

Measurement & Monitoring: 19th Quarterly Literature Update

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3D Behaviour of Contamination in Landfill Sites Using 2D Resistivity/IP Imaging: Case Studies in Portugal

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Environmental Geology, Vol 49 No 7, p 1071-1078, Apr 2006

Resistivity and induced polarization (IP) measurements were used to investigate contamination plumes in the vicinity of two municipal landfills where previous geophysical surveys and groundwater sampling had confirmed the contamination. The use of 2-D resistivity/IP surveys allowed a more accurate spatial model to be obtained. One survey consisted of two profiles with nine Wenner soundings each; the other survey was carried out along two individual lines using a Wenner standard pseudo-section. In both situations, negative IP values were found associated with positive IP values, which is attributed to 2-D or 3-D geometric effects caused by the presence of the conductive plumes. The data were modeled using RES2DINV, a 2D inversion program, and the resulting resistivity and chargeability distributions were displayed as pseudo-sections, thus defining the contamination plumes and the sedimentary structure.

Accelerated Solvent Extraction (ASE) as a Sample Preparation Technique for Polybrominated Diphenylethers (PBDEs) in Environmental Samples

Henderson, S., R. Carlson, and B. Richter, Dionex Corporation, Salt Lake City, UT.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Accelerated solvent extraction is accepted under EPA Method 3545A for the extraction of environmental toxins, such as PCBs, dioxins, PAHs, and pesticides. This technique uses elevated temperature and pressures to achieve analyte extractions from solid or semi-solid matrices in about 15 minutes and with small volumes of solvents. Traditional methods such as Soxhlet have been used to extract samples containing PBDEs. These methods require long periods of time (16 hours) and large volumes of solvent (300 mL). ASE can perform these extractions in short periods of time and with small amounts of solvent. This presentation discusses the use of ASE for the extraction of several environmental matrices for PBDEs including sediments, fish tissue, and human breast milk, with comparisons to traditional methods of extraction.

Ambient Air Toxics in the Houston-Galveston Area with High and Low TRI Emissions:
Monitoring in Three Areas Using Passive Sampling Devices (PSDs)

Stock, T.H., M.T. Morandi, and M. Afshar (Univ. of Texas School of Public Health, Houston);
K.C. Chung (U.S. EPA, Region 6, Dallas, TX).

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005,
Washington, DC. Abstracts.

Intensive spatial monitoring was conducted in the areas surrounding three existing air monitoring stations, i.e., in a high-density Toxics Release Inventory (TRI) area with high mobile source influence, a high-density TRI area with low mobile influence, and a low-density TRI area. Seventy-two-hour samples of volatile organic compounds (VOCs) were collected using the 3M 3500 Organic Vapor Monitors (OVMS). Samples were collected six times, every 24 days over approximately four months. During each of six sampling events, ambient samples were collected outside ten residences in each of the three areas, within a 2-mile radius of the central site, and simultaneously at the state-operated air monitoring site and at the centroid of the census tract in which the monitoring site was located, which totals 36 sampling sites. Field blank and field duplicate samples were also collected for quality assurance and quality control. All OVM samples were extracted and analyzed for 31 target compounds by gas chromatography/mass spectrometry (GC/MS). For the major target VOCs, including BTEX, MTBE, and chlorinated VOCs, the results are compared for the concentration distributions at all houses, the centroid, and the central monitoring station for each of the three study areas. Concentration distributions are also compared among the three study areas.

Analysis of Contaminated Soils and Sediments Using X-Ray Tube and Isotope Source Portable
XRF Instruments

Stupi, L. and D. Mercuro, Niton LLC, Billerica, MA. The 21st Annual Conference on
Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at
Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Niton LLC participated in a U.S. EPA Superfund Innovative Technology Evaluation of
X-ray fluorescence (XRF) technologies for measuring trace elements in soil and sediment in
January 2005. Two handheld field-portable instruments--the XLi 700 Series, equipped with
radioactive isotopes, and the XLt 700 Series, equipped with miniaturized x-ray tube technology--
were used to analyze 326 samples taken from nine locations across the continental United States.
Both analyzers were applied to determine 13 elements--antimony, arsenic, cadmium, chromium,
copper, iron, lead, mercury, nickel, selenium, silver, vanadium, and zinc--at varying
concentrations. Correlation data obtained from both field portable analyzers, as compared to the
reference laboratory, are presented.

Analysis of NDMA by Modified Method 1625 Utilizing Chemical Ionization and Large Volume Injection

McLean, S., J.F. Occhialini, A. Jones, and J. Todaro, Alpha Analytical Labs, Westborough, MA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

This paper presents a robust analytical procedure for N-nitrosodimethylamine based on a modification of EPA Method 1625. It is a GC/MS analysis utilizing isotope-dilution, chemical ionization, and large-volume injection. This technique is capable of reaching low parts per trillion (ppt) reporting limits.

Analysis of PCB Congeners by GC-MS-MS As Compared to Aroclor Analysis

Hamlett, P. and D. Klein, Texas Parks & Wildlife Environmental Contaminants Lab, San Marcos, TX.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Many organizations have historical PCB data that was compiled as Aroclor fractions or even total Aroclors. The Texas Parks & Wildlife Environmental Contaminants Lab has been working on a novel method to revise this semi-quantitative approach. Analytical chemistry works well when specific compounds are measured, but when data are multiplied by some factor and a selected number of analytes are used to represent a larger group, the quantitative analysis becomes less and less accurate. The authors discuss a method to obtain reliable data with acceptable sensitivity by employing the readily available technique of tandem mass spectrometry.

Application of a Wireless Remote Monitoring System on a Landfill Flare Station

Brody, Robyn (Weston Solutions, Inc., Norcross, GA); Harold Jarrett (Omnimetrix, LLC, Norcross, GA); Billy Malone (DeKalb County Government, Decatur, GA).

SWANA's 28th Annual Landfill Gas Symposium, 7-10 March 2005, San Diego, CA. Technical Paper #0501, 33 pp, 2005

The Seminole Road Landfill flare station in DeKalb County, GA, was previously equipped with an automatic telephone dialer system that contacted the operators of the flare via telephone when the flare station shut down, which occurred frequently. During flare station shutdowns, all repairs required a labor-intensive visit to the facility to diagnose the cause of the failure and restart the system. As a result, the County authorized a Remote Terminal Unit (RTU) to be installed to provide real-time remote monitoring, data capture, and alarm notification of 23 separate critical operational parameters measured at the flare station. The flare station is controlled by a programmable logic controller (PLC) for all critical operational parameters, and the RTU is interfaced through the PLC to a variety of existing on-site equipment. The RTU collects data from the PLC as input signals and stores the data, which are then output over a wireless network. The wireless remote system identifies conditions that cause the flare to shut down and instantly notifies the operators of the flare via email and text messaging of the cause of the shutdown when the flare station is down. The wireless remote system also records when values for critical parameters are being reached and instantly notifies

the operators of the flare so the operator can attempt to prevent the flare from shutting down. Access to all monitored flare station data is instantly available through a secure web page on the Internet. The wireless system provides volumes of historical data for all the parameters and it can all be reviewed via the Internet for diagnostics of wellfield and flare performance. Unlike traditional monitoring stations that are hardwired to power and connected to telephone systems, the wireless system with a battery backup remains online when the power is interrupted or when telephone lines are malfunctioning. The Wireless Remote Monitoring of the flare station is more reliable, enhances the ability to maintain compliance, greatly improves the consistency of the operation of the gas collection and control system, and reduces the number of malfunctions that resulted in shut down of the flare station prior to this enhancement.

http://www.westonsolutions.com/about/news_pubs/tech_papers/0501_Brody.pdf

Application of Chromium (VI) Speciation Results for Remedial Alternatives Evaluation

Petura, John C., Applied Environmental Management, Inc., Malvern, PA.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Although quantitatively speciating hexavalent chromium (Cr(VI)) in industrial wastes has been routine practice in the electroplating industry since the late 1960s, reliable quantification of Cr(VI) in solid matrices (e.g., soils, hazardous wastes) has been achieved only since the early 1990s. This quantification technique was developed through characterization and treatment of Cr(VI)-bearing soils, particularly those enriched with chromite ore-processing residue (COPR). A major landmark in quantifying Cr(VI) in solid matrices was promulgation of SW-846 Methods 3060A/7196A (Alkaline Digestion Followed by Colorimetric Determination for Analysis of Cr(VI) in Solid Matrices) in 1997. Acceptance of these methods essentially superseded prior conventional practice for quantitative speciation of Cr(VI) in solid matrices. The approach requires the use of ancillary parameters to determine the oxidizing or reducing state of a sample. Comparative analysis of samples containing COPR using SW-846 Method 6800 (Elemental and Speciated Isotope Dilution Mass Spectrometry) yielded essentially identical results to those obtained by Methods 3060A/7196A; however, Method 6800 has been used by only a limited number of researchers and is not yet available commercially. A regulatory agency has proposed Method 6800 for Cr(VI) analysis as part of a tiered decision hierarchy related to Cr(VI) data use that would reject Cr(VI) data obtained using Methods 3060A/7196A for site characterization and remedial actions. A better understanding of the significant differences in mobility and toxicology between soluble Cr(VI) and stable insoluble Cr(III) has been gained from the results from characterizing thousands of solid matrix (e.g., COPR, soils, debris, various other fill materials) samples. A major focus of treatability testing has been to determine if elevated Cr(VI) could be irreversibly reduced to contemplated soil cleanup criteria levels {~20 mg/kg to ~200 mg/kg), depending upon site-specific risk assessment results. This paper addresses the application of Cr(VI) speciation data collected for site characterization and delineation, as well as the evaluation of treatment alternatives and achievement of Cr(VI) soil cleanup criteria via ex situ or in situ site remediation activities.

Application of Electronic Data Verification With Data Validation to Site Characterization Projects to Maximize Efforts

Zeiner, S.T., R.L. Forman, and D.R. Blye, Environmental Standards, Inc., Valley Forge, PA. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

There is a growing trend to use electronic data verification (EDV) to assess data usability. EDV is an automated process by which the quality assurance/quality control (QA/QC) results supplied in an electronic data deliverable are utilized to assess the usability impact of select QA/QC information and to subsequently apply applicable data qualification codes to the associated investigative sample results. EDV generally evaluates only a subset of the QA/QC that is evaluated during the data validation process. EDV assumes that the reported analytical results and associated QA/QC results are correct as reported by the laboratory. EDV is quicker and less expensive than data validation because EDV is an automated process. Data validation, which must be performed by an experienced chemist, is a process by which the data package deliverable is reviewed relative to the following areas: correctness of the reported analytical results; completeness of the hardcopy data package deliverables to substantiate the reported analytical results; compliance with the associated analytical method and/or site-specific project requirements; and usability of the analytical results. Data validation examines all aspects of the data from sample receipt through data reporting, including the raw data for investigative samples, QA/QC samples, and calibrations. Data validation does not make any assumptions relative to the correctness of the information provided in the hard copy data package deliverable. Data validation requires more time and labor and is therefore more expensive than EDV. This presentation briefly describes the items reviewed during the data validation and EDV processes and provides case studies of large environmental investigations that utilized a combination of EDV and data validation to assess data usability. These case studies provide examples of issues identified in EDV that were not issues when data validation was performed and, conversely, issues not identified in EDV that were issues when data validation was performed. Though using the automated EDV process to evaluate project data is time-efficient and cost-effective, relying on EDV alone can result in increased costs based upon decisions made using incorrect or incomplete information, whereas using data validation and EDV together has proven to be a very powerful combination in understanding site characterization data.

Application of Geochemical Evaluation to Identify Metals Contamination in Soil at Firing Ranges

Myers, Jonathan (Shaw Environmental, Inc., Albuquerque, NM); Karen Thorbjornsen (Shaw Environmental, Inc., Knoxville, TN). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

A geochemical evaluation technique has been successfully applied during firing-range investigations to properly identify the contaminated soil samples. These evaluations are based on established associations of trace elements with specific minerals in the soil matrix. Correlation plots of trace element concentrations versus major element concentrations are constructed to explore these specific associations. For example, lead has a natural affinity to adsorb on the surfaces of manganese oxide minerals, and a positive correlation between lead and manganese concentrations is observed for uncontaminated samples. Anomalous samples that may contain a component of contamination are readily distinguished from uncontaminated samples by their

elevated lead/manganese ratios. Plots of antimony, copper, or zinc versus lead provide supporting evidence for the contaminant source; in oxic soils, covariance of these metal concentrations is not expected unless contamination is present. These evaluations have been successfully used to delineate the extent of contamination, identify hot spots for removal actions, confirm the success of remediation efforts, and facilitate site closure decisions. The technique utilizes existing analytical data obtained during typical site investigations, and requires only minimal level of effort to perform. The presentation contains examples from several firing-range investigations at military installations across the United States to illustrate the technique's utility in a variety of geological regimes and soil types.

An Approach to the Rapid Control of Oil Spill Bioremediation by Bioluminescent Method of Intracellular ATP Determination

Efremenko, E.N., R.E. Azizov, and A.A. Raeva (Moscow State Univ., Moscow, Russian Federation); V.M. Abbasov (Azerbaijan NAS, Y.H. Mamedaliyev Inst. of Petrochemical Processes, Baku, Azerbaijan); S.D. Varfolomeyev (Moscow State Univ.).

International Biodeterioration & Biodegradation, Vol 56 No 2, p 94-100, Sep 2005

The bioluminescence method of intracellular ATP determination was used in enumerating hydrocarbon-oxidizing bacteria in soil containing various concentrations of oil and cells. Investigation of the growth kinetics of *Rhodococcus ruber* and *Pseudomonas putida* in the oil-contaminated soil indicated that the specific growth rate depended on the initial pollutant concentration. The results of the bioluminescence method correlated with levels of oil biodegradation determined gravimetrically. In estimating the presence of indigenous microbiota in oil-contaminated oilfield soil samples, the total ATP level detected showed an inverse negative relationship with oil concentration in the sample. These results suggest that the bioluminescence method of intracellular ATP determination could be widely used to estimate the efficacy of application of hydrocarbon-oxidizing bacteria for bioremediation.

Assessing Sites for the Presence of Pesticides and Polychlorinated Biphenyls Using Passive Soil Gas Sampling

Whetzel, J.E., W.L. Gore and Associates, Inc., Elkton, MD.

The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Volatile organic compounds (VOCs) generally have boiling points below 200 degrees C and vapor pressures greater than 1mm Hg. These compounds are amenable to detection in soil gas using both active and passive sampling methods, whereas site assessment of semi-volatile organic compounds (SVOCs) using soil gas is limited to time integrated passive collection techniques. The range of SVOC compounds detectable by passive soil gas is highly dependent on the design of the collector because of their low volatility/low availability in the soil gas. The design must employ materials that do not impede vapor migration, but still provide protection of adsorbent materials from liquid water and soil particles. Organochlorinated pesticides and polychlorinated biphenyls (PCBs) are typically considered poor candidates for detection in the soil gas by any means; however, an advanced passive soil gas collector has been used successfully on several sites to detect pesticides and/or PCBs in the soil gas. Pesticides and PCB

congeners up to and including DDT and pentachlorobiphenyl have been observed. This presentation discusses the passive soil gas collector design and the survey results from pesticide and PCB site assessment programs.

Assessing the Performance of Thermal Conductive Heating for Remediation of Chlorinated VOCs in Saturated and Unsaturated Settings

LaChance, J.C., R.S. Baker, J.P. Galligan, and J.M. Bierschenk, TerraTherm, Inc., Fitchburg, MA. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

TerraTherm's thermal conduction heating (TCH) technology, also known as in situ thermal desorption (ISTD), was used to remediate three separate source zones contaminated with chlorinated volatile organic compounds (CVOCs) at an active manufacturing facility. Soils within two of the source zones were unsaturated, while soil within the third source zone was saturated with water. The total volume of soil remediated within the three source zones was 10,950 cubic yards. The results indicate that attaining an interwell soil temperature of 210 degrees F, the boiling point of water at the site, was effective in reducing CVOCs from maximum pre-treatment concentrations for trichloroethene (TCE) of 4,130 mg/kg to 0.07 mg/kg (average of 54 samples). The post-treatment sampling results were significantly below the remedial goal for TCE of 1 mg/kg and were achieved following 150 days of soil heating. Effective treatment of the source zones provided the basis for a No Further Action (NFA) letter for soils at the site. To monitor the progress of heating and to ensure that the coolest locations achieved the target temperature, TerraTherm installed temperature monitoring points equipped with thermocouples near thermal wells and at representative centroid locations. Pressure monitoring points were located throughout the thermal well fields to monitor the effectiveness of the vapor control/collection system. According to the results of confirmatory soil sampling, all three source zones achieved the remedial goals for TCE. Though nearly all of the targeted soil volume achieved the boiling point of water, the cleanup was accomplished while boiling off only a small fraction of the water content within the treatment zone. Monitoring of subsurface conditions enabled optimization of the application of TCH/ISTD to address infiltration and heat losses identified during the remediation while achieving the guaranteed project goals.

Assessment of In Situ Biodegradation Potential of MTBE Using ¹³C-Labeled MTBE and BIO-SEP(R) Beads

Busch-Harris, J., K.L. Sublette, K. Roberts, and E. Jennings (Univ. of Tulsa, Tulsa, OK); A. Peacock; D.C. White; G. Davis; W. Holmes; X. Yang. IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

A study was undertaken to demonstrate anaerobic, in situ biodegradation of MTBE and to investigate the responsible microorganisms. Bio-traps containing Bio-Sep(R) beads preloaded with ¹³C-labeled MTBE (16% ¹³C-MTBE and 84% ¹²C-MTBE) were deployed into an MTBE-contaminated aquifer in California and retrieved and analyzed after 30 days. The residual pool of MTBE was extracted and analyzed by GC-MS. MTBE concentrations decreased by 90% and the ¹³C/¹²C-MTBE ratio increased. The CG-cIR-MS analysis of polar lipid fatty acids showed enrichment of one signature fatty acid. These data suggested biological degradation and incorporation of the target compound. The experiment was repeated in an Illinois aquifer, with

modifications. MTBE concentrations were again depleted by 94% and the 13C/12C-MTBE ratio increased significantly in the residual pool of MTBE. Enrichment of microbial fatty acids was documented in 13C-MTBE Bio-traps. The 13C-MTBE Bio-traps baited with sulfate showed a significant increase in 13C enrichment of the same fatty acids.

Assessment of Vapor Intrusion in Homes near the Raymark Superfund Site Using Basement and Sub-Slab Air Samples

DiGiulio, D.C., C.J. Paul, R. Cody, R. Willey, S. Clifford, P. Kahn, and R. Mosley (U.S. EPA); A. Lee and K. Christensen (Xpert Design and Diagnostics, LLC, Stratham, NH). EPA 600-R-05-147, 131 pp, Mar 2006

This report describes the results of an investigation conducted to assist EPA's New England Regional Office in evaluating vapor intrusion in homes and a commercial building near the Raymark Superfund Site in Stratford, Connecticut. Methods were developed to sample sub-slab air and use basement and sub-slab air measurements to evaluate vapor intrusion on a building-by-building basis. Using the methods described in this report, volatile organic compounds detected in basement air due to vapor intrusion could be separated from numerous other halogenated and non-halogenated (e.g., petroleum hydrocarbons) compounds present in basement air.

<http://www.epa.gov/ada/download/reports/600R05147/600R05147.pdf>

Assessment of Vapor Intrusion Risk at Petroleum Release Sites in Minnesota

Burman, S.R. and T. Higgins, Remediation Division, Minnesota Pollution Control Agency, Saint Paul. Geological Society of America 2005 Salt Lake City Annual Meeting, 16-19 October 2005. Abstracts with Programs, Vol 37 No 7, p 392, 2005

In May 2005, the Minnesota Pollution Control Agency (MPCA) released guidance for addressing vapor intrusion into building structures located at or near petroleum release sites in the state. Because methods and techniques for ascertaining vapor intrusion are still evolving, pilot studies at petroleum release sites were necessary to determine the most appropriate and practical methods of investigating and interpreting vapor intrusion prior to introducing state guidance. Phase 1 of the pilot study was completed in 2003, focusing on the basics of soil gas definition and pathway evaluation. Three petroleum release sites were studied, and methodologies for collecting and analyzing soil gas, sub-slab gas, and indoor air samples were tested. The Phase I work showed that petroleum vapors can migrate significantly beyond the extent of the soil and groundwater contamination. Phase 2 was conducted in 2004 at 23 additional petroleum release sites to develop a better understanding of soil gas migration. The work at each of these sites consisted of vertical soil gas profiling and collection of soil for geotechnical parameters. The data collected are also being used to develop a potential vapor migration screening model. Phase 3 was conducted in 2005 at selected Phase 2 sites. The objective is to re-sample soil gas to verify migration as predicted by the draft screening model. Phase 4 will be conducted during winter 2005-2006 to analyze the impact of winter conditions--particularly the capping effect of frozen ground--on soil gas migration and therefore on vapor intrusion risk. In the interim, the results of Phase 1 and Phase 2 were used to develop the new vapor intrusion guidance document, MPCA Guidance Document 4.1a, 'Soil Vapor Intrusion Screening Assessments conducted during Site Investigations,' with mandatory implementation

from May 15, 2005. The impact of this new policy and guidance will be evaluated over the 2005 field season. This experience, along with the results of Phase 3 and Phase 4 of the pilot study will be used to make revisions and release a final guidance prior to the 2006 field season.

Automated Thermal Desorption Methodology Improvements for Environmental Analyses

Tipler, A. and Z. Grosser, PerkinElmer Life and Analytical Sciences, Shelton CT.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

The uses of thermal desorption-GC systems in environmental applications are well established. For industrial hygiene monitoring, volatile organics are trapped on a tube in the breathing range of workers, then desorbed and chromatographed to characterize the amount and type of potential hazardous material exposure. Ozone precursor analysis to evaluate outdoor air in noncompliance areas for volatile organics requires collection and analysis within an hour, thus allowing the modeling of changes in organic concentrations over the course of time to study the impact of troublesome compounds on the production of ground-level ozone. Thermal desorption-GC systems are also used to measure a variety of potentially toxic volatile compounds in air. The systems available for these types of analyses continue to improve. Recent advances have added additional throughput capability and data integrity testing to improve environmental analyses. Sample integrity can be assessed by adding the internal standard prior to collecting the sample. Testing the tube impedance can indicate the quality of data generated in the current desorption and ensure the integrity of the tube for future use. Other improvements in gas flow control, dry purging, and sample recollection improve laboratory productivity. Manifolds are used instead of valves, demonstrating better cleanliness in support of the trend to use mass spectrometry. This presentation discusses recent improvements and the implications for existing and future environmental analyses.

