorbent-based sampling systems. Sorbent-based systems collect integrated samples of mercury from stack gas onto selected sorbent material over an extended time period (from a few hours to several days). The collected mercury samples are then analyzed and the stack gas mercury concentrations are calculated. Appendix K defines procedures for use of such systems to collect total vapor-phase mercury in combustion source emissions and require the use of multi-stage sorbent traps pre-spiked with mercury as a quality assurance measure. Apex used atomic absorption for final analysis, while ESC uses cold vapor atomic fluorescence spectrometry.

Environmental Technology Verification Report: JSC OPTEC 3.02 P-A Chemiluminescent Ozone Analyzer
Holowecky, P., T. Kelly, Z. Willenberg, and A. Dindal, Battelle, Columbus, OH.
U.S. EPA, Environmental Technology Verification (ETV) Program, 37 pp, Feb 2008

The ETV Program evaluated the performance of the JSC Optec Inc. 3.02 P-A chemiluminescent ozone analyzer, a continuous monitor for determining ozone in air. The objective of this verification test was to evaluate the performance of the Optec 3.02 P-A, in part by comparing it to the response of the UV-absorption Federal Equivalent Method (FEM) for ozone. FEMs are established by EPA to assure high quality in ambient air monitoring data. The UV-absorption FEM for ozone is the method used for virtually all ambient ozone monitoring in the U.S. The specific commercial FEM monitor used in this test was the Thermo Environmental Model 49C (method EQOA-0880-047). The performance of the JSC OPTEC 3.02 P-A is detailed in Chapter 6 and summarized in Chapter 7.
http://www.epa.gov/nrmrl/std/etv/pubs/VR_OptecFeb2008.pdf

Evaluating the Impact of Extraction and Cleanup Parameters on the Yield of Total Petroleum Hydrocarbons in Soil

Saari, E., P. Peramaki, and J. Jalonen, Univ. of Oulu, Oulu, Finland.
Analytical and Bioanalytical Chemistry, Vol 392 No 6, p 1231-1240, Nov 2008

Interlaboratory comparisons for the analysis of mineral oil in polluted soil using the GC-FID method indicate that extraction and cleanup conditions have significant effects on the analytical results. A ruggedness test was performed on the extraction and cleanup method for the determination of total petroleum hydrocarbons (TPH) in soil. A two-level Plackett-Burman design was utilized to study the effect of 11 different method parameters on the extraction recovery of TPH in soil. Both qualitative and quantitative factors were investigated. The results indicate that TPH can be monitored relatively reliably through strict implementation of the ISO and CEN draft standards, but variation in certain method parameters may affect the validity of the results. The most critical factors affecting TPH recovery were the solvent and co-solvent used for extraction, the extraction time, adsorbent and its weight, and sample TPH concentration. Because adaptation of the draft standards especially with respect to these factors easily leads to TPH recoveries higher than 200% or lower than 70%, the validity of the adapted method should always be verified.

An Evaluation and Implementation Guide for Groundwater Contaminant Mass Flux Measurement Methods

Goltz, M.N. and J.G. Wheeldon (WPAFB); A.E. Hylko (USAFA); M. Brooks and A.L. Wood (U.S. EPA); A.E. Thal Jr. (AFIT); S. Leach (HQ AAFES).
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-159, 2008

Work is being funded under ESTCP Project ER-0318 to review the methods currently available and under development to measure groundwater contaminant flux and provide guidelines for the implementation and use of those methods in the field. The study considers various factors that need to be evaluated by a remediation project manager to decide which flux measurement technology to use and how best to apply it. A multi-attribute decision tree is being developed to assist in this evaluation. The present study looks at the conventional transect method (TM), and the newer passive flux meter (PFM), modified integral pumping test (MIPT), and tandem circulating well (TCW) methods of measuring contaminant mass flux. The investigators are evaluating technology capabilities, limitations, and costs for each of the methods by reviewing implementation practices and comparing the costs of applying the methods at 16 standardized "template" sites. The results of the analysis are consolidated into a decision tree that can be used to determine which measurement method would be most effective, from cost and performance standpoints, in meeting management objectives at a given site. The investigators found that in general, (1) the point methods (TM and PFM) were less expensive to use to characterize smaller areas of contamination, whereas the pumping methods (MIPT and TCW) would be more economical for larger areas, (2) the pumping methods are not capable of high-resolution sampling, which may be required to characterize heterogeneous systems or to design remediation technologies, and (3) when high resolution is required, the PFM is more economical than the TM. The study demonstrated that the newer methods arguably are as accurate as the traditionally used TM.

Evaluation of a New Passive Diffusion Sampler for Monitoring for Soil Gas and Ground Water at Two UST Sites
Paul, C.J., J.T. Wilson, D. DiGiulio, K. Jewell, R. Davis, J. Menatti, and R. Sharma.
EPA Region III States LUST Technical Workshop, 22-24 October 2007, Gettysburg, Pennsylvania. 53 slides, 2007

Conventional soil gas monitoring practice measures concentration of BTEX in groundwater beneath the building using a conventional well screened across the water table, assumes that concentration of contaminants in the capillary fringe is the average concentration of contaminants produced from the monitoring well, and uses screening models (i.e., Johnson & Ettinger) to estimate the effect of biodegradation on removal of hydrocarbon vapors. If oxygen is available at the capillary fringe, biodegradation may remove the fuel vapors before they have a chance to diffuse upward into buildings. The new passive diffusion sampler approach replaces the estimates of a mathematical model with monitoring to determine the presence of vapors that can diffuse into buildings in the soil gas immediately above the capillary fringe.
http://www.epa.gov/reg3wcmd/LUST-Workshop-2007/tues-morn/2_RegIII2007Rev_CindyPaul_forPost103107.pdf

Evaluation of Different Time Integral Indoor Air Measurements Collected from an Active Drycleaner
Rago, R.J. and G.M. Plantz, Haley & Aldrich, Inc.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

While laboratory analytical methods have developed greatly over the past decade, recommended sample collection techniques have changed little and often specify time-integrated sample collection. Regulatory guidance may even require the collection of indoor air samples over an 8- to 24-hour time period to allow for a representative sample; deviating from such sampling intervals can result in regulatory rejection of the collected data. This paper presents results from the collection of TO-15 samples over different time intervals from an active drycleaner with no known subsurface contamination. Grab, 1-hour, 8-hour, 24-hour, and 7-day indoor air samples were collected in the summer and fall. Sampling also included an evaluation of conditions when the drycleaner machine was not operating. Evaluation of the different time-integrated sample results is presented.

An Evaluation of Field Test Kits for Environmental Sampling
U.S. Army Corps of Engineers Public Works Technical Bulletin, PWTB 200-1-61, 36 pp, Oct 2008

This Public Works Technical Bulletin identifies some field test kits available on the market and discusses their effectiveness in identifying environmental contaminants, such as polychlorinated biphenyls (PCBs), heavy metals, explosives, petroleum, oils, and lubricants. Quick decisions are often necessary in scoping an environmental emergency and determining an appropriate response. In addition, screening a large area (or large number of items) requires efficient tools. Commercially available field test technologies may offer the best alternative for spill response, screening of recycling scrap or waste building materials, compliance, long-term monitoring and pre-screening of contaminated areas to determine future actions. Modern technical approaches, such as EPA's Triad for characterization and remediation of hazardous waste sites, encourage the use of real-time measurement technologies, including field analytical instrumentation. Some of the benefits of this modern approach are accelerated project schedules, cost reduction and improvement of project results. This bulletin describes the most commonly used field testing technologies and instruments based on these technologies and includes Army examples where implementation of field testing technologies has saved operational costs and project time. http://www.wbdg.org/ccb/ARMYCOE/PWTB/pwtb_200_1_61.pdf

Evaluation of Ultrafiltration Cartridges for a Water Sampling Apparatus
Holowecky, P.M., R.R. James, D.P. Lorch, and S.E. Straka (Battelle, Columbus, OH); H.D.A. Lindquist (U.S. EPA, NHSRC, Cincinnati, OH).
Journal of Applied Microbiology, Vol 106 No 3, p 738-747, Mar 2009

This study provides performance data on the ability of several different ultrafiltration cartridges (UFCs) to concentrate a panel of test microorganisms from three sources of potable water. Water utilities and first responders can use these data when selecting UFCs for emergency response.

An Excel(r) Workbook for Identifying Redox Processes in Ground Water
Jurgens, B.C., P.B. McMahon, F.H. Chapelle, and S.M. Eberts.
U.S. Geological Survey Open-File Report 2009-1004, 15 pp, 2009

The reduction/oxidation (redox) condition of ground water affects the concentration, transport, and fate of many anthropogenic and natural contaminants. The redox state of a ground-water sample is defined by the dominant type of reduction/oxidation reaction (redox process) occurring in the sample, as inferred from water-quality data. Because of the difficulty in defining and applying a systematic redox framework to samples from diverse hydrogeologic settings, many regional water-quality investigations do not attempt to determine the predominant redox process in ground water. Recently, a redox framework was applied to a large number of samples from 15 principal aquifer systems in the United States to examine the effect of redox processes on water quality. This framework was expanded to use measured sulfide data to differentiate between iron(III)- and sulfate-reducing conditions. These investigations showed that a systematic approach to characterize redox conditions in ground water could be applied to datasets from diverse hydrogeologic settings using water-quality data routinely collected in regional water-quality investigations. This report describes a workbook developed in Microsoft(r) Excel(r) that assigns the predominant redox process to samples using the framework created by McMahon and Chapelle (2008) and expanded by Chapelle and others. Assignment of redox conditions is based on concentrations of dissolved oxygen, nitrate, manganese, iron, sulfate, and sulfide. The logical arguments for assigning the predominant redox process to each sample are performed by a program called from buttons on the main worksheet. The number of samples that can be analyzed is only limited by the number of rows in Excel(r) (65,536 for the 2003 and XP versions; 1,048,576 for 2007), and is therefore appropriate for large datasets.
http://pubs.usgs.gov/of/2009/1004/

Feasibility of Assessing the Community Composition of Prasinophytes at the Helgoland Roads Sampling Site with a DNA Microarray
Gescher, C., K. Metfies, S. Frickenhaus, B. Knefelkamp, K.H. Wiltshire, and L.K. Medlin.
Applied and Environmental Microbiology, Vol 74 No 17, p 5305-5316, Sep 2008

To facilitate the assessment of the abundance of the Prasinophyceae, the authors designed and evaluated an 18S rRNA gene-targeted oligonucleotide microarray consisting of 21 probes targeting different taxonomic levels of prasinophytes. The microarray contains both previously published probes from other hybridization methods and new probes, which were designed for novel prasinophyte groups. The evaluation of the probe set was done under stringent conditions with 18S PCR fragments from 20 reference cultures used as positive targets. The samples were collected every 2 weeks between February 2004 and December 2006, and the results demonstrate the potential of DNA microarrays to be applied as a tool for quick general monitoring of microorganisms.

Field Techniques for Estimating Water Fluxes Between Surface Water and Ground Water
Rosenberry, D.O. and J.W. LaBaugh, eds.
U.S. Geological Survey Techniques and Methods 4-D2, 135 pp, 2008

This report focuses on measuring the flow of water across the interface between surface water and ground water, rather than on the hydrogeological or geochemical processes that occur at or near this interface. To make the reader aware of the breadth of approaches available for the study of the exchange between surface and ground water, the report is divided into four chapters. Chapter 1 describes many well-documented approaches for defining the flow between surface and ground waters. Subsequent chapters provide an in-depth presentation of particular methods. Chapter 2 focuses on three of the most commonly used methods either to calculate or directly measure the flow of water between surface-water bodies and the ground-water domain: (1) measurement of water levels in well networks in combination with measurement of water level in nearby surface water to determine water-level gradients and flow; (2) use of portable piezometers (wells) or hydraulic potentiomanometers to measure hydraulic gradients; and (3) use of seepage meters to measure flow directly. Chapter 3 focuses on describing the techniques involved in conducting water-tracer tests using fluorescent dyes, a method commonly used in the hydrogeologic investigation and characterization of karst aquifers, and in the study of water fluxes in karst terranes. Chapter 4 focuses on heat as a tracer in hydrological investigations of the near-surface environment. http://pubs.usgs.gov/tm/04d02/

Final Project Report for Investigation of the Influence of Temporal Variation on Active Soil Gas/Vapor Sampling
Schumacher, B.A., J. Elliott, D. Springer, B. Hartman, and G. Swanson.
EPA 600-R-07-141 (NTIS PB2008-105120), 92 pp, 2007

This study was conducted for quantitative assessment of the influence of temporal variations on soil gas sample results. It was designed to assess the effect of atmospheric variables (ambient temperature, barometric pressure, precipitation, and wind speed) on soil gas results. Variations in soil gas concentrations due to atmospheric conditions have not been well documented; however, recent data from three sites have shown temporal variability in soil gas concentrations to be typically less than a factor of two. While the data provide some indication that temporal variations have a limited impact on soil gas concentrations, none of the data sets were controlled studies conducted with the intent of determining impacts caused by temporal variations. With the increased use of quantitative soil gas data for vapor intrusion assessments, there is a large demand around the country for data documenting the level of impact that temporal variations have on measured soil gas concentrations. Developing a better understanding of the correlation between atmospheric changes and soil gas concentrations from fixed locations can lead to a better understanding of soil gas movement and can enable an investigator to optimize the timing of sample collection to yield representative samples and assess risk more effectively.

Final Project Report for the Development of an Active Soil Gas Sampling Method
U.S. EPA, Office of Research and Development.
EPA 600-R-07-076 (NTIS: PB2007-112084), 178 pp, 2007

This report documents the results of an investigation into the effects of purge rate, purge volume, and sample volume on soil gas sample results. The investigation also was designed to develop technically defensible values or ranges of values for these parameters that can be incorporated into active soil gas sampling guidance. Research groups and other agencies have developed guidance concerning sampling and analytical protocols for active soil gas measurements with the overall objective of facilitating a technically correct approach for site investigations; however, the various guidance documents often omit prescribed ranges for the principal parameters, or if prescribed, lack a quantitative basis for the recommended parameter settings. This investigation was designed to evaluate the principal parameters over the range of values commonly cited in guidance documents and provide defensible recommendations for parameter settings. The experiments were conducted at Installation Restoration Program (IRP) Site 15 on Vandenberg AFB, where an array of 15 soil vapor sampling probes was deployed at IRP Site 15 above the larger of two dissolved-phase TCE groundwater plumes. The results of 3 purge rate experiments show a pronounced increase in the measured TCE concentration at purge rates of 100 ml/min to 200 ml/min, followed by a modest trend of increasing measured concentrations with increasing purge rate. Although the observed variability in measured VOC concentrations generally would not be considered significant from a site characterization or vapor intrusion perspective, based on the data from this investigation, it appears that purge rates of 200 to 500 ml/min should be recommended. The results from the purge volume experiment indicate a statistically significant positive correlation between the measured TCE concentrations and purge volume, with concentrations typically more than doubling over the range of purge volumes tested. The effect of purge volume on the measured VOC concentrations was more pronounced than the effect of purge rate; however, this variability may not be significant in terms of site characterization. The data indicate that varying purge volume from 1 to 5 system volumes has relatively little effect on the sample results, but increasing purge volume above 5 system volumes appears to result in somewhat higher measured TCE concentrations. These experimental data suggest that purge volumes of 2 to 5 system volumes are most appropriate. Measured TCE concentrations were observed to increase with increasing sample volume from 25 to 1,000 ml, but then drop off in the 6,000 ml samples. This observation is significant as the 6,000 ml sample size is commonly used to achieve very low detection levels with EPA method TO-15, but the drop in measured TCE concentrations at a 6,000 ml sample volume suggests that the low detection levels achievable with large sample size may need to be balanced against the risk of over-purging. Based on the data obtained from this investigation, it appears that a sample volume of 1,000 ml should be recommended, as this volume resulted in the highest measured TCE concentrations. http://www.epa.gov/nerlesd1/cmb/pdf/203cmb07-Schmacher.pdf

Fluvial Sediments Characterization: Triad Approach and Field Determination of TPH Concentration with Hanby Environmental Test
Ruggeri, R., P. Pucillo, G. Zecchini, and R. Pellegatta, ENSR Italia, Milano, Italy.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

In July 2003, a fire that occurred at a lubricant depot in Italy released heavy oils into a creek used for irrigation in the surrounding agricultural areas. After all floating oil had been removed, about 1,200 m of the creek bed were investigated to assess the distribution of residual contamination on the sediments. The adopted sampling grid was extremely detailed to minimize the volume of impacted sediments to be remediated. The portion of the creek downstream from the facility was subdivided into four main sections, and these sections into smaller portions, each 25 m long. Four grab samples and a composite sample were collected from each of the subsections. Surface sediment (the top 15 cm) was sampled using a hand auger and then analyzed using the Hanby Environmental Test kit. The Hanby test can be used in the field to provide a real-time estimation of organic compound concentration. Before the field activities began, the Hanby test was calibrated on sediment samples with laboratory analysis (method EPA8440/1996). To verify the field results, 10% of the total samples (24 of 240) were analyzed in the laboratory. Only 6 contaminated subsections exceeding the target limit for TPH were identified and remediated. Adoption of the Hanby tests reduced overall analytical time (the procedure for one sample takes ~10 minutes) and resulted in significant cost and time savings for the site owner.

From Forensics to Environmental Science, Elemental Fingerprints Uncover the Clues
Wright, Sarah.
Oak Ridge National Laboratory Reporter, No 106, Dec 2008

The ORNL Environmental Sciences Division's Madhavi Martin uses laser-induced breakdown spectroscopy (LIBS)--a technique invented in the 1960s--to collect elemental fingerprints. The LIBS method uses a focused laser to evaporate sample materials, breaking down all of the bonds and producing optical emissions of very specific wavelengths depending on the elements present within the sample. The method can be applied to analyze any kind of sample: liquid, solid, gas, or aerosol. Madhavi's work has even helped to solve a murder, connecting a suspect to the victim by showing that firewood at the scene of a crime where the victim was burned in a bonfire came from the same tree that the suspect burned in the fireplace at his own home. The firewood was from a mesquite tree--one of the worst for analyzing tree rings because of its erratic growth patterns. [See "Analysis of Wood Samples from a Crime Scene using Laser-Induced Breakdown Spectroscopy (LIBS)," H.D. Grissino-Mayer and M.Z. Martin (2004) at http://web.utk.edu/~grissino/downloads/Libs%20Final%20Report.pdf] Madhavi has received a lot of press for her contributions to forensics, but she emphasizes that the LIBS technique is particularly useful for characterizing environmental threats, such as water and air pollution. She is using the technique to improve phytoremediation of large-scale polluted areas by monitoring the amount of pollutants present in prospective plants and helping to choose the best phytoremediation candidates.

Geophysical Imaging for Investigating the Delivery and Distribution of Amendments in the Heterogeneous Subsurface of the F.E. Warren AFB
Kelley, R. (Regenesis); S. Hubbard and J. Ajo-Franklin (LBNL); B. Butler-Veytia (URS Corp.).
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-157, 2008

By reducing uncertainty in amendment delivery, remedial design safety factors have the potential to match actual remedial performance more closely, thus reducing overall project costs. ESTCP project ER-0834 has focused on the installation of hydrogen release compound (HRC(r)) for biostimulation in sand fractures created via hydraulic fracturing. Soil borings have been used to understand the propagation of sand fractures and distribution of the HRC(r) within the aquifer. Significant interpretation between data points is required to estimate the size of installed fractures and the impact of emplaced HRC(r), resulting in design uncertainty and use of safety factors to ensure treatment. Geophysical imaging in combination with hydraulic fracturing has the potential to reduce uncertainty during the remedial design phase, as well as during performance monitoring. If geophysical imaging can be cost effective in comparison to monitoring tools currently used and provide data to support a reduction in remedial design uncertainty, its use likely will result in significant decreases in overall project costs and will be widely applicable. Multiple geophysical methods (seismic, radar, electrical) are being evaluated to monitor and detect the distribution of amendments introduced via hydraulic fracturing. In addition to responding to lithologic heterogeneities, three additional classes of geophysical responses are expected to be associated with the fracture amendment delivery strategy: those associated with the initial hydraulic fracturing, those related to the properties of the amendment, and those associated with biogeochemical transformations (such as gas generation or variations in total dissolved solids). The first phase of work is presented.

Geo-REX(tm): Easy Quantitative Evaluation of Heavy Metals in the Soils and Paddy-Rice
Nakagawa, K., R. Takeda, Y. Wakabayashi, K. Iwasa, S. Tamaki, S. Komemushi, and A. Sawabe, Sekisui Chemical Company, Ltd.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Geo-REX(tm) is a powerful tool for analyzing heavy metals in soils and plants. A new, compact micro-cartridge system for measuring heavy metals, Geo-REX(tm) does not use mercury for the analysis of whole soil or plant extracts. The analytical element fits within a micro-cartridge for automatic analysis of a 5 mL sample, with a change of the cartridge for every analyte (e.g., Pb, Cd, As, Cr[VI], Se, Hg). The authors compared the analytical performance of atomic absorption spectrophotometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS) with Geo-REX(tm) to measure heavy metal at trace levels between 0.1 and 1 ppb. Correlations of measurement with the new instrument and AAS or ICP-MS were good.

Groundwater Plume Forensics Using Minor Ions

Mutch, R.D. Jr. (HydroQual, Inc., Mahwah, NJ); R.F. Carbonaro (Manhattan College, Riverdale, NY). Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

While the principal contaminants in groundwater plumes commonly are VOCs or heavy metals, the sources often can be identified more definitively through analysis of other trace constituents in the plumes. The minor ions, bromide and iodide, can be particularly diagnostic in some cases because they behave conservatively as they move through the aquifer. These halides are rarely analyzed for in groundwater quality investigations and typically are present in very low concentrations in natural waters. Neutron activation analysis usually affords detection limits low enough to quantify the concentration of these minor ions. Cross plots of I/Na versus Br or Cl/Br versus Cl often can be used to distinguish the source of contaminants from landfills, septic systems, animal wastes, and road salting. Two case studies are presented. In one case, use of these minor ions enabled differentiation of landfill leachate-related groundwater contamination from septic system-related contamination and thereby identification of the source of accompanying VOC contamination. In the second case, the minor ions were used to identify conclusively the intrusion of landfill leachate into a deeper aquifer despite complex hydrogeologic conditions and overlapping plumes of contamination.

Guidance for the Sampling and Analysis of Lead in Indoor Residential Dust for Use in the Integrated Exposure Uptake Biokinetic (IEUBK) Model

U.S. EPA, Office of Superfund Remediation and Technology Innovation.
OSWER 9285.7-81, 23 pp, Dec 2008

In Superfund risk assessments, Pb in indoor dust typically is accounted for in the IEUBK model as an input parameter. By default, indoor dust Pb concentrations are estimated from outdoor soil Pb concentrations using the mass fraction of soil in indoor dust variable; however, the accuracy of the IEUBK model estimates for a specific site will improve when site-specific exposure data for media concentrations, such as indoor dust, are used. The recommendations in this guidance apply to applications of the IEUBK model in Superfund Pb risk assessments and may not be appropriate for other applications, such as HUD Pb risk assessments. Implementation of the sampling and analysis recommendations in this document will enhance consistency in Pb risk assessments at Superfund sites.
http://epa.gov/superfund/health/contaminants/lead/products/dust_sampling_guidance_final.pdf

Hardware/Software Codesign in a Compact Ion Mobility Spectrometer Sensor System for Subsurface Contaminant Detection

Loo, S.M., J.P. Cole and M.M. Gribb.
EURASIP Journal on Embedded Systems, Article ID 137295, 8 pp, 2008

A field-programmable, gate-array (FPGA)-based data acquisition and control system was designed in a hardware/software codesign environment using an embedded Xilinx Microblaze soft-core processor for use with a subsurface ion mobility spectrometer system designed for detection of gaseous VOCs. An FPGA is used to accelerate the digital signal processing algorithms and provide accurate timing and control. An embedded soft-core processor is used to ease development by implementing non-time-critical portions of the design in software. The

design was implemented successfully using a low-cost, off-the-shelf Xilinx Spartan-III FPGA and supporting digital and analog electronics.
http://ces.boisestate.edu/documents/Hardware%20Software%20Codesign%20in%20IMS%20System%20.pdf

Identification of Microbial Gene Biomarkers for In Situ RDX Biodegradation
Crocker, F.H., K. Indest, L. Eltis, C. Florizone, H.-P. Chen, J. Hawari, J.-S. Zhao, & N. Perrault.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-181, 2008

RDX, a recalcitrant nitramine explosive with a low sorption capacity, has affected the groundwater at some U.S. military bases. The toxicity and persistence of RDX ultimately threatens the long-term sustainability of these ranges for military training. In situ bioremediation and natural attenuation are potential remediation approaches for these sites, but methods for assessing in situ biodegradation of RDX generally are lacking; however, advances in molecular biology, such as high-throughput DNA sequencing and differential gene and protein expression analyses, are providing access to biochemical and genetic information on cultivable and uncultivable microorganisms. Biomarkers identified in this study will be used to develop molecular tools that can predict the potential for RDX biodegradation or monitor the progress of RDX bioremediation in the field. The results from studies with the Gordonia sp. strain KTR9 are discussed. Genome sequencing of strain KTR9 has identified a plasmid ~182 Kb in size. Preliminary gene annotation of the plasmid has identified 201 predicted open reading frames (ORFs). The majority of these ORFs are hypothetical proteins, while 38 ORFs match currently known ORFs. The plasmid contains the xplAB gene homologues responsible for RDX biodegradation, as well as an additional cytochrome P450 gene, a transcriptional regulator, and several transposase genes. Two-dimensional protein gel electrophoresis/mass spectrometry and sequencing of a fosmid library are being used to identify proteins that are differentially expressed by KTR9 in the presence of RDX. Key metabolites and end-products are being identified to elucidate the mechanism of RDX catabolism in KTR9. The results from these ongoing studies are providing key insights into those genes and genetic pathways that are candidates for biomarkers of explosives degradation.