Bacterial Community Composition Determined by Culture-Independent and -Dependent Methods During Propane-Stimulated Bioremediation in Trichloroethene-Contaminated Groundwater

Connon, S.A., A. Tovanabootr, M. Dolan, K. Vergin, S.J. Giovannoni, and L. Semprini, Oregon State Univ., Corvallis.

Environmental Microbiology, Vol 7 No 2, pp 165-178, 2005

An in situ cometabolic air sparging study was carried out at McClellan Air Force Base, Sacramento, CA, in an aquifer contaminated with trichloroethene (TCE) and cis-dichloroethene (cis-DCE). One test zone received 2% propane in air and the other (the control) received only air. During this study, bacterial population shifts were evaluated by length heterogeneity polymerase chain reaction (LH-PCR). The results showed that organisms with a fragment size of 385 bp were positively correlated with propane removal rates. The 385 bp fragment consisted of up to 83% of the total fragments in the analysis when propane removal rates peaked. The only bacterial species detected with this fragment size in samples of the propane-sparged groundwater consisted of clones of a TM7 division bacterium. Both propane removal rates and the 385 bp LH-PCR fragment decreased as nitrate levels in the groundwater decreased. The dominant cultures acquired from the sparged groundwater were from the *Herbaspirillum*/*Oxalobacter*

clade. The dominant cultures from the air-sparged groundwater were from a novel beta-Proteobacterial clade and named after isolate HTCC333.

http://wrhsrc.oregonstate.edu/semprini/pub_pdfs/envirmicro2005_7.pdf

Bromate/Bromide Speciation by HPLC-ICP-MS

Perrone, P.A., W.M. Reuter, K.R. Neubauer, and Z.A. Grosser, PerkinElmer Life and Analytical Sciences, Shelton CT. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

While ozone can be used effectively to kill bacteria in water purification, ozonolysis can also convert bromide (a natural component of many waters) into bromate, a carcinogen. This means that the need exists to measure bromate in drinking waters, and it must be measured separately from other forms of bromine. Current methods for measuring bromate and bromide involve separating the bromine-containing components by ion chromatography and using ICP-MS as a detector monitoring bromine at m/z 79, as stated in EPA method 321.8. This presentation focuses on bromide/bromate speciation by ion chromatography using dynamic reaction cell (DRC) ICP-MS as the detector. A faster chromatographic method is developed than is presented in the current version of method 321.8, more closely matching the capability of the detector. The bromate signals are stable and repeatable over several days. Possible interferences and the detection limit achievable are discussed.

Case Studies of Innovative Field Technologies Using a Portable GC/MS

Thielen, Carol. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

In a project directed by the U.S. Army Corp of Engineers, a man-portable GC/MS was employed to expedite site investigation of a contaminated airfield. The GC/MS was used to characterize both the vertical and horizontal extent of the contamination, with the results used to determine the appropriate placement of monitoring wells. The investigation revealed an unexpected contaminant in addition the expected contaminants. The use of this on-site technique saved the project 36% of the expended cost. In another case study, GC/MS was used to pinpoint the source of chlorinated solvent contamination around a landfill where the solvents were leaching into a nearby stream and contaminating the water. A third study describes the portable GC/MS in a vapor intrusion application in a home where the resident was suspected of illegally disposing of solvents, based on a preliminary analysis of the area surrounding the home using colorimetric indicator tubes. The GC/MS was deployed to determine the chemicals present in the home and surrounding area.

Case Study: Confirmation of TarGOST Laser-Induced Fluorescence DNAPL Delineation with Soil Boring Data

Okin, M.B. (NiSource, Inc., Columbus, OH); S.M. Carroll (Haley & Aldrich, Inc., East Hartford, CT); W.R. Fisher (Haley & Aldrich, Inc., Portland ME); R. St. Germain (Dakota Technologies, Inc., Fargo, ND). The International Symposium & Exhibition on the Redevelopment of Manufactured Gas Plant Sites (MGP 2006), 4-6 April 2006, Reading, UK. International Society of Technical & Environmental Professionals, Inc. (INSTEP), Tallahassee, FL.

This paper describes the use of the Tar-specific Green Optical Scanning Tool (TarGOST), developed by Dakota Technologies, Inc., to provide a real-time, semi-quantitative, and rapid assessment of the extent of dense nonaqueous phase liquids (DNAPLs) in the subsurface at a former manufactured gas plant (MGP) site in Fort Wayne, IN. TarGOST probing was conducted on land using cone penetrometer technology (CPT) and from a barge on a river using a Geoprobe rig to assess DNAPL impacts. Confirmation of the TarGOST probing results was performed using conventional (sonic drilling and Geoprobe) soil borings and UV fluorescence soil core photography at selected locations. These data agreed well with the TarGOST results. Intervals of high fluorescence observed using TarGOST were confirmed in UV photographs and agreed with visual observations during soil borings. A strong correlation was noted between the presence of NAPL as detected by TarGOST and the presence of sandy layers in the alluvium and glacial till as detected by CPT. Use of TarGOST enabled delineation of source areas where impacts were seen vertically over considerable depths. At locations distant from source areas, TarGOST showed the presence of DNAPL in thin, high-permeability seams sandwiched between lower permeability units. The distinction between source areas (thicker deposits) and distal residuals (very thin stringers) significantly affected the evaluation of the feasibility of remedial options considered for the site. [The Symposium proceedings will appear in a special issue of "Land Contamination and Reclamation."]

Characteristics of Several NIR Tuneable Diode Lasers for Spectroscopic Based Gas Sensing: A Comparison

Weldon, V., D. McInerney, R. Phelan, M. Lynch, and J. Donegan, Univ. of Dublin, Ireland. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, Vol 63 No 5, p 1013-1020, Apr 2006

The authors compare the characteristics of monolithic widely tuneable single frequency lasers, such as sampled grating distributed Bragg reflector laser and modulated grating Y-branch laser diodes, recently developed for optical communications. While some characteristics differ significantly across the range of lasers, each device has a number of useful intrinsic qualities for gas sensing. For example, the modulated grating Y laser and the sampled grating DBR laser have wide quasi-continuous tuneability (30 to 40 nm), display relatively low residual amplitude noise when grating-modulated in a harmonic detection scheme, and are particularly suitable for multi-gas sensing. ECLs are also capable of wide quasi-continuous tuneability (100 nm) but their architecture renders them unsuitable for gas sensing application outside a controlled laboratory environment. DFB devices are the easiest to work with, but their modest tuneability (4 nm maximum by temperature) usually limits their use to single-gas sensing applications.

Characterization of Infiltration Rates from Landfills: Supporting Groundwater Modeling Efforts
Moo-Young, H. (Lehigh Univ., Bethlehem, PA); B. Johnson, A. Johnson, and D. Carson (U.S. EPA); C. Lew, S. Liu, and K. Hancocks (Tetra Tech, Inc., Lafayette, CA).

Environmental Monitoring and Assessment, Vol 96 Nos 1-3, p 283-311, Aug-Sep 2004

This paper presents a review of the literature to characterize infiltration rates from landfill liners to support groundwater modeling efforts. Studies were sought that describe the performance of liners 'as installed' or 'as operated,' and information was found for 149 sites with compacted clay liners (CCLs) and for one site for a geosynthetic clay liner (GCL). The leakage rate through geomembrane liners and composite liners is reviewed for 259 sites. Because only 9 sites actually reported infiltration rates for CCLs, it was difficult to develop a national distribution. The field hydraulic conductivities for natural clay liners range from 1×10^{-9} cm/s to 1×10^{-4} cm/s, with an average of 6.5×10^{-8} cm/s. There was limited information on the geosynthetic clay liner. For composite lined and geomembrane systems, the leak detection system flow rates were utilized. The average monthly flow rate for composite liners ranged from 0 to 32 lphd for geomembrane and GCL systems to 0 to 1410 lphd for geomembrane and CCL systems. The increased infiltration for the geomembrane and CCL system may be attributed to consolidation water from the clay.

Chemical Field Screening for Real Time Decision Making During Remedial Investigations
Craigie, K. and L. Horzempa (Tetra Tech EC, Boston, MA); S. Clifford (U.S. EPA Region I, New England Regional Laboratory, North Chelmsford, MA). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

An integrated multi-analyte field screening and off-site analytical program was developed to drive field decision-making and chemical characterization at a relatively complex 30-acre Superfund site, an old industrial ash and cinder landfill that has been redeveloped into a mixed residential and commercial neighborhood. The presence of dissimilar classes of chemical contaminants--metals, PAHs, and PCBs--presented chemical characterization challenges and precluded the use of a single field screening methodology. Under the field program, over 110 soil samples were successfully screened for multiple metals (XRF), PAHs (immunoassay), and PCBs (GC) by one chemist within six working days. The field screening program helped to provide a clear and concise decision process for off-site analysis that would effectively address multiple federal and state regulatory requirements and associated risk assessment needs. The decision process was developed to utilize all the field analytical data to determine an appropriate selection of samples for off-site analysis. Overall, the screening results demonstrated good correlation with off-site analytical results. The integrated analytical program successfully provided a comprehensive yet cost-effective data set that facilitated an effective three-dimensional chemical characterization of the large site, supported by a core database of appropriate quality.

Chemical Sensor Design for Nitroaromatics Using Integrated Optical Waveguide Platforms

Linman, Matthew J. and Paul L. Edmiston, College of Wooster, Wooster, OH.

229th ACS National Meeting, 13-17 March 2005, San Diego, CA. American Chemical Society Division of Chemical Education: Abstracts, No 294.

A chemical sensor for nitroaromatics has been created based on planar integrated optical waveguides. Target molecules are adsorbed into a porous sol-gel adlayer by introducing nitroaromatic solutions across the sensing matrix. Sol-gel sensing layers are deposited on waveguides supported on a glass substrate via dip-coating. A laser beam is prism-coupled into the waveguide, where it is totally internally reflected. Attenuation of the beam by the sensing film is measured by out-coupling. Detection of nitroaromatics was accomplished by either incorporating solvatochromic dyes or basic molecules within the sol-gel sensing matrix to create attenuation of light at the wavelength of interest. Various nitroaromatic solutions have already been tested using this sensor design. Preliminary evidence suggests response times of less than 5 seconds and limits of detection near 5 to 10 ppm.

Chromium(III) Oxidation in Chromite Ore Processing Residue-Enriched Soils: Theoretical Predictions and Experimental Observations

James, Bruce R. (Univ. of Maryland, College Park); Rock J. Vitale (Environmental Standards, Inc., Valley Forge, PA). NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

The oxidation of Cr(III) to Cr(VI) in field-moist soils can theoretically occur using Mn(III, IV)(hydr)oxides as the oxidant. Uncertainties surrounding whether or not this redox reaction may occur in chromite ore processing residue (COPR)-enriched soils have complicated decision-making on the analysis, remediation, and regulation of these alkaline soils, which contain both Cr(III) and Cr(VI). In alkaline (pH 8-13), aerobic COPR-enriched soils, Cr(III) has been shown to be inert toward oxidation to Cr(VI), and Cr(VI) has also been shown to be inert toward reduction under unremediated field conditions. During the hot alkaline extraction used to dissolve sparingly-soluble and soluble forms of Cr(VI) from COPR-enriched soils (USEPA SW-846 Method 3060A), residual chromite, Cr₂O₃, and other COPR-borne forms of Cr(III) are not prone to oxidation, especially with Mg²⁺ added as a suppressant. In COPR soils in which remediation-by-reduction methods have been used to convert Cr(VI) to Cr(III), questions have been raised as to whether such newly-reduced, precipitated Cr(III) might re-oxidize in the future by O₂ or Mn(III or IV). Lab and field studies have failed to show that such a re-oxidation reaction occurs, presumably due to the recalcitrant nature of insoluble complexes of Cr(III) with OH⁻ or the oxidized forms of the reducing agents used for remediation. A knowledge of the redox soil chemistry of Cr is essential for predicting accurately the extent to which a given form and concentration of Cr(III) might oxidize in a COPR-enriched soil. Thermodynamic predictions, kinetic experiments, and site-specific observations and field trials provide evidence that COPR-borne forms of Cr(III) are not expected to oxidize to Cr(VI) under alkaline, aerobic field conditions.

Comparison of Field-Observed and Model-Predicted Plume Trends at Fuel-Contaminated Sites: Implications for Natural Attenuation Rates

Jeong, S.W., D.H. Kampbell, Y.J. An, and B.M. Henry, Kunsan National Univ., Kunsan, Korea. Journal of Environmental Monitoring, Vol 7 No 11, p 1099-1104, Nov 2005

Monitoring data were used to evaluate the effectiveness of natural attenuation at reducing contaminant concentrations in groundwater at seven fuel-contaminated sites and compared to previously executed modeling of NA processes at these sites to empirically assess the accuracy of some fundamental model input parameters and assumptions. Most of the models developed for the study sites tended to overestimate plume migration distance, source persistence, and/or the time required for the BTEX plumes to attenuate. Discrepancies between observed and predicted contaminant trends and plume behavior suggested that the influence of the natural attenuation process may not have been accurately simulated. The conservatism of model simulations may be attributed to underestimation of natural source weathering rates, overestimation of the mass of contaminant present in the source area, and/or use of overly conservative first-order solute decay rates.

Comparison of Techniques for Studying Sediment Desorption Kinetics of Hydrophobic Pollutants

Dunnivant, F.M., S. Saalfield, M. Murray, K. Taylor, and J. Wnuk, Whitman College, Walla Walla, WA. 228th American Chemical Society Meeting, 23 August 2004, Philadelphia, PA. Abstracts of Papers of the American Chemical Society, Vol 228, p U552, 2004

The desorption of pollutants from resuspended aquatic sediments is an important source of pollutants to many ecosystems. This presentation compares the desorption results from two commonly used techniques, the traditional gaseous purge technique and the relatively new vial mixing approach. Results indicate that the vial mixing approach is far superior to the gaseous purge technique. Labile desorption rates and percent of pollutant in the labile versus nonlabile phases are comparable between the two techniques; however, the nonlabile desorption rates are consistently slower in the vial method (about two orders of magnitude slower), which has significant impacts on how long sediment suspensions must be equilibrated prior to study, as well as the environmental availability of pollutants. The vial method has the advantages of a less costly apparatus, less required maintenance, fewer sources of contamination, and more realistic mixing conditions.

Computer Tomography Imaging of Non-Aqueous Phase Liquids in Porous Media

Subhasis Ghoshal and Sormeh Kashaf Haghighi, Department of Civil Engineering, McGill Univ. 2005 AEESP Research and Education Conference, 23-27 July 2005, Clarkson University, New York.

Obtaining accurate, three-dimensional, and non-destructive NAPL characterization in site soil cores is feasible using X-ray computed tomography (CT) scanning. An experimental technique was developed to non-destructively visualize and quantify NAPL volumes and saturation levels in natural soil columns using a medical X-ray CT scanner. NAPL-contaminated soil columns were CT-scanned to determine how freezing and freeze/thaw conditions, commonly encountered in cold climates, influence the morphology, displacement, and migration of petroleum oils in subsurface soils. Temperature changes that cause freezing and thawing of soil

moisture can result in the alteration of the soil meso-pore structure, development of thermal stress cracks in the soil, and changes to the physico-chemical properties of the oil phase. These factors can potentially alter the distribution of immobile oil phases and consequently change rates of mass flux of petroleum hydrocarbons from the spill (source) zone by volatilization, dissolution and biodegradation. The X-ray CT data were analyzed by an image subtraction technique to obtain 3-D arrays of soil porosity, NAPL saturation, and NAPL volume at a spatial resolution of approximately 0.7 mm in the scan plane. The computed NAPL saturation can be graphically represented as 3-D images of NAPLs in porous medium. The image subtraction technique involves repeated CT scanning of the soil column, saturated individually with each fluid phase in saturation in the porous media, as well as the column containing the sample with various fluid phases (air, water, NAPL) in the porous medium. The methodology was validated by imaging columns packed with various porous media and flushed with known quantities of gasoline or tetrachloroethene (PCE). X-ray CT-derived NAPL volume is subject to errors ranging from 3 to 16%, mainly due to instrument noise. Gasoline is subject to a higher measurement error than PCE because of its lower contrast (i.e., difference) in CT number with respect to pure water.

Continuous Multi-Parameter Water Quality Monitor: Man-Tech Associates Inc., TitraSip(TM) SA System. Environmental Technology Verification Report
James, R., A. Dindal, Z. Willenberg, and K. Riggs, Battelle, Columbus, OH.
U.S. EPA, Environmental Technology Verification Program, 52 pp, Oct 2005

The TitraSip(TM) SA (stand-alone) is designed for multi-parameter water-quality testing. The system used for the verification test analyzed pH (following EPA Method 150.1, including calibration buffers with pHs of 4, 7, and 10), conductivity (following Standard Method [SM] 2510), total alkalinity (following SM 2320B), total chlorine (following SM 4500-Cl B, with a potentiometric rather than a color, endpoint), temperature (following EPA Method 170.1), and turbidity (following SM 2130B). Additional water quality parameters and modules (i.e., autosampler) can be added. TitraSip(TM) collects a sample from a free-flowing source (e.g., overflow cup) into the TitraSip(TM) Analysis Vessel and automatically completes analysis cycles at set time intervals (in this case, once every 30 minutes) to complete the analysis for all six water quality parameters without user intervention. The system consists of a personal computer, software, interface, burets, turbidity module, pump/valve system for adding calibrants and standards, electrodes, overflow sample cup, and TitraSip(TM) Analysis Vessel. The system used for this verification test was positioned on a tabletop equipped with shelving for the sampling and analysis equipment. The total system was 30 in high and 36 in wide, excluding the personal computer. Data are automatically collected at the conclusion of each cycle of sample analysis. The PC-Titrate software controls all aspects of TitraSip(TM) operation. Data can be viewed directly on the personal computer as they are acquired or exported as a database or spreadsheet file. The cost of the TitraSip(TM) used for the verification test was approximately \$30,000, with additional approximate costs for the calibration reagents of \$220 per month, preventive maintenance costs of \$2,797 (parts only) per year, and electrode replacement costs of \$1,220 per year, assuming that new electrodes are needed every six months.
Report at <http://www.epa.gov/etv/pdfs/vrvs/600etv06007/600etv06007.pdf>

Current Passive Diffusion Sampling Devices and Their Performance with Selected Target Analytes

O'Neill, Dee, Columbia Analytical Services, Kelso, WA. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Passive diffusion sampler (PDS) technology has been applied to many sites to improve the information gained during monitoring and to reduce the cost of sampling. Wide acceptance of these samplers has been gained for hydrophobic volatile organic compounds (VOCs) using the polyethylene bag technique, with hundreds of studies demonstrating their effectiveness. Studies are underway to identify additional materials that would enable PDS monitoring for hydrophilic organics, semivolatile organics, and inorganic target analytes. Progress is discussed in the development of the following sampling options: polyethylene diffusion bag sampler (PDBS), nylon-screen diffusion sampler (NSDS), rigid porous polyethylene samplers (RPPS), dialysis membrane diffusion sampler (DMDS), polyethylene vapor diffusion sampler (PVDS), and the semi-permeable membrane device (SPMD). Efforts with the U.S. Geological Survey to develop passive diffusion samplers for common long-term monitoring inorganic and organic parameters include both laboratory and field demonstration studies. Recent data are presented to demonstrate the performance and feasibility of these materials in prototype sampler designs.

Delineation of a Petroleum Release Using the Soil Conductivity/Membrane Interface Probe Lamb, Roger, Maxim Technologies, Kansas City, KS.

IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

The delineation of the thickness, areal extent, and chemistry of a petroleum release in the subsurface was undertaken using the Geoprobe(R) Soil Conductivity Membrane Interface Probe (SC/MIP)/Sorbent Trap/GC system. This system allows for the detection of petroleum and the measurement of soil electrical conductivity in the subsurface at increments of 0.05 feet, as well as the speciation of the petroleum constituents collected with the membrane interface probe. The SC/MIP system has proved to be a very cost-effective and rapid screening tool at many petroleum release sites. The SC/MIP data collected provide a general indication of the subsurface hydrogeologic properties, a qualitative indication of the petroleum concentrations, and a very good definition of the horizontal and vertical extent and migration pathways of the petroleum release. This information can be used to guide the design of remediation programs and the placement of soil borings and/or monitor/remediation wells. The investigation included the advancement of 20 SC/MIP soundings to depths ranging from 7.5 to 39.25 feet and the collection of roughly 10,000 PID and soil electrical conductivity measurements.

Delineation of Chlorinated Solvent DNAPL and the Associated Groundwater Plume with MIP Screening

Linton, P. James, Alex Nadolishny, and John C. Alonso, Blasland, Bouck & Lee, Inc.

The 13th Annual West Coast Conference on Soils, Sediments and Water, 17-20 March 2003, San Diego, California. Abstracts. The Association for Environmental Health and Sciences, Amherst, MA.

The membrane interface probe (MIP) is a rapid, high-resolution, in situ volatile organic compound (VOC) screening technology that provides real-time data about relative VOC

concentrations and soil lithology. The technology has been used to delineate and characterize dense nonaqueous phase liquid (DNAPL), demonstrating good correlation with analytical results and providing significant cost savings by providing useful information for the optimization of a groundwater sampling program. This paper presents the results of an extensive MIP survey and conventional sampling conducted to delineate potential chlorinated VOC DNAPL and the associated groundwater plume beneath a former electronic components manufacturing facility in Florida. MIP and analytical results correlated well. The MIP provided a precise delineation of potential DNAPL areas and general contaminant distribution, as well as lithologic data that enabled the determination of topography of the underlying clay and other zones of reduced permeability that could inhibit vertical migration of the DNAPL. The delineation precision (0.25 foot) of contaminant distribution and lithology with the MIP provided exceptionally useful data, selection of optimum sampling intervals, and evaluation of alternatives for a focused source remediation.

Design and Development of Novel Sensor Materials for Toxic Heavy Metal Detection and Sequestration

Potts, Luke, H. Neil Gray, and Tanya Shtoyko, Univ. of Texas at Tyler.

229th ACS National Meeting, 13-17 March 2005, San Diego, CA. American Chemical Society Division of Chemical Education: Abstracts, No 995.

The authors report recent progress toward the development of new sensors for the detection of heavy metals on surfaces and in solution. Macromolecular sensors have been developed for the detection of lead, mercury, and uranium as components in sensor coating formulations. Their initial success in the development of optical and spectroelectrochemical sensors for heavy metals using gold nanoparticles on glass substrates and indium tin oxide optically transparent electrodes is also discussed.

Detection of a Chemical Warfare Agent Simulant in Various Aerosol Matrixes by Ion Mobility Time-of-Flight Mass Spectrometry

Steiner, W.E., S.J. Klopsch, W.A. English, B.H. Clowers, and H.H. Hill, Washington State Univ., Pullman.