Important Physical Processes for Vapor Intrusion: A Literature Review
McHugh, T.E., GSI Environmental, Houston, TX.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

A literature review conducted to identify research on the fate and transport of VOCs focused on three key environmental matrices or interfaces: the groundwater/soil gas and soil/soil gas interfaces, unsaturated zone soils, and the building foundation. The reviewed papers included field and lab studies and modeling analyses. Although much of the available literature supports the common conceptual model of vapor intrusion, some additional physical processes were identified that may have a significant influence on the pathway. (1) Impact of Fluctuating Water Table: A falling water table can cause a transient increase in VOC concentrations in deep soil gas as VOCs diffuse out of water trapped in the vadose zone. This transient effect may at least partly account for the poor correlation between measured VOC concentrations in groundwater and deep soil gas at some sites. As a result, recent changes in water-table elevation may be important for interpreting deep soil gas monitoring results. (2) VOC Transport Across Building Foundations: In almost all buildings, cross-foundation pressure gradients are sufficient so that advection rather than diffusion is the dominant transport mechanism into the building. Positive building pressure can inhibit vapor intrusion; however, for buildings with fluctuating or negative pressure gradients, changes in the magnitude of the pressure gradient do not correlate with changes in the magnitude of vapor intrusion. These findings (from research on radon conducted in the 1980s) suggest that vapor intrusion in passively ventilated buildings (i.e., most residences) will not increase in response to transient negative pressure events.

In Situ Hydrogen Consumption Kinetics as an Indicator of Subsurface Microbial Activity
Harris, S.H., R.L. Smith, and J.M. Suflita.
FEMS Microbiology Ecology, Vol 60 No 2, p 220-228, 2007

Scientists from USGS and the University of Oklahoma have developed a test for determining what microbiological processes are active in the subsurface at ground-water contamination sites. The test can be used to determine the effects of bioremediation systems or assess natural attenuation processes. The test involves injecting a solution containing a low concentration of dissolved hydrogen gas and a non-reactive (conservative) tracer into the subsurface. The resulting plume of hydrogen gas and conservative tracer is monitored through time with the injection well. Monitoring involves collecting water-quality samples as the natural flow of ground water makes it drift past the injection/monitoring well--a natural-gradient, single-well injection test. In some cases, the plume is withdrawn from the aquifer by continuous pumping during the sampling phase--a push-pull test. For either type of test, the concentration of the conservative tracer is compared with the concentration of hydrogen gas in water sampled during the test, which enables estimation of the rate at which microbial processes consume the added hydrogen. The hydrogen consumption rate can identify the types of microbial communities that are actively degrading contaminants (e,g,, iron-reducing, sulfate-reducing, or methane-producing bacteria). This is useful information for assessing the performance of remediation systems. The hydrogen single-well injection test was developed at USGS research sites at Norman Municipal Landfill in Oklahoma site and on Cape Cod, Massachusetts.

In Situ Push-Pull Tests for the Determination of TCE Degradation and Permanganate Consumption Rates
Ko, S.-O. and S.-H. Ji, Kyunghee Univ., Yongin, South Korea.
Environmental Geology, Vol 53 No 2, p 359-364, Oct 2007

A simple, single-well push-pull test was conducted at a TCE-contaminated site to estimate the site-specific TCE degradation and permanganate consumption rate. Known quantities of a conservative tracer (Br-) and permanganate were injected into a saturated aquifer and then periodically sampled during extraction from the same well. Concentrations of Br-, TCE, and permanganate were measured, and breakthrough curves (BTCs) for all species of solute were determined. Data analysis of BTCs for bromide and TCE showed that the first-order rate constant of TCE degradation by permanganate is 1.67 +/- 0.152/h. Further, the in situ permanganate demand rate by TCE and aquifer materials is estimated to be 0.54 +/- 0.371/h. This study demonstrates that in situ push-pull tests are useful and economical tools for field investigations to determine contaminant reaction and oxidant consumption rates, which then can be used to optimize groundwater remediation designs.

Innovative Site Characterization Tools Establish Sediment Remediation Goals at a Former Manufactured Gas Plant Site
Johnson, R.A., R. Cleary, and P. LaGoy.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Investigations at the former Springfield Gas Works (Springfield, MA) indicated potential subsurface seepage of coal tar to the river. A diving/video inspection of the riverbed revealed a surficial deposit of hardened tar approximately 400 feet long and 50 feet wide. Traditional and innovative technologies, including TarGOST (tar-specific green optical scanning tool), vibracore, forensic hydrocarbon chemistry, physical testing, and mussel counts were combined to assess possible modes of tar deposition and potential future migration. TarGOST borings were advanced for rapid screening of tar distribution, including NAPLs at depth, over a large area. Vibracores were then advanced to sample tar-affected sediment for analysis of aromatic hydrocarbons (MAHs and PAHs), including alkylated PAHs, to discern source type (i.e., petrogenic vs. pyrogenic). Undisturbed samples were collected for UV and white light photography. Core sub-samples were tested using a centrifuge method at incremental G forces for water and NAPL saturations and to assess mobility. Mussel counts, size, and age were evaluated to assess sediment stability and potential adverse affects of sediment remediation technologies. The chemistry data identified two tar types generated at different times at the plant. Based on the spatial distribution of tars in land borings and sediment samples, it appears that tar was discharged to the river from pipes, with minor contributions from subsurface seepage, thus limiting the scope of land-side remediation efforts. Centrifuge data indicate that tar in sediment meets the regulatory definition of NAPL; however, this material is pooled in clay depressions and has limited mobility. Natural processes have covered much of the tar with sediment having very low MAH/PAH concentrations that are able to support mussel communities. The extent of sediment remediation and potential for adverse environmental effects will be weighed against the benefits of tar removal from the river.

Integrated Forensics Approach to Fingerprint PCB Sources Using Rapid Screening Characterization and Advanced Chemical Fingerprinting
Leather, J. (Navy SPAWAR Systems Center, San Diego, CA); G. Durell (Battelle); G. Johnson (Univ. of Utah); M. Mills (U.S. EPA); K. Forman (NAVFAC). Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-182, 2008

Within the military complex, determining the original source of contamination for a heterogeneous matrix such as sediments is a requirement for both cleanup and compliance programs. The technology to be demonstrated under ESTCP Project ER-0826 includes two primary components: (1) rapid sediment characterization (RSC) screening technologies that provide for wide spatial and temporal coverage to delineate sediment contaminant heterogeneity in a cost-effective manner and (2) advanced chemical fingerprinting (ACF) on a selected subset of these samples to develop fingerprints and delineate sources. The techniques for the RSC of

PCBs in sediments have been adapted from soil methods, i.e., modifications of the standard immunoassay methods described under EPA Method 4020 (Screening for PCBs by Immunoassay). ACF has evolved into state-of-the-art PCB analytical methods using high-resolution gas chromatography and low-resolution mass spectrometry operating in selected ion monitoring mode (HRGC/LRM-SIM) that are highly cost-effective and provide detailed, high-quality data. The methods employ components of EPA Method 680 (HRGC/LRMS PCB homologue and total PCB method) and Method 1668a (HRGC/HRMS PCB congener method). The base methods have been modified to include many nonstandard, environmentally important, and diagnostic PCB congeners that will permit data analysis for differentiating potential sources. PCB forensics data reduction and analysis include various types of statistical and other numerical analyses, including the application of sophisticated receptor modeling methods to help tease out source relationships. The overall objective of the project is to provide guidance on integrating chemical techniques into a cost-effective forensics program to apportion regulatory costs among PRPs and/or to ensure all contaminant sources have been identified prior to mitigation efforts.

An Integrative Method to Quantify Contaminant Fluxes in the Groundwater of Urban Areas
Schiedek, T., M. Beier, and G. Ebhardt, Univ. of Technology, Darmstadt, Germany.
Journal of Soils and Sediments, Vol 7 No 4, p 261-269, 2007

A method has been developed that allows quantification of mass fluxes of contaminants in groundwater between control planes. Budget zones along the flow path are defined to calculate a contaminant balance and quantitatively reveal input areas. Concentrations and water budgets are used to calculate mass balances for each contaminant. The groundwater monitoring wells (GMWs) upstream of the city of Darmstadt (Germany) showed anthropogenically superposed background values for all naturally occurring inorganic species. The contaminant concentrations increased in the city (likely influenced by road traffic, gas stations, leaking sewers, etc.). Downstream from the city, concentrations usually decreased. Organic compounds typical for urban environments, such as PAHs, locally exceeded drinking water regulations. In GMWs with high concentrations of organic contaminants in the city or downstream from industrial areas, a significant increase in Fe(2+) and Mn(2+) was observed, in some cases coinciding with a decrease in nitrate and sulfate and an increase in ammonium. For typical urban contaminants, a positive budget was calculated in several zones, which showed that emissions from urban sources are reaching the groundwater. Negative budgets can mainly be explained with diving plumes and degradation. The input calculated from the individual budget zones is usually higher than the input estimated from urban emissions. Differences between the calculated and the estimated input can be explained with additional sources or (bio)degradation processes. The results obtained with the new method are plausible compared to the land use and the estimated urban input.

Inter-Laboratory Comparison of Quantitative PCR Test Results for Dehalococcoides
Lebron, C.A., D. Major, P. Dennis, F. Loeffler, E. Edwards, C. Yeager, D. Ogles, and C. Acheson. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-167, 2008

Quantitative PCR (qPCR) techniques have been widely used to measure Dehalococcoides (DHC) DNA in the groundwater at field sites for several years. SERDP project ER-1561, Standardized Procedures for Use of Nucleic Acid-Based Tools for Microbial Monitoring, is focused on development of standardized methods for qPCR sampling, shipping, and analysis with the goal of understanding and minimizing method variability. As part of this project, experiments have been conducted to establish the baseline variability and accuracy of qPCR quantification of DHC by five laboratories through a round-robin approach. Two of the participating laboratories perform this analysis commercially, two are academic, and one is a DOE laboratory. The DHC 16S rRNA gene was used as the molecular target with a variety of qPCR instruments, qPCR chemistries, primers and probes, and DNA extraction protocols utilized by the five laboratories. Three distinct test materials were circulated amongst the laboratories: (1) plasmid DNA, to assess variability of the qPCR methods and instruments; (2) artificial groundwater spiked with DHC, to determine variation associated with cell concentration, cell lysis and DNA extraction methods; and (3) multi-method quantified DHC (a standardized reference culture) spiked into artificial groundwater, to asses the DHC quantification accuracy of qPCR methods compared with other molecular and microscopic enumeration techniques. The first round robin (Plasmid DNA) data collection has been completed and data interpretation is underway. The second and third experiments will be completed in 2009. The results from these experiments will be used to determine critical points in the analysis where variation occurs and to identify methodological improvements that can improve agreement between laboratories.

Interpreting and Reporting Radiological Water-Quality Data
McCurdy, D.E., J.R. Garbarino, and A.H. Mullin.
U.S. Geological Survey Techniques and Methods, Book 5, Chap. B6, 39 pp, 2008

This document provides information to USGS Science Centers on interpreting and reporting radiological results for samples of environmental matrices, most notably water. The information provided is intended to be broadly useful throughout the United States, but scientists who work at sites containing radioactive hazardous wastes are recommended to consult additional sources for more detailed information. This document is based largely on recognized national standards and guidance documents for radioanalytical sample processing, most notably the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP), and on documents published by U.S. EPA and the American National Standards Institute. It does not include discussion of standard USGS practices, such as field quality-control sample analysis, interpretive report policies, and related issues. http://pubs.usgs.gov/tm/05b06/

Investigation and Mitigation of a Complex Source of Vapor Intrusion Using an Iterative Investigative Approach
Milone, C.J., S.D. MacMillin, S.A. Kessel, and S.M. Stecker, Brown and Caldwell, Allendale, NJ. Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments and Water, University of Massachusetts at Amherst, 20-23 October 2008

This paper presents the challenges and approaches associated with assessing and mitigating a complex vapor intrusion issue. Soil and groundwater contamination by chlorinated solvents is associated with a former dry well and underground piping that was discovered during building renovation and construction activities conducted at the site in 1996. Data gathered during remedial investigations revealed concentrations of PCE in sub-slab soil vapor samples 10 times higher than the applicable NJDEP soil gas screening level. In addition, indoor air samples collected within the site building over a 2-year period revealed concentrations of PCE consistently in excess of the NJDEP Indoor Air Screening Level (IASL), with periodic exceedances of the NJDEP Rapid Action Level (RAL). With approval from NJDEP, a sub-slab depressurization system was implemented in the known source area as an interim remedial measure intended to be protective of on-site workers while remedial investigation activities continued at the site. Four weeks following installation and activation of the sub-slab depressurization system, confirmation indoor air sampling was conducted to verify the effectiveness of the system. Based on the results of this and two subsequent rounds of indoor testing, concentrations of PCE had not decreased since the sub-slab depressurization system was activated and continued to exceed the applicable IASL with one sample location exceeding the RAL. This paper describes the methods and findings of a multimedia investigation undertaken to evaluate, characterize, and mitigate a complex source of vapor intrusion using an iterative investigative approach.

Investigation of Contaminated Ground Water at Solid Waste Management Unit 12, Naval Weapons Station Charleston, North Charleston, South Carolina, 2006-2007
Vroblesky, D.A., M.D. Petkewich, M.A. Lowery, K.J. Conlon, and L.G. Harrelson.
U.S. Geological Survey Scientific Investigations Report 2008-5097, 80 pp, 2008

Beginning in 2000, the U.S. Geological Survey investigated natural and engineered remediation of chlorinated volatile organic compound (VOC) ground-water contamination at Solid Waste Management Unit 12 at the Naval Weapons Station Charleston, South Carolina. The primary contaminants of interest in the study are tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, cis-1,2-dichloroethene, vinyl chloride, 1,1-dichloroethane, and 1,1-dichloroethene. One engineered remediation approach being utilized at the site is a permeable reactive barrier (PRB) containing zero-valent iron. The PRB is hydraulically downgradient from the source area and is used to intercept and control concentrations of chlorinated solvents moving downgradient into a lowland forest and toward a freshwater wetland. A second engineered remediation approach consists of a planted grove of loblolly pine saplings in the source area. The PRB, which lies along the main axis of the contaminant plume, appears to be actively removing contamination. In contrast to the central area of the PRB, the data from the southern end of the barrier indicate that contaminants are moving around the PRB. Concentrations in wells 12MW-10S and 12MW-03S, upgradient from the PRB, showed a general decrease in VOC concentrations. VOC concentrations in some wells in the forest showed a sharp increase, followed by a decrease. In 2007, the VOC concentrations began to increase in well 12MW-12S, downgradient from the PRB and thought to be unaffected by it. The VOC concentration changes in the forest, such as at well 12MW-12S, may represent lateral shifting of the plume in response to changes in ground-water-flow direction or may represent movement of a contamination pulse through the forest. http://pubs.usgs.gov/sir/2008/5097/

Investigation of the Total Organic Halogen Analytical Method at the Waste Sampling and Characterization Facility
Douglas, J.G., H.K. Meznarich, J.R. Olsen, G.A. Ross, and M. Stauffer.
HNF-39194, 31 pp, Sep 2008

Total organic halogen (TOX) is used as a parameter to screen groundwater samples at the Hanford Site. Trending is done for each groundwater well, and changes in TOX and other screening parameters can lead to costly changes in the monitoring protocol. The Waste Sampling and Characterization Facility (WSCF) analyzes groundwater samples for TOX using EPA SW-846 method 9020B. Samples are submitted to the WSCF for analysis without information regarding the source of the sample; each sample is in essence a "blind" sample to the laboratory. Owing to a surprising number of outlier values and inconsistent TOX results among field sample replicates, the WSCF lab performed an investigation of the TOX analysis to determine the cause of the outlier data points. Two causes were found that contributed to generating out-of-trend TOX data: (1) At inorganic chloride concentrations greater than about 10 ppm, apparent TOX values increase with increasing chloride concentration. A parallel observation is the increase in apparent breakthrough of TOX from the first to the second activated-carbon adsorption tubes with increasing inorganic chloride concentration. (2) During the sample preparation step, excessive purging of the adsorption tubes with oxygen pressurization gas after sample loading can cause channeling in the activated carbon bed. This channeling leads to poor removal of inorganic chloride during the subsequent wash step with aqueous potassium nitrate. The presence of this residual inorganic chloride then produces erroneously high TOX values. Upon investigation, the nitrate wash recommended by EPA SW-846 method 9020B was found to be inadequate to remove inorganic chloride interference. Increasing the nitrate wash concentration from 10 g/L to 100 g/L potassium nitrate and increasing the nitrate wash volume from 3 mL to 10 mL effectively removed the inorganic chloride up to at least 100 ppm chloride in the sample matrix. Excessive purging of the adsorption tubes during sample preparation was eliminated. These changes in sample preparation have been incorporated in the analytical procedure. The results using the revised sample preparation procedure show better agreement of TOX values both for replicate analyses of single samples and for the analysis of replicate samples acquired from the same groundwater well. Furthermore, less column breakthrough is observed with the revised procedure. One additional modification made to sample preparation was to discontinue the treatment of groundwater samples with sodium bisulfite. Sodium bisulfite is used to remove inorganic chlorine from the sample; inorganic chlorine is not expected to be a constituent in these groundwater samples.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=1&page=0&osti_id=940020

Isotope and Chemical Techniques in Assessing Groundwater Contamination from Metro Manila Landfill
Castaneda, S.S., R.V. Almoneda, L.G. Fernandez, R.J. Sucgang, C.L. Iblan, and D.G. Baui.
International Symposium on Advances in Isotope Hydrology and Its Role in Sustainable Water Resources Management, 21-25 May 2007, Vienna (Austria). International Atomic Energy Agency, Report No IAEA-CN-151 (Paper No IAEA-CN-151/28), Vol 2, p 453-460, 2008

Investigations were conducted to establish benchmark isotopic characteristics of water sources and baseline concentrations of trace elements related to contamination from the Montalban landfill. Water samples were collected from the production wells and surface water in

Rodriguez and in San Mateo, the municipalities nearest to the landfill. Stable isotope characterization of the deep groundwater and rivers shows isotopic values clustering along the local meteoric water line. Shallow groundwater is isotopically enriched, trending towards the evaporation line. The mean isotopic signatures of surface water and deep groundwater in Rodriguez are significantly distinct. San Mateo groundwater appear to be more isotopically enriched, indicating recharge different from that of Rodriguez groundwater. Leachate from the landfill exhibits a distinct isotopic composition from the freshwaters. The significant differences in the isotopic signatures of the different water sources in the study area facilitates detection of contamination from leachate run-off to surface water, and eventually to groundwater. Trace metals in the water samples generally were below the regulatory limits for drinking water and surface water. http://www-pub.iaea.org/MTCD/publications/PDF/Pub1310Vol2_web.pdf

Isotopic Approaches for Monitoring Potential Contamination of Shallow Aquifers with Produced Fluids or Gases from Coalbed Methane Operations in Alberta, Canada
Mayer, B., P. Klassen, K. Cheung, S. Taylor, and M. Shevalier.
International Symposium on Advances in Isotope Hydrology and Its Role in Sustainable Water Resources Management, 21-25 May 2007, Vienna (Austria). International Atomic Energy Agency, Report No IAEA-CN-151 (Paper No IAEA-CN-151/104), Vol 2, p 519-526, 2008

Production of coalbed methane or natural gas from coal (NGC) from shallow coal seams is a relatively new industry in Alberta, Canada, and constitutes a vital new source of natural gas supply in Western Canada. Significant environmental concerns are related to the potential negative impacts on shallow groundwater resources. The authors have analyzed the chemical and isotopic compositions of fluids and dissolved gases from more than 70 production wells in Alberta since 2004. Simultaneously, the research group began generation of a database summarizing chemical and isotopic parameters for shallow groundwater and its dissolved gases in the vicinity of coalbed methane operations. Preliminary data indicate that carbon isotope ratios of coalbed-derived methane often are isotopically distinct from dissolved background methane in shallow groundwater. Carbon isotope measurements on dissolved or free methane in shallow aquifers therefore can serve as a suitable tool for monitoring potential contamination of shallow groundwater resources with produced gases. As a consequence, the Alberta government has introduced mandatory baseline testing standards that include carbon isotope measurements for methane for water wells in the vicinity of NGC operations in Alberta.
http://www-pub.iaea.org/MTCD/publications/PDF/Pub1310Vol2_web.pdf

Lessons Learned from Continuous Emissions Monitoring Users Group (CEMUG) Conference
Electric Power Research Institute (EPRI), 5 pp, 2008

The 17th annual meeting of the Continuous Emissions Monitoring Users Group (CEMUG) was held May 14-16, 2008, in Nashville, Tennessee. The meeting brought together more than 600 attendees to discuss the latest regulatory decisions, describe experience using CEM equipment, and share solutions to common operating problems. The meeting was co-hosted by EPRI and Tennessee Valley Authority. Information was presented in several areas, including regulatory updates, mass particulate monitoring, mercury monitoring, reference method development, and advanced monitoring technologies and methods.
http://mydocs.epri.com/docs/CorporateDocuments/Generation/CEMUG%20Conference_1.doc

Long-Term Maintenance and Monitoring of a Phytoremediation Site and its Associated Reduction of Groundwater Contaminants

Prince, G. (U.S. EPA/ERT, Edison, NJ); C. Gussman, J. Huang, and S. Sovick (Lockheed Martin/REAC, Edison, NJ).

Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

An unusually complete data set now exists for some older locations where phytoremediation has been implemented, encompassing more than a decade of maintenance and monitoring efforts. After removal of containers and contaminated soil from the Edward Sears Property site (NJ), groundwater analysis revealed 470,000 ug/L dichloromethane, 510 ug/L trimethylbenzene, 1,890 ug/L trimethylbenzene, 510 ug/L TCE, 545 ug/L xylene, and other VOCs in smaller amounts. The site was determined to be ideal for phytoremediation, and one hundred hybrid poplars were planted in December 1996. Monitoring at the site has included extensive groundwater sampling data as well as sap flow and annual growth measurement of the phytoremediation trees. Many of the VOCs are no longer detectable or are present in very low concentrations. Temporal visualization has been developed to represent dispersion and movement of the contaminants over a 10-year-plus time frame. The geostatistical methodology selected for temporal analysis was directed by the geospatial distribution of the sampling locations and the range of samples in each data set. Although many phytoremediation efforts are initiated, very few are monitored long enough to visualize the technology taking effect.

Mass to Concentration Tie-In for Passive Soil Gas Surveys: Improved Technique for Source Area, Spatial Variability and Vapor Intrusion Assessment

Odencrantz, J.E. (Beacon Environmental Services, Inc., Newport Beach, CA), H. O'Neill, and P.C. Johnson. Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

The mass to concentration (MtoC) tie-in correlates passive soil gas (PSG) data in mass to active soil gas data in concentration determined by EPA Method TO-17. Passive soil gas surveys consist of rapid deployment of hydrophobic sorbents (dozens to several hundred locations typically installed in one day) to a depth of 6 in to 3 ft in a grid pattern with exposure in the field from 3 days to 2 weeks to target a wide variety of organic compounds. A power function is used on a compound-to-compound basis to correlate spatially varying mass (nanograms) from selected locations within a passive soil gas survey to concentration (ug/m3) at those same locations. The correlation from selected PSG locations is applied to the remainder of the PSG grid. The MtoC tie-in provides added value to a PSG survey, with the PSG data then used to estimate risk throughout the limits of the investigation for quantitative assessment. The results from a site in Northern California show the MtoC tie-in correlations for both benzene and total petroleum hydrocarbons (TPHs). The correlations are applied on a compound-to-compound basis to the remaining locations in the PSG grid to provide an estimate of concentration that can be used for comparison to risk/screening levels or fate and transport diagnostic tools (partitioning equations, solubility laws). An example of how the correlations are applied is presented in tabular form. The results from a chlorinated solvent survey show the MtoC tie-in correlation from a site in Maryland for PCE. In this instance, a near-perfect relationship was observed between the PSG mass and the active soil gas concentration. The concentration estimated throughout a PSG grid enables a vast new realm of interpretive power at sites.

Micro Ion Mobility Sensor for In Situ Monitoring of Contaminated Groundwater
Xu, J., W.B. Whitten, and D.B. Watson, Oak Ridge National Laboratory, Oak Ridge, TN.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-140, 2008

ORNL researchers are pursuing a hybrid technology that combines ion mobility spectrometry (IMS) and differential mobility spectrometry (DMS) technologies. Funded by SERDP Project ER-1603, this hybrid will provide a base for a field sensor for monitoring chlorinated hydrocarbons in ground water. It is difficult for IMS alone to separate chlorinated chemical species for identification, but DMS is capable of resolving this difference. By combining both IMS and DMS, the chemicals can be separated from each other as well as from any interferents in the matrix. The combined IMS and DMS structure has been constructed, and combined testing for gaseous samples is underway. In the future, chlorinated hydrocarbons in aquatic samples will be converted to vapor via membrane technology and tested in the hybrid analyzer.