Analytical Chemistry, Vol 77 No 15, p 4792-4799, 1 Aug 2005

A traditional radioactive nickel (Ni-63) beta emission ionization source for ion mobility spectrometry was employed with an atmospheric pressure ion mobility orthogonal reflector time-of-flight mass spectrometer (IM(tof)MS) to detect a chemical warfare agent (CWA) simulant from aerosol samples. Aerosol-phase sampling employed a quartz cyclonic chamber for sample introduction. An overall elevation in arbitrary signal intensity of approximately 1.0 order of magnitude was obtained by the progressive increase of the thermal AP-IMS temperature from 75 to 275 degrees C. A mixture of one G-type nerve simulant (dimethyl methylphosphonate (DMMP)) in four matrices (water, kerosene, gasoline, diesel) was found in each case to be clearly resolved in less than 2.20×10^4 microseconds using the IM(tof)MS instrument.

Determination of Mercury and 22 Other Metals in Hydrocarbon Matrices at Trace Level Concentrations Using a Novel Digestion Method

Hensman, C.E. and D. Cussen, Frontier Geosciences Inc., Seattle, WA.

IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

Though the analytical methods for determining metals at low to sub-ug/L levels are well established, problems can occur with the digestion techniques. A U.S. EPA report showcased the results from three analytical techniques for mercury. Two of these techniques, thermal combustion and chemical digestion, resulted in exemplary results, but these techniques are suitable for mercury analysis only. The thermal technique combusts the oil sample and specifically detects the mercury in the combustion products. The chemical digestion method uses bromine mono-chloride to digest the hydrocarbon matrix and oxidize the mercury, but the resulting total dissolved salts can interfere with mercury detection and render the low-level detection of other metals useless. Frontier Geosciences has developed a digestion technique for hydrocarbons that uses nitric acid and a high-pressure washer to produce a clean sample matrix that can be interrogated by many analytical techniques.

The Development of a MEMS-Based Integrated Wireless Remote Biosensors

Ososanya, Esther T., Mary Pierre, Jeffrey Zulu, Oluwakayode Bamiduro, and Anis Ben Ayed, University of the District of Columbia.

Prepared for the DC Water Resources Research Institute; 26 pp, May 2005

Funded by USGS, a data acquisition system was designed and implemented to continuously acquire and display the myoelectric data for multi-species aquatic animals, and the project has shown that bio-monitoring applications can be used to determine toxicity in estuaries. The research is a collaboration between the departments of electrical engineering, biology, and environmental science at the University of the District of Columbia.

<http://water.usgs.gov/wrri/04grants/Progress%20Completion%20Reports/2004DC56B.pdf>

Development of Improved Detection Systems for Monitoring of Toxic Heavy Metals in Groundwaters and Soils

Valiente, M. and G. Perez, Univ. Autonoma de Barcelona, Spain.

Sustainable Management of Soil and Groundwater in Urban Areas, 2-4 October 2002, University of Mining and Metallurgy, Cracow, Poland. Umweltbundesamt/Federal Environment Agency, Austria. CP-033, p 98-102, 2003

Monitoring land and groundwater contaminated with heavy metals is particularly important both for identification of trends of pollution and to control the efficiency of remediation activities. Monitoring of contaminated lands and waters with toxic heavy metals requires development of novel analytical detection systems for their quantitative determination in matrices of different complexity, including ground waters and soils of different types. The solution to this task requires, in turn the translation of measurements obtained via analytical methods developed for the determination of heavy metals in the laboratory (e.g, based on atomic absorption/emission spectroscopy, X-ray fluorescence, polarographic techniques, etc.) to simple field-portable instruments. The current heavy metal detection systems are generally limited to spectrophotometric chemical test kits. These kits offer the convenience of field analysis but have

several important limitations: speciation is not achieved, only total content is determined; chemical and physical interferences to measured signal can be dramatic; and the kits require a high degree of user competence. The authors describe work to address the development and validation of sensitive and robust sensing devices, including chemical sensors and biosensors and biomimetic systems for on-line operation and real-time measurements of metals present in contaminated soils and surface waters.

http://www.image-train.net/products/papers/CM2_dimdesmotom.pdf

Direct Injection GC Method for Measuring Light Hydrocarbon Emissions from Cooling-Tower Water

Lee, M.M., T.D. Logan, K. Sun, N.S. Hurley Jr., R.A. Swatloski, and S.J. Gluck.

Dow Chemical Company, Freeport, TX

Environmental Science & Technology, Vol 37 No 24, p 5721-5726, 15 Dec 2003

A direct-injection GC method for quantifying low levels of light hydrocarbons (C6 and below) in cooling water is intended to overcome the limitations of the currently available technology. This method uses a stripper column in a GC to strip water from the hydrocarbons prior to entering the separation column. Because the water sample is introduced directly into the GC, no sample preparation is required. Method validation indicates that direct injection GC offers approximately 15 min analysis time with excellent precision and recovery. Calibration studies with ethylene and propylene show that both liquid and gas standards are suitable for routine calibration and calibration verification. The sampling method using zero-headspace traditional VOA (volatile organic analysis) vials, and a sample chiller has also been validated. The sampling method minimizes the potential for losses of light hydrocarbons, and samples can be held at 4 degrees C for up to 7 days with more than 93% recovery. The method also offers <1 ppb (w/v) level method detection limits for ethylene, propylene, and benzene and is superior to the existing El Paso stripper method.

Distinguishing Between Multiple Chlorinated Solvent Plumes: A Comprehensive Approach

Jamall, I.S. and T. Lu (Risk-Based Decisions, Inc., Sacramento, CA); W.A. Huber (Quantitative Decisions, Merion Station, PA). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Using a unique approach to distinguishing between multiple chlorinated volatile organic compound (CVOC) plumes in groundwater, investigators began with the collection of soil gas samples taken just above groundwater in an area extending some 1,000 feet downgradient from a known source area. Chemical fingerprinting of perchlorethene, trichloroethene, and cis- and trans-1,2-dichloroethene in the samples suggested the presence of at least three distinct CVOCs plumes in the groundwater. The sample analysis data were used to target cone penetrometer tests (CPTs) to 30 feet below ground surface to characterize the subsurface stratigraphy. At each CPT location, a grab groundwater sample was also collected and analyzed for CVOCs. The logs of 296 CPT pushes were classified by depth and for sand or clay behavior, and the depths were then converted to elevations above mean sea level using the surface surveyed elevations. A geostatistical analysis was used to create a detailed solid model of the subsurface. The accuracy of the model was quantified and the model used to create fence diagrams and other 3-D images

of the subsurface, revealing the existence of two discrete sand channels connected by a sand bridge at the point where the soil gas fingerprints showed a separation of CVOC plumes. A geologic basis for the presence of different plumes was thus established. Chemical analysis of the grab groundwater samples confirmed the existence of multiple CVOCs plumes and showed that these plumes were separated at specific locations that could be understood by the distinctions in geology and hydrogeology.

Dynamic Metal Speciated Analysis Such as Cr(VI) and Alkylmercury Examined and Applied
Kingston, H.M., M. Rahman, T. Towns, D. Huo, Y. Lu, R. Cain, J. Kern, and R. Powell,
Duquesne Univ., Pittsburgh, PA. NEMC 2005: the 21st Annual National Environmental
Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Elemental speciation is one of the most challenging analytical measurements. Some elemental species undergo conversion or degradation of the species of interest during sampling, storage, and the measurement steps. Until recently, there were no diagnostic tools to trace the fate of species because conventional speciation methods can only measure species concentrations in the final solutions at the time of measurement. Knowing the transformation of the species is critical in the preparation and certification of standard reference materials and for accurate speciated measurements. The European Community through EVISA supports only isotopically traceable solutions as effective diagnostic tools. Speciated isotope dilution mass spectrometry (SIDMS), which addresses the correction for such degradations or conversions and its use in validation are discussed. SIDMS can be used to perform diagnostic analysis isolating specific procedural protocol steps in specific matrices enable their evaluation for species shifting potential. By spiking the sample at each step with enriched stable isotopes of the same species, SIDMS can be used as a diagnostic tool to identify the steps at which the species are altered. As examples, SIDMS has been applied to monitoring the fate of Cr(III) and Cr(VI) in processing samples under EPA method pair 3060A/7196A, which has been used for the quantification of Cr(VI) in solid samples. Method 3060A includes extracting Cr(VI) from samples in an alkaline solution, filtering the extracts, and neutralizing the filtrates. Method 7196A is a colorimetric detection method, using diphenylcarbazide to complex with Cr(VI), which forms a purple product that is usually measured at pH 2. IC and HPLC ICP-MS were used as detection methods in this study. Study results show that classical methods may not be able to detect alteration of the species from difficult matrix samples, and that neutralization and measurement steps can contribute to transformation of species. In specific and difficult matrices, Cr(III) could be oxidized to Cr(VI), and during neutralization, Cr(VI) could be reduced to Cr(III). The degree of species conversion is highly dependent on the sample matrix and the instrument's operating condition.

Emerging and Under Utilized Assessment Technologies for Determining Degradation Rates for In Situ Natural Attenuation Capacity

Raes, E.J. (Engineering and Land Planning Assoc., Inc., Clinton, NJ), K. Sublette, J. Istok, J. Fields, J. Jones, A. Peacock, and G. Davis. IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

In situ degradation rates are typically determined through calculating decreases in chemical concentrations over time from long-term groundwater monitoring programs, which can

be a costly and time-consuming approach. A field study was conducted using existing but underutilized remedial investigative tools to assess the feasibility of applying these techniques to determine degradation rate kinetics more quickly and cheaply than with the conventional approach. The field study was conducted at a petroleum distribution facility in New Jersey, where gasoline and an off-site source of tetrachloroethene (PCE) comingled. The objective was to create a protocol of sequential tests to determine if unamended natural attenuation was a sufficient remedial strategy for the site or if bio-stimulation or bioaugmentation was necessary, and then to quickly and cost-effectively screen these processes to select the remedial strategy with the greatest probability of success for this site. The following techniques were assessed. (1) Bio-Traps(TM) coupled with microbial analyses (PLFA and rPCR-DNA) were used to establish background microbial conditions. This novel, in-well sampling device is often referred to as an in-well microcosm. Bio-films, which rapidly form within the bio-traps, are analyzed for a presence/absence and abundance determination for known microbial groups documented to degrade, in part or fully, the compounds of interest. (2) Bio-Traps(TM) augmented with electron acceptors (oxygen, nitrate and sulfate) were used to determine the target contaminant degradation rates when exposed to these different electron acceptors (biostimulation). (3) A series of single-well, push-pull tests were used to determine in situ kinetics and microbial processes in the same wells. A test solution contained the same electron acceptors (oxygen, nitrate and sulfate) used in the Bio-Trap study in addition to a conservative tracer (bromide) to segregate abiotic and biotic in situ degradation rates of the chemicals of interest over time (short term) when exposed to different biostimulation substrates. Baited with electron acceptors, the Bio-traps were loaded with a ^{13}C -labeled benzene and passive flux meters to quantify mass reduction of the ^{13}C -labeled benzene. This allowed comparison of the biostimulated degradation rates to unamended degradation rates to determine whether natural attenuation could stand alone as a remedy or if bio-stimulation produced significantly better results. The different substrates were screened to identify which one had the highest probability of favorable results for a full-scale implementation. The biodegradation rates from the Bio-trap and push-pull studies were compared for similarities and contrasted with the overall site degradation rates generated from years of groundwater monitoring at the site.

Engineering and Design: Site Characterization and Analysis Penetrometer System (SCAPS)
U.S. Army Corps of Engineers.

Engineering Pamphlet 110-1-32, 25 pp, Nov 2005

This pamphlet provides information on the capabilities and potential uses of the Site Characterization and Analysis Penetrometer System (SCAPS) direct-push technology for the investigation of hazardous, toxic, and radioactive waste sites.

<http://www.usace.army.mil/publications/eng-pamphlets/ep1110-1-32/entire.pdf>

Environmental Forensic Methods for Soil Gas and Vapor Intrusion Investigations
Emsbo-Mattingly, S., K. McCarthy, A. Uhler, S. Stout, and G. Douglas, NewFields
Environmental Forensics Practice, LLC. The 21st Annual Conference on Contaminated Soils,
Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The
Association for the Environmental Health of Soils, Amherst, MA.

Though powerful methods are available for differentiating hydrocarbon-contaminated soil gas from ambient chemicals in indoor air, the techniques used during many soil gas and indoor air quality assessments lack a standard approach that can differentiate household chemicals from vapor derived from subsurface hydrocarbon contamination. Environmental contaminants, like benzene from in-house sources, could be inaccurately attributed to emission from subsurface NAPL. The problem becomes even more complex in the presence multiple subsurface vapor plumes derived from fugitive gasoline, fuel products, and tar. Currently, standard methods for characterizing the composition of indoor air, potential sources, and background air do not adequately measure a sufficient number of chemicals to accurately determine makeup and sources of chemicals found in indoor air. It is critically important to select appropriate analytical methods when identifying the source of indoor air chemicals. EPA TO-14 and other standard methods are used for measuring regulated compounds include few of the diagnostic hydrocarbons required for source identification and differentiation. As a result, the application of standard methods must be extended to include additional compounds needed for source identification. The sensitivity of the standard methods also must be increased to detect diagnostic compounds at low concentrations, approximately 1,000 times lower than most site assessment techniques. Recent advances in measurement methods using EPA TO-15 have demonstrated critical improvements in sensitivity and analyte richness for improved hydrocarbon source identification. Two case studies illustrate the improved capability of TO-15 enhancements for the differentiation of gasoline, diesel, and tar vapors from background signatures in indoor air.

EPA SITE Program Demonstration Project Results: TEQ Screening in the Field Using Integrated Parallel Immunoassays for Dioxin/Furan TEQ and Dioxin-Like PCB TEQ
Harrison, Robert O., CAPE Technologies, South Portland, ME. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Method 4025 for dioxin/furan TEQ, based on a commercially available kit, was approved in 2001 by EPA's Office of Solid Waste and Emergency Response. Because of this acceptance, Method 4025 is often considered an important first step in site assessment or an essential time-saving tool during remediation. The EPA Superfund Innovative Technology Evaluation (SITE) Program conducted a field demonstration project in 2004 for Method 4025 and related technologies. In addition to demonstrating the kit on which Method 4025 is based, CAPE Technologies added a second immunoassay kit for measurement of TEQ from dioxin-like PCBs. This PCB TEQ kit is expected to be validated in the near future for use in SW-846 Method 4026 for TEQ from dioxin-like PCBs. Due to the extremely wide range of source materials, sample types, and TEQ levels, the sample processing of the original Method 4025 was not used. Instead, an adaptation of the Smith-Stalling cleanup method was used for the rapid batch-wise cleanup of extracts made by shaking solid samples in acetone:hexane. This method (4025m, or modified Method 4025) allows for easy capture of two discrete fractions, one for dioxins and furans, and the other for dioxin-like PCBs. In the SITE demonstration project, these fractions were analyzed

separately using their respective immunoassay kits. The resulting TEQD/F and TEQPCB values were first evaluated separately, then again after adding the two component TEQ values together to get a total TEQ value. During the 2004 demonstration project, 209 soil and sediment samples were analyzed by both CAPE Technologies immunoassay methods as well as by Methods 1613B and 1668A. Comparisons were made in sample throughput, cost, ease of use, and waste generation, as well as in various analytical performance measurements, such as decision-making at pre-selected target levels. Specifics of the report are described and suggestions are offered about implementing this technology for routine use.

An Evaluation of Analyte Isolation and Analytical Finish Methods for Cr(VI) in Solids

Vitale, R.J. and K.R. Clay, Environmental Standards, Inc., Valley Forge, PA.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Chromium exists predominantly in two stable forms or valence states, as Cr(VI) and Cr(III). In environmental samples, there is a fundamental need to differentiate between the two valence states because Cr(III) is not considered to be toxic to humans, whereas Cr(VI) is considered an inhalation carcinogen. The analysis for total chromium is relatively straightforward; however, the successful analysis for Cr(VI) in complex soils/solid matrices can be more complex. In solid materials, there are always two steps to the quantification of Cr(VI): The extraction or isolation of the hexavalent chromium species and the analysis of the digestate for Cr(VI). The development and promulgation of the SW-846 alkaline digestion procedure (Method 3060A) provided the public with the critical means to reliably extract Cr(VI) in a solid matrix sample while preserving the native valence state of chromium in its environmental setting. A variety of analytical finish methods are available to quantify the Cr(VI) in solution. The colorimetric procedure, SW-846 Method 7196A, is the most common for Method 3060A digestates because of its wide availability and low cost. Method 7199 utilizes an ion chromatograph (IC) with separation of Cr(VI) on an anion exchange separator column. Method 6800, "Elemental and Speciated Isotope Dilution Mass Spectrometry," can be used to speciate chromium as well as other metals of environmental concern (e.g., As, Hg) in solid matrices, but Method 6800 is not yet available at commercial laboratories and the unit cost (currently much higher than 7196A or 7199) for commercial use remains to be determined. In New Jersey, regulators previously mandated the use of an alkaline digestion procedure (NJDEP-modified Method 3060) coupled with a colorimetric analytical finish (NJDEP-Modified Method 7196A) on New Jersey chromite ore processing residue (COPR) Sites. NJDEP-modified Methods 3060/7196A specify essentially identical chemistry and laboratory procedures as SW-846 Methods 3060A/7196A. Regardless of the analytical finish method performed, research has shown that in the analysis for Cr(VI), soils or waste samples rich in reducing agents (e.g., organic matter, sulfides, ferrous iron) cannot support chromium in the hexavalent state. Low matrix spike recoveries (<75%) are actually expected in these matrices, not because of bias, but because Cr(VI) cannot exist. Thus, the evaluation of Cr(VI) matrix spike recoveries when assessing method performance or potential bias requires a non-traditional approach. Specifically, it is inappropriate to automatically deduce poor method performance or result bias for Cr(VI) matrix spike recoveries outside the traditional acceptance range (e.g., 75 to 125% recovery).

Evaluation of the Remediation Progress of Three Hydrocarbon-Contaminated Soils Using a Simple Seedling-Based Bioassay

Slaski, J.J., X. Li, and D.J. Archambault, Environmental Technologies, Alberta Research Council Inc., Alberta, Canada. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

A simple, seedling-based bioassay was used to evaluate bioremediation progress of three hydrocarbon-contaminated wastes--a crude oil-and-brine-contaminated agricultural topsoil (waste 1), a diesel invert mud residue (waste 2), and a flare pit sludge (waste 3)--and to identify the main factors contributing to toxicity. The wastes were subjected to physical, chemical and thermal treatment in a bioreactor, then subsequently placed on agricultural land for further treatment. Three sets of experiments were conducted in which assessments were made of the rate of germination and shoot and root elongation of two indicator plant species, lettuce and wheat. The first experiment focused on the end-point evaluation of the effectiveness of previous remediation efforts; the toxicity of remediated wastes was compared to their initial toxicity. The second experiment examined the time-course of remediation processes over three years. The third experiment identified compounds in the waste materials that contributed to toxicity. The hypothesis that soluble (leacheable) salts adversely affect shoot and root elongation was tested. The results from a 5-day bioassay indicated that although progress in bioremediation was observable, all three wastes still exhibited toxicity to growth of both lettuce and wheat. Lettuce was more sensitive to the wastes than wheat. The results were generally consistent with those of field experiments where crops were grown in soil contaminated with the wastes. Contaminants in wastes 1 and 2 were tightly bound to soil particles, and compounds were released slowly. Extensive leaching of waste 3 reduced but did not eliminate toxicity, and most of the toxic compounds remained in the waste material.

Evaluation of Winter Stoneflies as Potential Hyporheic Water Quality Indicators

Russell, David E. (Miami Univ., Oxford, OH); Paul T. Russell (PTR & Associates, Williamsburg, OH); Sheldon I. Guttman (Miami Univ., Oxford, OH). The 13th Annual West Coast Conference on Soils, Sediments and Water, 17-20 March 2003, San Diego, California. Abstracts. The Association for Environmental Health and Sciences, Amherst, MA.

The interstices of stream sediments and associated fauna is referred to as the hyporheos. Winter stoneflies have potentially broad applicability for monitoring contaminants in these subsurface waters because stonefly nymphs are sensitive to water-borne pollutants, their immature stages develop in the hyporheos, and the adults are flightless, abundant, and easy to collect. A study was undertaken to determine if enough genetic variability existed in winter stoneflies to serve as a useful tool for monitoring water quality. Winter stoneflies were collected from two sites along a creek downstream from a closed hazardous waste dump in Clermont County, OH. Thirty-six specimens from one site and 29 specimens from a second site were compared to 41 individuals from a control population. Entire specimens were homogenized and starch gel electrophoresis was used to evaluate these populations. A total of 14 alleles from three loci were used in the final scoring, including four alleles for the MDH-1 locus, three for MDH-2, and seven for PGM. Changes in gene frequency in loci such as MDH, GPI, and PGM have been shown to correlate to inputs of heavy metals, organophosphates, and other contaminants of monitoring interest. With minor changes in technique and a more comprehensive investigation

into the variables affecting its population genetics, winter stoneflies appear to be viable candidates as water quality indicators of the hyporheic zone.

Fiber Optic Liquid Leak Detection Technique with an Ultrasonic Actuator and a Fiber Bragg Grating

Lee, Jung-Ryul and Hiroshi Tsuda, National Inst. of Advanced Industrial Science and Technology, Tsukuba, Japan.

Optics Letters, Vol 30 No 24, p 3293-3295, 15 Dec 2005

The authors present a technique for liquid leak detection in which ultrasonic and optical waves are introduced into a fiber simultaneously. The system is based on an ultrasonic technique using an ultrasonic actuator and a fiber Bragg grating receiver. A fiber-guided ultrasonic wave is utilized to stress the fiber Bragg grating, which is remote from the ultrasonic transmitter. When the traveling ultrasonic wave encounters a liquid, part of the wave leaks out from the fiber, which results in an ultrasonic strain decrease in the fiber Bragg grating. The ultrasonic wave and its attenuation are detected by the light variation of a narrow-band laser source reflected and transmitted from the fiber Bragg grating, and the amplitude variation of the ultrasound can eventually be correlated with the fiber area coupled with the liquid. Since the optical fiber does not corrode, it is appropriate for long-term monitoring, e.g., as a leak detection system for a pipeline transporting water, crude oil, or gasoline.