Microfluidic/Nanofluidic Sensors Using Catalytic DNA for Heavy Metal Detection
Cropek, D., T.S. Dalavoy, J.V. Sweedler, M. Shannon, Y. Lu, and P.W. Bohn.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, F-163, 2008

Under SERDP project ER-1459, a microchip-based lead sensor is being developed that employs lead-specific catalytic DNA as the recognition element. Lead-specific catalytic DNA (DNAzyme) cleaves its complementary substrate DNA strand in the presence of only cationic lead (Pb2+). Fluorescent tags on the substrate DNA convert the Pb2+ concentration to a measurable, optical signal. The DNAzyme responds sensitively and selectively to Pb2+. Microfluidic devices are being fabricated using polymers to create a chip that can inject a sample analyte plug containing many cationic species (e.g., Cu, Pb, Mn, Cd) through a molecular gate (i.e., NCAM membrane) and into a microfluidic separation channel. As the analyte plug moves along the separation channel, the heavy metal analytes separate according to their electrophoretic mobility, and flows can be manipulated to send the Pb2+ band to a unique detection location. The device consists of three separate microfluidic layers that contain one or more microfluidic channels per layer. These layers are separated in the vertical direction by NCAMs (nanocapillary array membranes) that serve as molecular gates across which sample plugs can be injected and separated bands can be collected. The Pb2+-specific DNAzyme fluorescent sensor was also modified with a biotin moiety to create immobilized spots on a superstreptavidin(r) glass surface. To form the enclosed chip, a microchannel structure was aligned onto the glass so that the microchannels bisect the predeposited DNA sites. The fluorescence in the channel is quenched upon hybridization with the quencher strand, while the fluorescence that is sealed beneath the polymer continues to act as an internal reference. In the presence of Pb, a fluorescence increase is observed with the reaction of Pb2+ with the complex. The sensing chemistry can be regenerated by hybridization of DNAzyme with more substrate strand in the channel.

Microfluidic devices have been fabricated with PDMS and superstreptavidin glass and are being used for the simultaneous detection of Pb2+ and UO(2)2+ ions using DNAzymes that respond specifically to each of these cations immobilized in different regions of the microchannel or labeled with different fluorophores. This device is an important step toward detecting multiple heavy metal ions with a single injection by immobilizing different DNAzymes at different locations on a single molecular gated device.

Mineral Phase and Groundwater Chemistry Characterization to Assess Natural Attenuation of Dissolved Nickel in Groundwater
Hammer, M.J., P.P. Gallagher, and C.A. Crocetti, Sanborn, Head & Associates, Inc.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

In an investigation focused on natural attenuation mechanisms for nickel and arsenic in groundwater, the primary source of nickel, and to a lesser extent arsenic, was acidic cold rinse water from former steel pickling operations that discharged to a former sanitary effluent pond for about 50 years. The transport and fate mechanisms were evaluated by characterizing the major anion/cation composition of the groundwater, assessing historical contaminant migration rates, reviewing literature on relevant attenuation/retardation factors to calculate contaminant migration rates, and obtaining property-specific data on soil characteristics from sequential extraction procedure (SEP) analysis. The SEP analysis uses multiple extraction solutions to evaluate the distribution of select major, minor, and trace metals within the solid/mineral phases of the soil sample. By modeling the fate and transport of nickel in groundwater using both property-specific and published partition coefficients, the investigators demonstrated that natural attenuation of nickel in groundwater resulted in a dissolved nickel velocity in groundwater of less than an inch per year away from the source area, showing that nickel migration could be effectively monitored in the future and that an active remedy to remove contamination or to control groundwater flow was unnecessary.

Modern Geochemical and Molecular Tools for Monitoring In-Situ Biodegradation of MTBE and TBA
Kuder, T. and P. Philp, Univ. of Oklahoma,
Reviews in Environmental Science and Biotechnology, Vol 7 No 1, p 79-91, 2008

This paper discusses recent progress in assessing in situ biodegradation using compound-specific isotope analysis (CSIA), molecular techniques based on nucleic acids analysis, and in situ application of stable isotope labels. Additionally, attenuation of tert-butyl alcohol (TBA) is of particular interest, as this compound tends to occur alongside MTBE introduced from the gasoline or produced by (mainly anaerobic) biodegradation of MTBE. [More information at http://ipec.utulsa.edu/32.d/32_FinalReportExecutiveSummary_2008.pdf]

Monitoring a Phosphate Plume at Asumet Pond, Cape Cod, MA
LeBlanc, D., USGS.
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 34pp, 2008

The author describes ongoing efforts to prevent a phosphate-containing groundwater plume from discharging to a downgradient recreational pond. USGS installed a geochemical barrier atop pond sediments in the area where the discharge is occurring. Multiport samplers, diffusion chambers, and seepage meters are used to monitor the 2-foot thick zero-valent iron barrier, and all methods show phosphate removal. MODFLOW was used to estimate flux to the pond for calculating phosphate load. Other methods, including temperature surveys, will be used to try to measure flux directly. http://www.epa.gov/tio/tsp/meetings.htm

Monitoring of Water and Contaminant Migration at the Groundwater-Surface Water Interface
Chadwick, B. and A. Hawkins.
Report No: SSC-TR-1967, 326 pp, 2008

The objective of Project ER200422 was to field, demonstrate, and evaluate the effectiveness of two technologies for characterizing coastal contaminant migration. Investigators assessed the performance of (1) the Trident probe in delineating areas where ground-water seepage is occurring and identifying contaminant concentrations in those areas and (2) the performance of the UltraSeep system in quantifying the flow of ground water and contaminant concentrations that might be impinging on the surface water system. The project also involved demonstrating the technologies to end-users and quantifying the costs associated with the operation of each technology. The Trident probe was used successfully at NSA Panama City to identify areas of ground-water discharge from site to surface waters of St. Andrews Bay, and the UltraSeep was used successfully to quantify ground-water discharge rates and volatile organic compound (VOC) discharge concentrations in two discharge zones identified with the Trident probe. At the former Naval Training Center Orlando, the Trident probe successfully identified areas of ground-water discharge from the site to the surface waters of Druid Lake and the UltraSeep successfully quantified ground-water discharge rates and VOC discharge concentrations in two discharge zones identified with the Trident probe. The cost analysis indicated that the cost of an integrated Trident probe/UltraSeep survey is expected to be on the order of $120K, which represents a cost savings of about 42% relative to the estimated cost for the baseline technology of about $210K. The demonstration at the NSA Panama City documented additional cost avoidance of about $1.25M based on support for selection of monitored natural attenuation as the corrective action at the site. The Trident probe and UltraSeep generally have gained strong acceptance from stakeholders and end-users.
Report at http://handle.dtic.mil/100.2/ADA486109

Nanoparticles-Based Immunosensors for Sensitive Detection of Explosives, PCB, and PAHs
Lin, Y. and J. Wang, Pacific Northwest National Laboratory, Richland, WA.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-154, 2008

Novel electrochemical immunosensors are being developed for detection of TNT, PCBs, and PAHs based on the functionalized nanoparticles label. The analogs, modified with poly(guanine)-functionalized NPs, are attached on the magnetic beads via immnoreaction and then displaced into solution by analytes. The resulting solution was separated and transferred to electrode surface for electrochemical measurements. The sensitive assay of TNT, PAHs, and PCBs is realized by amplification of dual signals: (1) a large amount of guanine residue is introduced in the solution through the displacement and poly(guanine)-functionalized silica NP label, in addition to (2) Ru(bpy)(3)2+-induced catalytic oxidation of guanine, which results in great enhancement of anodic current. The performance of the electrochemical immunosensor was evaluated and experiment parameters were optimized. The immunosensor based on the poly[guanine]-functionalized silica NP label offers great promise for rapid, simple, cost-effective detection of explosives, PCBs, and PAHs.

New ASTM Standard Provides for Assessment of Potential for Vapor Intrusion into Structures
ASTM International News Release #7917, 2008

Vapor intrusion from contaminated soil and ground water into structures potentially can create significant liability and have a material impact on property value; hence, accurately determining whether a property has vapor intrusion issues is a concern for property owners, prospective purchasers, and environmental professionals conducting due diligence. ASTM International Committee E50 on Environmental Assessment has approved a new standard, E 2600, Practice for Assessment of Vapor Intrusion into Structures on Property Involved in Real Estate Transactions, which will provide guidance for vapor intrusion testing. The standard is under the jurisdiction of Subcommittee E50.02 on Real Estate Assessment and Management. The specific intent of E 2600 was to establish a methodology to determine whether or not there is a reasonable probability that vapor intrusion could present an environmental risk and liability. For commercial real estate transactions, the vapor intrusion investigation as defined by E 2600 could be used independently of, or as a supplement to, E 1527, Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process. The evaluation process, as described in E 2600, consists of four tiers. The first two screening tiers are used to assess the potential for a vapor intrusion issue to exist, so that properties with a low risk can be screened out quickly and inexpensively. The third tier provides for more site-specific and comprehensive investigations if the potential for vapor intrusion cannot reasonably be eliminated at the Tier 1/Tier 2 levels. Tier 4 addresses mitigation alternatives. ASTM International standards can be purchased from Customer Service: 610/832-9585, service@astm.org, or at www.astm.org
For technical information, contact Anthony J. Buonicore, Milford, CT at 800-238-1841 or ajb@edrnet.com.

New Field Test for Lead (Pb2+) in Contaminated Soil
Jaunakais, I., M. Jaunakais, and B. Tatineni, Industrial Test Systems, Inc., Rock Hill, SC.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The LEADQuick(tm) test is a reliable, on-site kit based on the LeadQUICK(tm) Lead in Water Test Kit. The procedure to measure lead (Pb) in soil is done by a 5-minute extraction with a nitric acid and potassium nitrate solution for 0.15 grams of soil, which extracts greater then 60% of the total soil Pb. The 5-minute Pb test kit has the sensitivity to detect 0.03 ug/L; therefore, the extraction solution can be diluted 10,000 fold, which dilutes out all interferences,

yet still has the sensitivity necessary for soil Pb testing. Extraction and test procedure details, soil testing results, and data about the interference ions confirm the potential application of LEADQuick(tm) field test kit for soil Pb monitoring.
http://www.sensafe.com/PDF/Lead_Amsterdam_ITS_Presentation.pdf

Novel Sensor for Real-Time Characterization and Monitoring of Chlorinated Hydrocarbons in Groundwater
Major, W.R., D. Campbell, E. Aquino, F. Goetz.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-142, 2008

Under SERDP Project ER-1605, a joint effort between NAVFAC ESC, Georgia Tech Research Institute (GTRI), American Research Corporation of Virginia (ARCOVA), and Woodbank Environmental is being conducted to develop and optimize a novel real-time sensor technology to discriminate and quantify PCE, TCE, cis- and trans-DCE, and VC in groundwater. GTRI and ARCOVA have developed sensors independently that use polymers deposited on a glass slide to select and concentrate (reversibly) contaminants in groundwater or air as samples pass through the sensor. Both sensors use a diode laser positioned to elicit total internal reflectance, which generates an evanescent wave perpendicular to the direction of light propagation that queries the films for the presence of contaminants. Because the evanescent wave does not propagate into the bulk solution, nonspecific interference is greatly minimized. Both sensors measure analytes that partition from the bulk solution into the polymer film. The GTRI sensor measures changes in the index of refraction of the polymer, and the ARCOVA sensor detects changes in the fluorescence of analyte-specific reporter dyes immobilized within the polymer matrix. The choice of polymers (GTRI) and polymer dye conjugates (ARCOVA) enables analytes to be differentiated, and the magnitude of the response is proportional to the concentration of the analyte. Standards are used to calibrate the response of the photodetector, and an onboard microprocessor is used to convert changes in the index of refraction (GTRI) or fluorescence (ARCOVA) to analyte concentrations.
http://www.serdp.org/Research/upload/ER-1605.pdf

Optimal DNAPL Source Delineation
Ross, J. and G.F. Pinder, Univ. of Vermont, Burlington.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-132, 2008

An existing DNAPL source search strategy has been shown in a field test to achieve an acceptable level of DNAPL source location identification accuracy using the least possible number of water quality samples. Central to this capability is the ability to identify soil properties and source characteristics under uncertainty. In the second field test of this capability, new tools have been employed to assist in identifying uncertainty in hydraulic conductivity information. The introduction of expert knowledge in addition to new data into the process of data interpretation makes more effective use of information in identifying field parameters and their uncertainty than the use of measurement data alone. Improved evaluation of these uncertainties is reflected in improvement in the algorithm's results. To obtain an improved estimate of hydraulic conductivity and its uncertainty, a unifying framework was employed to incorporate the uncertainty characterization tools that comprise approximate reasoning, such as fuzzy sets, possibility distributions and random variables. This uncertainty framework, which has been used in advanced weapons systems for the U.S. military, allows incorporation of the knowledge and experience of professionals into the characterization process. This framework was built into the afore-mentioned existing source zone identification strategy the more accurately to identify DNAPL source locations. The success of the revised algorithm in achieving this goal is demonstrated through application to a simplified representation of the Hunters Point Shipyard contamination site in San Francisco, the site selected for the second demonstration of the effectiveness of the source zone search methodology. This work is funded by SERDP Project ER-1347.

Optimization of the Removal of a Volatile Organic Compound (VOC)-Impacted Source Area through Pre-Characterization

Picard, J.J., J.D. Flattery, and L.J. Burkhardt.

Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

A comprehensive characterization typically is not conducted following source area delineation; however, pre-characterizing a soil excavation area can yield benefits to a project by 1) reducing the need for real-time analytical data to support decision-making, 2) allowing for source area soil to be stockpiled based on the detailed characterization data, thereby minimizing the mixing of contaminated and uncontaminated soil, 3) reducing project uncertainties and capping project costs, and 4) reducing the total volume of soil for disposal at a waste treatment facility. At the subject site, a source area of ~25 ft vertical thickness over an 80 x 80 ft2 area was delineated using a combination of 13 Waterloo Profiler locations, 41 membrane interface probe (MIP) locations, and 20 soil borings. The maximum TCE concentration in the source area soil was 57,000 mg/kg, significantly greater than the regulatory standard of 300 mg/kg. Excavation of the source area soil utilizing a circular sheet pile cofferdam was determined to be the preferred remedial approach. Prior to initiating the remedial approach, continuous soil cores were collected from 41 locations within the excavation area. These cores were field screened for VOCs, and 132 soil samples were subjected to VOCs analysis. The resulting analytical data were used to optimize the performance of the excavation through an improved understanding of VOC presence within the source area.

Optimized Enhanced Bioremediation through 4D Geophysical Monitoring and Autonomous Data Collection, Processing and Analysis

Versteeg, R., W. Major, F. Day-Lewis, J. Lane, T. Johnson, K. Wright, and M. Rooney.

Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-176, 2008

A demonstration/validation of a hydrogeophysical performance monitoring system (HPMS) is being conducted under ESTCP Project ER-0717 to show the potential of HPMS for providing timely, actionable information to site managers on the processes associated with enhanced bioremediation. This system allows for the near real-time monitoring of amendments--e.g., vegetable oil and molasses--injected into an existing groundwater chlorinated contaminant plume. The HPMS autonomously acquires hydrological and electrical geophysical datasets.

These datasets undergo quality assurance/quality control (QA/QC) and are imported in a relational database. Subsequently, Web accessible tools allow for automated data processing and result delivery, both on demand and automatically. These are constructed as modular distributed software components (e.g., for data retrieval, data validation, and graphing), which are executed by configurable workflows that chain these elements together. Demonstration/validation of the HPMS system is currently being performed at the Brandywine Defense Reutilization and Marketing Office site. The primary groundwater contaminant at this site is TCE. The primary soil contaminant is PCBs and, to a lesser extent, metals and pesticides. Following feasibility studies at the site, it was determined that remediation of volatile organic compounds (VOC) contaminants could be done using in situ biodegradation. Consequently, a large enhanced bioremediation was executed between February and July 2008. The HPMS system deployed on site in December 2007 monitors the progress and behavior of two specific amendment injections that occurred on March 10 and 14, 2008. Time-lapse difference inversions of 4D electrical geophysical datasets collected at the site show the initial injection and subsequent behavior of the amendment over time. Similar amendment behavior over time is observed in two cross-hole ground-penetrating radar datasets. Sampling efforts that focus on enhancing the link geophysical signature and amendment behavior are ongoing, but initial analysis has shown the expected correlation between differenced time lapse inversions and changes in ground water conductivity resulting from amendment injections.
http://water.usgs.gov/ogw/bgas/estcp/bioremed-monitor.html

An Overview of Current Vapor Sampling and Modeling Techniques into Indoor and Outdoor Air
Lee, A., M. Howell, J. Wright, and S. Bowly, URS Australia Pty Ltd, North Sydney, NSW, Australia. Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Alternate techniques used to estimate indoor and outdoor air concentrations from contaminated soil and groundwater include sampling and analysis of soil gas (at varying depths), vapor emitted from the surface, and indoor/ambient air (i.e., the breathing zone). The selection and use of sampling techniques, as well as any vapor models used, should be based on the site-specific conceptual site model. The collection and use of data and models in conjunction with the conceptual model should assist in ensuring the most appropriate data are collected to characterize inhalation exposures on the site. This approach can, and has, provided a powerful tool for more accurately assessing and managing risks to human health where vapor issues are present.
This paper describes the advantages and disadvantages of these techniques associated with sampling and analysis, errors, and variability due to changing ambient conditions and background contaminant sources, as well as varying reliance on modeling. Australian case studies covering a wide range of contaminants are used to support the discussion.

Performance of the CAPE Technologies DF1 Dioxin/Furan Immunoassay Kit for Soil and Sediment Samples
U.S. EPA, Superfund Innovative Technology Evaluation (SITE) Program.
EPA 540-R-08-002, 47 pp, Feb 2008

This report describes the experimental design, analytical methods used, and the comparisons of the total dioxin/furan toxicity equivalents (TEQD/F) results from the high-

resolution mass spectrometry (HRMS) data to those reported by CAPE Technologies. In 2004, a demonstration of screening technologies was performed to determine the presence of dioxin and dioxin-like compounds in soil and sediment in Saginaw, Michigan. This report compares the DF1 kit's performance in the original SITE demonstration against the results from a site-specific case study. The data generated and evaluated during the site-specific study showed that the TEQ data produced by the DF1 were more comparable to the HRMS TEQD/F data than were the data reported during the original SITE demonstration. The quantitative correlation with HRMS TEQD/F was 0.94 for all the samples in the site-specific study. The average percent recovery value was 122%, with a range between 48 and 354%. The average relative standard deviation for the site specific study was 26%, with a range between 6 and 63%. These results show that the DF1 kit could be used as an effective screening tool to determine areas of greatest concern for cleanup at a site and could help to minimize the number of more expensive analyses needed for specific analytes, particularly considering that the cost and the time to analyze samples is significantly less than that of HRMS analyses.
http://www.epa.gov/ORD/SITE/reports/540r08002/540R08002.pdf

Prediction of Indoor Air Quality from Soil Gas Data at Industrial Buildings
Eklund, B. and D. Burrows, URS Corporation, Austin, TX.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

Sub-slab or shallow soil gas data are often compared with indoor air concentration data in vapor intrusion (VI) evaluations. If no indoor air data are available or confounding sources are present, or if future scenarios are considered, the soil gas data may be used to estimate the indoor air concentrations due to VI. The typical approach in risk assessments is to use the 95th percentile values from a set of concentration data. For VI studies, however, this rarely is an option because the data sets tend to be quite small. Various guidance documents urge the use of maximum soil gas values, which may be reasonable for small residential buildings, but can lead to very conservative estimates if applied to large industrial buildings with localized areas of contamination, especially given that the sampling locations may not be randomly selected and instead are biased towards worst-case locations. By this approach, VI guidance implicitly tolerates a large percentage of false-positive results to minimize the number of false-negative results. This paper illustrates implications of using maximum values with data sets from large industrial buildings at various sites. An alternative approach to using maximum soil gas values is proposed that serves to reduce the number of false positive results while controlling the number of false negatives to an acceptable level.

Procedures for Collecting and Processing Streambed Sediment and Pore Water for Analysis of Mercury as Part of the National Water-Quality Assessment Program
Lutz, M.A., M.E. Brigham, and M. Marvin-DiPasquale.
U.S. Geological Survey Open-File Report 2008-1279, 82 pp, 2008

USGS reconnaissance studies of mercury (Hg) contamination entailed one-time sampling events at 266 stream sites across the U.S. Detailed studies entailed intensive spatial and temporal sampling of a small number of streams in an effort to develop a more complete, process-level understanding of benthic Hg geochemistry and the underlying factors controlling it. This report

summarizes the sampling methods used for the collection and processing of streambed sediment and pore water in association with both of these study levels. Bed-sediment characteristics, such as organic content and grain size, strongly influence Hg geochemistry; detailed characterization of these constituents within a stream reach will allow for the extrapolation of related Hg biogeochemical constituents to the reach scale.
http://pubs.usgs.gov/of/2008/1279/

Proposed New ASTM Vadose Zone Standard to Aid in Vapor Intrusion Evaluations
ASTM International News Release #7987, 2008

A proposed new practice being developed by ASTM Subcommittee D18.21 on Ground Water and Vadose Zone Investigations will cover techniques for actively collecting soil gas samples from the vadose zone beneath buildings. WK18835, Practice for Active Soil Gas Sampling in the Vadose Zone for Vapor Intrusion Evaluations, is under the jurisdiction of ASTM International Committee D18 on Soil and Rock. The proposed practice will provide a greater level of applied detail than exists in current guides. Subcommittee D18.21.02 on Vadose Zone Monitoring has completed a series of over 10 ASTM standard guides that cover technologies such as pore-liquid sampling, soil sampling, water content measurements, unsaturated hydraulic conductivity, matrix potential determination, and horizontal application of neutron probes that currently are used in vadose zone work. As each of the guides is approved, corresponding practices and test methods are being developed. WK18835 is one such proposed standard, having been developed to correspond with D5314, Guide for Soil Gas Monitoring in the Vadose Zone. Use of the proposed standard will ensure that soil gas sampling is being done correctly to identify potential vapor intrusion hazards that are addressed in the widely used new ASTM standard E2600, Practice for Assessment of Vapor Intrusion into Structures on Property Involved in Real Estate Transactions. In addition to work on WK18835, the subcommittee plans to develop other standards associated with passive soil gas sampling technologies. For technical information, contact Dr. Lorne Everett, Haley & Aldrich, Santa Barbara, CA, 805-563-8007 or leverett@haleyaldrich.com

Quantifying Enhanced Microbial Dehalogenation Impacting the Fate and Transport of Organohalide Mixtures in Contaminated Sediments
Haggblom, M., J.-W. Park, Y.-B. Ahn, H. Liu, D.E. Fennell, V. Krumins, F. Liu, L. Rodenburg, L.J. Kerkhof, K. Sowers, B. Kjellerup, and K. Gillespie. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-189, 2008

The overall objective of SERDP project ER-1492 is to stimulate anaerobic biological dechlorination in contaminated sediments toward the eventual detoxification and complete degradation of halogenated contaminant mixtures. Results from micro- and mesocosm experiments indicate that sediments from the Anacostia River, Kearny Marsh, and Kymijoki River contain diverse populations of dehalogenating microorganisms. A suite of molecular tools has been refined and optimized for rapid high-throughput detection, enumeration, and diversity characterization of bacterial populations that reductively dehalogenate the target organohalides. Active dechlorinating populations are present in these sediments, and biostimulation may enhance the activity of both native Dehalococcoides and bioaugmented Dehalococcoides species. Evidence is provided for a combined bioaugmentation/biostimulation approach to the bioremediation of sediments contaminated with chlorinated biphenyls, diphenyl ethers, dibenzo-p-dioxins and/or dibenzofurans. The addition of halogenated co-amendments might be one tool to enhance dechlorination of PCBs and PCDD/Fs in historically contaminated sediments and the halogenated amendments potentially are useful for producing exogenous dehalogenating biomass for bioaugmentation. The anticipated end result is an understanding of the microbial in-sediment processes involved in biodegradation of organohalide mixtures.

Quantifying Organic Chemicals in Soil Samples: Effects of Sampling Method Attributes under Varied Contaminant Characteristics and Environmental Conditions
Siegrist, R.L., R. Oesterreich, L. Woods, and M. Crimi. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-102, 2008

Although widely employed, standard monitoring practices do not necessarily yield accurate and unbiased estimates of contaminant levels or remediation effectiveness. To enhance the fundamental understanding of current practices and to develop improved methods for obtaining and utilizing data from direct-push cores and groundwater wells, SERDP Project ER-1490 is ongoing at the Colorado School of Mines (CSM). The project has two complementary elements that are focused on understanding and mitigating (1) the organic chemical losses that occur during sample acquisition and handling, and (2) the effects of remediation-induced changes in the behavior of untreated organic chemicals, including DNAPL compounds. This poster presentation highlights the methods and results obtained from the first of these two project elements. During this research, soil cores were contaminated under laboratory conditions and then used to quantify the ability of different sampling methods to yield accurate and unbiased measurements of contaminant levels in soil samples obtained from an intact core and how that ability was affected by varied contaminant characteristics and environmental conditions. Three chemicals with contrasting properties were studied (1,1,1-TCA, TCE, PCE) at three different contaminant levels. Five different sampling methods were studied -- including standard and improved methods -- spanning a range of media disaggregation and atmospheric exposure that can occur during soil sample acquisition and handling. Environmental conditions were varied to include different soil types (different particle size distributions and organic carbon contents), soil water contents (vadose zone and groundwater zone water conditions), and soil temperatures (five levels ranging from 5 degrees C to 80 degrees C representing different ambient and thermal treatment conditions). Research results have revealed that standard sampling methods commonly introduce a negative bias in measured concentrations of 50% or more, with the magnitude depending on the attributes of the sampling method used and the contaminant characteristics and environmental conditions. The research findings provide essential insight into the need for and selection of effective yet practical sampling methods that can generate accurate and unbiased contaminant data. Moreover, the research has revealed that under certain environmental conditions, it may be virtually impossible to obtain accurate measurements of certain organic chemicals, illustrating the need for alternative strategies for site assessment and remediation performance assessment.
http://www.serdp-estcp.org/Symposium2008/Posters/upload/W30-Siegrist.pdf

Quantifying the Bias in Sediment Concentration Monitoring in Surface Water Runoff
Fowler, G.D., S. Piney, R.M. Roseen, T.P. Ballestero, and J. Houle, Univ. of New Hampshire.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The accuracy of sediment concentration and particle size distribution monitoring in surface runoff depends on the monitoring method. Sediment loads in stormwater were evaluated using 4 methods: total suspended solids (TSS), suspended sediment concentration (SSC), turbidity (NTU), and real-time sediment concentration monitoring (RSC). TSS and SSC samples were collected using automatic samplers, and a sediment concentration and NTU relationship was established. The RSC device measured sediment concentration levels throughout an event. In addition to these methods, a large 7,000-10,000 L sample was retained during the respective sampling period. From this total capture, an actual sediment concentration level for each event was compared with the sediment loads predicted by the four methods. Preliminary results show the disparity for TSS in predicting total sediment load can be large, with a mean variation of +/- 45% while SSC generally is a better predictor (+/- 22%). The accuracy of turbidity as a predictive method varied greatly (48 to 68%) due to the correlation between NTU and sediment concentration (mg/L). Particle size distributions from samples collected by the automated sampler had an average D75 of 65 um, while the D75 from the total capture samples averaged 450 um. These results provide insight for the development of guidelines for measurement of sediment concentrations and removal efficiency standards, while underscoring the importance of understanding the methods by which sediment load concentrations are reported and the respective biases.

Quantifying the Degradation and Dilution Contribution to Natural Attenuation of Contaminants by Means of an Open System Rayleigh Equation
Van Breukelen, B.M., VU Univ. Amsterdam, Netherlands.
Environmental Science and Technology, Vol 41 No 14, p 4980-4985, 2007

Dilution as a consequence of hydrodynamic dispersion can contribute considerably to natural attenuation (NA) without reducing the mass of pollution. Unfortunately, tracers to quantify dilution usually are lacking; however, degradation of low-molecular-weight organic chemicals such as BTEX, chlorinated ethenes, and MTBE is associated uniquely with increases in isotope ratios for steady-state plumes. Compound-specific isotope analysis (CSIA) data commonly are interpreted by means of the Rayleigh equation (originally developed for closed systems) to calculate the extent of degradation under open-system field conditions. For that reason, the validity of this approach has been questioned. The Rayleigh equation accordingly was modified to account for dilution, and showed that dilution contributed several to many times more to NA than biodegradation at a groundwater benzene plume. Derived equations also (i) underlined that field-derived isotopic enrichment factors underestimate actual values operative as a consequence of dilution, and (ii) provide a check on the lower limit of isotopic fractionation, thereby resulting in more reliable predictions on the extent of degradation.

Quantitative Passive Diffusive Samplers for Assessing Vapor Intrusion
McAlary, T., H. Groenevelt, D. Crump, T. Gorecki, P. Sacco, M. Tuday, B. Schumacher, and P. Johnson. Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

This paper presents interim results from a multi-year, ESTCP-funded study comparing conventional active sampling methods for assessing subsurface vapor intrusion to indoor air to 4 different quantitative passive diffusive samplers: Radiello(tm) samplers from Italy, the polydimethyl siloxane (PDMS) membrane sampler from the University of Waterloo, an automatic thermal desorption (ATD) tube sampler developed in the UK, and the Ultra II badge sampler from SKC. None of the 4 passive samplers was specifically designed for soil gas monitoring. Each of the passive diffusive samplers contains an adsorbent medium that traps VOCs over time during exposure of the sampler to indoor air or soil gas. Vapor concentrations can be calculated if the exposure time, uptake rate, and uptake area are known, using calculations based on Fick's First Law of diffusion. The quantitative passive samplers represent a significant improvement over currently available passive samplers, and have at least four potential benefits over conventional sampling using Summa canisters: 1) lower cost, 2) minimal training needed by users, 3) deployable for long periods of time, and 4) smaller and less noticeable (and therefore less disruptive). The reporting limit is inversely proportional to the exposure time, so lower reporting limits can be achieved without increasing the cost of the analytical method, simply by leaving the samplers in place longer.

Real-Time X-Ray Absorption Spectroscopy of Uranium, Iron, and Manganese in Contaminated Sediments during Bioreduction
Tokunaga, T.K., J. Wan, Y. Kim, S.R. Sutton, M. Newville, A. Lanzirotti, and W. Rao. Environmental Science & Technology, Vol 42 No 8, p 2839-2844, 2008

A study was conducted to determine changes in oxidation states of U, Fe, and Mn in U-contaminated sediments from Oak Ridge National Laboratory. Oxidation states of these elements were measured nondestructively in real time using X-ray absorption spectroscopy on sediment columns supplied with synthetic groundwater containing organic carbon (OC, 0, 3, 10, 30, and 100 mM OC as lactate) for over 400 days. In sediments supplied with OC >/= 30 mM, 80% of the U was reduced to U(IV), with transient reoxidation at about 150 days. Mn(III,IV) oxides were completely reduced to Mn(II) in sediments infused with OC >/= 3 mM. Fe remained largely unreduced in all sediment columns, however, showing that Fe(III) can persist as an electron acceptor in reducing sediments over long times. This result in combination with the complete reduction of all other potential electron acceptors supports the hypothesis that the reactive Fe(III) fraction was responsible for reoxidizing U(IV).
http://repositories.cdlib.org/lbnl/LBNL-718E/

The Reality of Sampling and Assessing Vapour Intrusion on Petroleum Sites
Wright, J. and C. Robinson, URS Australia Pty Ltd. Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

The authors discuss issues associated with the assessment of over 30 petroleum-contaminated sites where vapor intrusion has been assessed on the basis of both modeling and the collection of site-specific data. The review identifies the key limitations on data collected on these sites and discusses whether the limitations are significant enough to affect the outcome and degree of uncertainty of the assessment. The review also evaluates whether the data collected are sufficiently robust to be assessed critically against current theories associated with the migration of petroleum hydrocarbon vapors in the subsurface and potential for vapor intrusion issues. The paper identifies the key aspects of vapor intrusion assessments that must be addressed in any regulatory or client-driven environment to enable an adequate assessment of an issue where the ultimate goal is the protection of human health.

Recent Developments in Thermal Desorption (TD)-GCMS Technology for Further Enhancements in Trace Detection
Hughes, P.G., J. Dwan, and D. Miser, Markes International Ltd., Llantrisant, UK.
Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

Thermal desorption (TD) is a versatile, sensitive and labor-saving sample preparation technique for the measurement of VOCs and SVOCs in air and materials. It provides the ultimate sample introduction technology for GC/GCMS by combining selective concentration enhancement with direct extraction into the carrier gas and efficient transfer/injection all in one fully automated and labor-saving package. Thermal desorption is now recognized as the technique of choice for air monitoring and is the subject of many international standard methods (e.g., EN ISO 16017, ASTM D6196, USEPA TO-15 (canisters) and TO-17 (tubes), NIOSH 2549). The authors discuss the following recent developments in TD/GCMS technology for further enhancements in trace detection for air quality monitoring: higher precision developments for better reproducibility; novel approaches for result validity for increased confidence in analytical results; and electronic sample/tube tagging technology for ultimate sample traceability, simplified work flow, and enhanced productivity

Reducing Uncertainty in DNAPL Characterization
Bittner, A. and K. Herman, Gradient Corporation, Cambridge, MA.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The authors discuss two distinct techniques (one based on analytical data and the other on visual observations) to delineate DNAPL extent and magnitude (mass). The results from these two techniques can be combined to minimize uncertainty. Both techniques were applied at a former manufactured gas plant site with sediments impacted by tar and its constituent PAHs. For the analytical data approach, DNAPL extent was estimated by comparing all measured sediment PAH concentration data with site-specific solubility limits, then all of the PAH concentrations within the delineated zone were used to estimate the mass of tar at the site. For the visual observation approach, field-recorded observations of DNAPL were taken from sediment cores to estimate extents, and then the total DNAPL mass was calculated by assigning representative DNAPL saturation levels. Individually, each source characterization approach may have uncertainties, but using both allowed for a more confident estimation of DNAPL extent and mass, which should lead to more appropriate remedy decisions.

Residential Indoor Air Comparative Study Near DoD Facility: Canisters v. Sorbent Tubes v. Passive Diffusion Samplers
Odencrantz, J.E., H. O'Neill, S.J. Steinmacher, J.D. Case, and P.C. Johnson.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Sampling indoor air for potential vapor intrusion impacts using current standard 24-hour sample collection methods may not account adequately for temporal variability or detect contamination best represented by long-term sampling periods. Investigators at Hill AFB in Utah evaluated vapor intrusion impacts originating from groundwater plumes (predominantly dissolved-phase TCE) emanating from the Base and migrating beneath adjacent residential communities. Over 4,500 24-hour indoor air samples were collected in area residences. In November 2007, indoor air at 4 residences was sampled to measure TCE concentrations over short- and long-duration intervals. The investigation consisted of triplicate samplers for three different methods: dedicated 6-liter Summa canisters (EPA Method TO-15), pump/sorbent tubes (EPA Method TO-17), and passive diffusion samplers (MDHS 80). The first two methods collected samples simultaneously for 24 hrs, and the passive diffusion method collected samples for 2 weeks in November 2007. Data collected using Methods TO-15 (canisters) and TO-17 (tubes) provided reliable short-duration TCE concentrations that agreed with prior 24-hour sampling events in each of the residences, and the PDS time-weighted measurements tracked very closely to the TO-17 results. The measured TCE concentrations were consistent with previous results with as much as 28.0 ug/m3 measured. The PDS results were consistently lower than both the TO-15/17 concentrations, and the effects of time-weighting of the samplers were more evident at increasing concentrations. The effects of time-weighting the sampling process over a 2-week period tended to dampen the peaks by lowering the average concentration. The TO-17 results more closely tracked the PDS concentrations with a range of 3.5 to 30% lower concentrations for the 2-week versus 24-hour sampling periods, respectively.

Resistivity Profiling for Mapping Gravel Layers That May Control Contaminant Migration at the Amargosa Desert Research Site, Nevada
Lucius, J.E., J.D. Abraham, and B.L. Burton.
U.S. Geological Survey Scientific Investigations Report 2008-5091, 34 pp, 2008

Gaseous contaminants, including CFC 113, chloroform, and tritiated compounds, move preferentially in unsaturated subsurface gravel layers away from disposal trenches at a closed low-level radioactive waste-disposal facility in the Amargosa Desert about 17 kilometers south of Beatty, Nevada. Two distinct gravel layers are involved in contaminant transport: a thin, shallow layer between about 0.5 and 2.2 meters below the surface and a layer of variable thickness between about 15 and 30 meters below land surface. From 2003 to 2005, the U.S. Geological Survey used multielectrode DC and AC resistivity surveys to map these gravel layers. Previous core sampling indicates the fine-grained sediments generally have higher water content than the gravel layers or the sediments near the surface. The relatively higher electrical resistivity of the dry gravel layers, compared to that of the surrounding finer sediments, makes the gravel readily mappable using electrical resistivity profiling. The upper gravel layer is not easily distinguished from the very dry, fine-grained deposits at the surface. Two-dimensional resistivity models, however, clearly identify the resistive lower gravel layer, which is continuous near the facility except to the southeast. Multielectrode resistivity surveys provide a practical noninvasive method to image hydrogeologic features in the arid environment of the Amargosa Desert. http://pubs.usgs.gov/sir/2008/5091/

Scientists Find Black Gold Amidst Overlooked Data
Carlowicz, Mike.
Goddard Space Flight Center News Release, 18 Feb 2009

Oil decreases the roughness of the ocean surface. Depending on the angles of the camera and of the light reflection, oil creates contrasting swaths that can show up in airborne images as either lighter or darker than the surrounding waters. The detection and monitoring of oil spills and seeps by satellite is not new. Visible, infrared, microwave, and radar sensors have all been used, with synthetic aperture radar (SAR) being the most popular and reliable method in recent years. SAR imagery can be very expensive, and timely, repeat coverage is not always possible, particularly in tropical regions. Using imagery from the Moderate Resolution Imaging Spectroradiometer (MODIS) instruments on NASA's Terra and Aqua satellites can be far cheaper because the data are collected daily and provided freely by NASA, without the need for special observation requests. The polar orbits of Terra and Aqua allow images of oil slicks to be collected several times per week in tropical regions and perhaps several times a day at higher latitudes. The description of the new technique was published in January in Geophysical Research Letters. Researchers happened upon oil imagery from these satellites while looking for signs of harmful algal blooms--commonly referred to as "red tide"--in the western Gulf of Mexico. The MODIS images showed streaks across the sun-glint reflections. The researchers became aware that the streaks could be oil from natural seeps on the seafloor. The team reviewed more than 200 images collected over 9 consecutive years that contained sun glint, and found more than 50 with extensive oil slicks. The capacity to detect oil in the ocean has great potential, not just for oil seeps but for responding to oil spills. Scientists might be able to use this monitoring tool forensically to study old spills, to watch how new ones evolve in real time, and to rule out a spill when there is none. The technique could be useful for detecting and monitoring oil spills from ships and other platforms, though the spills must be large enough (at least hundreds of meters or feet) to be visible in the MODIS imagery. If there is suspicion of a large human-caused spill, for instance, researchers would be able to review ocean imagery to see if the slick was present before the alleged spill, indicating a natural seepage. On the other hand, MODIS satellite imagery collected on a regular basis could help coastal managers track and mitigate the effects of large accidental spills. The first few days after a spill are critical to tracking oil in the ocean, so it helps to be able to use technology in real time to make informed decisions about cleanup. http://www.nasa.gov/topics/earth/features/oilslick.html

Screening of Brick-Kiln Area Soil for Determination of Heavy Metal Pb Using LIBS
Pandhija, S. and A.K. Rai, Allahabad Univ., Allahabad, India.
Environmental Monitoring and Assessment, Vol 148 Nos 1-4, Jan 2009

This paper discussed results of the quantitative analysis of lead (Pb) by laser-induced breakdown spectroscopy (LIBS) in an Indian agricultural soil in the area surrounding a brick kiln. LIBS spectra of soil have been recorded in the wavelength range from the ultraviolet (UV) to the infrared region (200 to 1,100 nm). The authors realized that 220.3 nm, which is observed in the UV region of LIBS spectra, is completely interference free and well suited for the quantification of trace amounts of Pb in soil because it has the best linear regression coefficient and smallest standard deviation of the background signal. In this region, the detection limit for Pb in soil was found to be 45 ppm. The concentration of Pb in agricultural soil of the brick-kiln area was found to be ~570 ppm, which is higher than the regulatory standard of 400 ppm imposed by U.S. EPA for the presence of lead in soil.

Selection of Monitoring Times to Assess Remediation Performance
Kueper, B.H. and K. Mundle, Queen's Univ., Kingston, ON, Canada.
Proceedings of OttawaGeo 2007: The 60th Diamond Jubilee. Canadian Geotechnical Conference and 8th Joint CGS/IAH-CNC Groundwater Conference, 21-24 October 2007, Ottawa, ON. BiTech Publishers Ltd., Richmond, BC, Canada. ISBN: 0-920505-36-8, Vol 1, p 581-585, 2007

Several factors determine the time needed for a plume to respond to nonaqueous-phase liquid (NAPL) source zone remediation. Remediation of most spills of NAPLs (fuels, chlorinated solvents, PCB oils, creosote, and coal tar) requires aggressive mass removal via technologies such as chemical oxidation, thermal treatments, alcohol flushing, surfactant flushing, and hydraulic displacement. While much attention has been given to the development of these remediation technologies, little attention has been given to the response of the plume downstream of the treatment zone and the selection of an appropriate monitoring time scale to evaluate the impacts of remediation adequately. This study focused on the prevalence of diffusive sinks, contaminant mobility, and the hydraulic conductivity of subsurface materials. Typically, plumes in subsurface environments dominated by diffusive sinks or low-permeability materials need long periods of time to detach after source removal. This paper presents generic plume-response model simulations that illustrate concentration rebound following the use of in situ chemical oxidation in fractured clay containing trichloroethene. The investigators determined that approximately two years are needed to reach peak rebound concentration after cessation of remedial action. Downgradient monitoring well concentrations may be reduced considerably during remedial action due to the fact that oxidant occupies the fracture and because oxidant diffuses into the clay matrix, creating a short period of contaminant reduction in the area of flowing ground water.

Semipermeable Membrane Device (SPMD) for Monitoring PCDD and PCDF Levels from a Paper Mill Effluent in the Androscoggin River, Maine, USA
Charlestra, L., D.L. Courtemanch, A. Amirbahman, and H. Patterson, Univ. of Maine, Orono.
Chemosphere, Vol 72 No 8, p 1171-1180, 2008

Paper mill effluents can contain PCDDs and PCDFs as a result of the chlorinated bleaching of pulp and paper. Semipermeable membrane devices (SPMDs) were used to monitor PCDD/F levels upstream and downstream of a paper mill on the Androscoggin River, in Jay, Maine. Following the 36-day deployment, SPMD dialysis, and cleanup, the samples were analyzed by HRGC/HRMS. Total concentrations of PCDD/Fs in SPMDs (the sum of all tetra- through octachlorinated congeners) ranged from 4.71 pg/g to 26.26 pg/g. Five out of the targeted 17 toxic congeners were detected. Permeability reference compounds were used for in situ calibration of the SPMD sampling rate. No consistent pattern of upstream-downstream gradient in the PCDD/F levels was observed, which suggested that processes other than the mill in Jay (i.e., multiple sources, river dynamics) governed the flux of PCDD/Fs in the sampling locations. The SPMD results were validated by comparison to other studies on the Androscoggin River, confirming the potential of the device as a useful monitoring technique for PCDD/Fs in large river systems.

Sensicore, Inc. Waterpoint 870: Environmental Technology Verification Report
James, R., R. Mangaraj, Z. Willenberg, and A. Dindal, Battelle, Columbus, OH.
U.S. EPA, Environmental Technology Verification Program, 32 pp, Sep 2007

Sensicore has developed a lab-on-chip micro-sensor array technology called the WaterPOINT 870 that incorporates chemical selective sensors and physical measuring devices on a single silicon chip, providing a panel of tests that can be used for 5-minute chemical profiling of drinking water and other liquids. This handheld system was designed for both municipal and industrial applications. It employs Sensicore's platform sensor chip with five membrane-based ion-selective electrodes capable of detecting light metal ions and dissolved gases, two micro-amperometric arrays for detecting free chlorine and monochloramine species, and electronic sensors for measuring oxidation/reduction potential (ORP), conductivity, and temperature. All of these sensors are incorporated on a single silicon substrate that is 4 millimeters (mm) by 5 mm in size and conveniently packaged in a semi-disposable unit that also contains its own reference electrode. In all, with the direct measurements and calculated values that can be obtained from the direct measurements, the system reports 16 different results as follows: pH, ORP, conductivity, total dissolved solids, free chlorine, monochloramine, free and total ammonia, chlorine-ammonia ratio, biocide-food ratio, carbon dioxide, total alkalinity, calcium, calcium hardness, total hardness, and Langelier Saturation Index. This test verified only the direct measurements: pH, ORP, conductivity, free chlorine, monochloramine, free ammonia, calcium hardness, and total alkalinity results. The device completes full analysis within 5 minutes. New sensors include all necessary calibration solutions and sample buffers and conditioners required for the sample analyses. http://www.epa.gov/etv/pubs/600etv07051.pdf

Sensitive Electrochemical Immunoassay for 2,4,6-Trinitrotoluene Based on Functionalized Silica Nanoparticle Labels
Wang, J., G. Liu, H. Wu, and Y. Lin.
Analytica Chimica Acta, Vol 610 No 1, p 112-118, 2008

A poly(guanine)-functionalized silica nanoparticle (NP) label-based electrochemical immunoassay has been developed for sensitive detection of TNT. This immunoassay takes advantage of a magnetic bead-based platform for competitive displacement immunoreactions and separation and uses electroactive nanoparticles as labels for signal amplification. For the assay, anti-TNT-coated magnetic beads interacted with TNT analog-conjugated poly(guanine)-silica NPs and formed analog-anti-TNT immunocomplexes on magnetic beads. The immunocomplexes-coated magnetic beads were exposed to TNT samples, which resulted in displacing the analog-conjugated poly(guanine) silica NPs into solution by TNT. No guanine residues were released into solution in the absence of TNT. The reaction solution then was separated from the magnetic beads and transferred to the electrode surface for electrochemical measurements of guanine oxidation with Ru(bpy)(3)2+ as mediator. The sensitivity of this TNT assay was greatly enhanced through dual signal amplifications: (1) a large amount of guanine residue on silica nanoparticles was introduced into the test solution by displacement immunoreactions and (2) a Ru(bpy)(3)2+-induced guanine catalytic oxidation further enhanced the electrochemical signal. The detection limit of this sensitive assay is 0.1 ng/mL TNT.

Simultaneous Speciation of Arsenic, Selenium, and Chromium by HPLC-ICP-MS
Wolf, R.E., S.A. Morman, J.M. Morrison, and P.J. Lamothe.
U.S. Geological Survey Open-File Report 2008-1334, 27 pp, 2008

An adaptation of an analytical method developed for chromium speciation has been utilized for the simultaneous determination of As(III), As(V), Se(IV), Se(VI), Cr(III), and Cr(VI) species using high performance liquid chromatography (HPLC) separation with ICP-MS detection. Reduction of interferences for the determination of As, Se, and Cr by ICP-MS is a major consideration for this method. Toward this end, a dynamic reaction cell (DRC) ICP-MS system was used to detect the species eluted from the chromatographic column. A variety of reaction cell gases and conditions can be utilized, and the advantages and limitations of the gases tested to date are presented and discussed. The separation and detection of the As, Se, and Cr species of interest can be achieved using the same chromatographic conditions in less than 2 minutes by complexing the Cr(III) with EDTA prior to injection on the HPLC column. Practical aspects of simultaneous speciation analysis are presented and discussed, including issues with HPLC sample vial contamination, standard and sample contamination, species stability, and considerations regarding sample collection and preservation methods. The results of testing to determine the method's robustness to common concomitant element and anion effects also are described. The method has been applied to the analysis of a variety of environmental and geological samples, including waters, soil leachates, and simulated bio-fluid leachates.
http://pubs.usgs.gov/of/2008/1334/

Site Characterization to Support Use of Monitored Natural Attenuation for Remediation of Inorganic Contaminants in Ground Water
Ford, R.G., R.T. Wilkin, and S. Acree.
EPA 600-R-08-114, 16 pp, Nov 2008

In principle, monitored natural attenuation (MNA) can provide a reasonable remedy for attaining ground-water cleanup objectives for some sites with inorganic contaminants (typically metals and radionuclides). Due to potential limitations in attenuation capacity within an aquifer, MNA is likely to be more applicable as a polishing step and/or under more dilute plume concentrations as compared to situations encountered in source zones or in more concentrated regions of a ground-water plume. The objective of site characterization for assessing the viability of MNA as a component of ground-water cleanup is determination of the performance characteristics of the subsurface system with respect to achieving cleanup goals. The presumption for sites where "sorption" (immobilization) appears to result in contaminant attenuation is that a specific mechanism (or mechanisms) controls contaminant partitioning to aquifer solids. Thus, to evaluate the capacity for and stability of contaminant immobilization within the aquifer, the mechanistic characteristics of the partitioning process and the identification of the subsurface components that influence the extent of the immobilization reaction need to be understood. This process requires information on the abundance and chemical speciation of solid phase reactants and products that participate in the immobilization

reaction. The purpose of this Ground Water Issue is to highlight at what stage of the process solid-phase characterization techniques need to be implemented in the site characterization process and to describe two case studies (one site affected by arsenic and the other by uranium) where the results of these techniques were critical to evaluation of MNA as a potential component of ground-water cleanup.
http://www.epa.gov/nrmrl/pubs/600r08114/600r08114.htm

Soil Water Potential Effects on Bio-Inspired Sensor Response
Reynolds, C.M., K.L. Foley, and D.B. Ringelberg (Army ERDC/CRREL, Hanover, NH); J.E. Anderson (Army ERDC/TEC, Alexandria, VA).
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

The authors exploited the concept that soil water potential is comprised of matric, osmotic, and gravitational components and used the osmotic potential of an ionic solution to mimic soil water potential, which can be dominated by matric contributions. Soil water potential was related to ionic strength of a simple salt solution by generating a water retention curve for soil, which expressed matric water potential to water content, as well as a water potential curve for salt solutions, which expressed osmotic water potential as a function of salt concentrations. Activities of alkaline phosphatase and beta-glucosaminidase were measured in increasing salt concentrations and expressed as 1st order decay. When related to soil water potential, enzyme activity profiles observed in the salt solutions were similar to those measured in soils at different water potentials. Many bio-inspired sensors, such as molecularly imprinted polymers (MIPs), are analogs of enzymes. A similar approach was followed to measure a MIP response as a function of water potential. Using a system having constant concentration of a target molecule, a linear decrease in MIP performance from 0.1M to 5.0M NaCl was measured. The results obtained represent a unique dataset that relates the response of a biomimitic sensor to low water potentials representative of surface soils. This approach has application in predicting times when biomimitic sensor response would be maximal, based on ephemeral soil conditons.