<http://myhome.naver.com/leejrr/download/FW1.pdf>

Field Screening for Halogenated Volatile Organic Compounds

Schabron, John F., Joseph F. Rovani, Jr., and Theresa M. Bomstad, Western Research Institute. WRI-03-R006, OSTI: DE00820761, 33 pp, 2003

Supported by DOE, Western Research Institute is working toward the development of new screening methodology and a test kit to measure halogenated volatile organic compounds (VOCs) in the field. Heated diode and corona discharge sensors are commonly used to detect leaks of refrigerants from air conditioners, freezers, and refrigerators. They are both selective to the presence of halogens. In prior work, the devices were tested for response to carbon tetrachloride, heptane, toluene, and water vapors. In the current work, sensor response was evaluated with sixteen halogenated VOCs relative to carbon tetrachloride. The results show that the response of the various chlorinated VOCs is within an order of magnitude of the response to carbon tetrachloride for each of the sensors. Thus, for field screening a single response factor can be used. Both types of leak detectors are being further modified to provide an on-board LCD signal readout, which is related to VOC concentration. The units will be fully portable and will operate with 115-V line or battery power. Signal background, noise level, and response data on the Bacharach heated diode detector and the TIF corona discharge detector show that when the response curves are plotted against the log of concentration, the plot is linear to the upper limit for the particular unit, with some curvature at lower levels. When response is plotted directly against concentration, the response is linear at the low end and is curved at the high end. The dynamic ranges for carbon tetrachloride of the two devices from the lower detection limit (S/N=2) to signal saturation are 4-850 vapor parts per million (vppm) for the corona discharge unit and 0.01-70 vppm for the heated diode unit. Additional circuit modifications are being made to lower the detection limit and increase the dynamic response range of the corona discharge

unit. The results indicate that both devices show potential utility for future analytical method development work toward the goal of developing a portable test kit for screening halogenated VOCs in the field.

http://www.osti.gov/bridge/product.biblio.jsp?query_id=1&page=0&osti_id=820761

Field Validation of Helium as a Tracer Gas During Soil Vapor Sample Collection

Banikowski, J.E., S. Kaczmar, and J. Hunt (O'Brien & Gere Engineers, Inc., Syracuse, NY); R. Pellegrino (CENTEK Laboratories LLC, Syracuse, NY). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

This paper presents the results of a field validation study of helium used as a tracer, utilizing a commercially available helium leak detector. Observations are reported on the frequency and degree of short-circuiting observed in soil vapor sampling from replicate installations of implants installed in differing soil types and depths. First, the tracer gas field validation investigators examined the ability of the method to detect short-circuiting in implants installed at four and eight feet below the ground surface. The implants were designed to short-circuit by introducing higher permeability material around the implant tubing and annular space. Following installation, a container was placed directly over the implant at the ground surface and filled with helium. Soil gas was then withdrawn from the implant and measured for helium. Conditions were varied and replicates were performed to investigate factors contributing to short-circuiting and to establish response times and detection levels. In a second phase of the study, the frequency and magnitude of leakage was investigated under typical field conditions and standard installation protocols. A total of 64 soil replicate vapor implants was installed by a field team experienced in soil vapor sampling, 32 in a sandy soil horizon and 32 in glacial till, to depths of four and eight feet below ground surface. The frequency of atmospheric short circuiting was monitored according to the validated helium tracer field protocol, with consideration of soil type, depth, time, and total volume of soil gas collected.

Fingerprinting Organic Lead Species in Automotive Gasolines and Free Products Using Direct Injection GC/MS

Healey, E.M., S.A. Smith, K.J. McCarthy, S.A. Stout, R.M. Uhler, A.D. Uhler, S.D. Emsbo-Mattingly, & G.S. Douglas, Battelle Environmental Forensics Investigation Group, Duxbury, MA. The 13th Annual West Coast Conference on Soils, Sediments and Water, 17-20 March 2003, San Diego, California. Abstracts. The Association for Environmental Health and Sciences, Amherst, MA.

Among the most important additives in the evolution of automotive gasoline was organic lead, specifically tetraethyl lead (TEL). From 1923 to 1960, TEL was the lone organic lead compound added to automotive gasoline, then tetramethyl lead (TML) was formulated, and various lead packages were developed and introduced to the gasoline market, including both physical mixtures and reacted mixtures of TEL and TML. This poster describes a specialized analytical method used in the molecular characterization of the five organic lead species found in historic automotive gasolines. The analytical method consists of quantitative high-resolution gas chromatography with mass spectrometry detection in the selected ion monitoring mode following adaptations of EPA Method 8270. The analysis is performed using a direct injection

technique for gasoline and free-phase petroleum. Interpretive forensic techniques, utilizing the organic lead results generated with this method are discussed. Two case studies are presented in which organic Pb fingerprinting used in conjunction with conventional gasoline fingerprinting was useful in determining liability at old gasoline-contaminated sites.

Four Tips for the Handling of Aqueous Diffusion Samplers

Springer, C.D. and A.C. Easterday, EA Engineering, Science, and Technology, Inc., Southborough, MA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

The aqueous diffusion bag (ADB) sampler is made of semi-permeable polyethylene membranes filled with de-ionized water. The major advantage of ADB samplers is the decreased cost and labor of sampling because their use does not require on-site sampling equipment, well purging, or disposal of purge liquids. The ADB sampling technique provides a cost-effective and time-saving alternative to low-flow sampling in a long-term monitoring program: the total time for an example event decreased from 12 days to 5 days--1 day to fill and setup bags, 2 days to deploy bags, and 2 days to retrieve bags and collect samples. The authors have identified four ADB setup and handling tips to optimize economical use of the device. (1) For easier deployment, use a weight to counteract the ADB's natural buoyancy. Make sure the weight will not affect other sampling parameters, such as metals. (2) Assemble the ADB setup--including the single or multiple bag setups and weight--in a clean off-site location. By creating each well setup prior to mobilizing to the sampling point, labor time in the field can be reduced. (3) Transport the ADB setup in pre-cleaned, flat containers from preparation location to sampling point to avoid accidental breakage or cross-contamination. Large "under-the-bed" polyvinyl chloride storage containers with lids have proved to be useful. (4) For long-term use, install dedicated bag setups made of stainless steel wire with bag clips attached at predetermined levels. For each sampling event, the ADBs are clipped onto the wire and lowered into the well. By creating a setup that can be used for multiple events, significant time savings can be realized.

Functional and Taxonomic Microarrays for Profiling Natural Microbial Populations Involved in Bioremediation

Greer, C.W., D.F. Juck, S. Sanschagrin, and D. Labbe (Biotechnology Research Inst., National Research Council Canada, Montreal, Quebec); J.R. Lawrence (National Water Research Inst., Environment Canada, Saskatoon, SK); L.G. Whyte (McGill Univ., Ste-Anne-de-Bellevue, Quebec). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Two types of microarrays were developed to profile indigenous microorganisms in a variety of environments. The functional gene microarray uses gene probe amplicons derived from various bacterial catabolic pathways for organic pollutants and biogeochemical cycles. The taxonomic microarray has oligonucleotide probes derived from the 16S rDNA gene and the cpn60, chaperonin gene. These two microarrays have been used to monitor changes in the indigenous microbial population during a bioremediation project at Eureka, in the high Arctic. Treatment of the hydrocarbon-contaminated soils was started in 2000 and consists of applying nutrients (solid and liquid fertilizers) and tilling the soil during the summer. The effect of this

treatment on the composition and activity of the indigenous microbial population has been monitored on a yearly basis in the active and supra-permafrost layers of treated and untreated soils. Total petroleum hydrocarbon (TPH) concentrations in the treated soil have been reduced by 63% in the active zone, and by 75% in the supra-permafrost zone. Although total heterotrophic or diesel-degrading bacterial population sizes have not changed significantly during the treatment, the *ndoB* (naphthalene degradation) and *alkB* (alkane degradation) genotypes increased in 2001 and 2002, respectively. Mineralization assays using radiolabeled naphthalene and hexadecane demonstrated a corresponding increase, and functional gene microarray analysis indicated that hydrocarbon degrader genotypes increased, which was supported by a quantitative analysis of target gene signal intensity. Analysis with the taxonomic microarray indicated that the composition of the indigenous population had changed during the monitoring period, and specific microorganisms such as *Pseudomonas*, *Rhodococcus*, and *Vibrio* increased significantly, paralleling the increase in corresponding catabolic genes associated with these microorganisms. The use of functional gene and taxonomic microarrays provides a new method to rapidly evaluate the composition and functional capacity of indigenous microbial communities, and to monitor their responses to, and recovery from, stress.

Functionalization of Nanowire Arrays for the Detection of Chlorpyrifos

Hunt, Lynne M. and Lyman H. Rickard, Millersville Univ., Millersville, PA.

229th ACS National Meeting, 13-17 March 2005, San Diego, CA. American Chemical Society Division of Chemical Education: Abstracts, No 320.

New chemical nanosensors can be developed based on the functionalization of metallic nanowire arrays to bind to specific analytes. Spectroscopic techniques can then be used to identify and quantitatively measure the analyte. The authors describe the functionalization of gold nanowires for the measurement of the pesticide, chlorpyrifos. Characterization of the gold nanowires was performed using reflectance infrared spectroscopy, cyclic voltammetry, fluorescence microscopy, and scanning electron microscopy. Each method showed a dramatic change in the gold surface of the wires after the addition of a bridging molecule and the chlorpyrifos antibody.

Guidance for Evaluating Landfill Gas Emissions from Closed or Abandoned Facilities

U.S. EPA, Office of Research and Development.

EPA 600-R-05-123a, 207 pp, Sep 2005

This report provides guidance to Superfund remedial project managers, on-scene coordinators, facility owners, and potentially responsible parties for conducting an air pathway analysis for landfill gas emissions under CERCLA and RCRA. The document provides procedures and a set of tools for evaluating landfill gas emissions to ambient air, subsurface vapor migration due to landfill gas pressure gradients, and subsurface vapor intrusion into buildings.

<http://clu-in.org/download/char/epa-600-r-05-123.pdf>

How to Improve Detection Limits, Reduce Maintenance Time and Minimize Breakdown for Pesticide Analysis and Other EPA Method 8270 Analytes Using Enhanced Large Volume Injection

Marotta, Lee, Andy Tipler, and Heidi Griffith, PerkinElmer LAS, Shelton, CT.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Several techniques are employed to optimize the analysis of pesticides with mass spectrometry (MS) and/or electron capture detection (ECD). To attain goals, the parameters employed are enhanced large volume injection (injector isolation and backflush modes) and simultaneous full scan and single ion monitoring. With enhanced large volume injection, the analyst has the ability to inject large volumes of sample into the gas chromatograph. During the solvent purge time, the injector is completely isolated from the analytical column, thereby preventing solvent from reaching the column and detectors. This enables the use of less sample and less extraction solvent while maintaining and exceeding the necessary detection limits. Isolating the injector allows the use of chlorinated solvents with ECD. Isolating the injector after the injection has been made enables the baking and maintaining of the injector port during the analysis. With a program injector, the analytes of interest (e.g., pesticides) experience controlled evaporation, minimizing thermal breakdown inherent in classical flash injections. Two advantages will be discussed: the ability to increase sensitivity by at least 25 times and the ability to enhance integration and improve precision.

How to Recognize a Hydrocarbon Fuel in the Environment and Estimate Its Age of Release

Alimi, H., Global Petroleum & Environmental Geochemistry.

Proceedings of the 1st IMAGE-TRAIN Cluster Meeting, Karlsruhe, 7-9 November 2001.

Umweltbundesamt/Federal Environment Agency, Austria, p 49-54, 2002

When soils become saturated with released fuel, the hydrocarbon components will migrate and penetrate groundwater. Because these pollutants can migrate over long distances, a strong possibility exists for mixing of different hydrocarbon product plumes from different sources. When this occurs, complex mixtures of fuels result, some of which may have undergone chemical/biological alteration, changing their original chemical composition. To characterize such a fuel mixture becomes a challenge. 'Chemical fingerprinting' is a term used to describe the ability to distinguish the age and often the origin of a chemical. Chemical fingerprinting is most commonly used in hydrocarbon contamination cases. In its simplest form, it identifies or characterizes the type of hydrocarbons (diesel, gasoline, jet fuels, kerosene, and organic solvents, such as mineral spirits and Stoddard solvent) as a means to identify the source and often the timing of a release. Areas involving petroleum hydrocarbons where chemical fingerprinting may play an important role are oil spills, gas leaks, production allocation disputes, pipeline leakages, and unknown gas sources. Characteristics of oil and refined products will change due to weathering in the environment. Sophisticated analytical techniques are available to characterize the spilled fuel oils and correlate them with their respective sources even after extensive weathering has occurred.

http://www.image-train.net/products/papers/CM1_alimi.pdf

Indoor Air as a Source of VOC Contamination in Shallow Soils Below Buildings

McHugh, T.E., P.C. de Blanc, and R.J. Pokluda, Groundwater Services, Inc., Houston, TX.

The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Both U.S. EPA and some state guidance documents recommend sub-slab sampling in site investigations conducted to determine if vapor migration from underlying soil is a completed exposure pathway. If VOCs are detected in the sub-slab, then migration from the subsurface is assumed to be occurring and further evaluation is required to determine the extent of the impact. This guidance is predicated on the assumption that VOCs detected in sub-slab samples have originated from deeper within the subsurface, but detection of VOCs in sub-slab samples may not be sufficient evidence to conclude that VOCs are migrating from the subsurface toward a building. VOCs detected in sub-slab samples can originate from indoor sources, migrating through the slab by diffusion or advection. Commonly used conceptual models of vapor intrusion include VOC migration from the subsurface into buildings but do not consider the potential for VOC migration from buildings into the subsurface, but the advective and diffusive forces that result in the migration of VOCs from the subsurface into buildings are equally likely to result in the migration of VOCs from buildings into the subsurface under suitable pressure or concentration gradients. The authors present simple analytical modeling indicating that indoor sources of VOCs may cause sub-slab impacts through advection across the building foundation, field analyses from a site where indoor sources rather than subsurface contamination was the source of VOCs detected in sub-slab samples, and recommendations for field investigation methods to allow the discrimination of subsurface versus indoor sources of sub-slab VOCs.

In-Situ Measurement of Rhizosphere Degradation Kinetics

Thoma, G., T.B. Lam, P.-T. Hsu, K. Karim, D. Wolf, and S. Ziegler, Univ. of Arkansas, Fayetteville. IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

Mathematical modeling suggests that the spatial extent of the plant rhizosphere and degradation rate within the rhizosphere is an important parameter in the degradation of immobile constituents in petroleum-contaminated soil by phytoremediation based on rhizodegradation. The authors calculated the rhizosphere extent from a digitized high-resolution in situ image (non-destructively obtained) of the root zone during phytoremediation of a pyrene or phenanthrene thin film. Initial estimates of the extent of the rhizosphere surrounding Bermuda grass suggest that it is only a few hundred microns in extent, on the order of the root diameter. Quantitative study of the fluorescent thin films has allowed in situ calculation of degradation rates in rhizosphere zones surrounding fine root structures.

In-Situ Temperature Monitoring of Geomembranes

Koerner, G.R. and R.M. Koerner.

Geo-Frontiers 2005: Geosynthetics Research and Development in Progress (GRI-18).

American Society of Civil Engineers, Reston, VA. ISBN: 0-7844-0769-X, 2005

To accurately evaluate a polymer material's long-term performance, it is important to know the environmental conditions that it will experience during its service life. In situ

temperature is a key environmental condition for a geomembrane, as well as other geosynthetics. Researchers have obtained long-term temperature data at two solid-waste landfills using thermocouples attached to geomembrane liners and covers. The monitoring has been conducted at both dry (conventional) and wet (bioreactor) landfills. The data indicate that liner temperatures beneath the solid waste at dry landfills are lower than at wet landfills; however, cover temperatures are controlled by ambient temperatures at the site and show a pronounced annual cyclic behavior. Temperature monitoring at these sites is ongoing.

The Integration of the Membrane Interface Probe with In-Situ Remediation Injection Technology to Facilitate Cost Effective Treatment of Groundwater

Eliot Cooper, Vironex, Golden, CO.

IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [Abstract only]

The effectiveness of in situ bioremediation or chemical oxidation remediation technologies is a function of the delivery of reagents into direct contact with contaminants located in the dissolved, desorbed, and NAPL phases. The location of contaminant mass in relation to lithology must be determined to deliver reagents effectively. Many in situ remediation projects move into full-scale without a good understanding of the radius of influence and distribution of reagents that can be achieved. The membrane interface probe (MIP) is a direct-push applied sensing tool that simultaneously measures soil conductivity and volatile organic compounds. Once contaminant mass has been identified, a reagent delivery strategy can be developed to maximize reagent distribution, radius of influence, and injection rates, as well as to optimize project costs. Delivery of reagents into the saturated zones is accomplished through direct push technology or injection wells. Injection is facilitated through a wide range of injection pumps, technologies, and delivery techniques. Distribution of reagents, radius of influence, and injection rates are directly affected by the hydraulic conductivity and heterogeneity of the target interval. Case studies are presented of site characterization data obtained with the MIP. These data were used to integrate soil conductivity and contaminant mass information into injection strategies, delivery techniques, and equipment selection.

Initial Site Assessment for Dehalococcoides Using PCR and Ethene Concentrations: Comparison with Microcosm Results

Fogel, S., M. Findlay, and D. Smoler (Bioremediation Consulting Inc., Watertown, MA); S. Fam (Innovative Engineering Solutions Inc., Norwood, MA). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

An initial evaluation of the bioremediation potential of 20 sites contaminated with chlorinated ethenes and ethanes is being conducted by evaluating the results from several wells from each site for three sources of information: (1) the ethene concentration in groundwater samples, (2) the presence of DNA from Dehalococcoides ethenogenes by genetic testing using PCR, and (3) microcosm tests with added electron donor, conducted to measure dechlorination of the site contaminants in site groundwater. The sites tested were contaminated by historic releases of industrial chemicals, including PCE (tetrachloroethene) and its daughter products, as well as other chlorinated compounds. Results indicate a strong, but not absolute, correlation

between negative PCR results for a well and lack of ethene in the groundwater from that well. For 25 PCR-negative wells from 13 sites, 23 had ethene concentrations less than 0.3 ppb, and two had ethene between 6 and 18 ppb. In cases in which PCR results are positive and microcosm results are negative, it would be concluded that the PCR test is reporting non-viable DNA, indicating that the organisms were previously active, but that changing site conditions have reduced their viability. For sites where native dechlorinators are found in only some sections of the site, additional microcosm tests have been useful in designing strategies for intra-site bioaugmentation. Sites negative for both microcosm and PCR can undertake additional detailed microcosm tests to design a strategy for site modification and bioaugmentation with laboratory-grown dechlorinating cultures.

INL Wireless Sensor Platform

Kunerth, D.C., J.M. Svoboda, and J.T. Johnson, Idaho National Laboratory (INL), Idaho Falls, ID. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Idaho National Laboratory is developing a versatile micro-power sensor interface platform for the purpose of periodic remote sensing of environmental variables, such as subsurface moisture, temperature, pressure, contamination, or radiation. The key characteristic of the platform architecture is that all platform components are inactive until energized by a remote power source; no internal power source (e.g., a battery) is required. The platform communicates via short-range telemetry, so no wires need penetrate to the subsurface or through a barrier. The platform has the potential for a long service life and a compact size that makes it well suited for retrofitting existing structures. Functionally, the sensor package is "read" by a short-range induction field that both powers/activates the sensor platform and carries sensor information via a response signal superimposed on the field by the embedded microprocessor. Though well suited for the intended application, this approach does have inherent limitations and/or tradeoffs, such as a limited functional range as defined by the extent of the interrogating induction field and a power budget as defined by the onboard energy storage capacitors. Specific applications require tradeoffs between charge time (measurement cycle time), available power, and working depth. For example, an increase in required power to run sensors will result in either a reduced working depth and/or an increase in charge time. The platform is being developed to address DOE long-term stewardship needs, but it has the potential to address other monitoring applications where sensors are buried beneath a surface that must not be penetrated by wires, e.g., in areas where it might be desirable to avoid visual impact or conceal sensors to avoid theft or vandalism, or where above-ground sensors or wiring might be damaged by the weather, equipment, or personnel.

Innovative, Effective Site Assessment: A Case Study

Hodny, J.W. (W.L. Gore & Associates, Inc.); A. Brown; L. LaPlante. The 13th Annual West Coast Conference on Soils, Sediments and Water, 17-20 March 2003, San Diego, California. Abstracts. The Association for Environmental Health and Sciences, Amherst, MA.

Soil gas sampling continues to be an efficient and effective tool in deciphering the nature and extent of subsurface impact by volatile and semivolatile organic compounds. Soil gas

sampling generally utilizes a larger number of sample points when compared to conventional soil or groundwater sampling, and a more comprehensive assessment of the subsurface impact to the site is realized. Comprehensive soil gas site assessments will shift subsequent regulated matrix sampling programs from exploration to confirmation. With subsurface contamination confirmed, the resulting matrix data provide better overall input to remedial system design. The net effect is a reduction in short- and long-term remediation costs, while increasing overall remediation success. This presentation discusses an innovative soil-gas site assessment technology that has a proven track record of success, illustrated with a case study in which a soil gas survey identified a significant, persistent source that conventional soil and groundwater sampling had failed to identify. This discovery led to a significant redesign of the remedial strategy.

An Integrated Geophysical Approach to Environmental Site Investigation

Brown, M., J. Japitana, and R. Cataldo, ENSR International, Westford, MA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

This presentation discusses an integrated geophysical approach utilizing ground penetrating radar (GPR) and/or electromagnetic (EM) terrain conductivity measurements to rapidly, non-invasively, and cost-effectively identify subsurface characteristics and features at environmental sites in a variety of field settings. Through case studies, the authors demonstrate how integrated GPR and EM survey techniques are commonly used to identify orphan underground storage tanks, buried debris/industrial waste, and other environmentally related subsurface site characteristics and how the data can be used efficiently to direct more costly investigative programs.