Spectral Induced Polarization and Electrodic Potential Monitoring of Microbially-Mediated Iron Sulfide Transformations
Personna, Y.R., D. Ntarlagiannis, L. Slater, N. Yee, M. O'Brien, and S. Hubbard.
Journal of Geophysical Research, Vol 113 No G2, doi:10.1029/2007JG000614, 2008

Stimulated sulfate reduction is a bioremediation technique used to sequester heavy metals in the subsurface. Researchers performed laboratory column experiments to investigate the geoelectrical response of iron sulfide transformations by Desulfovibrio vulgaris using spectral induced polarization (SIP) and electrodic potential measurements. Aqueous geochemistry (sulfate, lactate, sulfide, and acetate), observations of precipitates (identified from electron microscopy as iron sulfide), and electrodic potentials on bisulfide ion (HS) sensitive silver/silver chloride (Ag/AgCl) electrodes (630 mV) were diagnostic of induced transitions between anaerobic iron sulfide forming conditions and aerobic conditions promoting iron sulfide dissolution. The temporal variation in the model parameters in this study is consistent with filling and emptying of pores by iron sulfide biofilms, as the system transitions between anaerobic (pore filling) and aerobic (pore emptying) conditions. The results suggest that combined SIP and

electrodic potential measurements might be used to monitor spatiotemporal variability in microbial iron sulfide transformations in the field.
http://repositories.cdlib.org/lbnl/LBNL-354E/

Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events, Revision 4.0
U.S. EPA, National Homeland Security Research Center.
EPA 600-R-04-126D, 266 pp, Sep 2008

Widely different analytical methods are required for various phases of environmental sample analyses in support of homeland security preparation and response: (1) ongoing surveillance and monitoring; (2) response and rapid screening for determining whether an event has occurred; (3) preliminary site characterizations to determine the extent and type of contamination; and (4) confirmatory laboratory analyses to plan, implement, and evaluate the effectiveness of site remediation. EPA's Standardized Analytical Methods for Environmental Restoration Following Homeland Security Events (SAM) provides information for analytical methods to be applied during the site remediation phase.
http://www.epa.gov/nhsrc/pubs/600r04126d.pdf

Strategies for Detecting Organic Liquids on Soils Using Mid-Infrared Reflection Spectroscopy
Gallagher, N.B., P.L. Gassman, and T.A. Blake, Eigenvector Research, Inc., Manson, WA.
Environmental Science & Technology, Vol 42 No 15, p 5700-5705, 1 Aug 2008

Stand-off monitoring for chemical spills can provide timely information for cleanup efforts, and mid-infrared reflection spectroscopy is one approach being investigated for spill detection. Using laboratory data, anomaly and target detection strategies were examined for the detection of 4 different low-volatility organic liquids on two different soil types. Anomaly detection for C-H bands was good using second-derivative preprocessing and provided similar performance to that of target detection approaches, such as generalized least-squares and partial least-squares, with detections at soil loads of approximately 3 to 6 ug/cm(2) areal dosage.

Sub-Slab vs. Near-Slab Soil Vapor Profiles at a Chlorinated Solvent Site
Swanson, G. and J. Elliot (Tetra Tech); B. Schumacher and J. Zimmerman (U.S. EPA-NERL); B. Hartman (H&P Mobile Geochemistry). Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

U.S. EPA funded a research project Naval Air Station Lemoore, CA (IRP Site 14), where a large chlorinated solvent plume exists in the site's groundwater, to compare vertical profiles of soil gas concentrations near a slab to concentration profiles under a slab. Soil vapor probes were installed at depths of 2, 4, 7, and 10 feet bgs at a series of sampling locations that were spaced along a transect from ~20 feet inside the slab to 60 feet outside the slab. Soil vapor samples were collected in replicate and analyzed by EPA Method 8021 at a mobile laboratory on site. The results were plotted as graphs of the measured vapor concentration profile along the transect. These graphs indicate that soil vapor concentrations near a slab can change dramatically both with horizontal distance and with depth in the vadose zone. The results from this project have substantial implications for vapor intrusion assessments, particularly with respect to sub-slab vs. near-slab soil vapor sampling and modeling of soil vapor profiles.

Tekran Instruments Corporation Series 3300 Mercury Continuous Emissions Monitoring System: Environmental Technology Verification Report
Kelly, T., J. Satola, Z. Willenberg, and A. Dindal, Battelle, Columbus, OH.
U.S. EPA, Environmental Technology Verification Program, 40 pp, Feb 2007

The Series 3300 measures total mercury (HgT), elemental mercury (Hg0), and oxidized mercury (HgOX) in combustion sources. It has a dual channel stack gas conditioner with selective scrubbing. The system is designed to separate mercury into elemental and oxidized species, while removing interfering acid gases, and provide real-time feedback to optimize mercury reduction technologies. It is designed to be insensitive to the presence of sulfur dioxide (SO2), nitrogen oxides (NOX), carbon monoxide, hydrogen chloride (HCl), and other common combustion byproducts and can operate unattended for extended periods. In this verification, the Series 3300 was programmed to report a reading of mercury concentration every 2.5 minutes. The CEM alternated measurements of HgT and Hg0, providing two successive readings of HgT, followed by two of Hg0. The Series 3300 consists of a sampling probe, a heated umbilical line, a sample conditioner, a mercury analyzer, a saturated Hg0 vapor calibrator, and a control system. It uses a stack-mounted inertial probe to minimize mercury measurement artifacts due to filtering. The sample flow is then diluted and sent at a high rate through a heated line to the sample conditioning module. The probe performs automated filter blowback, multi-point calibrations, and standard additions of mercury into the sample matrix. The conditioning module speciates the mercury into elemental and oxidized forms, without using chemical reagents or solid sorbents. The diluted sample is split into two streams. In the first stream, a thermal conditioner unit converts all mercury forms into Hg0. The patented thermal conditioner/scrubber system is designed to avoid recombination by the quantitative removal of HCl and other gases. The second pathway removes oxidized (water soluble) mercury, leaving only the Hg0 to pass through to the converter. This stream is then subjected to additional conditioning to remove acid gases and excess humidity from the sample. The two conditioned streams are analyzed using a Tekran Model 2537A mercury vapor analyzer. The analyzer uses gold preconcentration combined with atomic fluorescence detection. A calibration source of Hg0 allows both multi-point calibrations and standard additions to be initiated automatically. Both these operations are performed through the entire CEM path, including all probe filters. The calibration unit generates concentrations of Hg0 by using a saturated mercury vapor source. Precision mass flow controllers dilute the output of this source to the desired value. The computer provides full control of each module within the system. All temperatures, flows, and pressures are displayed by the application program and may be set by authorized users. The system features remote operation and problem diagnosis. The Series 3300 can be audited by introduction of mercury calibration gas standards, which can be delivered directly to the probe inlet by the umbilical line. The cost of the Series 3300 CEM as tested was ~$125,000, excluding the umbilical line, installation, and training. This report describes the performance of the test unit.
http://www.epa.gov/etv/pubs/600etv07009.pdf

Testing of Screening Technologies for Detection of Toxic Industrial Chemicals in All Hazards Receipt Facilities: Technology Evaluation Report
Kelly, T., W. Baxter, and M. McCauley, Battelle, Columbus, OH.
EPA 600-R-08-034, 50 pp, Mar 2008

This document is the final report on an evaluation of commercially available screening technologies designed for rapid detection and, in some cases, indication of the concentration of toxic industrial chemicals in air or in water samples. The technologies evaluated were identified as possible candidates for use in EPA's All Hazards Receipt Facilities (AHRF). The AHRF are intended for screening of samples for chemical, explosive, and radiological hazards to protect laboratory workers from injury and facilities from contamination and to ensure the integrity of collected samples. These facilities are not intended to provide detailed or quantitative analytical results, but instead to provide initial screening of samples prior to full laboratory analysis, for the safety of laboratory personnel. Screening technologies used in the AHRF are intended to be rapid and qualitative, and may be "low tech" in design and of relatively low cost, but must provide accurate identification of hazardous samples. The screening technologies tested ranged from simple test papers, kits, and color-indicating tubes to hand-held electronic detectors based on photoionization detection, electrochemical sensors, and flame spectrophotometry. The screening technologies were challenged with hydrogen cyanide, cyanogen chloride, phosgene, arsine, hydrogen sulfide, and chlorine in air at concentrations that would be seriously hazardous to personnel within a few minutes' exposure.
http://www.epa.gov/nhsrc/tte_chemdetectech.html

Thermal Methods for Detecting Groundwater Discharge
Conant, B., Univ. of Waterloo.
National Association of Remedial Project Managers/Technical Support Project (NARPM/TSP) Conference, 7-11 July 2008, Portland, Oregon. 53 pp, 2008

Temperature-based methods were summarized--infrared cameras, electric conductivity and temperature probes, and streambed temperature mapping--for locating discharges of groundwater to surface water. These methods are relatively inexpensive compared with conventional measurements of discharge (e.g., seepage meters and mini-piezometers) and have good spatial and temporal resolution. Temperature mapping also provides reasonable estimates of flux. http://www.epa.gov/tio/tsp/meetings.htm

Thermo Electron Mercury Freedom System: Environmental Technology Verification Report
Kelly, Thomas, Jan Satola, Zachary Willenberg, and Amy Dindal, Battelle, Columbus, OH.
U.S. EPA, Environmental Technology Verification Program, 34 pp, Feb 2007

Designed to meet the provisions of 40 CFR Parts 60 and 75, the Mercury Freedom System (MFS) can determine elemental (Hg0), oxidized (HgOX), and total mercury (HgT) in exhaust stacks of coal-fired boilers. The system uses a direct measurement atomic fluorescence method that precludes the use of argon tanks and gold amalgamation. The system extracts a small sample flow from the flue gas stream and immediately dilutes it inside the probe. Any HgOX in the diluted sample is then converted to Hg0 in a dry heated converter to obtain an HgT measurement. This diluted, converted sample is continuously transported to the mercury analyzer in the MFS rack where it is analyzed using atomic fluorescence technology developed specifically for measuring mercury vapor concentrations on a continuous, real-time basis. In this test, the continuous readings of the MFS were averaged and reported at one-minute intervals. The MFS determined only HgT for the purposes of this test. The MFS consists of a sampling probe with an integrated converter, heated umbilical line, probe controller, saturated Hg0 vapor calibrator, and an atomic fluorescence analyzer. The MFS can be audited by introduction of mercury calibration gas standards, which can be delivered directly to the probe inlet by the MFS umbilical. In its rack configuration, the system is 70 inches high by 36 inches deep by 24 inches wide. The probe box measures 34.5 inches long by 18.5 inches high by 10.5 inches wide and weighs 90 pounds. Onboard data storage capacity is 4 megabytes. Recording to a data acquisition system can be accomplished using analog output signals, digital (RS232/485), or modbus (via an industry standard Ethernet port). The list price of the system, as tested, excluding installation, training, and umbilical line, was $124,790. This report describes the performance of the test unit. http://www.epa.gov/etv/pubs/600etv07010.pdf

Ultrasensitive Detection of TNT in Soil and Water Using Enhanced Electrogenerated Chemiluminescence
Pittman, T.L., B. Thomson, and W. Miao, Univ. of Southern Mississippi, Hattiesburg.
Analytica Chimica Acta, Vol 632 No 2, p 197-202, 2009

Ultrasensitive detection of TNT was accomplished on the basis of a sandwich-type TNT immunoassay combined with electrogenerated chemiluminescence (ECL) technology. Biotinylated anti-TNT species were attached to the surface of streptavidin-coated magnetic beads (MB) of 1-um diameter and avidin-coated polystyrene microspheres/beads (PSB) 10-μm diameter pre-loaded with ECL labels (7 billion hydrophobic ruthenium(II) tris(2,2′-bipyridine) (RuII) molecules per bead) to form anti-TNT/MB and anti-TNT/PSB(RuII) conjugates, respectively. Sandwich-type PSB(RuII)/anti-TNT < TNT > anti-TNT/MB aggregates were formed when PSB(RuII)/anti-TNT was mixed with anti-TNT/MB conjugates in the presence of analyte TNT and 2.0% bovine serum albumin blocking agent. The newly formed aggregates were magnetically separated from the aqueous reaction media and dissolved in acetonitrile containing 0.10 M tri-n-propylamine ECL coreactant/0.055 M trifluoroacetic acid/0.10 M tetrabutylammonium tetrafluoroborate electrolyte. The limit of detection (</=0.10 +/- 0.01 ppb) is about 600 times lower compared with the most sensitive TNT detection method in the literature, and the absolute detection limit in mass (0.1 pg) is only 0.5% of that from mass spectroscopy.

Uncertainty in Stabilization/Solidification Effectiveness Using the Toxicity Characteristic Leaching Procedure
Fuessle, R.W. and M.A. Taylor, Bradley Univ., Peoria, IL.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Stabilization/solidification (S/S) is practiced world-wide because of its low cost and moderate technical requirements. This paper describes the effect of certain sources of error and variability on the determination by TCLP of treatment effectiveness of S/S samples aged with laboratory ambient air. Sources of error and variability include material non-homogeneity, random placement due to mixing, chemical analyses, and curing age in ambient laboratory air.

Knowledge of the source and magnitude of these errors and variability can improve monitoring and risk assessment procedures for the long-term effectiveness of S/S treatment.

Use of a Heated Transfer Line/Membrane Interface Probe to Characterize Polycyclic Aromatic Hydrocarbons at a Manufactured Gas Plant Site
Electric Power Research Institute (EPRI), Inc., Palo Alto, CA. Product 1016862, Apr 2008

This Technical Update describes bench-scale and field pilot tests of a heated transfer line/membrane interface probe (HTL/MIP) used in situ to characterize polycyclic aromatic hydrocarbons (PAHs) in manufactured gas plant (MGP) soils. This tool has the potential to reduce the time and cost associated with MGP site investigations. When mounted on a mobile platform and driven into the subsurface by a cone penetrometer, the HTL/MIP thermally extracts organic compounds from saturated and unsaturated MGP soils. Compounds are detected using a screening photo-ionization detector and analyzed in situ using fast gas chromatographic/mass spectroscopic analysis. The HTL/MIP worked well in the laboratory, but there were limitations to its use in the field. Further work is needed to identify membrane materials that can withstand temperatures needed for efficient extraction of PAHs from both saturated and unsaturated soils, and to control sample loss in the freeze trap leading to the analytical equipment. Because of these problems, thermal extraction in the field recovered only 17% of the PAHs recovered by solvent extraction of comparable samples in the laboratory. For more information on this technology, contact Andrew Coleman, 650-855-2249, acoleman@epri.com. EPRI products generally are not free.

Use of Advanced Passive Soil Gas Technology for Site Conceptualization and Closure Strategies
O'Neill, H. (Beacon Environmental Services, Bel Air, MD); J.E. Odencrantz (Beacon Environmental Services, Newport Beach, CA).
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

Passive soil gas (PSG) testing is a powerful investigatory tool that involves engineered sorbents in contact with the subsurface for a period of several days to several weeks. The time-weighted capture of VOCs combined with a grid pattern of sorbent placement allows for a detailed assessment of the spatial variability of contaminant sources as well as the extent of contamination over a wide range of geologic materials and molecular weights of the target VOCs. Advanced PSG technology involves both a rigorous analytical laboratory methodology for determining the mass of VOCs captured on the sorbents and a sufficient density of samplers to ensure adequate spatial variability assessment. ASTM D 5314-92(2006) is the standard guide for soil gas monitoring in the vadose zone and ASTM WK20609 is a working standard passive soil gas practice that outlines procedures for PSG sample collection, analysis, and reporting for different applications, such as vapor intrusion evaluation, monitoring, spatial variability assessment, and source identification. Additionally, monitoring of the effectiveness of remediation systems often is limited to an examination of data collected from permanent monitoring or pumping points in the vadose zone or groundwater system, which may not indicate what is occurring in areas away from the immediate vicinity of remedial efforts. PSG sampling on a regular basis in a grid pattern in and around the active remedial areas can give a reliable snapshot of system performance.

Use of Enzyme Probes for Estimation of Trichloroethene Degradation Rates and Acceptance of Monitored Natural Attenuation

Lee, M.H., D. Swift, and A. O'Hagan, North Wind, Inc., Idaho Falls, ID.

Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p F-117, 2008

Estimating degradation rates is necessary for evaluating the potential of selecting monitored natural attenuation (MNA) as a remedy at field sites. Molecular biological tools (MBTs) can contribute significantly in directly estimating or documenting the extent and rate of microbial degradation. A demonstration to develop the relationship between enzyme activity probes (EAP) for aerobic cometabolic enzymes and TCE degradation rates is presently underway for contaminant plumes at 2 sites. The primary objectives of this ESTCP demonstration are to validate methods for directly assessing the activity and contribution of targeted enzymes for cometabolism, and determining TCE degradation rates for aerobic chlorinated solvent plumes. Building 3001, Tinker AFB, OK, is the site of a mixed chromium and chlorinated solvent plume. Contaminant trend data suggest that the chlorinated solvents are attenuating and regions of the plume are aerobic. Initial EAP analysis of groundwater from the site revealed a significant response to at least one of the EAPs at 4 of the 5 wells analyzed in the upper zone or shallow aquifer. Other aerobic geochemical indicators, including elevated alkalinity, elevated chloride concentrations, and overall lower total organic carbon concentrations, were present in this zone as well. The middle zone of the aquifer also showed significant response with the EAPs at 3 of 5 wells. The three lower zone groundwater wells evaluated also exhibited activity with at least one of the EAP. In general, groundwater wells that exhibited conditions appropriate for aerobic microbial growth also showed significant activity with EAPs. The first round of screening for aerobic cometabolic activity is underway at Installation Restoration Program Site 2, El Toro, CA. Current work at El Toro involves microbiological sampling for EAP analysis and collection of contaminant and geochemical data, providing control assays for groundwater and soil analyses, employing molecular techniques independently of the EAP, and executing a microcosm study to obtain a degradation rate.

The Use of Molecular Techniques to Characterize the Microbial Communities in Contaminated Soil and Water

Malik, A., M. Beer, M. Megharaj, and R. Naidua, CRC CARE, Mawson Lakes, South Australia.

Environment International, Vol 34 No 2, p 265-276, 2008

This review examines the current application of molecular techniques for the characterization of microbial communities in contaminated soil and water, i.e., techniques that identify and quantify microbial population and catabolic genes involved in biodegradation. The authors also discuss methods that directly link microbial phylogeny to its ecological function at contaminated sites, as well as high throughput methods for complex microbial community studies.

Use of Sediment Core Profiling in Assessing Effectiveness of Monitored Natural Recovery: Sediment Issue
U.S. EPA, National Risk Management Research Laboratory, Cincinnati, OH.
EPA 600-S-08-014, 8 pp, Aug 2008

The success of monitored natural recovery (MNR) as a risk reduction approach for contaminated sediments typically is dependent on understanding the dynamics of the contaminated environment and the fate and mobility of the contaminant in that environment. The natural recovery process evaluated at the two study sites documented in this Sediment Issue--the Wyckoff/Eagle Harbor Superfund site and Sangamo-Weston/ Twelvemile Creek/Lake Hartwell Superfund Site--relied on vertical contaminant profiling and age dating of sediment cores to assess the history of contaminant accumulation, measure the extent of natural sediment capping, and document contaminant accumulation, compositional changes, and sources over time and space. For the Eagle Harbor site, the investigation revealed that three distinct PAH sources (creosote, urban runoff, and natural background) contributed contamination, with urban runoff continuing as an ongoing source. In addition, no evidence was found to indicate that the study area was being covered by natural deposits of clean, uncontaminated sediments; thus, MNR was not employed as the final cleanup remedy. Conversely, the cleanup plan for the Lake Hartwell site relies on natural recovery, which involves natural capping by the deposition of clean sediment entering the lake. The results of the investigation at this site were used to determine surface sedimentation, surface sedimentation rates, and predictions for the year cleanup goals would be achieved in the surface sediment. Given the inherent challenge of making future predictions based on extrapolation of historical data, long-term monitoring of the natural recovery remedy is needed at this site to determine whether recovery of surface sediments continues to occur. http://www.epa.gov/nrmrl/pubs/600s08014/600s08014.pdf

Use of the Modified BCR Three-Step Sequential Extraction Procedure for the Study of Trace Element Dynamics in Contaminated Soils
Pueyo, M., J. Mateu, A. Rigol, M. Vidal, J.F. Lopez-Sanchez, and G. Rauret, Univ. de Barcelona, Spain.
Environmental Pollution, Vol 152 No 2, p 330-341, 2008

A modified BCR three-step sequential extraction procedure was used to examine the temporal dynamics of trace elements in soils contaminated by an accidental spill from an opencast mine in Spain. Some soils were affected by both pyritic sludge and acidic wastewater and some only by acidic wastewater. The investigators compared contaminant distributions obtained for major (Ca, Fe, Mn) and trace elements (As, Cd, Cu, Pb, Zn) in the sludge and soil samples taken at different times (at 1 to 3 months and at 21 months) after the accident. Sequential extractions were used to identify different sources of contamination and to obtain additional information on the solubility of secondary minerals formed by pyrite oxidation. The BCR procedure provided a useful tool for predicting short- and long-term mobility of trace elements in a complex environmental scenario.

User's guide to HandLens: A Computer Program that Calculates the Chemistry of Minerals in Mixtures
Eberl, D.D.
U.S. Geological Survey Open-File Report 2008-1244, 27 pp, 2008

HandLens is a computer program written in Excel macro language that calculates the chemistry of minerals in mineral mixtures (for example, in rocks, soils, and sediments) for related samples from inputs of quantitative mineralogy and chemistry. For best results, the related samples should contain minerals having the same chemical compositions; that is, the samples should differ only in the proportions of minerals present. This manual describes how to use the program, discusses the theory behind its operation, and presents test results of the program's accuracy. Required input for HandLens includes quantitative mineralogical data, obtained, for example, by RockJock analysis of X-ray diffraction (XRD) patterns, and quantitative chemical data, obtained, for example, by X-ray florescence (XRF) analysis of the same samples. Other quantitative data, such as sample depth, temperature, surface area, also can be entered. The minerals present in the samples are selected from a list, and the program is started. The results of the calculation include: (1) a table of linear coefficients of determination (r2s) which relate pairs of input data (e.g., Si versus quartz weight percents); (2) a utility for plotting all input data, either as pairs of variables, or as sums of up to eight variables; (3) a table that presents the calculated chemical formulae for minerals in the samples; (4) a table that lists the calculated concentrations of major, minor, and trace elements in the various minerals; and (5) a table that presents chemical formulae for the minerals that have been corrected for possible systematic errors in the mineralogical and/or chemical analyses. In addition, the program contains a method for testing the assumption of constant chemistry of the minerals within a sample set. http://pubs.usgs.gov/of/2008/1244/

Using Nitrogen and Oxygen Isotope Compositions of Nitrate to Distinguish Contaminant Sources in Hanford Soil and Groundwater
Conrad, M. and M. Bill, Lawrence Berkeley National Laboratory, Berkeley, CA.
Paper LBNL-1020E, 9 pp, Nov 2008

The nitrogen and oxygen isotopic compositions of nitrate in the environment are primarily a function of the source of the nitrate. The authors outline the ranges of isotopic compositions for nitrate resulting from common sources. Processes such as microbial metabolism can modify the isotopic compositions of the nitrate, but the effects of these processes generally are predictable. Although the amount of isotope data for nitrate in the 200 West Area is limited, good evidence indicates that the nitrogen and oxygen isotopic values of the nitrate contamination in groundwater may be very useful for identifying and distinguishing between different potential sources of the nitrate. When combined with other indicators of waste processing practices (e.g., Tc-99 concentrations, Tc-99/nitrate ratios, uranium isotope compositions), the nitrate isotope data can be helpful for quantifying mixing relations between different, overlapping waste streams. Because nitrate is a highly mobile compound, the nitrate isotope data could also be a valuable precursor for determining potential pathways for transport of contaminants to groundwater.
http://www.osti.gov/bridge/product.biblio.jsp?query_id=3&page=1&osti_id=940585

Using Perchlorate Reductase from Dechloromonas agitata str CKB to Detect Perchlorate in the ppb Range
Coates, J., M. Heinnickel, S. Smith, and J. Koo, Univ. of California, Berkeley.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-146, 2008

Work under SERDP project ER-1530 has focused on the development of an alternative mechanism for perchlorate determination--i.e., a simple, highly sensitive, specific bioassay for perchlorate that can be performed on the benchtop with basic equipment. The bioassay developed in this study takes advantage of the unique biochemistry of the perchlorate reductase enzyme (PCR) purified from the perchlorate reducer, Dechloromonas agitata strain CKB. Results indicated that the biochemical electron donor, NADH, combined with the dye N-methylphenazinium methosulfate (PMS) provided the optimum mechanism for supplying electrons to the PCR to reduce perchlorate. Monitoring NADH concentrations by absorbance at 340 nm revealed a strong reproducible correlation between the perchlorate reduced and the NADH oxidized by PCR under anaerobic conditions. A similar correlation was observed when the assay was conducted aerobically on a benchtop underneath mineral oil. To bring the detection limit to below California regulatory limits, a perchlorate concentration step was added to the protocol. In a procedure modified from a protocol published by the U.S. Army Corp of Engineers, the perchlorate sample is loaded on styrene-divinyl benzene columns pre-conditioned with DTAB and eluted using MOPs buffer. Interfering ions, such as nitrate or chlorate, are differentially eluted to avoid false positives. These combined techniques quantitatively detected perchlorate in samples containing concentrations below 1 ppb. The developed bioassay detected perchlorate in 6 different groundwater and soil samples, and the results were verified with excellent accuracy using ion chromatography. From an economical aspect, each sample requires only $0.43 worth of chemicals and materials per measurement, which is far less than the cost per sample analyzed by ion chromatography. Pippets, quartz cuvettes, and a handheld spectrophotometer are the only equipment necessary for this analysis. The cost of cuvettes and a handheld spectrophotometer can be as low as $500, significantly cheaper than an ion chromatography system at $25,000. These studies have resulted in the successful development of a highly sensitive and robust colorimetric biossay for the specific determination of perchlorate concentrations. This assay has proven to be cheap and accurate and has already been reliably applied to the determination of perchlorate contamination in diverse environmental groundwater and soil samples.