Introduction to an Ongoing Technology Development Project on a Complex on Site Investigation Approach

Morvai, B., Agruniver Environmental Service and Management Ltd., Hungary. Sustainable Management of Soil and Groundwater in Urban Areas, 2-4 October 2002, University of Mining and Metallurgy, Cracow, Poland. Umweltbundesamt/Federal Environment Agency, Austria. CP-033, p 81-85, 2003

The aim of the NORISC (Network-Oriented Risk Assessment by In-situ Screening of Contamination) project is to provide a standard guideline in the form of a decision tool software system for more efficient characterization and risk assessment of contamination profiles in urban areas. The system combines and integrates new and existing site investigation methods focusing on in situ and on site techniques, including geophysical screening, (hydro-) geological survey, chemical analysis, toxicological, and other short tests to achieve a faster, cheaper, and more reliable site assessment. The approach is based on flexible and dynamic investigation strategy as well, supporting on-site positioning and GIS based data processing that includes geostatistics and modeling. The developed guideline is being verified against quantifiable and quality criteria, so real field tests with detailed evaluation are carried out. The NORISC system will be a valuable tool for city planners, decision-makers, landowners, investors, and other stakeholders in contaminated site management, especially in brownfield redevelopment.

http://www.image-train.net/products/papers/CM2_norisc.pdf

Investigation of Microbial Consortia Stimulated by Denitrification-based Bioremediation in a Gasoline-Contaminated Aquifer via DGGE, Realtime PCR and Multi-Color Fluorescence In-Situ Hybridization ("mFISH")

Hince, Eric (Geovation Consultants, Inc., Florida, NY); Dora Ogles (Microbial Insights, Inc., Rockford, TN). IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

A large-scale field demonstration of a proprietary denitrification-based bioremediation (DBB) technology was initiated in October 2004 at a DoD-owned service station in the northeastern United States. More than 4,500 kg (>99%) of the gasoline-related hydrocarbon mass was present in the sorbed phase within the aquifer media. Groundwater conditions were anaerobic and highly reducing prior to DBB treatment. The existing microbial consortia before and after DBB treatment were investigated via a combination of denaturing-gradient gel electrophoresis (DGGE), real-time polymerase chain reaction (rtPCR), and multicolor FISH. DGGE profiling was conducted for eubacteria, archaea, and fungi. rtPCR assays were conducted on target groups and genes, including total eubacteria, iron/sulfate reducing bacteria (delta proteobacteria), methanogens, nirS and nirK (genes involved in denitrification), benzyl succinate synthase (BssA), and the catechol dioxygenase genes. mFISH analyses primarily focused on evaluating trends at a few key locations over time with the MP1 multi-color. The combined results of these genomic methods, together with the results of biogeochemical monitoring, revealed that a smaller, more diverse, and less active anaerobic consortia was present prior to treatment, whereas DBB treatment stimulated a larger, less diverse, more active, and primarily denitrifying consortium. Both mFISH and DGGE indicated a shift toward a beta proteobacteria-dominated bacterial community within the main treatment zone, whereas rtPCR indicated a decrease in delta proteobacteria as well as an increase in total eubacteria and the detected copies of the catechol dioxygenase, nirS, nirK, and BssA genes in response to treatment.

Investigation of Subsurface Contamination Using an Integral Approach

Ptak, T., Univ. of Tubingen, Germany.

Sustainable Management of Soil and Groundwater in Urban Areas, 2-4 October 2002, University of Mining and Metallurgy, Cracow, Poland. Umweltbundesamt/Federal Environment Agency, Austria. CP-033, p 33-40, 2003

At most contaminated sites, the pollutant hot spots and aquifer heterogeneity can cause an irregular distribution of contaminants in groundwater. Many monitoring wells would be needed to reliably determine the concentration distribution downgradient of the pollutant source zone based on point scale measurements. A new approach to site assessment focuses on groundwater quality and complex contamination patterns, which are typical for urban industrial megasites in many European cities. The new approach comprises three cycles: (a) the assessment of groundwater contamination using an innovative integral mass flow rate-based investigation method at the scale of entire industrial sites, (b) the delimiting of potential contamination source zones using backtracking and contaminant fingerprinting techniques, and (c) the development of emission-oriented remediation strategies. The major advantage of the new approach is that the number of areas to be considered for further investigation and remediation is reduced from one

cycle to the next. Consequently, a large potentially contaminated area is screened initially, but only a small area may be finally remediated, yielding a significant reduction of costs.

http://www.image-train.net/products/papers/CM2_incore.pdf

Kodiak Island and Northway ACS/Staging Field, Alaska

Defense Environmental Programs Annual Report to Congress: Fiscal Year 2004 -- Success Stories. Apr 2005

An innovative technology, the Rapid Optical Screening Tool (ROST), was implemented in 2004 at both Kodiak Island and Northway ACS/Staging Field, AK, where multiple investigations had been performed previously. Both investigations were needed to determine the nature and extent of the contamination to aid future cleanup and site closeout. ROST utilizes laser-induced fluorescence (LIF) to determine if contaminants are present in either saturated or unsaturated soil via a direct-push probe. The LIF is a screening tool that sends ultraviolet light (UV) through optical fibers that are strung through rods. The light exits the probe through a sapphire window on the side of the probe tip. As the probe is advanced, soil sliding past the window is exposed to UV light. If fluorescent compounds exist, light is emitted. The data are collected and shown in real-time, providing an instant color log that depicts zones of contamination across the entire soil column. The technology not only identifies the type of petroleum present, but also its relative concentration and exact location of the smear zones. The probe is capable of continuously gathering information from the surface to a depth of 30 feet or more. The source of contamination at the Kodiak Island Airport Staging Area was a fire training pit in which flammable liquids were ignited and extinguished. The investigators combined multiple innovative investigation approaches--LIF screening, geophysics, soil borings, and groundwater and sediment sampling--to determine the nature and extent of the contamination in the area. At Northway ACS/ Staging Field, the tool was used at four areas of concern within the two separate FUDS. Cost savings from use of innovative site characterization techniques approached \$100,000 during the Kodiak investigation. To replicate the data gathered by the LIF and the geophysical survey, it would have been necessary to install and sample an additional 38 soil borings. At Northway, the needed information was gathered at approximately one-third the cost of conventional techniques. LIF screening is considerably faster than soil boring, with the capability of advancing 10 LIF locations or more per day. Conventional soil borings generally can be accomplished only at a rate of three per day. By using the LIF, fieldwork was completed in less than one-third the time than would have been required using a classic approach.

http://derparc.egovservices.net/Derparc_FY04/pdfs/stories/FUDS_KodiakIslandandNorthwayACSSStagingField.pdf

Laboratory-Scale Application of Fiber Optic Transflection Dip Probe (FOTDP) for In Situ Monitoring of Gas Phase Ozone in Unsaturated Porous Media

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Journal of Contaminant Hydrology, Vol 82 No 1-2, p 133-144, 5 Jan 2006

A fiber optic transflection dip probe (FOTDP) system was developed for in situ and real-time monitoring of the transport of gas-phase ozone in unsaturated porous media. This system

employs a dip probe, which is inserted within the porous media. At the probe's tip, incoming light interacts with gas-phase ozone and is partially reflected back into the probe by a mirror attached to the tip. Calibration of the FOTDP system was successfully carried out with various ozone concentrations using a column packed with glass beads. The FOTDP system worked well for in situ monitoring of gas-phase ozone in a column packed with sand under various water saturations.

A LC/MS Multi-Analyte Screening Method for Deleterious Organics in Water

Krol, Jim and Joe Romano (Waters Corporation, Milford, MA); Lawrence Zintek (EPA Region 5 Laboratory, Chicago, IL). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Homeland Security Presidential Directive HSPD-9 mandates that the EPA Office of Water expand monitoring and surveillance systems for recognizing a terrorist attack, or a significant change in water quality, such as the presence of deleterious organics. The ability to screen for numerous organics simultaneously would help maximize efforts to determine the presence and significance of poisonous agents. It will require a broad analytical approach strategy utilizing the specificity of liquid chromatography/mass spectrometry (LC/MS and LC/MS/MS). Many of these organics are not amenable to gas chromatography/mass spectrometry (GC/MS). Universal detection with high sensitivity is needed for multiple analytes, including explosives and perchlorate. For non-MS detection methods, analyte resolution is critical for identification and quantification; however, the capability of MS to detect a single m/z (molecular weight/charge) gives analyte detection specificity that does not require chromatographic resolution. Thus, a universal reversed phase gradient providing a degree of analyte separation coupled with the specificity of mass spectrometry allows for screening for multi-analytes simultaneously. The authors discuss the development of a single multi-analyte screening strategy for several pesticides and herbicides in drinking water using HPLC/electrospray mass spectrometry.

Measurement Uncertainty of Activated Charcoal and Alpha-Track Indoor Radon Detectors

Mushrush, G., D. Mose, and F. Simoni, George Mason Univ., Fairfax, VA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

When a home is purchased, it may be tested for indoor radon. EPA protocol recommends using a short-term (2 to 7 day) device like a container of activated charcoal, and the indoor radon concentration should be less than 4 pCi/L. When a home is tested because long-term (i.e., many years) occupancy is likely, the test is commonly done using a long-term (3-month) device like a container of film that can record the alpha tracks generated by radon and its immediate radioactive decay products. For long-term occupancy, EPA recommends that the indoor radon concentration be less than 2 pCi/L. In a study of the indoor radon in over 1000 homes, using both short-term (3-day) activated charcoal detectors and long-term (3-month) alpha-track detectors, at the 70% confidence level when trying to estimate the average indoor radon over an entire year,

an uncertainty of +/- 90% had to be applied to single activated charcoal detectors and +/- 30% to single alpha-track detectors.

Methodology for Integrating Direct Sensing Tools With In-Situ Remediation Injection Technology to Facilitate Effective Treatment of Groundwater

Cooper, E. (Univ. of Illinois/Vironex, Inc., Golden, CO); T. Hanna and F. Stolfi (Vironex, Inc., Santa Ana, CA). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster presentation.

To deliver reagents to the subsurface effectively, the location of contaminant mass in relation to lithology must be determined. The membrane interface probe (MIP) is a direct-push applied sensing tool that simultaneously measures soil conductivity and volatile organic compounds. Once contaminant mass has been identified, a reagent delivery strategy is developed to maximize reagent distribution, radius of influence, and injection rates, as well as to optimize project costs. Delivery of reagents into the saturated zones is accomplished through direct-push technology or injection wells. Injection is facilitated through a wide range of injection pumps and other delivery techniques. Distribution of reagents, radius of influence, and injection rates are directly affected by the hydraulic conductivity and heterogeneity of the target interval. The authors present a new methodology that utilizes site characterization data obtained with the MIP and integrates this soil conductivity and contaminant mass information into injection strategies, delivery techniques, and equipment selection for a wide range of chemical oxidation and bioremediation reagents, contaminants, and site subsurface conditions.

Microbial & Molecular Techniques to Evaluate In-Situ Biodegradation Potential and Activity at Sites Contaminated with Aromatic and Chlorinated Hydrocarbons

Henkler, H. Christoph and Frank P.M. Karg.

INTERSOL Conference on Soil, Sediment and Water, 2003

To implement in situ bioremediation successfully to clean up a site, it is necessary to investigate the potential of the indigenous microbial population to degrade the contaminants of concern. The evaluation of naturally-occurring degradative activity in initial screening of soil and groundwater samples using recently developed molecular and microbial methods may allow for contaminant reduction and management without the need for fully engineered remediation intervention. Limited engineering approaches (e.g., nutrient delivery) can be implemented to support naturally occurring biodegradation processes and achieve a controlled, dynamic attenuation of contaminants. Techniques for monitoring pollutant-degrading microorganisms were previously limited to standard culturing techniques. More recently, techniques based upon detection of genetic elements and metabolic activities have been developed in Europe in collaboration with university partners, especially in France. The modern techniques are more sensitive for monitoring microbial populations, metabolic activity, and the genetic potential to degrade contaminants, thereby avoiding the need for cultivation of microbes under artificial conditions in the laboratory. These modern tools and approaches have been applied successfully at several field sites for the evaluation, implementation, and ongoing monitoring of the attenuation of various aromatic and chlorinated compounds.

Microbial Incorporation of ^{13}C -Labeled Acetate at the Field Scale: Detection of Microbes Responsible for Reduction of U(VI)

Chang, Y.-J. (Univ. of Tennessee, Knoxville), P.E. Long, R. Geyer, A.D. Peacock, C.T. Resch, K. Sublette, S. Pfiffner, A. Smithgall, R.T. Anderson, H.A. Vronis, J.R. Stephen, R. Dayvault, I. Ortiz-Bernad, D.R. Lovley, and D.C. White.

Environmental Science & Technology, Vol 39 No 23, p 9039-9048, 2005

A field-scale acetate amendment experiment was performed in a contaminated aquifer at Old Rifle, CO, to stimulate in situ microbial reduction of U(VI) in groundwater. Acetate labeled with C-13 was introduced into well bores via bio-traps containing porous activated carbon beads (Bio-Sep(R)) to evaluate the microorganisms responsible for microbial uranium reduction during the experiment. *Geobacter* dominated in downgradient wells closer to the acetate injection gallery, while various sulfate reducers were prominent in different downgradient wells, which is consistent with the geochemical evidence of Fe(III) , U(VI) , and SO_4^{2-} reduction. The direct application of C-13 labeling to biosystems, coupled with DNA and PLFA analysis (combining detailed taxonomic description with a quantitative measure of metabolic diversity), allowed investigators to identify the metabolically active portion of the microbial community during reduction of U(VI) .

Modelling and Interpretation of Gas Detection Using Remote Laser Pointers

Hodgkinson, J. (Advantica, Loughborough, UK); B. van Well and M. Padgett (Glasgow Univ., Glasgow, UK); R.D. Pride (Advantica, Loughborough, UK).

Spectrochimica Acta A: Molecular and Biomolecular Spectroscopy, Vol 63 No 5, p 929-939, Apr 2006

The authors have developed a quantitative model of the performance of laser pointer-style gas leak detectors, which are based on remote detection of backscattered radiation. The model incorporates instrumental noise limits, the reflectivity of the target background surface, and a mathematical description of gas leak dispersion in constant wind speed and turbulence conditions. Optimum instrument performance and limits of detection in simulated leak detection situations have been investigated. The optimum height for instruments is estimated to be at eye level or above, giving an operating range of 10m or more for most background surfaces, in wind speeds of up to 2.5m/s. For ground-based leak sources, laser pointer measurements are dominated by gas concentrations over a short distance close to the target surface, making their readings intuitive to end users in most cases, which is consistent with the results of field trials.

Molecular Tools for Assessing the Bioremediation Potential in Organohalogen-Contaminated Sites: Strategy to Detect Reductive Dehalogenase Genes

Regeard, C. and C. Delbes (Ecole Polytechnique Federale de Lausanne, CH), M. Gobel, L. Gorres, D. Janssen, J. Krooneman, J. Maillard, J. Oppentocht, W. Reineke, B.Z. Ruffinen, M. Schlomann, J. Seifert, C. Strompl, K. Szylnsky, M. van der Velde, J. van de Waarde, F. Wettstein, D. Pieper, and C. Holliger. Sustainable Management of Soil and Groundwater in Urban Areas, 2-4 October 2002, University of Mining and Metallurgy, Cracow, Poland. Umweltbundesamt/Federal Environment Agency, Austria. CP-033, p 120-124, 2003

In field situations, stimulated or natural (intrinsic) bioremediation seems to be appropriate for the removal of chlorinated hydrocarbons; however, in practice it is difficult to predict the

bioremediation potential at polluted sites. Effective, easy-to-handle tools are needed to predict and monitor the degradative capacity of microbes within a contaminated environment. These tools should not be dependent on the culturability of the microorganisms of interest but directly assess the gene coding for enzymes that catalyze the key reactions in the degradation pathways of contaminants. Mainly PCR-based techniques have been set up in this project and used for the characterization of samples from different industrial sites contaminated with monochlorobenzene, chloroethenes, and/or chlorinated propenes. Based on various new isolates, scientists have developed PCR primers for reductive dehalogenases and key genes of the aerobic degradation of haloaliphatics and haloaromatics. Those primers have been successfully applied to follow the catabolic state of microbial communities under environmental conditions. The authors present the detection strategy developed for the peculiar case of reductive dehalogenases. http://www.image-train.net/products/papers/CM2_maroc.pdf

Molecularly Imprinted Polymers for Selective Analysis of Chemical Warfare Surrogate and Nuclear Signature Compounds in Complex Matrices

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Journal of Separation Science, Vol 28 No 11, p 1221-1230, July 2005

This paper describes the preparation and evaluation of molecularly imprinted polymers (MIPs) that display specificity toward diisopropyl methylphosphonate (DIMP) and tributyl phosphate (TBP). Polymer activity was assessed by solid-phase extraction and high-performance liquid chromatography experiments. Both DIMP- and TBP-specific vinylpyridine-based MIPs selectively retained their targets relative to a non-imprinted control. Proof-of-principle experiments demonstrated highly selective analysis of the targets from fortified complex matrix samples (diesel fuel, gasoline, and air extract concentrate). The retained MIP fractions gave near-quantitative recovery of the target analytes with very low matrix background content. The same fraction from the control sorbent recovered only about half of the analyte and tended to be less pure.

Molecularly Imprinted Sol-Gel Films for the Detection of TNT

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Abstracts of Papers of the American Chemical Society [229th ACS National Meeting], Vol 229, p U392-U392, 2005

Molecularly imprinted sol-gels films were prepared for use as selective binding matrices for trinitrotoluene (TNT). Imprinting was accomplished using a template molecule of similar chemical structure to TNT covalently linked to the siloxane backbone through a labile bond. The imprinted sol-gel material was deposited as a film onto germanium attenuated total reflectance (ATR) crystals to detect TNT binding by infrared spectrometry. After chemical treatment steps, the imprinted sol-gel films and non-imprinted controls were exposed to TNT solutions. Binding was tested using FT-ATR-IR and measuring the appearance of the peaks due to nitro groups. The experimental results show that molecular imprinting leads to selective binding of TNT.

Monitoring Aerobic Ethene Biostimulation in a Low-Concentration Vinyl Chloride Plume
LeBlanc, C.R. (East Coast Engineering Inc., Marion, MA), S. Fogel (Bioremediation Consulting, Inc., Watertown, MA); J.F. Begley (MT Environmental Restoration, Plymouth, MA).
In Situ and On-Site Bioremediation: the 8th International Symposium, 6-9 June 2005, Baltimore, MD. Battelle Press, Columbus, OH.

A Massachusetts site is affected by a large plume of vinyl chloride (VC) with low concentrations of 2 to 29 ppb. The remediation approach includes in situ aerobic biostimulation using the iSOC(R) system to deliver oxygen and ethene by infusion, plus addition of mineral nutrients. Previous laboratory microcosm studies showed the complete degradation of low levels of VC in contaminated groundwater under ethenotrophic conditions, which suggests that addition of ethene to groundwater in the field might stimulate the growth of ethene-consuming bacteria sufficiently to enable them to biodegrade very low concentrations of VC, as was seen in the microcosm tests. This approach is designed to overcome substrate limited conditions at the site by providing ethene as a co-substrate for growth-coupled complete biodegradation of the contaminant. The monitoring program is designed to evaluate the effectiveness of the delivery of oxygen and ethene gases via the infusion wells as part of the treatment optimization program. Groundwater monitoring includes measurement of dissolved gases, O₂, ethene, and VC, as well as periodic enumeration of ethene-oxidizing and VC-oxidizing bacteria.

Monitoring Bioremediation by In Situ Gene Expression Analysis

Holmes, D.E., R.A. O'Neil, K.P. Nevin, and D.R. Lovley, Univ. of Massachusetts, Amherst, MA. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Researchers evaluated the ability to monitor the in situ metabolic state of the microbial community via mRNA analysis using mRNA extracted from three different subsurface Fe(III)-reducing subsurface environments where Geobacteraceae predominate. In situ gene expression studies were first carried out on three genes that are unique to micro-organisms within the Geobacteraceae: *nifD*, which encodes the dinitrogenase gene involved in nitrogen fixation; citrate synthase, a key enzyme in Geobacteraceae central metabolism that is distinct from other prokaryotes; and *ompB*, a gene with homology to previously described multicopper oxidases that is thought to be involved in the reduction of insoluble Fe(III)-oxides. *nifD* was selected because it has been suggested that there might be a need for nitrogen fixation in acetate-amended or petroleum-contaminated subsurface sediments where the influx of organic carbon into these otherwise nutrient-poor subsurface environments can result in a limitation of fixed nitrogen relative to the availability of carbon substrates. Analysis of levels of *nifD* mRNA in sediments collected from the petroleum-contaminated site did demonstrate that Geobacteraceae were expressing nitrogen fixation genes. Expression of *nifD* was repressed when ammonium was added to the sediments. A diversity of Geobacteraceae citrate synthase, *ompB*, *recA*, and *nifD* genes have also been identified in the three subsurface environment test sites, and their levels of expression have been monitored. BAC and small insert libraries from genomic DNA extracted from these sites are being assembled to identify other significant genes that are unique to the Geobacteraceae for future in situ gene expression studies. These results demonstrate that monitoring the in situ metabolic state of the microbial community as well as estimating rates of metabolism is feasible via mRNA analysis.

Monitoring Subsurface Microbial Ecology in a Sulfate-Amended Gasoline-Contaminated Aquifer

Sublette, K.L. (Univ. of Tulsa, Tulsa, OK); A. Peacock; D.C. White; G. Davis; D. Ogles; D. Cook; X. Yang; D. Beckmann. IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

An unconfined, gasoline-contaminated aquifer (2.3 to 5 m water table) in fractured sedimentary bedrock has been under remediation since 1999 in Bellingham, WA. The central portion of the groundwater plume has been difficult to remediate because of the fractured sedimentary bedrock and the presence of utilities that have prevented the application of aerobic in situ cleanup methods. A 15-month field trial was conducted to determine the efficacy of enhancing the attenuation of BTEX hydrocarbons at the site by continuously amending the aquifer with sulfate, which was initially introduced into the aquifer using an infiltration trench. The goal was to stimulate anaerobic bacteria and enhance dissolved-phase gasoline and BTEX biodegradation rates. The subsurface microbial ecology in the aquifer was monitored during sulfate injection using Bio-Sep(R) bio-traps (Microbial Insights, Inc., Rockford, TN). Sulfate injection was shown to increase the rates of biodegradation of BTEX components more than 2-fold for toluene, for example, and about 5-fold for gasoline-range hydrocarbons. The subsurface microbial community became more anaerobic in character as sulfate utilization increased as indicated by its depletion in the aquifer. Bead biofilms were also compared to planktonic samples from groundwater monitoring wells. During sulfate injection, bead biofilms biomarkers were found to correlate with changes in groundwater geochemistry, while planktonic samples from groundwater remained relatively unchanged over time.

Multi-Parameter Water Monitors for Distribution Systems: Clarion Sensing Systems, Inc. Sentinal(TM) 500 Series Continuous Multi-Parameter Water Quality Monitor. Environmental Technology Verification Report

James, R., A. Dindal, Z. Willenberg, and K. Riggs, Battelle, Columbus, OH.
EPA 600-ETV-06-008, 43 pp, Oct 2005

The Sentinal(TM) 500 is designed to remotely monitor and report drinking water quality. The device uses a sensor array to acquire information about drinking water quality on site in near-real time by analyzing the water quality and comparing it to its normal baseline values. A signal notifies utility/security personnel if water quality changes significantly from baseline. The Sentinal(TM) 500 used in this verification test measured pH, temperature, free chlorine, conductivity, and the ORP of drinking water. The sensors measured these parameters by potentiometric, amperometric, and conductance methods. Performance was assessed in terms of accuracy, response to injected contaminants, inter-unit reproducibility, ease of use, and data acquisition. The verification test was conducted between August 9 and October 28, 2004, and consisted of three stages, each designed to evaluate a particular performance characteristic of the Sentinal(TM) 500. All three stages of the test were conducted using a recirculating pipe loop at the U.S. EPA's Test and Evaluation Facility in Cincinnati, OH.

<http://www.epa.gov/ORD/NRMRL/pubs/index.html>

Multi-Parameter Water Monitors for Distribution Systems: Hach Company Water Distribution Monitoring Panel and the Event Monitor(TM) Trigger System. Environmental Technology Verification Report

Ryan, J., A. Dindal, Z. Willenberg, and K. Riggs, Battelle, Columbus, OH.

EPA 600-ETV-06-006, 66 pp, Nov 2005

This report provides results for the verification testing of the Hach Company Water Distribution Monitoring Panel (WDMP), as well as the Hach Event Monitor(TM) Trigger System (EMTS), in continuously measuring total chlorine, turbidity, temperature, conductivity, pH, and total organic carbon (TOC) in drinking water. The EMTS functions in concert with the WDMP. For the purposes of this report, the astroTOC online ultraviolet (UV) TOC analyzer was considered a part of the WDMP, even though the TOC analyzer is actually a standalone continuous monitor.

<http://www.epa.gov/etv/pdfs/vrvs/600etv06006/600etv06006.pdf>

Natural Gas Pipeline Leak Detector Based on NIR Diode Laser Absorption Spectroscopy

Gao, X. (Chinese Academy of Sciences, Hefei, People's Republic of China), H. Fan, T. Huang, X. Wang, J. Bao, X. Li, W. Huang, and W. Zhang.

Spectrochimica Acta A: Molecular Biomolecular Spectroscopy, 2006 [from pre-publication info]

An integrated natural gas pipeline leak detector has been developed that is based on diode laser absorption spectroscopy. The detector transmits a 1.653um DFB diode laser with 10mW and detects a fraction of the backscatter reflected from the topographic targets. A ratio detection technique was used to eliminate the effect of topographic scatter targets. Wavelength modulation and harmonic detection were used to improve the detection sensitivity. In experiments, the detection limit was 50 ppm, and remote detection for up to 20 m distance from a topographic scatter target was demonstrated. Using a known simulative leak pipe, minimum detectable pipe leak flux is less than 10mL/min.

New Approaches in Data Visualization of LNAPL

Engel, L.B. (The RETEC Group Inc., Atlanta, GA); J.A. Johnson (The RETEC Group Inc., Houston, TX). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

The authors present the use of new approaches and tools to gather, store, and share data, including generation of 3-D GIS, for a site investigation. The site involved the contamination of a variety of constituents of interest and light nonaqueous phase liquids (LNAPL). To evaluate the distribution and migration of LNAPL, model results were applied with ArcGIS and other visualization software to generate 3-D graphics. The tools allowed for a more cost-effective characterization of the contamination and groundwater evaluation. Given the reduced effort required to manage the data, a more detailed and thorough evaluation of the site was possible, thereby eliminating misinterpretations and enabling better communication to stakeholders. Graphical examples are presented to demonstrate the advantages and explain this approach to subsurface investigation.

Newer GPS Technology and Its Application to Improved Site Characterization

Cote, K. (Shaw Environmental & Infrastructure, Stoughton, MA); M. Leipert (U.S. Navy, EFA Northeast, NAVFAC, Lester, PA); K. Creighton (Shaw Environmental & Infrastructure). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

An innovative characterization approach combines global positioning systems (GPS), historical aerial photographs, and Microstation drafting software to determine the present location of a former potential release area. This approach provides an accurate and cost-effective method for determining the correct locations for sampling. Sampling and assessment are straightforward and streamlined by accurate identification of the potential release areas. The following steps comprise the approach: (1) possible locations of staining/spills are identified on historical photographs; (2) benchmark locations to key the historical photographs are identified; (3) the GPS unit utilizes recent field surveys to register the points in the photograph, using drafting and geo-reference software; this manipulated electronic file is then installed in a data-logger within the hand-held GPS unit, which is carried to relative location of the historical aerial photo, where the location of the release can be charted. This is a visual field tool for complicated sites that allows the end user to determine the present location of the former potential spill area depicted on a historical aerial photo in real time. This method can save money by eliminating the repetitive sampling rounds that traditionally occur at many sites. Case studies of the successful application of the method are provided to demonstrate that the use of the methodology can save cost and time while providing sufficient evidence for regulatory concurrence.

Newly Developed Biota- and Biological-Related Standard Reference Materials for the Determination of Organic Contaminants

Poster, D.L., M.M. Schantz, J.R. Kucklick, B.J. Porter, H.M. Stapleton, and S.A. Wise, National Institute of Standards and Technology, Gaithersburg, MD. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Since 1990, the National Institute of Standards and Technology (NIST) has issued cryogenically homogenized tissue standard reference materials (SRMs) with certified and reference values assigned for organic contaminants. The cryogenically homogenized materials are powder-like with the endogenous water retained. A series of natural mussel-tissue SRMs has been developed from mussels collected in Boston Harbor, MA. SRM 1974b is the third and current material in this series and has certified and reference values for a range of polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyl (PCB) congeners (1 non-ortho), total PCBs, chlorinated pesticides, methyl-Hg, Hg, selected trace elements, and total extractable organics. An additional mussel tissue SRM, SRM 2977, is also available as a freeze-dried tissue homogenate prepared from mussels collected in Guanabara Bay, Brazil. Two cryogenically homogenized fish tissue SRMs have been developed from filleted adult lake trout (*Salvelinus namaycush* namaycush)--SRMs 1946 (Lake Superior Fish Tissue) and 1947 (Lake Michigan Fish Tissue)--for a range of PCB congeners, chlorinated pesticides, methyl-Hg, Hg, selected trace elements, fatty acids, calories, and proximates. SRM 1946 was also examined for total toxaphene and toxaphene congeners and SRM 1947 has been examined for selected polybrominated diphenyl ether (PBDE) congeners. Two updated biologically-related SRMs are a cod liver oil SRM, SRM 1588a, and a human serum SRM, SRM 1589a. Two new SRMs for

serum analyses are currently in development: SRM 1957 will be characterized for natural levels of selected PCDDs, PCDFs, PCBs, PBDEs, chlorinated pesticides, toxaphene congeners, polychlorinated naphthalenes, and other halogenated compounds, and SRM 1958 will be characterized for the same suite of analytes, though these compounds will be added to the material. The authors present measurements of organic contaminants in the biota- and biologically-related SRMs with an emphasis on the approach and methods used for the chemical characterization of these natural-matrix SRMs.

A Note on In Situ Estimates of Sorption Using Push-Pull Tests

Cassiani, Giorgio, Lee F. Burbery, and Michela Giustiniani.

Water Resources Research, Vol 41 No 3, p , Mar 2005

A simplified model has been proposed (Schroth et al., 2001) for the interpretation of push-pull tests applied to determine solute retardation properties. The method is based on the approximate analytical solution of the radial dispersion problem presented by Gelhar and Collins, which by default limits the applicability of the method to cases where the distance traveled by the solute is much larger than the aquifer longitudinal dispersivity. In the proposed interpretation method, the aquifer longitudinal dispersivity is estimated from the breakthrough curve of a nonsorbing tracer, and the retardation factor is consequently estimated from the breakthrough curve of an adsorbing solute, using the same dispersivity value. The sensitivity of the parameters and interrelationship that exists between them are as yet uncharacterized. The objectives of this technical note are (1) to investigate the sensitivity of, and assess any correlation that may exist between, the two estimated governing parameters of push-pull sorption studies-- dispersivity and retardation factor--by means of a numerical radial flow model and automated numerical inversion procedure, (2) to compare results obtained with the numerical model with those calculated using the Gelhar and Collins 1971 model to highlight the limitations of the existing interpretation method, which is heavily based on this model, and (3) to develop a modified data interpretation method that uses a type-curve approach to produce more accurate prediction of retardation from push-pull tests.

http://web.engr.oregonstate.edu/~istokj/pdf/Cassiani_et_al_2005.pdf

Novel Helmholtz-Based Photoacoustic Sensor for Trace Gas Detection at ppm Level Using GaInAsSb/GaAlAsSb DFB Lasers

Mattiello, M. and M. Niklesa (Omnisens SA, Lausanne, Switzerland); S. Schilt, L. Thevenaz, A. Salhi, D. Barat, A. Vicet, Y. Rouillard, R. Werner, and J. Koeth.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 63 No 5, p 952-958, Apr 2006 [5th International Conference on Tunable Diode Laser Spectroscopy, 2005]

A compact new photoacoustic sensor for trace gas detection in the 2 to 2.5 μm atmospheric window is based on a Helmholtz resonator and is designed to fully benefit from the highly divergent emission of an antimonide laser. The antimonide-based DFB laser was developed with single-mode emission in this spectral range, and a novel photoacoustic cell was adapted to the laser characteristics. In fabrication, the structure was first grown by molecular beam epitaxy and then a metallic DFB grating was processed. An optimized modulation scheme based on wavelength modulation of the laser source combined with second harmonic detection

has been implemented for efficient suppression of wall noise. Using a 2211 nm laser, sub-ppm detection limit has been demonstrated for ammonia.

Numerical Simulations of Radon as an In Situ Partitioning Tracer for NAPL Quantifying Contamination Using Push-Pull Tests

Davis, B.M., J.D. Istok, and L. Semprini, Oregon State Univ., Corvallis.

Journal of Contaminant Hydrology, Vol 78 Nos 1-2, p 87-103, 2005

Results previously presented by Davis et al. (Davis, B.M., J.D. Istok, L. Semprini. 2002. Push/pull partitioning tracer tests using radon-222 to quantify nonaqueous phase liquid contamination. J. Contam. Hydrol. 58:129-146) have been reinterpreted for push/pull tests using radon as a naturally occurring partitioning tracer for evaluating NAPL contamination. In a push/pull test where radon-free water and bromide are injected, the presence of NAPL is manifested in greater dispersion of the radon breakthrough curve (BTC) relative to the bromide BTC during the extraction phase as a result of radon partitioning into the NAPL. In the laboratory, the previously used modeling approach applied to push/pull tests in a dense or DNAPL-contaminated physical aquifer model resulted in an overestimation of the DNAPL (trichloroethene) saturation (S_n). The authors investigated the influence of initial radon concentrations, which vary as a function of S_n , and heterogeneity in S_n distribution within the radius of influence of the push/pull test. Their simulations showed that these two factors influence radon BTCs and resulting estimates of S_n . This paper presents a revised method of interpreting radon BTCs that takes into account initial radon concentrations and uses non-normalized radon BTCs, producing greater radon BTC sensitivity at small values of S_n . The revised method was used to re-analyze the results from the push/pull tests reported by Davis et al., which resulted in a more accurate estimate of S_n (1.8%) compared with the previously estimated value (7.4%). The revised method was then applied to results from a push/pull test conducted in a light or LNAPL-contaminated aquifer at a field site, resulting in a more accurate estimate of S_n (4.1%) compared with a previously estimated value (13.6%). Though the revised method improves upon the efficacy of the radon push/pull test to estimate NAPL saturations, it requires background radon concentrations from a non-contaminated well in the NAPL-contaminated aquifer to accurately estimate NAPL saturation. The method has potential as a means of monitoring the progress of NAPL remediation.

http://web.engr.oregonstate.edu/~istokj/pdf/David_et_al_2005.pdf

Nylon-Mesh Passive Samplers and 1,4-Dioxane: A Case Study in Fractured Rock in Florida
Linton, J.P. and J.C. Alonso, Blasland, Bouck and Lee, Inc., Tampa, FL. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

First-generation passive diffusion samplers were constructed of polyethylene film filled with laboratory-grade water. They have been proven effective for evaluating concentrations of volatile organic compounds; however, these samplers rely on diffusion across a membrane and are not suitable for other classes of analytes, specifically semi-volatile organic compounds and metals. A new generation of passive samplers using a fine nylon mesh that allows a direct water-to-water interface has shown a potential application to these other classes of analytes. At a

former electronics component manufacturing facility in west-central Florida, a 1,4-dioxane/chlorinated solvent plume is present in the fractured rock aquifer beneath the site. The rock aquifer monitoring wells present at the site were constructed in the early 1990s, generally as open-hole wells with a monitoring interval greater than 50 feet, which limits the understanding of the potential vertical distribution of the contaminants in groundwater. A plan to evaluate vertical distribution using down-hole vertical and horizontal flow measurement and multiple-level sampling with nylon-mesh samplers was presented to the Florida Department of Environmental Protection, and the plan was approved. The authors describe the approach presented to the regulatory agency and the results of the subsequent study.

Optimization of KMnO₄ Injection and Distribution by Color Tracking

Defense Environmental Programs Annual Report to Congress: Fiscal Year 2004 -- Success Stories. Apr 2005

Multiple applications of injected potassium permanganate (KMnO₄) solution were made during in situ remediation of tetrachloroethene (PCE) in groundwater at the United States Air Force Academy in Colorado Springs, CO. Complex hydrogeologic conditions at the site presented challenges for predicting injected KMnO₄ distribution in the aquifer. These challenges were addressed by using groundwater color tracking and mapping with data acquired from KMnO₄ application to optimize injection and distribution for the second KMnO₄ application. During the first application, a 1% KMnO₄ solution was injected via direct push into closely spaced, variable-depth injection locations. Groundwater samples for color observation were collected from monitoring wells bi-weekly for 14 weeks after injection. During this monitoring period, water within the wells generally changed from dark purple to light pink or clear, indicating KMnO₄ was being consumed, diluted, and transported with groundwater. Color samples collected during the monitoring period were used to create a computer-generated color ramp scale using geographic information systems. This color ramp provided qualitative concentrations of KMnO₄ in samples collected from the monitoring wells. Color contour maps provided a simple method of interpreting KMnO₄ distribution after the first application and were used to optimize the plan for KMnO₄ injection and distribution during subsequent applications. Results to date indicate most of the PCE has been neutralized. Site closure is expected shortly.

An Overview of the Hydraulic Testing of the Final Fuel Spill-1 Remedial System Design at Massachusetts Military Reservation

Citterman, R.J. (CH2M Hill, Otis ANGB, MA), J. Glass, F. Lewis, J. Dalrymple, and P. Clement; J. Schoolfield (AFCEE, Otis ANGB, MA). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst. Poster presentation.

As a result of historic fuel spills dating back to the 1950s at the Massachusetts Military Reservation, a plume of ethylene dibromide-contaminated groundwater extends for more than a mile southeast of the facility. This plume, designated Fuel Spill-1, is detached from its source area and is migrating in a southerly direction, terminating at the Quashnet River and surrounding cranberry bogs. The flow of the Quashnet River increases two to three times as a direct result of groundwater discharge to the river and surrounding bog ditches. Groundwater fate and transport modeling was used in the design of groundwater remedial system for the FS-1 plume.

Subsequent hydraulic testing of the remedial system has been performed to verify the effectiveness of the system design at meeting the remedial objectives. During hydraulic testing, changes in the groundwater and surface water levels in response to various pumping stresses are monitored. The resulting data provide insights regarding aquifer hydraulic properties, the spatial influence of the remedial pumping, and the nature of groundwater and surface water interactions. The testing data are also used in conjunction with the groundwater fate and transport model to delineate the capture zones of the remedial system's extraction wells, and to compare actual conditions with the predicted conditions of the original wellfield design. The hydraulic data are also used to optimize the operation of the remedial system and the effectiveness and efficiency of the hydraulic and chemical monitoring network. In this way, the groundwater restoration timeframe is minimized and potential impacts to local ecosystems (i.e., excessive drawdown of groundwater) are eliminated.

Passive Vapor Sampling: Advances in Vapor Concentration Capabilities

Hodny, J.W. and H.S. Anderson II, W. L. Gore & Associates, Inc., Elkton, MD. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Passive sampling techniques present an effective alternative to active methods for sampling vapors in the vadose zone, beneath building slabs, in crawlspaces, and in other indoor and outdoor air environments. Most passive techniques are simple to install and operate, require no energy, and have no mechanical parts, so field sampling errors are therefore minimal. The sorbent-based, vapor-permeable membrane sampler has been recognized for more than a dozen years as an accurate investigative tool for site assessment. As compared to discrete matrix sampling and active vapor sampling methods, the sampler is known to exhibit a greater sensitivity to a broader range of compounds while minimizing field sampling errors. Recently, methods to report organic vapor data in the parts per trillion range have been developed and applied to this vapor-permeable membrane sampler. To provide an accurate estimate of the volume of air the sampler encounters, investigations have been performed to determine the sampler uptake rate. This presentation offers a status update on the properties of the vapor permeable membrane sampler, with the research and development of the vapor concentration capabilities and comparable datasets.

Perchlorate in Water: A Comparison of Methods 314.0 and 332.0

McLean, S., J.F. Occhialini, A. Jones, and J. Todaro, Alpha Analytical Labs, Westborough, MA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

The current accepted method for low-level analysis of perchlorate, EPA 314.0, utilizes an ion chromatograph fitted with a conductivity detector and a suppressor to reduce interference from background contaminants; however, this method encounters problems in the presence of elevated sample conductivity. An alternative method, EPA 332.0, which utilizes an IC fitted with an MS or MS/MS, has been developed to address these problems. The MS technology allows detection of perchlorate to sub-ppb concentrations even in the presence of high concentrations of

interferents. The authors present method qualification data, as well as real-world sample data from both methods. Comparison of real-world data from samples with high conductivity demonstrate the capability of Method 332.0 to accurately and precisely quantitate perchlorate at or below the current draft MCLs.

Plume Delineation and Monitoring of Natural Attenuation Processes via In Situ Flux Measurement

Tartre, Andre, EcoRemediation Inc., Burlington, VT. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Research has been conducted in Canada to develop an innovative sampling technique for petroleum-contaminated sites. This new method quantifies the rate at which vapors or gases are "produced" during a particular period of time under specific conditions of ventilation. The new proposed sampling technique involves purging the soil with a non-contaminated gas 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 this stabilization period, the purge is reduced or halted. Rebounds after the purging period indicate if petroleum products 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, and investigation wastes are almost eliminated. This approach has been further developed for the saturated zone; rebounds are used to locate chlorinated solvent pockets or to estimate in situ flux rates of oxygen and biogenic gases. Field data are presented.

A Practical Approach to Distinguishing Vapor Intrusion Indoor Air Impacts from Background Last, Adam J., Corporate Environmental Advisors, West Boylston, MA. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. Association for the Environmental Health of Soils, Amherst, MA.

When the potential for the migration of volatile organic compounds from contaminated soil, groundwater, or soil gas into indoor air has been identified, the following three steps are typically taken consecutively: field screening of soil vapor from probes, laboratory analysis of soil vapor from probes, and laboratory analysis of indoor air samples. Based on site-specific information, steps may be skipped, added, or combined. This presentation introduces vapor intrusion assessment methods that may be used to distinguish between indoor air contaminants that are attributable to vapor intrusion and those that are attributable to background sources. Numerous background sources of volatile organic compounds (VOCs) are present in residential, commercial, and industrial buildings, which makes assessing and remediating the source of contaminants in indoor air a complex problem. Combined assessment and data evaluation techniques can help to determine if the contaminants detected in indoor air are attributable to the release being assessed. In distinguishing vapor intrusion indoor air impacts from background, the author considers tracer gases, seasonal fluctuations, comparing indoor air data to soil vapor data, and establishing and interpreting ratios of indoor air data to soil vapor data. The topic is illustrated with a case study.

Preliminary Knowledge Base of the Association between Molecular Techniques and Other Site Parameters for Better Evaluating Reductive Dechlorination Potential

Davis, G., A. Peacock, D. Ogles, D. McElroy, and J. Streufert, Microbial Insights, Inc., Rockford, TN. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

Research conducted to understand the microbiology of reductive dechlorination has led to the isolation of genera known to dechlorinate (e.g., Dehalococcoides, Dehalobacter) as well as the isolation of specific functional genes (tceA, BAV1) associated with certain steps in the dechlorination process. Recently, modern molecular techniques (such as Bio-Dechlor CENSUS(SM)) have been applied to quantify the abundance of specific bacterial groups involved in reductive dechlorination and also to quantify functional genes of interest. Microbial Insights is creating a database that includes these microbial indicators, with associated contaminant concentrations and other geochemical parameters that could provide essential information for effective site management and decision-making. Preliminary results on the distribution of known dechlorinating bacteria in association with other site specific parameters have been combined into this Knowledge Database. This presentation identifies the trends that have been observed thus far, based on data from over 1,000 samples from a wide range of sites.

Push-Pull Tests Evaluating In Situ Aerobic Cometabolism of Ethylene, Propylene, and cis-1,2-Dichloroethylene

Kim, Y. (Korea Univ., Choong Nam, Korea); J.D. Istok and L. Semprini (Oregon State Univ., Corvallis). Journal of Contaminant Hydrology, Vol 82 No 1-2, p 165-181, 5 Jan 2006

In situ aerobic cometabolic transformations of ethylene, propylene, and cis-1,2-dichloroethylene (c-DCE) by microorganisms stimulated on propane were examined in groundwater contaminated with c-DCE and trichloroethene (TCE). Field push/pull tests provided in situ measurements. The tests involved the injection of site groundwater amended with a bromide tracer and combinations of propane, dissolved oxygen (DO), nitrate, ethylene, propylene, c-DCE, and TCE into existing monitoring wells and sampling the same wells over time. Mass balance and transformation rate calculations were performed after adjusting for dilution losses using measured tracer concentrations. Initial rates of propane utilization were very low, but the rates increased substantially following sequential additions of propane and DO. The injected ethylene and propylene were transformed to the cometabolic byproducts ethylene oxide and propylene oxide, whereas these transformations were inhibited in the presence of co-injected acetylene, a known monooxygenase mechanism-based inactivator. These results suggest that a series of push/pull tests performed with nontoxic chemical probes can be useful for detecting and monitoring in situ aerobic cometabolism of chlorinated aliphatic hydrocarbons.

http://web.engr.oregonstate.edu/~istokj/pdf/Kim_et_al_2006.pdf

Push-Pull Test Evaluation of the In Situ Aerobic Cometabolism of Chlorinated Ethenes by Toluene-Utilizing Microorganisms

Azizian, M.F., J.D. Istok, and L. Semprini, Oregon State Univ., Corvallis.