Using Performance Reference Compounds to Calibrate Polyethylene Passive Samplers for Measuring Mixtures of Hydrophobic Organic Compounds (HOCS) in Sediment Porewaters
Gschwend, P., L. Fernandez, J. MacFarlane, and K. Fleming, Massachusetts Inst. of Technology, Cambridge. Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, p G-181, 2008

To make the polyethylene (PE) passive sampling methodology useful for a wide range of HOCs (e.g., PCB congeners, alkylated PAHs) for which performance reference compounds are not readily available, researchers under SERDP project ER-1496 have worked to extend the method for cases in which the reference compounds could not be assumed the same as the target compounds of interest in key mass transfer properties. The method requires that diffusivity of the target compound in PE be known, as well as its PE-water partition coefficient (KPEW) and the site-specific sediment/water-sorption coefficient (Kd). PE diffusivities of several alkylated PAHs and PCBs were measured, and a method to estimate PE diffusivity from chemical structure was developed. A mass-transfer model and observations of performance reference compound losses in specific sediments were used to estimate Kd for target chemicals. These parameters, along with KPEW values, measured or estimated from structure, allowed deduction of the freely dissolved porewater concentrations of alkylated PAHs and PCBs in a sediment sample from a site contaminated with coal tar. The PE-deduced concentrations were compared to concentrations measured in porewaters that had been physically separated from the sediments and corrected for colloid-associated fractions.

Vapor Intrusion Pathway for a Commercial Facility at a Former Manufacturing Facility: Not the Typical Regulatory Conceptual Model
Murphy, M.J., P.J. Muller, D.E. Heislein, and R.R. Rustad (MACTEC Engineering & Consulting, Inc.); G. Rotondi (Pine & Swallow Associates).
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

A step-wise vapor intrusion investigation of a commercial facility in Rhode Island was conducted in response to low levels of chlorinated VOCs in upgradient groundwater. A sub-slab soil vapor survey was conducted within the building complex and along its exterior perimeter to evaluate potential vapor intrusion. Based on the soil vapor survey, indoor and outdoor air sampling and analysis was conducted. Average indoor air concentrations of PCE and TCE were at or above target industrial/commercial indoor air screening criteria. Using direct-push technology and a mobile laboratory, a more comprehensive soil vapor investigation was conducted to delineate VOC concentrations horizontally and vertically, identify source areas within the building footprint, and identify vertical concentration gradients in the subsurface. Contamination within the groundwater and possibly within the vadose zone soils was identified as the likely source for the observed VOCs in soil vapors and indoor air. Sampling and analysis of groundwater monitoring wells within the building in the soil vapor source area beneath the building confirmed a groundwater source. The relationships among groundwater, soil vapor, and air concentration distributions are not consistent with many regulatory programs and associated guidance. Gradients and attenuation factors in particular for this commercial site vary considerably from a typical regulatory program conceptual model. The physical characteristics of the site and the building's configuration and condition impact several components of the vapor intrusion pathway. The investigation results, pre-design vacuum testing results, and additional groundwater investigation will support vapor mitigation and groundwater remedial system design. This investigation highlights the importance of site-specific investigations and the differences between actual site conditions and the typical vapor intrusion conceptual models that have been incorporated into many regulatory programs and guidance.

Vapor Intrusion Sampling Options: Performance Data for Canisters, Badges, and Sorbent Tubes for VOCs
Coyne, L.S. (SKC Inc. Eighty Four, PA); G. Havalias (American Analytics Inc., Chatsworth, CA); T. Jordan (SKC West Inc., Fullerton, CA). Vapor Intrusion 2009, San Diego, California, 27-30 January. Air & Waste Management Association Conference Abstracts, 2009

Sorbent tubes are less expensive and easier to use than canisters, and their use is approved for sampling volatiles and semi-volatiles by EPA method TO-17. Sorbent tubes with battery-operated pumps also are the basis for hundreds of OSHA and NIOSH monitoring methods. The use of sorbent tubes, under certain conditions, can achieve detection limits lower than canisters. Questions remain as to the reliability of the sorbent and the possibility of undetected breakthrough during sorbent tube use. In a study conducted in the state of New York between passive badges and canisters, the correlation coefficients between canisters and an Ultra II badge packed with Anasorb GCB1 for benzene and perchloroethylene were 0.9533 and 0.9831, respectively. Toluene and xylenes also showed good correlation coefficients. Lab studies with benzene at levels from 0.1 to 10 ppm show recoveries greater than 90% and no breakthrough for 2-hour sampling time intervals. The data in this study demonstrate that sorbent-based sampling devices can be used effectively in vapor intrusion and are a reliable alternative to canister sampling.

Verification of Methods for Assessing the Sustainability of Monitored Natural Attenuation
Widdowson, M., F. Chapelle, J. Parker, J. Novak, C. Lebron.
Partners in Environmental Technology Technical Symposium & Workshop, 2-4 December 2008. Program Abstracts, G-138, 2008

Under SERDP project ER-1349, Chapelle and others developed a methodology for assessing Long-term MNA sustainability by computing the net plume behavior in response to the stoichiometric balance between electron donors and acceptors and transport processes using SEAM3D. This proposed approach utilizes a simple but novel method to quantify the operationally defined BOC and a field-scale source-zone depletion (SZD) function to estimate contaminant fluxes and remediation time-frame. The three main technical objectives of ESTCP project ER-0824 are to (1) validate a methodology for calculating by establishing correlations with field-measured dissolved oxygen and chloroethene concentrations, concentrations of natural organic carbon compounds present in aquifer sediment, and rate and extent of reductive dechlorination; (2) verify the scaled-up SZD function using site contaminant concentration data for a range of source zone geometries; and (3) demonstrate long-term MNA sustainability assessment using SEAM3D v.2.1. Initial results suggest that while BOC correlates positively with total organic carbon (TOC) of aquifer sediment, TOC alone is not a clear indicator of the rate and extent of reductive dechlorination. Concentrations of BOC in sediments from a variety of chlorinated ethene-contaminated sites correlate positively with amino acid concentrations. Because amino acids are known to be relatively bioavailable carbon compounds, this correlation suggests that the sequential chemical extraction procedure used to measure BOC--a much simpler procedure than measuring concentrations of compounds such as amino acids--is a useful indicator of bioavailable carbon in soils and aquifer sediments.

Wavelets and Spectral Analysis, Powerful Tools for Estimating Aquifer Hydraulic Parameters without Extracting Water
Achour, F. and C. Serlin, ENVIRON International Corporation, Irvine, CA.
Abstracts: The 24th Annual International Conference on Contaminated Soils, Sediments, and Water, University of Massachusetts at Amherst, 20-23 October 2008

A pumping test involves removing ground water from a well and measuring water levels in the pumping well and surrounding piezometers. When the aquifer is contaminated, the extracted water must be handled with care. Alternatives to the standard pump test are available that are cost effective and "environmentally friendly." A methodology to estimate aquifer parameters--hydraulic conductivity, barometric efficiency, porosity, specific storage coefficient, and storage coefficient--was developed by analyzing the influence of solid Earth tides and atmospheric pressure on ground water natural fluctuation at a contaminated site in southern California. The hydraulic parameters were calculated using tools such as Morlet wavelets, correlation and spectral analyses, gain and coherence functions, and the Bredehoeft model. Unlike traditional approaches, the proposed approach considers the response of groundwater level within a well to be an external event--the system is investigated according to its response to an event without making any assumption on the lithology, geometry, structure, and voids distribution in the geological formation. The main advantage of the approach is that it allows for estimation of the above mentioned hydraulic parameters in multiple wells within a short time, leading to an accurate characterization of spatial heterogeneities and providing a better understanding of rates and directions of groundwater flow and contaminant transport.

SBIR AND OTHER GRANT AWARDS

U.S. Department of Defense

Advanced Algorithms for a Combined Chem-Bio Standoff Sensor (Army 2008 STTR Phase 1)
Dr. David Cohn, PI, (310) 607-6894, dbctechnology@earthlink.net
South Bay Science & Technology Corp., Playa del Rey, CA, partnered with SRI International, Menlo Park, CA
Contract W911SR-08-C-0060
8/7/2008 to 2/7/2009
Award Amount: $99,843

The program addresses algorithm development in critical areas that have received little or no attention in the past, including mixtures of chemical vapors, single and mixed chemical aerosols, mixtures of bio aerosols, and mixtures of chemical vapors. New approaches based on parallel extraction of material spectral dependence of the material in parallel with its path-integrated concentration and nonnegative matrix factorization originally used for unmixing hyperspectral data will be attempted. The algorithms will combine orthogonal data sets for DIAL and DISC in the likely case of mixtures of chemical vapors and aerosols. Methods to process DIAL and DISC data collected simultaneously to achieve rapid realtime output will be investigated and analysis will be undertaken to show the specific sensor changes required to take full advantage of the new algorithms.

Advanced Point Sensor (Army 2008 STTR Phase 1)
Dr. David Cohn, PI, (310) 378-4156, dbctechnology@earthlink.net
DBC Technology Corp., Torrance, CA, partnered with SRI International
Contract W911SR-08-P-0058
7/31/2008 to 1/31/2009
Award Amount: $99,122

The enhanced capability point bio and chem sensor is based respectively on the recently discovered phenomenology of biological aerosol differential backscatter in the long wave infrared proven in field trials with a standoff sensor and on differential absorption. The novel point sensor will use compact, wavelength agile transmitters, including quantum cascade lasers and/or miniature CO2 lasers operating in the 8-12 micron band that will be integrated into a combined differential absorption and backscatter cell with diagnostics typical of ringdown spectroscopy. The new point sensor will improve on present technology with the ability to detect and identify biological agent classes with good specificity and distinguish them from naturally occurring aerosols and interferants such as diesel exhaust, and it will be able to identify chemical agents using the same components and in the same package.

Advanced Robotic Detection of Chemical Agents, Toxic Industrial Gases, and IEDs for Force Health Protection (Army 2008 STTR Phase 2)
James R. Weiss, PI, (626) 241-6041, jweiss@Ionfinity.com
IonFinity, LLC, Pasadena, CA, partnered with NASA - JPL
Contract W81XWH-06-C-0386
8/1/2008 to 8/3/2010
Award Amount: $750,000

We propose to develop a novel chemical agent sensor through a joint collaborative effort involving IonFinity, the Jet Propulsion Laboratory, Caltech, and Imaginative Technologies. This chemical sensor consists of 1) a new and powerful detector called a Differential Mobility Spectrometer developed by Imaginative Technologies team member Dr. Gary Eiceman in collabortion with Sionex, and 2) a novel '"soft-ionization" method that does not fragment or multiply-ionize sampled species of interest. Our goal is to develop and prototype an inexpensive, compact, 2 Kg, field-portable, stand-off, high-efficiency, rugged, integrated detection and identification system (TRL 6) for chemical & biowarfare agents; industrial toxic gases, and chemical components of Improvised Explosive Devices in air, water, or solids and integrate it with one of the emerging family of Joint Architecture for Unmanned Systems compliant unmanned ground vehicles intended for medical force health protection and combat casualty care missions. The resultant device will detect chemicals at ppt to low ppb levels after 10 seconds. Detection levels are similar to those of mass spectrometry but without the complicated bulky vacuum system.

Compact Instant Multi-Spectral Imager (DoD DARPA 2008 SBIR Phase 1)
Jame Yang, PI, (305) 235-6928, jyang@new-span.com
New Span Opto-Technology, Inc., Miami, FL
Contract W31P4Q-09-C-0139
1/5/2009 to 8/30/2009
Award Amount: $98,996

Multispectral/hyperspectral imaging is a technique that acquires and analyzes both spectral and spatial information. It provides the potential for more accurate and detailed information extraction than possible with those conventional imaging techniques. Spectral imaging sensors have applications in various military and commercial fields including spectral discrimination target identification, camouflage detection, environmental monitoring, etc. Thus far, some prototype spectral imaging systems have been produced, each with its own strengths and weaknesses. Especially, the volume and weight of these systems are too large to be portable. There is a demand to develop the optical train for a multispectral imager based on micro-optical elements that is ultra-compact compared to similar current optical systems. New Span Opto-Technology Inc. proposes herein an innovative optical architecture that can realize a compact multispectral imager. It can present spectral images of all desired bands instantly. Task dependent spectral bands selection will achieve optimal target discrimination. There is a potential to realize a dynamically reconfigurable spectral imager based on the proposed scheme. Phase I will conduct technical analysis and design, and construct a preliminary bench top experimental setup to demonstrate critical components technologies and the feasibility of the proposed concept. Phase II will fabricate a working sensor prototype.

Compact Intense THz Unit for Eye-Safe Standoff Explosive Detection (Army 2008 SBIR Phase 1)
Jianming Dai, PI, (518) 833-0577, jianming.dai@zomega-terahertz.com
Zomega Terahertz Corp., Troy, NY
Contract W15QKN-09-C-0043
10/31/2008 to 4/30/2009
Award Amount: $69,949

We will develop a compact THz system with standoff spectroscopic detection capability, using an intense 1-µm Yb fiber laser with a tilted optical pulse wave-front to excite a nonlinear optical crystal (such as, LiNbO3) as the THz emitter, and a balanced electric-optic (EO) crystal incorporated with a quartz lens as the detector. The proposed unit will have THz average power greater than 1 mW and signal-to-noise ratio with real-time detection at 10 meters better than 1,000. Explosives and related compounds (ERCs) feature broad spectral signatures that are separable from narrow water absorption spectral lines using our proposed novel algorithm. Improvements in the emitter, detector and software will significantly improve the signal/noise ratio of the device by at least two orders with a bandwidth over 3.0 THz, and consequently, extend the standoff detection distance from ~10 m to over 30 m.

Compact Multi-Spectral Real Time Imager (DoD DARPA 2008 SBIR Phase 1)
James Murguia, PI, (603) 598-1194, jim@solidstatescientific.com
Solid State Scientific Corp., Hollis, NY
Contract W31P4Q-09-C-0193
1/6/2009 to 9/18/2009
Award Amount: $98,998

Solid State Scientific Corporation (SSSC) is pleased to propose a Phase I SBIR program to develop a unique multi-spectral imaging sensor prototype The proposed spectral sensor will be lightweight, portable, low-power and rugged with simultaneous imaging of all the spatially registered spectral bands. The optical system which is less than 1 cubic centimeter in volume will provide a sensor field of view of approximately 30° and cover a spectral range between 400-1000nm. The system will operate at video rates, weigh approximately one pound and dissipate approximately 10 watts.

Compact Unit for Eye-Safe Standoff Explosive Detection (Army 2008 SBIR Phase 1)
Richard Myers, PI, (617) 668-6800, RMyers@rmdinc.com
Radiation Monitoring Devices, Inc., Watertown, MA
Contract W15QKN-09-C-0028
10/31/2008 to 4/30/2009
Award Amount: $69,997

The goal of this work is to develop a novel Raman scattering spectrometer for advance standoff detection of IEDs and suicide bomber threats. When using the proposed instrument, we will obtain rapid, chemical-specific analysis at standoff distances of up to 30 m. This instrument will have significantly increased detection sensitivity, measurement accuracy and analysis rates compared to more conventional spectroscopy methods. To achieve a compact and low cost instrument design, we will use a custom, high-gain APD array detector as the basis of the proposed analytical instrument. The collected spectral data will also be analyzed with sophisticated software tools to provide near-real time analysis of potential threats. The final instrument will rapidly image trace amounts of explosive chemicals and other explosive related compounds (ERC), allowing time for preemptive action. Existing development of UV Raman scattering for standoff detection of explosives will be leveraged to support this effort and increase the opportunity for success.

Composite Transistor Array Vapor Sensor (Air Force 2008 STTR Phase 1)
Dr. Robert C. McDonald, PI, (781) 529-0530, rmcdonald@ginerinc.com
Giner, Inc., Newton, MA, partnered with the Univ. of California, San Diego
Contract FA9550-08-C-0072
9/28/2008 to 6/28/2009
Award Amount: $99,692

The Giner, Inc. Phase I program will examine the response to explosive and toxic gas simulants of sensor arrays using a combination of specifically doped metal oxides (DMO) developed at Giner, Inc. in conjunction with metallophthalocyanine (MPc) thin films developed at the University of California at San Diego. Electronic controls developed for the MPc sensors will be evaluated also for the metal oxide sensors to enhance vapor discrimination, sensitivity and response time. The different response characteristics of these two classes of sensors for trace peroxides and other select stimulant vapors in the presence of typical atmospheric components will be used to design arrays having the required sensitivity and selectivity for Air Force needs.

Development of Protein-Based Taggants for Chemical and Biological Agent Detection (Air Force 2008 SBIR Phase 2)
Dr. Melanie M. Tomczak, PI, (937) 426-6900, mtomczak@ues.com
UES, Inc., Dayton, OH
Contract FA8650-08-C-5018
3/26/2008 to 7/26/2010
Award Amount: $749,985

UES proposes a sensor that is based on short peptide sequences that act as ligands for the target(s) of interest. Due to their small size, these ligands are not susceptible to conformational instability and the sensors should have a long lifetime even when deployed. Additionally, we propose a "dry" signal transduction mechanism that only requires the binding of the target of interest in order to relay that event. No washing or blocking steps are required. After deployment, the sensor on which the binding takes place can be interrogated, either locally or remotely, by a reader to determine if the target of interest has bound.

Drinking Water Quality Sensor System (Dr. Watsen) (Army 2008 SBIR Phase 1)
Carl A. Palmer, PI, (585) 424-1990, carl.palmer@impact-tek.com
Impact Technologies, LLC, Rochester, NY
Contract W56HZV-09-C-0153
12/16/2008 to 6/16/2009
Award Amount: $69,875

Impact Technologies, in cooperation with Dr. Lynn Fuller of Rochester Institute of Technology, with oversight from SFA's Defense Products Division (DPD) who produce the Tactical Water Purification System (TWPS) for the military, proposes to develop a MEMS based sensor platform that integrates several key water quality tests into a single chip. These tests are pH, free residual chlorine, turbidity, temperature, total dissolved solids (TDS), and biological contaminants. This system will provide soldiers in the field with real-time monitoring of their water supply to guard against disease and toxic agents. Key tasks for Phase I include: 1) Finalizing sensing technologies to measure desired parameters, 2) Designing and producing prototype MEMS chips, 3) Packaging prototypes for testing - developing supporting electronics to perform signal conditioning and data analysis, 4) Determining metrics of successful system operation based upon currently accepted standards of water quality monitoring: characterizing the MEMS sensor performance 5) Comparing MEMS system performance to that of commercially available water monitoring systems and sensors 6) Identifying and integrating necessary system modifications to meet Army goals for the Phase II effort. 7) Determine the path towards deployment as part of productization for potable water systems in Phase II and beyond.

Dynamic Multicomponent Optical Analyzer for Chemical Weapon (CW) Exposure Studies (DoD CBD 2008 SBIR Phase 1)
Dr. Coorg R. Prasad, PI, (443) 539-1731, prasad@sesi-md.com
Science & Engineering Services, Inc., Columbia, MD
Contract W911SR-08-P-0028
5/8/2008 to 11/8/2008
Award Amount: $69,991

We propose to build a compact laser photoacoustic spectrometric (LPAS) sensor for continuous, real-time broadband analysis of multiple chemical components, and perform field tests to qualify it for dynamic monitoring of chemical warfare agents (CWA). Our sensor will be based on our laboratory LPAS instrument (at technology readiness level TRL-4) that has already demonstrated successful multicomponent chemical detection with CWA, toxic chemicals, and explosives. It utilizes a tunable infrared laser (CO2 or quantum cascade), a high sensitivity photoacoustic cell with an air sampler and an efficient algorithm to rapidly complete high sensitivity, selective multicomponent measurements in under a minute. In Phase I we will carry out extensive laboratory and preliminary field site tests of LPAS with simuants, and a comprehensive analysis of the sensor performance using a model to determine the LOD and

ROC curves for the sensor and establish its feasibility. A rugged and portable prototype sensor (TRL-5) will be built in Phase II. It will be field tested with actual toxic agents in DoD test sites to qualify (TRL-6) and characterize the sensor.

Dynamic Multicomponent Optical Analyzer for Chemical Weapon (CW) Exposure Studies
(DoD CBD 2008 SBIR Phase 1)
Dr. Douglas Baer, (650) 965-7772, d.baer@lgrinc.com
Los Gatos Research, Mountain View, CA
Contract W911SR-08-P-0019
5/6/2008 to 11/6/2008
Award Amount: $69,997

In this SBIR Phase I effort, Los Gatos Research (LGR) proposes to design, develop and test a novel laser-based gas analyzer optimized for chemical weapon exposure studies based on cavity enhanced absorption in the mid-infrared spectral region. This analyzer will provide sensitive and accurate quantification of several chemical weapons through real-time measurements of high-resolution absorption spectra recorded in the mid-infrared. The instrument will employ Off-Axis ICOS, an extraordinarily rugged and commercially-proven cavity enhanced laser absorption technique that uses an optical cavity as absorption cell for significantly improved sensitivity, and mid-infrared lasers for high specificity and low false positives. The SBIR instrument will be the first system capable of providing rapid quantification of chemical agents and enable improved understanding of the dose-response characteristics of the subject in real time.

Dynamic Multicomponent Optical Analyzer for Chemical Weapon (CW) Exposure Studies
(DoD CBD 2008 SBIR Phase 1)
Dr. Pajo Vujkovic-Cvijin, (781) 273-4770, pajo@spectral.com
Spectral Sciences, Inc., Burlington, MA
Contract W911SR-08-P-0029
4/28/2008 to 10/28/2008
Award Amount: $69,990

Spectral Sciences Inc. proposes to develop a prototype sensor for real-time trace-level analysis of complex multicomponent gas mixtures, specifically those containing Chemical Weapon (CW) agents and interferents. The instrument is based on high power quantum cascade lasers and photocoustic spectroscopy detection. Advanced detection algorithms take advantage of wide spectral coverage to provide high sensitivity with low occurrence of false positives. The laser source features digitally controlled fast wavelength tuning and wavelength modulation. An integrated-optics acoustic transducer provides noise-cancelling gas absorption signal acquisition. In Phase I and Phase I Option tasks, the digitally tunable and lockable laser source will be demonstrated, followed by the delivery of a laboratory prototype by the end of Phase II.

Fast-Scan, High-Performance, Portable Imaging Spectrometer for Chemical-Biological Sensing (Army 2008 SBIR Phase 1)
Thomas E. Koscica, PI, (908) 781-0393, hongbinli@lcpegasus.com
L.C. Pegasus Corp., Basking Ridge, NY
Contract W911NF-09-C-0007
11/6/2008 to 5/5/2009
Award Amount: $70,000

Pegasus proposes to design and develop a fast, high-performance, portable, field-operable chemical-biological imaging-sensing system, which consists of a spectrometer and a "system-on-a-chip" data acquisition, processing, and analysis unit. The proposed system will possess a significantly enhanced ability to detect and selectively analyze chemical and biological agents, through the integration of a portable Fourier transform infrared (FTIR) spectrometer and high-performance field-programmable gate array (FPGA) technologies. The resulting system is small in size, rugged in design, easy to use, and consumes minimal power.

Field Sensor for Measuring Total Trihalomethanes (TTHM) Concentrations in Drinking Water (Air Force 2008 SBIR Phase 1)
Dr. Won Tae Kim, PI, (505) 524-3664, wkim@lasysinc.com
Nantal, Inc., Las Cruces, NM
Contract FA9302-08-M-0013
1/25/2008 to 10/22/2008
Award Amount: $99,991

Nantal Inc. is developing a proprietary nanoparticle/fractal based sensor, which will be integrated into two electronic devices that will result in an ultra sensitive optical detector based on the Raman effect. The devices will be capable of detecting chemical contaminants in water at concentrations in the low ppb range. In Phase I the sensor will qualitatively detect total trihalomethanes (TTHM) both above and below EPA's Maximum Contaminant Level of 80 ppb. In Phase II the sensor will be scaled-up to production levels and integrated into two newly designed and developed electronic instrument devices that will quantitatively detect TTHM in water in the 20 to 200 ppb range. The devices will include a small handheld, field ready device and a bench top unit for use in a laboratory. The ultra sensitive instruments will provide accurate, precise, and quantitative measurements in real time via a digital readout, require no preparative steps and be simple to use in the hands of non-technical individuals. TTHM results from the reaction of chlorine with organic materials in water. Two of the four organic TTHM agents are classified as possible carcinogens and the group has shown to affect development and reproduction in laboratory animals.

Fluctuation-Enhanced Chemical & Biological Sensor Systems (Army 2008 SBIR Phase 2)
Dr. Nicolai Panikov, PI, (908) 781-0393, nicolaipanikov@lcpegasus.com
L.C. Pegasus Corp., Basking Ridge, NJ
Contract W911NF-08-C-0118
8/21/2008 to 8/20/2010
Award Amount: $729,995

This proposed project is aimed at the design and development of a portable chemical-based sensing system that will possess a significantly enhanced ability to detect and selectively analyze chemical (and potentially biological) agents, at parts per million (ppm) concentrations and below, using stochastic fingerprinting techniques. This new technological approach is based on the principle of Fluctuation-Enhanced Sensing (FES) that utilizes the micro-fluctuations already present in the sensor and that are influenced by very low concentrations of chemical (and also potentially by biological) agents in a statistically meaningful way. Following our Phase-I feasibility studies of utilizing Fluctuation-Enhanced Sensing (FES) techniques for the detection and analysis of chemical agents at very low concentrations, and several scenarios for potential extensions of the technique for biological agent sensing, this Phase-II effort will be focused on the design and demonstration of an FES-based sensory platform which will be constructed using commercial off the self (COTS) sensor technology. This sensor prototype will be compact and will exhibit significantly enhanced performance in terms of chemical (and possibly biological) agent detection and selective analysis capability.