Water Science & Technology, Vol 52 No 7, p 35-40, 2005

Single-well, push-pull tests were conducted in a contaminated aquifer to evaluate the ability of toluene-oxidizing microorganisms to cometabolize chlorinated aliphatic hydrocarbons (CAHs), such as trichloroethene (TCE). Biostimulation tests were performed by injecting a test solution containing dissolved toluene substrate, hydrogen peroxide, bromide, and nitrate to increase the biomass of toluene-utilizing microorganisms. The single-well tests demonstrated the stimulation of indigenous toluene-utilizing microorganisms in a CAH-contaminated aquifer. Activity tests demonstrated the stimulation of microorganisms that had CAH transformation potential. Isobutene was an effective reactive surrogate, with isobutene oxide easily detected as a cometabolic transformation product. Evidence that injected toluene stimulated organisms with the ortho-monooxygenase enzyme system was provided by the oxidation of injected isobutene to isobutene oxide and by the inhibition of toluene and isobutene oxidation in the presence of a coinjected 1-butyne inhibitor. Evidence was also obtained for the in situ transformation of injected cis-DCE and trans-DCE, but not TCE. The results demonstrated that push-pull tests can be used to evaluate the potential for in situ cometabolic metabolism of chlorinated ethenes.

http://web.engr.oregonstate.edu/~istokj/pdf/Azizian_et_al_2005.pdf

Push-Pull Tests to Quantify In Situ Degradation Rates at a Phytoremediation Site

Pitterle, M.T., R.G. Andersen, J.T. Novak, and M.A. Widdowson, Virginia Polytechnic Inst. and State Univ., Blacksburg.

Environmental Science & Technology, Vol 39 No 23, p 9317-9323, 1 Dec 2005

A creosote-contaminated site in Oneida, TN, has been the subject of extensive monitoring and research since the installation of 1,146 hybrid poplar trees for a phytoremediation study in 1997. Nine push-pull tests were performed to determine in situ aerobic respiration rates at the site and to assess the contribution of hybrid poplar trees to the remediation of polynuclear aromatic hydrocarbons in ground water. The push-pull tests were conducted by injecting reactive tracers (a solution containing dissolved oxygen and naphthalene) with a nonreactive tracer (bromide) into wells constructed in a shallow unconfined aquifer. The tracer study was conducted to determine seasonal variation and spatial differences (contaminated versus uncontaminated areas and treed versus untreed areas) in the rate of consumption of dissolved oxygen. First-order aerobic respiration rates varied from 0.0 in a control well to 1.25/hr at a planted area in early summer. Rates measured in winter at treed areas were greater by a factor of 3 to 5 when compared to winter rates determined at nontreed areas of the site. Rates at treed regions were found to increase more than 4 times in summer relative to winter at the same location.

http://web.engr.oregonstate.edu/~istokj/pdf/Pitterle_et_al_2005.pdf

Quantitative Detection of and Bioaugmentation with Reductive Dechlorinators

Koenigsberg, S.S. and E. Rasch, Regenes Bioremediation Products, San Clemente, CA. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

With the discovery that the microorganisms responsible for the complete biodegradation of chlorinated solvents may not be present at all sites, bioaugmentation with mixed cultures capable of degrading a wide range of contaminants is now being successfully used in the field to increase the rate of reductive dechlorination and reduce the time that it takes to obtain site closure. By using a "differential diagnosis" approach, bioaugmentation can be used to close sites that may otherwise not have achieved complete reductive dechlorination within a reasonable time frame. Real-time polymerase chain reaction (RT-PCR) is a technique in which the number of organisms in a sample can be determined by measuring the amount fluorescence of produced during the PCR reaction. Available commercially as Bio-Dechlor CENSUS(SM), this technique is now being used not only to determine if the necessary microorganisms are present within the aquifer in the appropriate numbers and whether the addition of external organisms is required, but also to track the changes induced in the microbial community by the addition of a carbon source or the addition of organisms. Recent advances in this technology have allowed functional genes to be targeted, or gene sequences that are specific to organisms able to perform the desired reductive dechlorination tasks, as opposed to only genes on the 16S rRNA sequence that are common to all organisms with this phylogenetic group. DNA-based methods such as denaturing gradient gel electrophoresis (DGGE) and lipid analyses such as phospholipid fatty acid analysis (PLFA) can also be used to observe the effects of bioaugmentation or biostimulation on the microbial community as a whole, often more quickly than the effects of the application can be observed through VOC analysis only. The integration of these techniques and others into existing monitoring programs provides a greater understanding of what is occurring within the subsurface.

The Rapid Detection of Methyl tert-Butyl Ether (MtBE) in Water Using a Prototype Gas Sensor System

de Lacy Costello, B.P., P.S. Sivanand, N.M. Ratcliffe, and D.M. Reynolds, Univ. of the West of England, Bristol, UK. Water Science & Technology, Vol 52 No 8, p 117-123, 2005

Methyl tert-butyl ether (MTBE) is the second most common contaminant of groundwater in the United States and represents an important soil contaminant as a result of leaking underground fuel storage facilities (gasoline storage tanks and pipelines). The ability to detect MTBE at low levels (ppb) and on line at high-risk groundwater sites is highly desirable. The authors report the use of commercial and metal oxide sensor arrays for the detection of MTBE in drinking and surface waters at the low ppb level (ug/L range). The output responses from some of the sensors were found to correlate well with MTBE concentrations determined under laboratory conditions.

Rapid-MS Chromatography and Tandem Mass Spectrometry for Trace Determination of Brominated Flame Retardants

Brittian, Robert, Varian, Inc., Walnut Creek, CA. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Polybrominated diphenyl ethers (PDBEs) have been widely used since the 1960s as flame retardants in a variety of products, such as clothing, furniture, carpets, electronic components, and plastics. This presentation describes a sensitive and selective method for the detection of PDBEs in environmental and food samples that involves the use of a column known as Rapid-MS combined with tandem mass spectrometry. Rapid-MS vacuum chromatography accomplishes efficient transfer of even the heaviest deca-BDE into the mass spectrometer while maintaining excellent chromatographic resolution in a very short run time. Traditional selected ion monitoring methods are very sensitive, but lack the ability to separate the target compounds from complex matrices. Tandem ion-trap mass spectrometry ensures that complex matrix interferences are eliminated, providing accurate quantitation at sub-pg detection limits.

Real-Time DNAPL Source Delineation Using the Triad Approach

Singletary, M.A., M.J. Maughon, and M.R. Keisler, Southern Division, Naval Facilities Engineering Command, North Charleston, SC. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

A focused, real-time investigation of a dense nonaqueous phase liquid (DNAPL) source zone was conducted at the Solid Waste Management Unit 1, Naval Air Station Pensacola, FL, which had received industrial waste from painting and electroplating operations in the 1950s and '60s. Chlorinated solvents, including trichloroethene (TCE), were released to the subsurface from drying beds used to dewater sludges generated by wastewater treatment processes, and the presence of DNAPL is suspected as disconnected residual at the base of the unconfined aquifer, 40 to 44 feet below ground surface. In 1998-99, 10,000 gallons of hydrogen peroxide/iron catalyst solution were injected into the aquifer as part of a strategy to reduce TCE levels below the default natural attenuation concentrations established by the state regulatory agency. Within two years of hydrogen peroxide injection, TCE concentrations rebounded to initial levels. It appeared that poor remedy performance was due to incomplete characterization of the DNAPL source zone, as well as to the short-lived nature of the oxidant solution. A focused characterization study was planned using the Triad Approach as guidance. A direct-push rig equipped with a membrane interface probe (MIP) for DNAPL detection and an electrical conductivity detector for soil stratigraphy mapping were used to delineate the zone of DNAPL residual. The number and location of data collection points were decided by a team of scientists and engineers as the investigation progressed based upon the collection of real-time data and a continuously updated conceptual site model. Following the initial MIP survey, a mobile laboratory, capable of producing data of quality equal to that of a fixed-base laboratory, was used to collect confirmation samples during the same mobilization. By combining the use of field analytical techniques with more traditional fixed-based laboratory methods in a single field mobilization, the DNAPL source zone was delineated at considerable cost savings, while still achieving project data quality objectives.

Real-Time Measurement of Radionuclides in Soil: Technology and Case Studies
The Interstate Technology & Regulatory Council (ITRC) Radionuclides Team.
RAD-4, 177 pp, Feb 2006

This technical overview describes field instruments, data collection approaches, and real-time measurement technologies used in site characterization, remediation, and closure. Regulatory and stakeholder issues have emerged from the limited number of deployments of real-time measurement systems. Real-time measurements have become widely accepted for characterization and remedial phases at most sites; however, the use of these technologies has generally not been allowed for final certification purposes. While the physical sampling and statistical analyses performed for non-radionuclides have well-established protocols that are familiar to most regulators and stakeholders, the protocols and data presentations for real-time radiological surveys are not. Communicating to stakeholders the results from these surveys and the associated risks will require explanations different than those used for traditional sampling techniques. Real-time radiological data collection techniques have now been used at several sites so that the collected experiences can be evaluated for future users. Case studies document the applications of the detectors on various platforms, on various terrains, measuring different contaminants in combination with dynamic work plans. These case studies confirm that cost savings can be realized by utilizing real-time survey methods in characterization, remediation, and verification phases of the cleanup process.

http://www.itrcweb.org/Documents/RAD_4Web.pdf

Reductive Dechlorination of the Vinyl Chloride Surrogate Chlorofluoroethene in TCE-Contaminated Groundwaters

Ennis, E., R. Reed, M. Dolan, L. Semprini, J. Istok, & J. Field, Oregon State Univ., Corvallis. Environmental Science & Technology, Vol 39 No 17, p 6777-6785, 30 July 2005

Quantitative tools are needed to determine the in situ rates of vinyl chloride (VC) transformation to ethene in contaminated groundwater. Single-well push/pull tests were conducted at a TCE-contaminated field site by injecting E-/ Z-chlorofluoroethene (E-/ Z-CFE) as a VC surrogate and monitoring for the formation of fluoroethene (FE) over a period of up to 80 days. The rates for VC transformation to ethene and E-CFE transformation to FE were within a factor of 2.7 for laboratory microcosm systems and all preferentially transformed E-CFE over Z-CFE. The in situ rates of FE production from injected E-CFE in the field ranged from 0.0018 to 1.15 uM/day, while the in situ rates of E-CFE disappearance ranged from 0.17 to 0.99 uM/day. No significant Z-CFE transformation was observed in field tests, which indicated preferential utilization of E-CFE over Z-CFE under in situ field conditions. The study results indicate the potential of E-CFE as a surrogate for estimating the in situ rates of VC transformation.

http://web.engr.oregonstate.edu/~istokj/pdf/Ennis_et_al_2005.pdf

Remote Telemetry Board Performance

Sitkoff, Susan, BEM Systems, Inc., Orlando, FL. The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

A remote telemetry board was installed on an existing horizontal and vertical air sparge system to notify personnel immediately when the system falls out of normal operating ranges and to allow personnel to reprogram or restart the system remotely. After installation, analysis of the

system performance parameters indicates that the PLC board has had the additional benefits of improving system efficiency and effectiveness. Since the implementation of the PLC board, the system ware has run more consistently and shows an increase in VOC degradation in this vicinity. Remote operation and monitoring has decreased labor costs for the system, as unscheduled site visits are no longer required to check on operation or to inspect the system after a failure. Operation and maintenance have been performed on the system for 3 years. Initially, the system operated with one 2-inch leg and one 3-inch leg running in tandem. The airflow was manually changed from the sets of legs on a rotating basis and the system ran with each set of legs operational for 24 to 48 hours. After the implementation of the remote board, the run time for the legs was reduced to 4 hours. The pressure required to overcome the groundwater infiltration into the air pathways after 24 to 48 hours of non-operation previously resulted in stress to the system. Since the installation of the remote telemetry board, a steady decline in the airflow has been observed, consistent with the required vane replacements that have been scheduled on a quarterly basis. The shorter run time has minimized system stress and enabled it to run more efficiently.

A Review of Field Technologies for Long-Term Monitoring of Ordnance-Related Compounds in Groundwater

MacMillan, D.K. and D.E. Splichal, U.S. Army Engineer Research and Development Center, Vicksburg, MS. ERDC/EL TR-05-14, 60 pp, Sep 2005

This technical report identifies proven and promising sampling devices and on-site analytical instrumentation that could be used now for long-term monitoring (LTM) of ordnance-related compounds (ORCs) in ground water. Of the many field analytical technologies available commercially, not all are appropriate for meeting the needs of LTM for ORCs. Appropriate instrumentation must be sufficiently sensitive to detect analytes of concern at action levels and must have excellent precision and accuracy to meet data quality requirements. Instrumentation for LTM must provide rigorous qualitative as well as quantitative identifications, although sites under LTM are presumably so well characterized that some leeway is possible in the steps toward qualitative analysis. For example, systems known to have chromatographic co-elutions may be acceptable for LTM if one of the co-eluting compounds is known not to be present at the site. The report addresses the following general categories of technologies applicable to volatile organic chemicals and organic ORCs: water quality monitors associated with low-flow purge techniques, discrete interval samplers, immunoassay for detection of explosives, chemical sensors, colorimetric technologies, and gas chromatography, mass spectrometry, and ion mobility spectrometry with liquid compatible inlets. This report is not exhaustive in that some technologies fitting the above categories may not be included; however, inclusion or inadvertent oversight of any instrumentation or technology does not represent positive or negative bias toward the technology. In addition, the report does not discuss technologies that are intended for detection of metals and inorganic compounds or solely for volatile organic compounds.

<http://el.erdcl.usace.army.mil/elpubs/pdf/trel05-14.pdf>

Review of Recent Research on Vapor Intrusion

Tillman, Fred D. and James W. Weaver, National Exposure Research Laboratory, Athens, GA.
EPA 600-R-05-106, 47 pp, Sep 2005

Intrusion of contaminated vapors into buildings can provide a significant pathway for exposure to hazardous contaminants. Assessment of this problem is difficult, because of limitations of sampling methodologies, contamination in ambient air, internal sources and sinks of contaminants, and uncertainty in model application. The information in this report is intended to provide a background for future work that addresses the complexities of this problem. This review begins with a description of the challenges in evaluating the subsurface to indoor air pathway, followed by a discussion of the fate and transport mechanisms affecting vapors along this pathway. A brief overview of current federal regulations and proposed guidance concerning vapor intrusion, a review of vapor intrusion studies from scientific literature, a survey of published approaches to vapor intrusion modeling, and conclusions and ideas about future research needs comprise the remainder of the report.

<http://www.epa.gov/athens/publications/reports/Weaver600R05106ReviewRecentResearch.pdf>

Rosemount Analytical Model WQS Continuous Multi-Parameter Water Quality Monitor: Environmental Technology Verification Report

James, R., A. Dindal, Z. Willenberg, and K. Riggs, Battelle, Columbus, OH.
EPA 600-ETV-06-009, 43 pp, Oct 2005

The WQS unit measures pH, oxidation-reduction potential, conductivity, temperature, and free chlorine in drinking water. The system combines user-specified instruments and sensors to create a customized system for monitoring water quality. The WQS unit does not need added reagents and uses minimum process flows of less than 183 milliliters per minute. The WQS unit uses three basic electrochemical principles of operation: millivolt measurements for pH and ORP, conductance/resistance measurements for conductivity, and amperometric/polarographic measurements for chlorine residuals. The WQS unit continuously monitors each parameter to provide constant surveillance of water quality events to ensure that acceptable water quality conditions are maintained. The performance of the WQS unit was assessed in terms of its accuracy, response to injected contaminants, inter-unit reproducibility, ease of use, and data acquisition. The verification test was conducted between August 9 and October 28, 2004, and consisted of three stages, each designed to evaluate a particular performance characteristic of the WQS unit. All three stages of the test were conducted using a recirculating pipe loop at U.S. EPA's Test and Evaluation Facility in Cincinnati, OH.

<http://www.epa.gov/etv/pdfs/vrvs/600etv06009/600etv06009.pdf>

Sensor Application of Fibre Ultrasonic Waveguide

Lee, Jung-Ryul and Hiroshi Tsuda.

Measurement Science Technology, Vol 17, p 645-652, 2006

The authors discuss the development of a new ultrasonic waveguide and its application as an environmental sensor. The ultrasonic waveguide uses an optical fiber and piezoelectric transducers and has been demonstrated in a few promising applications, i.e., for liquid leak detection, liquid evaporation monitoring, and resin front sensing. The fiber waveguide affords

notable advantages, such as long-distance monitoring, minimally invasive probing, and cost-effective implementation.

Significance of Changes in 2005 NELAC/USEPA Proficiency Testing Requirements

Carter, M.J., J. Lowry, and S. Kassner, Environmental Resource Associates, Inc., Arvada, CO. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

There have been many recent changes in the proficiency testing (PT) requirements with which laboratories must comply to become accredited. In 1998, USEPA published a Criteria Document that established PT requirements for the potable and non-potable water analytes that the Agency included in their historical PT programs, i.e., organic and inorganic chemistry, microbiology, radiochemistry, and whole effluent toxicity. NELAC established requirements for additional potable and non-potable water analytes in water and requirements for RCRA solids. In 2004, the NELAC program was split into laboratory accreditation standards development (INELA) and regulatory standards adoption (NELAC). A Proficiency Testing Board, with state and EPA participation, was established to set PT policy. Working under the PT Board, a broadly-based subcommittee (Fields of Proficiency Testing) worked to resolve issues with the historical PT requirements and establish expanded FoPTs to better respond to laboratory accreditation needs. In November 2004, NELAC published a major revision to the PT requirements that must be implemented by June 1, 2005. For the potable and non-potable water programs, both "Accreditation" and "Experimental" tables of analytes and PT requirements were established. The significance of the two sets of tables are discussed and the list of PT analytes is compared to those regulated or required by major state and federal programs. The authors discuss the significant changes in sample design requirements, reporting, and acceptance limits, and address the expected impact on laboratory PT data quality expectations and pass/fail rates.

Social Paper Wasps as Bioindicators: a Preliminary Research with *Polistes dominulus* (Hymenoptera Vespidae) as a Trace Metal Accumulator

Urbini, A., E. Sparvoli, and S. Turillazzi, Univ. degli Studi di Firenze, Firenze, Italy. Chemosphere, 6 Jan 2006

Paper wasps of the genus *Polistes* are distributed world-wide and are commonly found in human-built areas. Like other social wasps, they are high in the insect food chain and are therefore exposed to the dangers of biomagnification because the larvae are fed predominantly with herbivorous insects. From the analysis of sample nests of *Polistes dominulus* in various sites of the urban area of Florence, investigators found that the larval fecal masses provide an analytical substrate from which it is possible to distinguish zones with differing degrees of lead pollution. The lead concentration measured in the larval fecal masses turns out to be directly correlated with vehicle traffic density, the main lead source in Florence at the time the survey was carried out. The notable increase in the lead concentration of larval fecal masses from the rural to the urban nest (11.15 times), in contrast with the much more limited level of pupae (4.39 times), seems to indicate the efficiency of the excretion and/or barrier mechanisms. These wasps seem to be a promising species for biomonitoring lead pollution.

Soil Characterization Under an Operating Facility: An Innovative Approach

Kaback, D.S. (Geomatrix Consultants, Inc., Denver CO); M. Frank (Fluor Fernald, Cincinnati, OH); R. Johnson (Argonne National Lab., Argonne, IL); D. Ombalski (Directed Technologies Drilling, Boalsburg, PA). The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Closure of DOE's Fernald facility near Cincinnati, OH, involves removal of all above-ground structures by 2006. The preferred approach for the Transfer Tank Area Building may involve leaving the building slab in place as a cost-effective alternative. To consider this option, characterization of the soils immediately under the slab to assess soil contaminant levels against final remediation levels (FRLs) for uranium, thorium, and radium had to be completed. If the soil did not meet FRLs, an estimate of the volume of soil requiring on-site disposal was wanted to facilitate the closure planning process. Because vertical drilling through the foundation could not be done due to the presence of large tanks occupying most of the building's floor space, and angle drilling could not provide samples at multiple locations immediately beneath the foundation, horizontal directional drilling was deemed to be the only practical alternative for collection of core samples. A statistically designed sampling plan for locating the boreholes and discrete sampling points called for collection of 16 1-foot core samples, four from each of four boreholes at the target depth of ~6 inches beneath the foundation (approximately 3.5 feet below ground surface). A Vermeer 16x20 horizontal drilling rig was used to collect the samples from locations as far as 200 feet from four different launching points in clay and silty clay soils. The project was successfully completed in nine days at a cost significantly less than the original estimate, proving the value of this technology for a specific application where site access is a particular challenge. Sample analysis indicated that a few sample results (<3%) were slightly above the soil FRLs for two contaminants. The remediation plan for this area is yet to be determined.

Stable Isotope Analysis in Remediation of Gasoline Oxygenates and Hydrocarbons

Kuder, Tomasz and Paul Philp, Univ. of Oklahoma, Norman.

IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

This presentation summarizes progress in compound-specific isotope analysis applied to remediation of gasoline-range contaminants. The authors identify three complementary sets of results: 1) carbon and hydrogen isotope composition of individual compounds in fresh gasoline to provide a benchmark for degradation studies; 2) microcosm evaluation of isotope effects caused by biodegradation; 3) detection of biodegradation in the field based on the changes of carbon and/or hydrogen isotope ratios of contaminants. The two latter topics focus on MTBE and TBA, while fresh gasoline characterization also includes the aromatic fraction (benzene to methylnaphthalenes). Newly analyzed field sites yielded strongly enriched isotope ratios in MTBE, and a few of them indicate that TBA may be also biodegraded as suggested by isotope ratios enriched in C-13. The field data were used to screen candidates for microcosm studies. Microcosm work has been initiated to collect isotope fractionation data on MTBE biodegradation by diverse anaerobic cultures and to confirm TBA biodegradation potential and determine the magnitude of associated isotope effects. Better definition of the magnitude of isotope

fractionation by anaerobic MTBE (and possibly TBA degraders) will be useful for improving the precision of in situ application of compound-specific isotope analysis.

Stable-Isotope Probing: An Emerging Molecular Tool to Identify "Who's Doing What" in Complex Microbial Communities

Aitken, M.D., D.R. Singleton, and S.N. Powel (Univ. of North Carolina at Chapel Hill); R. Frontera-Suau, Elizabeth City State Univ.).