Handheld IR Raman Spectroscopy for Rapid Chemical Identification (DoD CBD 2008 SBIR Phase 1)
Dr. Michael MacDougal, PI, (805) 642-4645, macdougal@aeriusphotonics.com
Aerius Photonics, LLC, Ventura, CA
Contract W911SR-08-C-0040
5/30/2008 to 11/30/2008
Award Amount: $69,949

Aerius Photonics and partner Ahura Scientific, propose to develop a handheld system, based on Ahura's successful FirstDefender Raman system, that employs an excitation laser emitting at 980 nm and a low noise InGaAs array based on Aerius' high performance InGaAs technology. This system will substantially reduce the fluorescence present in CCD-based systems, and unmask otherwise obscured spectra. The combination promises to establish a new standard for identifying low concentrations of chemicals using a compact, easy-to-use system. At the end of a successful Phase II, we would deliver a prototype unit having a footprint similar to the FirstDefender that is capable of identifying chemicals within seconds, and ready to be put into use very quickly. In Phase I of this program, we plan to build a breadboard version of the system that employs a 980 nm laser, a probe, a miniature spectrometer, and an InGaAs array.

Hand-Held Raman Analyzer for Chemical Identification (DoD CBD 2008 SBIR Phase 1)
Dr. Stuart Farquharson, PI, (860) 635-9800, stu@rta.biz
Real-Time Analyzers, Middletown, CT
Contract W911SR-08-C-0041
6/18/2008 to 12/18/2008
Award Amount: $67,436

The overall goal of this proposed program (through Phase III) is to build a hand-held Raman analyzer that can perform non-contact identification of chemicals in the field. This will be accomplished by modifying a commercially available FT-Raman analyzer to employ 976 or 1064 nm laser excitation. Feasibility will be demonstrated in Phase I by comparing the ability of three Raman systems using laser excitation at 785, 976, and 1064 nm to measure some 50 chemicals in terms of fluorescence and thermal emission minimization, and identification of unknowns using spectral matching algorithms. During Phase II an ~ 10 pound hand-held Raman analyzer will be designed and built that includes a comprehensive spectral library of actual chemical warfare agents, explosives, and toxic industrial chemicals; and employs a Personnel

Digital Assistant for analyzer control that includes spectral acquisition and spectral matching with statistics to allow chemical identification in real-time (< 5 minutes). The analyzer will employ a simple to operate user-interface, and will be delivered at the end of the program.

Hand-Held System for On-Site Trihalomethane Measurement (Air Force 2008 SBIR Phase 1)
Dr. Kevin R. Cooper, PI, (910) 695-8884, kevin@scribner.com
Scribner Assoc., Inc., Southern Pines, NC
Contract FA9302-08-M-0014
1/25/2008 to 10/22/2008
Award Amount: $99,953

A handheld total Trihalomethane sensor system would permit water system operators to identify and implement mitigation strategies to the contamination source avoiding costly regulatory violations. The aim of the proposed work is to develop an electrochemical-based sensor array system and measurement method procedure for rapid, accurate determination of the total Trihalomethane content of drinking water. The proposed electrochemical approach is well-suited to accurate quantification of part per billion-level analytes; electrochemical-based sensor array systems are ideal for portable applications because they are easily miniaturized without sacrificing performance, are low power which facilitates battery operation, and are inherently safe. High-density sensor arrays permit redundant analysis for enhanced measurement fidelity as well as targeted detection of multiple analytes without sacrificing cost or portability. The Phase I will demonstrate the technical feasibility of the proposed electroanalytical approach and the efficacy of developing small, low mass and power analytical instrumentation for the sensor array. Using results from the Phase I, the expected performance of the detection system will be critically evaluated against established performance criteria. In Phase II, the research team will develop a prototype handheld detection system.

Hand-Portable GC-TMS Instrumentation for Rapid Detection and Differentiation of Airborne Biological Threats (Army 2008 SBIR Phase 1)
Dr. Douglas W. Later, PI, (801) 830-6083, doug.later@torion.com
Torion Technologies, Pleasant Grove, UT
Contract W911S6-08-C-0002
2/4/2008 to 8/4/2008
Award Amount: $70,000

Rapid detection and identification of biological threats in air during field operations and in gaseus flow streams from swatch permeation test fixtures are critical to protect the warfighter, first responders and civilians from exposure to infectious biological agents. The focus of this proposal is to develop these capabilities based on a proprietary hand-portable gas chromatograph-toroidal ion trap mass spectrometer (GC-TMS) instrument that has been developed by Torion Technologies for chemical threat detection. The proposed technology will be capable of sampling and concentrating bacterial endospores from gaseous media such as air, converting the particles into unique chemical biomarkers that can be analyzed by the GC-TMS system, and determining the presence of any target endospores using sophisticated deconvolution and spectral matching algorithms that can isolate relevant GC profiles and MS fingerprints from irrelevant background biological and chemical interferences to construct reliable bacterial endospore signatures. Specifically, in this Phase I project, we will demonstrate the collection of bacterial endospores using a small, battery-operated two-stage particle impactor, generate reproducible chemical biomarker signatures from captured bacterial endospores using acid-catalyzed hydrolysis/methylation, and apply a new classification and discrimination algorithm that is robust to growth conditions for identifying bacterial endospores.

High Performance and Portable Electronic Dog-Nose with Fluctuation-Enhanced Sensing and Prompt Bacterium-Identifier Option (Army 2008 SBIR Phase 2)
Dr. Chiman Kwan, PI, (240) 505-2641, chiman.kwan@signalpro.net
Signal Processing, Inc., Rockville, MD
Contract W911NF-08-C-0031
1/11/2008 to 1/10/2010
Award Amount: $730,000

Signal Processing plans to achieve the following Phase II tasks. First, we will carry out nano-sensor performance analysis for the new nano-tube sensor idea developed in Phase I. Second, we will implement a real-time portable chemical/biological agent detection system "Electronic Dog Nose" (EDN) with commercial off-the-shelf (COTS) sensors in fluctuation-enhanced mode. Both hardware and software will be included. Third, we will implement the optimized enhancing tools in the EDN. We will install nanoparticle film sensors fabricated at Uppsala University and re-optimize the system. Fourth, we will run extensive tests with the COTS sensors (conventional and nanoparticle film) and enhance sensory information by higher-order statistical and hyper-spectral software tool used on the actual experimental data. Receiver Operating Characteristics (ROC) curves will be generated. We will also compare the performance of nanoparticle film sensors with conventional COTS sensors. Fifth, we will apply our advanced processing techniques on some specific applications such as Ion Mobility Spectrometer (IMS) data, electronic nose data, gas chromatography (GC) sensor data, and explosive sensor data. Finally, we will perform commercialization of the EDN. Our strategy is to team up with industrial partners which already have products. We will find ways to integrate our software modules into their systems.

Hybrid Silicon Chip for Detection of Explosives in Waste Water (DoD DARPA 2008 SBIR Phase 2)
R. Shashidhar, PI, (703) 615-1023, rshashidhar@polestartech.com
Polestar Technologies, Inc., Needham Heights, MA
Contract W31P4Q-08-C-0401
8/14/2008 to 11/9/2009
Award Amount: $742,652

The aim of this DARPA Adoption SBIR Phase II Proposal is to develop a hybrid silicon-based chip by integrating the two types of sensor arrays: electrochemical and molecular recognition sensor array. We will design and fabricate the first prototype chip with separate stand-alone electronics and demonstrate the feasibility of detecting both explosives and the byproducts of explosives in simulated waste water. The development of such a hybrid chip will give a unique capability for DoD for operating in both urban and rural environments.

Hyperspectral Identification for Collaborative Tracking (Air Force 2008 SBIR Phase 2)
Dr. William S. McCormick, PI, (937) 885-9767, william.mccormick@wright.edu
GITAM Technologies, Inc., Dayton, OH
Contract FA8650-08-C-1320
10/25/2007 to 2/28/2010
Award Amount: $750,000

The primary goal of this effort is to develop advanced Hyperspectral Image (HSI) data and algorithms for early detection of plant degradation due to Chemical/Biological agents. During Phase I, proof-of-concept demonstrated that HSI algorithms are capable of detecting de-greening in arabidopsis plants infused with covert de-greening circuits. In Phase II, the major objectives are: (1) Extend genetic engineering towards more operational viability, i.e., subject larger and mature plants to a wider range of chemical and biological agents, (2) Develop advanced Detection/Classification algorithms: multiple-hypothesis detect/ID for multiple plant specimens affected by different chem-bio agents, signature-based temporal change/anomaly detection, kernelization of linear algorithms to account for nonlinearities, ICA-based unmixing of HSI data, genetic algorithm for automated feature extraction, (3) HSI aided Triage resource management for distinguishing live and deceased dismounts in urban calamity region using HSI thermal-IR bands, and (4) Generation of and experimentation with synthetic remote sensing data and analytical prediction models: Incorporate healthy/de-greened plant and human skin spectral reflectance/emissivity signatures within FASSP/DIRSIG modeling environment, add atmospheric/illumination/sensor effects to generate synthetic electro-optical imagery that an airborne sensor might observe from a distance, apply appropriate detect/ID algorithms on the synthetic images, and perform model based sensitivity analysis to explore detection bounds. [Another potential application: phytoremediation monitoring]

In-Line Toxicity Monitoring System (Army 2008 SBIR Phase 2)
Naibing Ma, PI, (310) 320-3088, EOSProposals@poc.com
Physical Optics Corp., Torrance, CA
Contract W56HZV-09-C-0058
12/5/2008 to 12/31/2010
Award Amount: $729,989

Physical Optics Corporation (POC) proposes to continue developing the In-Line TOxicity MOnitoring (TOMO) system to meet the U.S. Army need for an in-line continuous water toxicity monitoring system to maintain the integrity of the 92W tactical water purification system. Based on successful development and testing of a Phase I TOMO prototype, POC proposes in Phase II to develop an easy-to-use, reliable, and sensitive in-line continuous water toxicity monitoring system capable of detecting multiple nerve agents and their hydrolysis products while meeting the required detection level (0.004 mg/L) at low false alarm rate (<5%) and low cost (< $4000 per unit). TOMO is based on the use of AChE reversible inhibitor immobilized on gold electrodes of polymer micromembrane capacitive sensor array and detection of surface stress-induced capacitance change. The capability and feasibility of TOMO was successfully demonstrated in Phase I; POC modeled and simulated the sensor performance and fabricated and tested a sensor chip with three military exposure guideline (MEG) chemicals. Phase II efforts will focus on optimizing the TOMO design, fabricating and testing a prototype capable of detecting multiple nerve agents in water with required detection limit. The Phase II prototype will operate continuously in-line, generating results every five minutes.

Lightweight, Compact Atmospheric Gas Sensor (DoD SOCOM 2008 SBIR Phase 1)
Brent Marquis, PI, (207) 866-0100, bmarquis@srdcorp.com
Sensor Research & Development Corp., Orono, ME
Contract H92222-08-P-0016
5/6/2008 to 11/6/2008
Award Amount: $100,000

SRD will develop a miniaturized atmospheric gas sensor array and design a gas analyzer (sensor analyzer module, SAM) capable of accurately detecting and autonomously monitoring critical atmospheric gases in enclosed spaces. In this Phase I effort, SRD will use its current, existing technology (miniaturized sensor platform, proprietary SMO sensor coatings and advanced signal processing algorithms) and make appropriate engineering modifications to meet the environmental background challenges specified by the solicitation. O2, CO2, CO, and TCA will be detected and identified in real-time, in a continuous monitoring mode at pressures ranging from 1 to 6 ATM, temperatures of 32 to 105 degrees F, and a wide range of humidity. The low power requirement of the sensor array and supporting electronics will lead to rapid development of a lightweight, portable, waterproof atmospheric SAM, suitable for environmental monitoring and atmospheric control applications aboard small submersible vessels, within piping systems or adapted for use in atmospheric monitoring and control of UBAs. The portable gas analyzer will be used as an autonomous real-time gas monitor with the option of linking multiple analyzers together with wireless communication to create a distributed environmental gas monitoring network.

Lightweight, Compact Atmospheric Gas Sensor (DoD SOCOM 2008 SBIR Phase 1)
Debra J. Deininger, PI, (720) 494-8401, ddeininger@synkera.com
Synkera Technologies, Inc., Longmont, CO
Contract H92222-08-P-0018
5/5/2008 to 11/5/2008
Award Amount: $100,000

The objective of the SBIR project is to develop a lightweight and compact atmospheric and trace gas sensors that can be safely used within the Scope of Certification boundary to provide real-time monitoring of CO2, O2 and trace contaminant levels in manned compartments or within piping systems onboard submersibles. Synkera has extensive experience at development of sensor technologies for industrial health and safety, air quality and process control applications. Synkera proposes to adapt its family of sensor technologies based upon chemiresistive, electrochemical and acoustic mechanisms to meet the needs identified in SOCOM topic 08-005. Synkera's toxic gas sensors have been shown to detect ppb levels of a wide range of atmospheric contaminants, and are robust and reliable. The proposed analyzer will utilize sensors based upon advances in materials chemistry, nanotechnology and ceramic micromachining to exceed the performance available from state of the art commercial devices.

MEMS Enhanced Laser Spectrometer for Ultra-Sensitive Toxic Chemical Detection (Army 2008 SBIR Phase 2)
E. Robert Schildkraut, PI, (508) 480-9643, bob.schildkraut@blockeng.com
Block MEMS LLC, Marlborough, MA
Contract W911SR-09-C-0015
12/22/2008 to 12/22/2010
Award Amount: $729,436

The Joint Services is seeking a miniaturized, low cost sensor for detection and identification of chemical warfare agents (CWAs) and toxic industrial chemicals (TICs). To meet this requirement, Block MEMS has successfully completed a Phase I effort to develop a widely tunable MEMS enhanced quantum cascade laser (QCL) spectrometer called LaserChem(tm). LaserChem(tm) will have sensitivity in the parts per trillion, be under 1800 cubic cm in size, have very low false alarms (due to its use of absorption spectroscopy in the "fingerprint" 8-12micron spectral region and its 0.5 wave number resolution), and should cost under $3,000. In Phase I Block achieved >30% of QCL tuning. This wide tunability will necessitate the use of only 2 laser chips, resulting in a very low cost sensor. The Phase II effort will focus on the development of a second QCL chip to complete coverage of the 10-12 micron region as well as the development of a MEMS constructed Fabry-Perot device to tune the QCLs. The team will develop a bench prototype ready for lab and field testing. Due to its size, cost and specificity, LaserChem(tm) will have broad applicability to military and commercial applications/markets, including the JCAD program, homeland security, analytical instrumentation, process monitoring, safety and medical.

Microfluidic Sensors for In-Line Water Monitoring Applications (Army 2008 SBIR Phase 1)
Ross C. Thomas, PI, (720) 841-7852, rcthomas@syntrotek.com
Syntrotek Corp., Boulder, CO
Contract W56HZV-09-C-0152
11/25/2008 to 5/25/2009
Award Amount: $69,996

The proposed SBIR project addresses the U.S. Army's desire to confirm, on a real-time basis, the quality of drinking water supplies produced by Military tactical water purification systems that are used to ensure the safety of U.S. soldiers. The development/commercialization of new microfluidic sensors, as discussed herein, provides an innovative solution for reliably integrating together a multitude of water quality measurements (i.e., TDS, pH, turbidity, free chlorine residual, temperature, TOC, DO, conductivity, etc.) inside an autonomous, in-line sensor package. For example, microfluidic-based sensors (i.e., MEMs, micro-analytical systems, lab-on-a-chip devices, etc.) have unprecedented commercial potential for enabling new water monitoring breakthroughs for military, government and commercial sector applications. Value-added benefits that make microfluidic sensors commercially attractive include low end-user costs, simple/non-technical deployment capabilities, device ruggedness, fast response times and excellent sensitivity/selectivity to the desired target analytes in the presence of chemical/physical interferences. Phase I research efforts will focus on demonstrating the technical efficacy of the proposed microfluidic sensor technology in relation to commercially available water quality sensors/analyzers, which are presently used to continually (versus periodically) verify the proper operation of water purification systems in real time.

A Miniature RFID Sensor for Biological Warfare Agents (BWAs) Detection (Air Force 2008 STTR Phase 1)
Dr. Pengcheng Lv, PI, (301) 294-4764, plv@i-a-i.com
Intelligent Automation, Inc., Rockville, MD, partnered with Univ. of California, Davis
Contract FA9550-07-C-0097
8/16/2007 to 5/16/2008
Award Amount: $100,000

Intelligent Automation Inc. (IAI) and the University of California at Davis (UC Davis) detail the development of a novel miniature RFID sensor for BWA tracking and identification at a standoff distance. The key innovations of our approach include: a)The design of a planar inverted- F antenna (PIFA) on the RFID chip to receive and transmit RF signal. The compactness, good impedance and radiation performance, and ease of fabrication make PIFA well suited for the current application.; b)The use of a DNA decorated carbon nanotube (CNT) resonator as the chemical sensing element.; c)A compact reader will be implemented with Conventional-Off-The-Shelf (COTS) elements to allow portable applications; and d)The application of similarity measure algorithms to detect minute changes in the detected signal, thus increasing the detection probability and standoff range. Consequently, it is an attainable goal to realize a miniature RFID sensor with a compact and portable reader for long range identification purpose. We expect that the RFID chip will be smaller than 1 cm2, the reader will be manportable, and the total cost of the RFID sensor and the reader will be less than $1K if produced in small volume.

Nanotechnology-Enhanced Sensor for Toxic Industrial Chemicals (DoD DARPA 2008 SBIR Phase 1)
Dr. Dolly Batra, PI, (617) 498-5926, batra.dolly@tiaxllc.com
TIAX LLC, Cambridge, MA
Contract W31P4Q-08-C-0009
2/7/2008 to 9/30/2008
Award Amount: $98,871

Traditionally, concern over warfighter exposure to chemicals has centered on chemical warfare agents (CWAs), due to their acute toxicity and weaponized status. Recently, however, additional concern has arisen regarding toxic industrial chemicals (TICs), which are industrial chemicals that have the potential to cause adverse health effects in people through deliberate or accidental exposure. While they are not as lethal as conventional CWAs, TICs pose a threat to warfighters and civilian populations, simply due to their increased abundance and availability compared to CWAs. We propose to develop reagent-free sensing materials incorporating nanoscale features which will enhance the detection, identification and quantification of various TICs. Interaction between analyte molecules and the nanocomposite sensing material will result in a significant change in measurable properties of the material that can be easily monitored by standard techniques. In Phase I, we will fabricate nanoscale sensing materials, demonstrate their TICs detection capability and illustrate their improved performance brought about by the nanoscale components. The sensing materials will eventually be incorporated into a sensor array (Phase II) which enable the identification and quantification of the TICs.

Nanotechnology-Enhanced Sensor for Toxic Industrial Chemicals (DoD DARPA 2008 SBIR Phase 1)
Dr. Michael Vogt, PI, (256) 713-1220
Streamline Automation, LLC, Huntsville, AL
Contract W31P4Q-08-C-0007
1/31/2008 to 8/22/2008
Award Amount: $98,962

One of the significant challenges with preventing attacks that involve toxic industrial chemicals (TICs) like chlorine, ammonia is that they have genuine civilian uses for water treatment, in refrigeration systems, and others, that makes it impossible to outlaw their sale and possession. In order to address this, Streamline Automation proposes to develop a thin-film voltammetric gas sensor that utilizes nanoscale features to enhance sensitivity to TICs. This will involve doping the sensor materials with catalysts that enhance reactions with specific chemicals of interest through techniques such as ion implantation. The use of thin-film fabrication techniques will enable an array of voltammetric sensing cells to be laid down in a very small area and tailored to the detection of a range of TICs. The Phase 1 effort will focus on demonstrating that a thin-film sensor behaves as expected with the addition of a dopant, and on identifying candidate dopants for several high-hazard TICs.

Novel Nanofluidics-Based Sensor System (DoD DARPA 2008 SBIR Phase 2)
Kapil Pant, PI, (256) 726-4871, tsb@cfdrc.com
CFD Research Corp., Huntsville, Al
Contract W31P4Q-08-C-0358
8/19/2008 to 8/30/2010
Award Amount: $374,903

CDF proposes to develop a nanofluidics-based biosensor system for detection and quantitation of biological threat agents. The proposed system will harness the potential of recently discovered nanofluidic phenomena, not possible in microfluidic/capillary systems, to enhance rapid and sensitive sample preparation and detection. Specifically, we will develop a nanofluidics-based device to separate and concentrate small volumes of genomic sample. This will be coupled to a carbon nanotube-based, electrochemical sensor featuring high sensitivity and specificity along with easy integration and read-out for field deployment purposes. In Phase I, using multi-physics simulations, preliminary concepts for DNA separation and concentration using nanofluidic channels were developed. Designs were fabricated using volume-production friendly standard lithography techniques. Electrokinetic sample injection and separation in these nanochannels was successfully demonstrated. During Phase II, the nanofluidic pre-concentration and separation components will be further developed and tested with a variety of genomic samples. In parallel, we will also develop and characterize a label-free, highly sensitive electrochemical DNA sensor employing a nanocomposite layer of conductive polymers and carbon nano-tubes. The preparation and sensing components will subsequently be integrated, ultimately leading to a compact and portable, nanofluidic-based biological threat agent detector that will consume little power, be ruggedly constructed, use small sample volumes, and be UAVmountable. A multidisciplinary team with proven expertise in micro-/nano-design and fabrication, electrochemical sensing and biology has been assembled.

Portable Time of Flight Mass Spectrometer for Nuclear Forensics (DoD DTRA 2008 SBIR Phase 1)
Robert J. Kline-Schoder, PI, (603) 643-3800, rjk@creare.com
Creare, Inc., Hanover, NH
Contract HDTRA1-08-P-0042
5/19/2008 to 11/18/2008
Award Amount: $99,911

Analysis of nuclear material samples in the field has many advantages over laboratory analysis. Laboratory analyses can be slow, involve increased expense, lead to additional waste generation and disposal problems, and may introduce errors due to sample degradation or mishandling. In situ analysis mitigates all of these problems. The specific aim of this project is the development of a truly portable mass spectrometer for nuclear forensics. Our device will feature greatly reduced size and improved portability over commercially available units by combining proven, miniaturized mass spectrometer, vacuum system, and laser ablation ionization technologies. These technologies will be combined with an easy-to-use package and interface that will enable soldiers-in-the-field to perform analyses in less than a day that today require days to complete due to the need to ship samples from the field to DoE laboratories. The Creare team is extremely well qualified to develop and transition/commercialize this technology. The team is currently collaborating on the development and fielding of a mass spectrometer and vacuum system that will be used to perform in situ mass spectrometry on Mars as part of the 2009 NASA Mars Science Laboratory mission.

Spatially and Spectrally Foveated Imaging Sensor (U.S. Army 2008 SBIR Phase 1)
Jame J. Yang, PI, (305) 235-6928, jyang@new-span.com
New Span Opto-Technology, Inc., Miami, FL
Contract W15QKN-09-C-0025
10/20/2008 to 4/20/2009
Award Amount: $69,998

Wide field-of-view imaging sensors with high spatial and spectral resolution ability have extensive applications in military and commercial fields. Current methodology of employing FLIR or video imaging sensors to search and acquire potential targets is time consuming since the operator must continuously scan the area of interest in a wide view field and zoom in a local area to acquire the target details. The format size of existing imaging arrays cannot support high-resolution imaging and wide field-of-view simultaneously. Furthermore, spectral information is also significant for applications such as spectral discrimination in target identification, camouflage detection, and environmental monitoring. Several prototype hyperspectral systems have been produced, each with its own strengths and weaknesses. There is a demand to develop an electronically controlled spectral- and spatial-foveated multi/hyperspectral sensor that is dynamically programmable to achieve variable spectral/spatial resolution in user defined regions of the image. New Span Opto-Technology Inc. proposes herein a compact optical configuration that is capable of simultaneously providing panoramic monitoring and high spatial and spectral resolution in areas of interest without mechanical scanning to facilitate instant hyperspectral imaging for improved surveillance and identification capability. Phase I will establish the model and demonstrate the feasibility of the proposed architecture.

Speciation, Identification and Quantification of Atmospheric Gases (DoD SOCOM 2008 SBIR Phase 1)
Dr. Sanjay V. Patel, PI, (760) 268-0083, sanjay@seacoastscience.com
Seacoast Science, Inc., Carlsbad, CA
Contract H92222-08-P-0015
5/6/2008 to 11/6/2008
Award Amount: $100,000

Accurate speciation and measurement of the composition of air environments in Navy submersibles is vital to crew safety and health. This proposal focuses on the development of a detection system specifically for collection, speciation, identification and quantification of gas phase chemicals found aboard submersibles. The proposed hybrid sensor system will be approximately 1/10 the size and cost of traditional bench top analytical instruments and will be capable of unmanned sample collection and battery-powered operation without compressed gas. We believe no single chemical detector technology will be able to serve the solicited detection requirements. The proposed system will utilize multiple sensor technologies to meet the requirements of the solicitation, including chemicapacitive, metal-oxide, and electrochemical sensors integrated with a preconcentration/chromatography system; thus combining selectivity from a diverse array of sensors with a miniature sampling system for amplified sensitivity. Specific components include: a vapor collection pump, a gas sampling loop, sample preconcentrator capable of quick heating and in stages, capillary column for separating chemicals released from the preconcentrator, providing selectivity, integrated array of chemical sensors including chemoselective chemicapacitors, chemiresistive metal-oxides, and electrochemical sensors, and integrated touch screen computer.

Super Hardened, EMI and Vibration Immune Chemical Biological FTIR Sensor (U.S. Army 2008 STTR Phase 1)
Dr. Philippe Bado, PI, (734) 528-6330, pbado@translume.com
Translume, Ann Arbor, MI, partnered with Kettering Univ., Flint, MI
Contract W911SR-08-C-0058
7/29/2008 to 1/30/2009
Award Amount: $99,962

The Joint Services have the need for affordable, wide area monitoring, detection and alarm for presence of chemical agents, biological agents and toxic industrial chemical and materials. Infrared spectrometers are known to provide the desired sensitivity and selectivity for the application of interest but they are large, delicate and expensive instruments. Translume has developed techniques and manufacturing expertise to fabricate small, optical analyzers for demanding field-applications. These micro-analyzers are carved from glass monoliths. We will use our unique ability to micromachine fused silica, and to integrate mechanical elements with optical elements in a fused silica monolith to produce a very small, extremely robust, inexpensive, yet sensitive Fourier-transform Infrared spectrometer for chemical/biological detection. Our Fourier-transform (FT)spectrometer is based on a monolithic scanning interferometer with integrated optical position readout. This approach is the most conductive to the successful development of a functioning FT spectrometer prototype within the context of a SBIR program.

Super Hardened, EMI and Vibration Immune Chemical Biological Sensor (U.S. Army 2008 STTR Phase 1)
Dr. Silviu Velicu, PI, (630) 771-0203, svelicu@epir.com
EPIR Technologies, Inc. partnered with Univ. of California, Santa Cruz
Contract W911SR-08-C-0077
9/5/2008 to 3/4/2009
Award Amount: $99,999

For the detection and identification of chemical and biological agents, infrared detectors must discriminate within a narrow spectral band tunable over large portions of the infrared spectrum. Currently, large, complex, power hungry and computationally intensive FTIR systems are used for this purpose. We propose here the integration of HgCdTe infrared emitter and detector technology with MEMS technology, which matches HgCdTe's sensitivity and spectral resolution characteristics with an inexpensive microscale MEMS device immune to vibration and hardened to survive shocks. Initially, an optically pumped HgCdTe microcavity emitter will be coupled with an HgCdTe detector to detect agents with infrared spectral characteristics. In the second step, MEMS technology will be used to tune the emission of the HgCdTe microcavity. In the last step, both the emitter and the detector will be integrated in a monolithic architecture, significantly reducing the complexity and cost of the sensor package. In Phase I, we will design the microcavity and detector components of the sensor. We will also fabricate MWIR fixed cavity emitters and MWIR high operating temperature detectors. The sensors will be used to detect chemical agents and their sensitivity and spectral capabilities will be experimentally measured.

Technology for Detection of Chemicals in Extreme Environmental Conditions (Army SBIR 2008 Phase 2)
Dr. Edward Locke, PI, (757) 431-2260, elocke@morphtec.com
K&M Environmental, Inc., Virginia Beach, VA
Contract W911NF-08-C-0129
9/9/2008 to 9/9/2010
Award Amount: $723,384

In Phase I, K&M Environmental successfully identified chemistries suitable for the development of Chameleon cassettes which are sensitive to the agents of interest and show promise in meeting the robust performance requirements outlined earlier. In Phase II, Morphix will formulate these chemistries into sensor layers which will be used to manufacture sensor cassettes which will be validated for use in detecting several high-risk toxic industrial chemicals (TICs). The Phase II effort will involve sensor formulation, cassette manufacture, and product validation. Performance criteria to be validated include package and service-life stability, fresh and saltwater immersion testing, cross interference and field interferent testing, and the sensitive detection of high risk TIC analytes.

Terahertz Intracavity Spectrometer (Army 2008 SBIR Phase 1)
Oliver Edwards, PI, (407) 295-5955, oliver@zyberwear.com
Zyberwear, Inc., Ocoee, FL
Contract W911NF-09-C-0015
11/6/2008 to 5/5/2009
Award Amount: $70,000

This SBIR Phase I project will develop a hand-held sensing and alarm system for ultra-trace concentrations of chemical gases, biological aerosols, and explosive vapors. Unprecedented sensitivity will be achieved by differential intracavity laser absorption spectroscopy (ICLAS) which provides up to kilometer effective optical path lengths in a device with centimeter dimensions. Innovations include the use of semiconductor quantum cascade lasers (QCL) that operate in the terahertz region of the electromagnetic spectrum, a region rich in molecular signatures but under-utilized for spectral sensing. The Phase I work plan will experimentally demonstrate ICLAS using THz QCLs for the first time. This demonstration will utilize the relevant low-vapor pressure explosive TNT. In addition, sensitivity limits will be determined for a range of other customer-identified compounds. The Phase I option will produce a detailed design for field-deployable prototype threat sensor to be prototyped in Phase II. A feature of the effort is that feasibility will be supported by original terahertz spectroscopic measurements on threat vapors, many for the first time.

Ultra-Sensitive Portable Biotoxin Sensor (DoD DARPA 2008 STTR Phase 1)
Dr. Elena Komarova, PI, (727) 723-3006, elenka27@hotmail.com
Fractal Systems, Inc., Safety Harbor, FL, partnered with the Univ. of South Florida, Tampa
Contract W31P4Q-08-C-0415
8/18/2008 to 11/5/2009
Award Amount: $99,000

This Phase I STTR project addresses the development of a biotoxin sensor with high sensitivity and specificity based on our preliminary study. We have identified a highly sensitive fluorophore-quencher pair based on a fluorescent molecular wire polymer in order to amplify the detection signal. The conductive fluorescent polymer and the protein substrate specific towards botulinum toxin type B having a pendant quencher group have been successfully synthesized in our laboratory. Field/laboratory application of this assay would require specific detection of the different serotypes of the toxin with high sensitivity. Therefore, the different protein substrates will be modeled and synthesized during this effort, which will be continued in Phase II towards optimization of the assay in a buffer solution and its expansion to a variety of matrices such as milk, human serum spiked with the toxin. We are currently interacting with interested parties in the industry for the purpose of commercializing the technology.

Xenopus Melanophore-Based Toxicity Sensor for Water (Army 2008 STTR Phase 2)
Dr. Kathie Berghorn, PI, (607) 272-0002, kberghorn@agavebio.com
Agave Biosystems, Inc., Austin, TX, partnered with Northwestern Univ., Chicago, IL
Contract W81XWH-07-C-0107
9/28/2008 to 10/29/2010
Award Amount: $750,000

Analysis of water supplies often requires complex instrumentation that is not practical for field use. An innovative alternative is the use of cell-based biosensors that can rapidly assess the general toxicity of the water sample and can be made field-portable. The use of living test organisms is a reliable way of measuring the biological impact or toxicity of unknown samples. Agave BioSystems has successfully demonstrated a broad-ranging water toxicity monitoring system using electrical impedance measurements across endothelial cell monolayers. While this system has proven sensitive to many chemicals of interest, the Army desires to extend detection capability to a broader class of toxicants including neurotoxins. Therefore, in collaboration with Dr. Vladimir Gelfand of Northwestern University and in consultation with Dr. Ethan Lerner of Harvard University, Agave BioSystems proposes to demonstrate that Xenopus melanophores can be used as a powerful field toxicity detection system for a wide variety of waterborne toxicants including neurotoxins.

U.S. Environmental Protection Agency

Development of an In Situ Thermal Extraction Detection System (TEDS) for Rapid, Accurate, Quantitative Analysis of Environmental Pollutants in the Subsurface (EPA 2008 SBIR Phase 1)
John Moore, PI, (401) 767-4360
Ion Signature Technology, Inc., North Smithfield, RI
Contract EPD09025
February 1, 2009 through July 31, 2009
Award Amount: $69,989

Ion Signature Technology, Inc. (IST) will develop and market a collection and analysis system that will retrieve soil-bound pollutants as well as soluble and non-soluble contaminants from groundwater as the probe is pushed by cone penetrometry of Geoprobe into the subsurface. The goal of this project is to detect in real-time the wide range of compounds listed in EPA Method 8260 (VOCs) and 8270 (SVOCs) methods. On one end of a heated transfer line is a variably heated collection port that desorbs/extracts organics and brings them to the surface. On the other end of the heated transfer line is a valve that funnels the sample to photoionization (BTEX, PAH) and electron capture (chlorinated solvents, PCBs, pesticides) detectors or to a gas chromatography/ mass spectrometry detector (GS/MS) to provide quantitative data. When the system is commercialized, it will "sniff" for the presence of pollutants as the probe is advanced into the subsurface at the rate of 2 cm/sec. Once detected, the valve switches to the GC/MS, positive ID is made, and the amount in the sample at known depth is recorded. When real-time and speciated chemical measurements are combined with geological and hydrogeological site data, conceptual models emerge that depict the location and rate of movement of pollution. Moreover, the thermal extraction and detection system (called TEDs) fits squarely into EPA’s mission and importantly, EPA’s TRIAD process because TEDs will deliver data on-site and in real-time. The goal is to provide data to better manage site investigations and cleanup. TPS has shown that when projects employ the TRIAD process, which encompasses systematic planning, dynamic work strategies, and real-time measurement systems, remediation costs are reduced.

Low Cost Imager for Pollutant Gas Leak Detection (EPA 2009 SBIR Phase 2)
Lawrence H. Domash, PI, 978-694-1006, LDomash@agiltron.com
Agiltron Inc., Woburn, MA
Contract EPD09041
March 1, 2009 through February 28, 2011
Award Amount: $344,910

An inexpensive imaging Instrument to quickly locate leaks of methane and other greenhouse and VOC gases would reduce the cost and effort expended by industry to comply with EPA regulations. In Phase I, of this WBIR program, a new gas leak visualization camera was demonstrated using Agiltron's infrared image sensor, which our company has under advance development and expects to manufacture in large volumes at much lower cost than any existing technology. In Phase I, using methane as an example target gas, we were able to detect leaks on the order of 10SCFH with only ambient IR illumination, by using our sensor together with proprietary methods of optical filtering and image processing. Building on this proof of principle, the Phase II prototype will be 10X more sensitive and entirely free of false alarms. The final product will be smaller, lighter, and much less expensive than any competing system, about $2,000 end user cost compared to $70-100K for currently available solutions. This will enable wide distribution in industries such as refineries and pipelines and for local businesses, including natural gas maintenance, supermarkets, and automotive and HVAC repair shops. In addition to methane, a wide variety of gases with absorption bands in the 6-12 um IR range can be detected including SF6 and refrigerants, supporting compliance with EPA regulations for VOC and greenhouse gases. The unit is switched in sensitivity from one gas to another with a user-changeable filter. In Phase II Agiltron proposes to develop and test a prototype methane product which will incorporate sophisticated software algorithms and optimized optical designs to reach higher sensitivities along with ruggedness and ease of use. An LCD display will show an overlay of the gas leak plume with an ordinary visual image, making it easy for relatively untrained personnel to locate leaks very quickly. The performance of the instrument will be verified by a third party laboratory.

Nanostructured Planar Waveguide Device for Molecular Identification of Hazardous Compounds in Water by Evanescent Surface Enhanced Raman Spectroscopy (EPA 2008 SBIR Phase 1)
David J. Costello, PI, (505) 891-0034
Senspex, Inc., Rio Rancho, NM
Contract EPD09033
February 1, 2009 through July 31, 2009
Award Amount: $69,994

Senspex, Inc. proposes to investigate a novel diagnostic tool based upon evanescent field planar waveguide sensing and complementary nanostructured mediated molecular vibration spectroscopy methods for rapid detection and analysis of hazardous biological and chemical targets in water and air. The main characteristic of the proposed approach is the use of evanescent field Surface Enhanced Raman Spectroscopy (SERS) comprising a pathlength-integrated planar waveguide sensor employing a periodic nanoparticle array on a thin film waveguide substrate. The investigators propose to develop designs and fabrication methods for nanostructured planar waveguide mechanisms to produce amplified molecularly specific Raman emission spectral signatures from the sensor. The sensor element will be attached to a Raman identification system previously developed by Senspex to obtain and analyze the spectral output. The technique is expected to result in a robust, reagentless sensor system for continuous sensing and monitoring of hazardous compounds in water. Potential commercial applications of the proposed sensor system for environmental contamination include development of real-time monitoring equipment for hazardous industrial environments; detection of toxic industrial chemical spills in commercial/industrial chemical storage and transport locations; development of the real-time monitor for drinking water contaminants; in situ detection of contamination in agricultural production; and drinking water security monitoring.

Next Generation Sediment Toxicity Testing via DNA Microarrays (EPA 2008 SBIR Phase 1)
Owen Hughes, PI, (530) 758-5804
Eon Research Corporation, Davis, CA
Contract EPD09020
February 1, 2009 through July 31, 2009
Award Amount: $70,000

Development of new methods for testing contaminated sediments is an area of particular concern because many industrial chemical such as pesticides, polycyclic aromatic hydrocarbons, chlorinated hydrocarbons, and heavy metals accumulate in sediments and can pose a significant threat to both human health and the environment. Currently available Toxicity Identification and Evaluation/ Toxicity Reduction Evaluation (TIE/TRE) methodologies for examining sediments are difficult, time consuming, and expensive. DNA microarrays have the potential be a practical technology for identifying, characterizing, and monitoring biologically relevant toxins in complex sediment backgrounds. There are, however, no microarrays for sediment testing organisms. Eon Corp. proposes developing a microarray for one of the most commonly used sediment monitoring organisms, the non-biting midge Chironomul tentants. In Phase I, high-throughput sequencing of a normalized cDNA library will be used to design a 72,000 element oligonucleotide array representing at least 10,000 distinct genes. In Phase II, the feasibility of using these microarrays to identify toxins in TIE/TRE studies will be demonstrated by showing that distinctive signatures for a series of model toxins can be identified when presented within the context of complex sediment backgrounds. By the end of Phase II work, environmental toxicity testing microarrays for sediments will be commercially available.

Ocean Energy Extraction for Sensor Applications (Navy 2008 STTR Phase 1)
Dr. Edward Davis, PI, (808) 442-7030, edavis@trexenterprises.com
TREX Enterprises Corp., San Diego, CA, partnered with the Univ. of Hawaii at Manoa
Contract N00014-08-M-0275
6/30/2008 to 4/29/2009
Award Amount: $69,989

Remote ocean instrumentation often relies on floating buoys with sensors to acquire time series measurements such as ambient noise, acoustic tracking or communications, consuming 100 - 200 Watts of power. The operating lifetime of small remote buoys is limited by batteries (often to 12 - 24 hrs), and recharging is so inconvenient or impractical that many small sonobuoys are designed to scuttle themselves after about a day. The associated cost, as well as the environmental impact of sending large amounts of battery and electronic hardware to the bottom of the ocean is a strong driver for developing renewable ocean power. Trex Enterprises Corp, proposes to develop and demonstrate a simple, low-cost buoy size platform capable of generating power by scavenging energy from ocean waves. The phase 1 prototype will be designed to deliver over 50 Watts of power from moderate (sea state 3) waves, and the phase 2 prototype and ultimate product will develop 100 - 200 W. The basic power generation scheme will rely on a buoyant surface float that moves with the wave motion tethered to a submerged anchor (phase 1) or sea anchor (phase 2 & beyond) that does not move with the waves.

Ocean Energy Extraction for Sensor Applications (Navy 2008 STTR Phase 1)
Jess Sargent, PI, (714) 224-4410, jsargent@sara.com
Scientific Applications & Research Assoc., Cypress, CA, partnered with the Univ. of Texas, Austin
Contract N00014-08-M-0273
6/30/2008 to 4/29/2009
Award Amount: $69,998

We propose to generate electricity for data buoys in a whole new way, leveraging SARA's laboratory-demonstrated and patented liquid-metal magnetohydrodynamic (LMMHD) technology. Phase I will prove feasibility via experiments, analyses, and system-level design of a practical and compact MHD-based wave energy conversion system (MWEC) capable of providing continuously 200 W to buoy onboard sensor and telemetry systems. In previous SBIR work supported by the US Navy (ONR, NSWCCD), we designed and demonstrated both low power (200W) and much higher-power (~100kW) LMMHD generators in the lab. We propose now to develop a small-scale, efficient, economical, and reliable unit for use in sensor buoy applications. In contrast to problematic alternatives employing conventional generators, LMMHD allows us to shift the ocean-wave impedance-matching burden from the mechanical domain, where it is difficult to manage, to the electrical domain, where efficient switching-type upconversion can be applied to great advantage. Our STTR partner, the Center for Electromechanics (CEM) at the University of Texas, Austin, will provide key support in this area. The proposed R&D will lead to a hermetically-sealed and nearly maintenance-free LMMHD generator and upconversion unit, to be placed between the buoy and its underwater mooring cable, thus making retrofitting an existing buoy straightforward.

Ocean Energy Extraction for Sensor Applications (Navy 2008 STTR Phase 1)
William Serstad, PI, (260) 312-4705, bill.serstad@verizon.net
Lewtech Co., Inc., Fort Wayne, IN, partnered with the Univ. of Miami
Contract N00014-08-M-0274
6/30/2008 to 4/29/2009
Award Amount: $69,893

Energy extraction is needed for various ocean deployed devices. Extracted energy can be expected to be at various levels and intermittent, but plentiful. The Phase I effort will recommend an extraction technique that directly converts ocean energy into electrical power. The extractor will be inherently self-starting, require no external inputs from the crew when deployed and produces enough power to provide buoy operational life for long periods. For extracting energy from the environment some of the possible inputs may be wind, wave motion, water current, solar, etc. For this program a scalable, energy extraction technique was selected that could work on various ocean deployed buoy types. The approach will use ocean modeling to determine achievable electrical power from various ocean conditions. The candidate system will trade-off representative buoy sizes from “A” size to large data buoy sizes, in both a moored and free-floating configuration, to determine the associated electrical power extraction capability. Various hardware parameters will be evaluated and modeled to optimize the power extracted during the Phase I study. The proposed approach will not be affected by corrosion, bio-fouling or mechanical degradation for long operational periods in various sea states and will have a low manufacturing cost.

Ocean Energy Extraction for Sensor Applications (Navy 2008 STTR Phase 1)
Dr. Francis Grosz, PI, (985) 643-6444, fgrosz@otiengineering.com
Omni Technologies, Inc., Slidell, LA, partnered with the Univ. of New Orleans
Contract N00014-08-M-0276
6/30/2008 to 4/29/2009
Award Amount: $69,947

This project researches the feasibility of creating a self-powered buoy system. The technology being investigated is a means of efficiently extracting energy from ocean wave dynamics. The mechanics of ocean waves is such that they contain significant energy in the water motion and pressure changes. If a portion of that energy could be efficiently extracted, it would easily be sufficient to power the sensor systems of various buoys of interest to both the Navy and commercial interests. The goal is to efficiently extract this energy in a robust and reliable manner without unduly affecting the sensor systems being powered or making the buoy more obtrusive than it would otherwise be. Doing this will require attention not only to the mechanical system but the ability to deploy and retrieve the buoy, the ability of the buoy to survive in the ocean environment, the capacity to operate in a wide range of different sea states and to store energy for times when the wave dynamics do not generate sufficient power to meet the requirement. The power requirement for the current system under investigation is 200 Watts averaged over deployment intervals from a few days to a few weeks.

Ocean Energy Extraction for Sensor Applications (Navy 2008 STTR Phase 1)
Dr. Steven Bastien, PI, (401) 943-1164, StevenB@lab.electrostandards.com
Electro Standards Laboratories, Cranston, RI, partnered with the Univ. of Rhode Island
Contract N00014-08-M-0277
6/30/2008 to 4/29/2008
Award Amount: $69,909

The United States Navy seeks to use buoy systems to increase situational awareness and battle-group integration by enabling power independent data acquisition and distributed sensor networks. Electro Standards Laboratories proposes to meet the requirements with mechanical wave energy extraction accomplished using integrated electrical generators. This work develops, demonstrates, and tests, direct-drive wave-energy conversion concepts. A detailed system model is developed to predict scalability of the proposed system to higher power levels. Form factor constraints are considered and the system is optimized for different deployment strategies. This approach is designed to achieve the goal of inexpensive, compact, efficient and reliable wave energy harvesting.

Online Water Monitoring Utilizing an Automated Microarray Biosensor Instrument (EPA 2008 SBIR Phase 1)
Theresa Trindade, PI, (800) 335-7355, info@contech.com
Constellation Technology Corporation, Largo, FL
Contract EPD09016
February 1, 2009 through July 31, 2009
Award Amount: $70,000

Constellation Technology Corporation (Constellation) proposes the use of an integrated recovery and detection system for online water supply monitoring. The integrated system is designed to efficiently capture and recover pathogens such as bacteria, viruses, parasites, and toxins from water supplies and to detect and identify those pathogens in an automated fashion. Current methods of pathogen detection include laboratory culture and molecular techniques such as PCR. These methods require specialized personnel, sample preparation, and longer time periods to obtain results. Constellation's Automated Concentration System (ACS) has been shown to effectively concentrate large volumes of water. The Advance Array BioSensor (Advance ABS) has been shown to be a sensitive and specific detection system for the assay of a panel of 10 biological agents including Bacillus anthracis, Staphylococcal enterotoxin B (SEB), and the viral stimulant Vaccinia virus. Under Phase I of this project, assays will be developed combining ACS ultrafiltration with Advance ABS immunoassay technology for the detection of E.coli O157:H7, Cryptosporidium parvum, and Hepatitis A virus in large volumes of water within 2 hours. In Phase II, this assay panel will be expanded to include other agents from the U.S. Environmental Protection Agency (EPA) Microbial Contaminant Candidates list to form a test panel of 10 waterborne pathogens of concern. Constellation proposes this method to be a rapid, sensitive, specific, and cost-effective alternative to other methods currently used. It will be a rugged online water monitoring system for drinking water, which will generate minor quantities of waste product (1-2 milliliters per test) than can be easily disposed of with no effect on the environment. This system will be designed to allow for the frequent sampling and routine monitoring of water supply systems.

Reagentless Field-Usable Fixed-Site and Portable Analyzer for Trihalomethane (THM) Concentrations in Drinking Water (EPA 2008 SBIR Phase 1)
Mel Findlay, PI, (510) 794-4296
KWJ Engineering, Inc., Newark, CA
Contract EPD09028
February 1, 2009 through July 31, 2009
Award Amount: $70,000

The overall goal of this project is to develop and demonstrate feasibility of a MEMS (microeletrome systems) sensor-based prototype hardware and a simple analytical method that can measure TTHM at concentrations below the EPA regulated level of 80 ug/L in water. The experimental goal is to design, fabricate, and package a U-MEMS sensor chip with the rare-earth functionalization on it, demonstrate that it is responsive to THM by putting it into a membrane sampled flow path, and record the signal for RHM vs. standard solutions of THM in water. A further goal is to develop a practical design for a prototype instrument that integrates the U-MENS sensor with the passive water samples.

A Sensitive and Affordable Compact Ammonia Monitor (EPA 2009 SBIR Phase 2)
Joanne H. Shorter, PI, 978-663-9500x208, shorter@aerodyne.com
Aerodyne Research Inc., Billerica, MA
Contract EPD09039
March 1, 2009 through February 28, 2011
SBIR Funds: $345,000

In the Phase I program, Aerodyne demonstrated the feasibility of developing a lower cost, highly sensitive compact instrument for autonomous real time monitoring of ammonia. The instrument is based upon Tunable Infrared Laser Differential Absorption Spectroscopy (TILDAS) using Quantum Cascade lasers. We identified two possible cell designs for the instrument: an in-line astigmatic multipass cell design and a second novel cell design using low cost components. We have designed lower cost collection optics and simpler cooling approaches for the laser and detector. The incorporation of these innovations and a novel cell will lead to a lower cost, more commercial air monitoring instrument for ammonia and other important atmospheric tract gases. The objective of the Phase II project is to fabricate and demonstrate a fully functional, affordable, highly sensitive, rapid response, robust and portable instrument for autonomous real time monitoring of ammonia. The instrument will have compact size to fit in a rack mountable box and be capable of long term monitoring. The instrument will use mid-infrared quantum cascade laser absorption to accurately quantify ammonia with a precision of 0.3 parts per billion (ppbv) in a 1-second measurement without cryogens or calibration gases. The reduced cost ammonia monitor will be possible with the development of our novel multipass absorption cell. The cell will allow design of an instrument that is reduced to its optical essentials--little more than a laser, an absorption volume and a detector. The cell will be either an in-line astigmatic cell or a novel proprietary multipass cell based on low cost components. The development of a sensitive, affordable instrument for ammonia detection has wide benefits for atmospheric and environmental research. This novel compact QCL instrument will have extensive commercial applications in areas such as air pollution and air toxics monitoring, regulatory monitoring, breath analysis for medical diagnostics, combustion exhaust research, and plasma diagnostics for semiconductor fabrication.

Water Security Monitoring Using Surface-Enhanced Raman Spectroscopy (EPA 2009 SBIR Phase 2)
Kevin M. Spencer, PI, 781-769-9450, spencer@eiclabs.com
EIC Laboratories Inc., Norwood, MA
Contract EPD09042
March 1, 2009 through February 28, 2011
Award Amount: $344,977

This program will demonstrate a handheld sensor that could also be potentially used in-line. This sensor is based on Surface-enhanced Raman Spectroscopy (SERS); the ability of SERS to detect chemical warfare agents was demonstrated at EIC Laboratories during the Joint

Services Agent Water Monitoring program. In the Phase I program, SERS detection of a wide variety of chemical warfare agent simulants and degradation products as well as several pesticides and other TICs was demonstrated. Unique identification of each analyte was shown and ROC curve analyses were performed on some agent simulants. The ROC curves demonstrate that SERS can detect the analytes of interest with a high degree of sensitivity and selectivity. The highly encouraging Phase I experiments performed showed very few false positives and very few false negatives. The Phase II program will engineer and fabricate a compact, full range high resolution totally automatable SERS spectrograph with sampling accessory for rapid (~60s) field identification and quantification of aqueous toxins. The throughput and stray light rejection abilities of the instrument will be defined as will the precision of the SERS sensors. An expanded library of TICs will be collects and ROC curves generated. The program will culminate with testing against a chemical warfare agent during the ETV option. The Phase I results are extremely encouraging and point to the possibility for a fieldable instrument that can rapidly identify and quantify chemical warfare agent or toxic industrial chemicals that have entered the water supply. Although developed for Homeland Security measures, this sensor can also be used to monitor cleanups of toxic spills or pesticide/fertilizer runoff from nearby farms. The sensor could also be extended to biological contaminations.