2005 AEESP Research and Education Conference, 23-27 July 2005, Clarkson University, New York.

Stable-isotope probing (SIP) is an emerging tool that can connect an uncultivated organism with its function in a complex system, specifically by identifying those organisms capable of utilizing a particular carbon source. When a microbial community is incubated with a C-13-labeled carbon source, any organism that assimilated the labeled carbon will contain C-13-labeled macromolecules, including nucleic acids. The C-13-enriched nucleic acids can be separated from the unlabeled nucleic acids associated with the remaining organisms by density-gradient ultracentrifugation. Once physically separated, the "heavy" nucleic acid can be evaluated by conventional molecular techniques. This presentation focuses on potential applications of SIP in environmental engineering. Two applications from the authors' own work will be discussed to illustrate its use. In the first application, SIP has been used to identify the organisms capable of degrading polycyclic aromatic hydrocarbons (PAHs) in a lab-scale bioreactor treating contaminated soil from a former manufactured-gas plant site. Groups of organisms primarily responsible for degrading naphthalene, phenanthrene, and pyrene appear to be unique to the compound, with little overlap between compounds. The two most dominant organisms associated with pyrene degradation in the bioreactor are not closely related to any previously cultivated organism. In the second application, SIP was incorporated into a project that involved operating a chemostat inoculated with activated sludge from a municipal wastewater treatment plant, with phenol as a sole carbon source. SIP was among the set of analytical and molecular methods incorporated in the project, and it showed that even with a single carbon source, a microbial community is surprisingly complex. Extensions of SIP beyond identifying specific organisms, such as isolating genes that code for specific enzyme activities, are also discussed.

Study of an Inexpensive Device Using Anodic Stripping Voltammetry to Detect Heavy Metals

Dauchez, Arnaud and Tom L. Fisher, Juniata College, Huntingdon, PA.

229th ACS National Meeting, 13-17 March 2005, San Diego, CA. American Chemical Society Division of Chemical Education: Abstracts, No 361.

Anodic stripping voltammetry (ASV) can detect heavy metals at the sub parts-per-million level; however, the cost of commercial instruments has placed ASV in competition with spectroscopic methods with which it compares unfavorably in terms of speed of analysis (~6 min per run) and number of elements detectable (~10). The authors have developed a device that is readily transportable, easy to use, maintenance-free, and very inexpensive (~\$250 including electrodes but not the required PC). This system compares favorably to environmental test kits in terms of reliability, detection limit, accuracy, and precision.

Sub-ppm Multi-Gas Photoacoustic Sensor

Besson, Jean-Philippe, Stephane Schilt, and Luc Thevenaz, Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 63 No 5, p 899-904, Apr 2006

The authors report on a photoacoustic multi-gas sensor using tuneable laser diodes in the near-infrared region and describe an optimized resonant configuration based on an acoustic longitudinal mode. The device is capable of automatic tracking of the acoustic resonance frequency using a piezo-electric transducer and servo electronics. Water vapor, methane, and hydrogen chloride have been measured at the sub-ppm level in different buffer gas mixtures. The paper describes the use of this sensor for trace gas measurements.

Technology Overview of Passive Sampler Technologies

The Interstate Technology & Regulatory Council (ITRC) Diffusion Sampler Team.

DSP-4, 115 pp, Mar 2006

This document presents technical overviews of 12 passive sampling technologies. It describes each technology's basis of operation, intended applications, advantages, limitations, and development status. Contacts for additional information are provided. This overview is an outgrowth of interest and information generated in preparation of ITRC's 2004 "Technical and Regulatory Guidance for Using Polyethylene Diffusion Bag Samplers to Monitor VOCs in Groundwater." While the initial focus was on passive sampling of groundwater monitor wells, many of the technologies are applicable to surface water and/or vapor as well. Though not a comprehensive overview of all passive sampling technologies, this report will be of interest to those concerned with the development and use of passive sampling devices. A summary table highlighting the important attributes of each technology, including appropriate analytes, availability, and cost information, follows the 12 individual text descriptions.

http://www.itrcweb.org/Documents/DSP_4.pdf

Testing, Modeling, and Monitoring to Enable Simpler, Cheaper, Longer-Lived Surface Caps

Piet, S.J., R.P. Breckenridge, D.E. Burns, et al., Idaho National Engineering and Environmental Laboratory (INEEL), Idaho Falls, ID.

Waste Management 2003, 23-27 February, Tucson, Arizona. 19 pp, 2003

A project team is developing a Barrier Improvement Cycle (iterative learning and application) to enable Remediation System Performance Management (doing the right maintenance neither too early nor too late). The knowledge gained and the capabilities built will help verify the adequacy of past remedial decisions, improve barrier management, and enable improved solutions for future decisions. It will be possible to develop simpler, longer-lived, less expensive caps that are easier to monitor, manage, and repair. The project is planned to a) improve the knowledge of degradation mechanisms in times shorter than service life, b) improve modeling of barrier degradation dynamics, c) develop sensor systems to identify early degradation, and d) provide a better basis for developing and testing of new barrier systems. This project combines selected exploratory studies (benchtop and field scale), coupled effects accelerated aging testing at the intermediate meso-scale, testing of new monitoring concepts, and

modeling of dynamic systems. The emphasis on meso-scale (coupled) tests, accelerated effects testing, and dynamic modeling differentiates the project from other efforts, while simultaneously building on that body of knowledge. The performance of evapotranspiration, capillary, and grout-based barriers is being examined. The authors report on developing new approaches to the problem, building new experimental and modeling capabilities, and a few preliminary results. <http://www.wmsym.org/abstracts/2003/pdfs/512.pdf>

The TIGER Biosensor: Applications in Biodefense, Epidemiology and Infectious Disease Surveillance

Hofstadler, S.A., K.L. Hari, and D.J. Ecker, Isis Pharmaceuticals, Carlsbad, CA. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

The TIGER (Triangulation Identification for Genetic Evaluation of Risk) biosensor provides a novel and universal strategy for the detection and characterization of microorganisms associated with a potential biological warfare attack or a natural outbreak of an emerging infectious disease. The process uses mass spectrometry, signal processing, and base composition analysis of PCR amplification products from biologically conserved regions of microbial genomes to simultaneously identify the organisms present in a sample without the need for culture. The sample can be derived from air filtration devices, clinical samples, or other sources. Core to this approach are "intelligent PCR primers" that target broadly conserved regions of microbial genomes that flank variable regions. TIGER requires no prior knowledge about an organism to identify it in a sample. The approach requires that high-performance mass measurements be made on PCR products in the 80 to 140 bp size range in a high-throughput, robust modality. The base compositions from multiple primer pairs are used to triangulate the identity of the organisms present in the sample. Use of species-specific primers allows rapid strain-typing of the organism. The concept is equally applicable to bacteria and viruses and could be further applied to fungi and protozoa. The use of biologically essential gene targets to obtain microbe signatures enables the high-probability detection of both natural and bioengineered agents. Excellent performance is demonstrated even in the presence of a significant "clutter" of background organisms. Preliminary results are presented on testing normal drinking water for the presence of biological threat agents. Another study is described that demonstrated that TIGER can be used to detect and identify infectious agents directly from throat swabs. In the present configuration, hundreds of samples can be analyzed within 12 hours, allowing near real-time evaluation of patient samples. The use of "drill down" primers allows closely related strain variants to be distinguished and accurately identified.

TraceDetect Wins 'New Technology' Award for Automated Arsenic Analyzer Water & Wastes Digest, 30 Aug 2005

TraceDetect, Inc., an analytical instrumentation company specializing in products that measure trace metals, earned the People's Choice Award for the "most useful new or improved product" at the ACE'05 Annual Conference of the American Water Works Association (AWWA). The SafeGuard automated arsenic analyzer garnered the top prize in the New Product Technology Showcase at the San Francisco conference held in June. SafeGuard is an automated analyzer with the accuracy required to meet the EPA established arsenic limit for drinking water.

Water quality analysts are accustomed to waiting two weeks for arsenic analyses from off-site labs. SafeGuard displays test results on site in 30 minutes, measuring total arsenic down to 1 ppb without requiring a chemist to operate the instrument and interpret the results.

Tree Coring for Ground-Water Contaminant Tracking and as an Optimization Tool for Monitoring-Well Placement

Vroblesky, D.A. (U.S. Geological Survey, Columbia, SC); C.C. Casey (Southern Division Naval Facilities Engineering Command, Charleston, SC); G.J. Harvey (U.S. Air Force Aeronautical System Center, Wright Patterson AFB, OH). NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Trichloroethene (TCE) was detected in cores of trees growing above TCE-contaminated groundwater in a variety of environments, including the foothills of the Rocky Mountains, a golf course in Texas, pine forests in South Carolina, and a cypress swamp in South Carolina. The data show that tree coring can be used to locate TCE-contaminated groundwater, and in some cases, to map the lateral extent. Tree coring can also be a useful reconnaissance tool for optimizing well placement. Solid Waste Management Unit 17, Naval Weapons Station Charleston, SC, is in a forested area between two tidally influenced surface-water bodies. The dominant tree species is loblolly pine. Three exploratory monitoring wells at the site showed the presence of chlorinated-solvent contaminated groundwater. Tidal influences on the water table made it difficult to predict the probable transport direction of the contamination, and hence difficult to place additional wells to map the plume. To provide a preliminary assessment of the extent of contamination and aid in well placement, 63 trees were cored at the site and analyzed using photoionization detection gas chromatography to determine the TCE, PCE, and cis-1,2-dichloroethene (cDCE) content of the head space in sealed serum vials that contained the cores. Most of the cores were collected on a single day. The tree coring showed the presence of two apparently separate plumes of subsurface contamination, one predominantly composed of TCE and the other of PCE. The tree-coring results were used to direct a subsurface investigation with membrane interface probes. Contaminant concentrations from the groundwater samples showed good correspondence with the TCE, PCE, and cDCE concentrations in the tree cores, thus demonstrating that tree coring can be a fast and inexpensive reconnaissance tool to locate and map volatile organic compounds in contaminated groundwater and to optimize placement of monitoring wells.

Uncertainty and the Johnson-Ettinger Model for Vapor Intrusion Calculations

Weaver, J.W. and F.D. Tillman, National Exposure Research Laboratory, Athens, GA. EPA 600-R-05-110, 43 pp, Sep 2005

Intrusion of contaminated vapors into buildings can provide a significant pathway for exposure to hazardous contaminants. Assessment of this problem is difficult because of limitations of sampling methodologies, contamination in external ambient air, internal sources and sinks of contaminants, and as discussed in this report, uncertainty in model application. The work described in this report is intended to set the stage for more widespread application of uncertainty analysis in site assessment, and to provide readily available tools to streamline the required calculation. The Johnson-Ettinger Model is widely used for assessing the impacts of

contaminated vapors on residential air quality. Typical use of this model relies on a suite of estimated data, with few site-specific measurements. Software was developed to provide the public with automated uncertainty analysis applied to the model. (Tools available at <http://www.epa.gov/athens/onsite>) An uncertainty analysis was performed on the model that accounted for synergistic effects among variable model parameters. This analysis showed that a simple one-at-a time parameter uncertainty analysis provides a rough guide for the uncertainty generated by individual parameters and allows their ranking. The one-at-a-time analysis, however, underestimated the uncertainty in the model results when all or groups of parameters were assumed to be uncertain. An apparent increase in simulated cancer risk caused by the uncertainty introduced from the input parameters was as much as 1,285%. The model response to the input parameters showed that for the example studied, there was a positive skew in the model response to parameter variation.

<http://www.epa.gov/athens/publications/reports/Weaver600R05110UncertaintyJohnsonEttinger.pdf>

Use of a GIS-Based Site Conceptual Model for Site Characterization, Regulatory Interaction and Feasibility Analysis, Harbor Point MGP Site, Utica, NY
Ashley, E. and A. Daxikar (Camp Dresser & McKee Inc, Cambridge, MA); T. Young (Niagara Mohawk, Syracuse, NY). The 20th Annual International Conference on Soils, Sediments and Water, 18-21 October 2004, University of Massachusetts at Amherst.

A geographic information system (GIS) can be used to assimilate, evaluate, and present large amounts of data from multiple investigations and can facilitate site characterization, interactions with regulators, and remedial feasibility study analysis. For a large manufactured gas plant site in New York, a GIS-based conceptual site model was used to describe the distribution of constituents of concern in various media, the interrelationships of three Operable Units, and to identify, evaluate, and recommend remedial alternatives. This presentation describes the challenges of this specific site, the goals of the conceptual site model, the process of creating the GIS, the GIS capabilities, and how it was used to advance the remedial process.

The Use of Direct-Push Well Technology for Long-Term Environmental Monitoring in Groundwater Investigations

Interstate Technology and Regulatory Council (ITRC) Sampling, Characterization and Monitoring Team. SCM-2, 102 pp, Mar 2006

This technical/regulatory guidance presents detailed information related to direct-push well technology. The text contains a description of direct-push well technology; identifies equipment and installation requirements, known regulatory barriers and concerns, technology advantages and limitations, and health and safety issues; discusses stakeholder involvement; and compares data between direct push and conventionally drilled wells for contaminant detection and water level measurements as obtained from case studies. This document is intended to provide the information required to make an informed decision regarding the use of direct-push wells for long-term groundwater chemistry monitoring and for static ground water levels.

http://www.itcreweb.org/Documents/SCM_2_ForWeb.pdf

The Use of Field Portable X-Ray Florescence (XRF) to Evaluate Lead in Soil

Zdeb, Thomas F. (URS Woodward Clyde, Santa Ana, CA); Diana F. Clark (PCR Mobile Laboratories, San Marcos, CA). The 13th Annual West Coast Conference on Soils, Sediments and Water, 17-20 March 2003, San Diego, California. Abstracts. The Association for Environmental Health and Sciences, Amherst, MA.

The use of field-portable X-ray florescence (XRF) analyses (EPA Method 6200) can provide essentially real-time information regarding the concentrations of many metals of environmental concern, such as lead in soil. Use of field-portable XRF can accelerate investigations related to concentrations of metals in soils because conventional laboratory turn-around time is effectively eliminated. And because the results of properly conducted field-portable XRF analyses are accepted by many, if not most regulatory agencies, the need for further confirmatory laboratory analyses may be substantially reduced and/or eliminated. A case study is presented that includes the results of over 200 soil samples analyzed for lead to depths of 6, 12, and/or 24 inches around eight homes built between 1930 and 1950 in Southern California. The use of multidepth sample locations at multiple distances from the structure allowed 3-D characterization of the lead concentrations to be completed. Selected samples containing concentrations of lead above 255mg/Kg were also sent to a fixed laboratory for confirmatory analyses by either EPA Method 6010B or 7421. The results of soils analyzed with the XRF compared favorably to the results of soil samples analyzed by the stationary laboratory, showing an overall correlation coefficient of approximately 0.90.

Use of Non-Standard Mass Spectrometric Techniques to Solve Analytical Problems for Emerging Contaminants

Burrows, Richard, Severn Trent Laboratories, Arvada, CO. NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

Analysis of low levels of some emerging contaminants in complex matrices can be challenging, and in some cases requires the use of more advanced mass spectrometric techniques to assure sufficiently low quantitation limits and freedom from matrix interference. This presentation provides the following examples: N-nitrosodimethylamine by GC/chemical ionization MS/MS, explosives by LC/MS/MS, PBDEs, and PFOA. Limitations of the standard methods along with performance details of the new methods are presented.

Use of Respirometry to Determine Metal Toxicity Through Measurement of Hydrogen Consumption by Sulfate Reducing Bacteria in the Presence of Heavy Metals.

Tabak, H., E. Holder, M. Kupferle, and J. Haines, U.S. EPA. Fourth SETAC World Congress, 25th Annual Meeting in North America, 14-18 November 2004, Portland, Oregon. Society of Environmental Toxicology and Chemistry, Pensacola, FL. Abstract 306, 2004

Acid mine drainage (AMD) poses a severe pollution problem. The metals of concern found in AMD are arsenic, cadmium, aluminum, manganese, iron, lead, zinc, and copper, and the inorganic contaminant in the acidic waste is sulfate. A unique biological method was developed to treat acid mine water present in the Berkeley Pit in Butte, MT, as well as to recover metal resources from such acidic mine water pits. The biotreatment of AMD and the metal biorecovery and recycle process is based on complete separation of the biological sulfate reduction step resulting from the activity of hydrogen-consuming sulfate-reducing bacteria (SRB), from the

metal precipitation step. Hydrogen sulfide produced in the SRB membrane bioreactor systems is used in the metal sequential separation and precipitation step to form insoluble metal sulfides and hydroxides. U.S. EPA research studies have shown that the heavy metals as ions or metal sulfides in the acidic wastes are toxic and inhibitory to SRB. A respirometric procedure was developed to determine the toxic and inhibitory effects of the heavy metals on the hydrogen-consuming SRB by quantitatively measuring the hydrogen utilization by SRB in the presence of AMD heavy metals. Respirometers (NCON Systems, Inc.) were adapted to measure H₂ uptake by SRB in presence of various metal concentrations. Respirometric studies undertaken to measure toxicity and inhibition of the heavy metals zinc, copper, and iron to H₂-consuming SRB showed that zinc has an inhibitory effect on SRB between 10 and 25 ppm and copper is inhibitory at 17 ppm. Iron, as ferrous or ferric species, was found not to be toxic at concentrations up to 400 ppm. In experiments combining Fe (200 ppm) with Cu, the sensitivity of the SRB to Cu was decreased such that inhibition occurred at 7 ppm instead of 4 ppm.

Use of SPME/GC to Monitor the Progress of Phytoremediation of a Site Contaminated by Chlorinated Organic Compounds

Sytsma, L.F., N. Bosch, J.F. Schneider, M.C. Negri, and R.R. Hinchman, Argonne National Lab., Argonne, IL. PITTCON 2001, 5-8 March 2001, New Orleans, Louisiana.

Phytoremediation uses green plants to clean up contaminated sites. In this process, plants send roots down into the contaminated zone, and the roots take up and thus remove the contaminant in the soil solution. Uptake and subsequent translocation of the contaminant within the plant is driven by transpiration. Certain plants have also been demonstrated to degrade the contaminant into a less-volatile compound, such as trichloroacetic acid. Leaves of trees grown in areas with groundwater and soil contaminated by chlorinated hydrocarbons were analyzed for trichloroethene, perchloroethene, chloroform, carbon tetrachloride, and trichloroacetic acid. Different solid-phase microextraction (SPME) fibers were tested with a gas chromatograph (Hewlett-Packard 5790 Model II plus) equipped with electron capture detection. The results are compared with those obtained from automated headspace analyses (using a Hewlett Packard 19395A Headspace Analyzer) with the same gas chromatograph. The SPME method demonstrated several advantages. For example, some fibers showed a 30-fold increase in sensitivity compared with the use of the automated headspace analyzer. The increased sensitivity allowed minor amounts of additional compounds to be identified by gas chromatography/mass spectroscopy. And because the SPME field sampler is portable, air around the plant could be analyzed to detect compounds emitted via evapotranspiration as that process occurred. Some interfering spurious peaks found when samples were analyzed using the head-space sampler were not present when the SPME method was used.

Using Waterproof, Vapor Permeable Membrane Samplers for Groundwater Sampling: Delivering Groundwater Data Without Collecting a Water Sample

Hodny, J.W. and W.M. Wells, II, W.L. Gore & Associates, Inc., Elkton, MD. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

The more common diffusion-based sampling devices are generally effective in collecting and reporting non-water soluble volatile organic compounds, but they can be cumbersome to handle, may require costly field sampling time, and can be prone to collection errors and sampling variability. In 2002, a sorbent-based passive diffusion sampler constructed of waterproof, vapor-permeable membrane was verified by the U.S. EPA Environmental Technology Verification program for volatile compound monitoring in groundwater applications. Renewed research and development efforts and laboratory and field sampling experiments have demonstrated that this sampler can detect 1,4-dioxane and other water-soluble compounds, plus compounds in the volatile and semi-volatile range. The ability to report the data in units of concentration has been investigated with promising results. This presentation discusses the recent sampling results and concentration capability development efforts to demonstrate that accurate and reliable groundwater data can be acquired without collecting a water sample.

Utility of Lipid Biomarkers in Support of Bioremediation

Ringelberg, Dave and Mike Reynolds, US Army ERDC-CRREL, Hanover, NH.

IPEC 2005: 12th Annual International Petroleum Environmental Conference, 7-11 November 2005, Houston, TX. [abstract only]

Lipid biomarker analysis is a valuable component in testing the hypothesis that attributes of the extant microbiota can directly reflect the occurrence of contaminant biodegradation. In a past effort, dredged harbor sediment contaminated with polycyclic aromatic hydrocarbons (PAHs) was removed from a confined treatment facility and examined for biodegradative capacity. By integrating analytic chemistry, microbiology, and molecular biology techniques, the successional characteristics of indigenous microbes were determined and related to the contaminant profile. PAH loss was preceded by a shift in the microbial phenotype and genotype toward one conducive to PAH biodegradation. In another past effort, a 50-year-old diesel fuel oil contamination plume was assayed via the co-recovery of petroleum hydrocarbons and bacterial membrane phospholipids in a single organic solvent extraction. Two areas within the plume showed a significance loss in TPH, increased mineralization activity (^{14}C -phenanthrene) and phospholipid fatty acid patterns that were similar to each other and significantly different from those throughout the remainder of the core. Current research is using lipid biomarkers to measure the humification potential of nitro-amines, as well as the possibility that cell/cell signaling may be involved in contaminant biodegradation.

A Vadose Zone Soil Gas Sampler: Its Design, Implementation and Performance

Wong, Tai T. and John G. Agar, O'Connor Associates Environmental Inc., Calgary, Alberta, Canada. The 21st Annual Conference on Contaminated Soils, Sediments and Water, 17-20 October 2005, University of Massachusetts at Amherst. The Association for the Environmental Health of Soils, Amherst, MA.

Potential indoor air quality impacts can be assessed by collecting air samples indoors and submitting them for laboratory chemical analyses; however, indoor air quality is often affected by VOC vapors released indoors by cigarette smoke, building materials, and household solvents and thus may not be a reliable indicator of the presence of vapors resulting from subsurface contamination. An indirect method of assessment consists of sampling soil gas near the basement or ground floor slab of a building and using transport modeling to estimate soil gas flow rates

and VOC flux into a building. The VOC flux concentration is then used to evaluate the potential human exposure to soil or groundwater derived VOCs and estimate the associated human health risks. The soil gas transport model most commonly used is an axisymmetric analytical model: the Johnson and Ettinger model. O'Connor Associates uses a soil gas sampler (SGS) and sampling procedures specifically designed for collecting representative soil gas samples in the vadose zone adjacent to a building basement or a ground floor slab. Using the SGS and a vacuum canister, a constant volume of representative soil gas can be collected at a fixed location for every sampling event. To more accurately simulate soil gas transport, a 3-D finite element soil gas transport code has been adapted to study the influence of such factors as soil type, degree of saturation, sampler volume, sampling rate, proximity to the building structure, and atmospheric pressure variations. The results are then used to evaluate the design requirements and performance of the SGS. This paper presents analytical results for samples collected from indoor air, sub-slab backfill, and SGSs and compares them to predicted sub-slab and indoor VOC concentrations.

Validation of a New Soil VOC Sampler: Performance of the En Core Sampler at -7 [degrees] C and -21 [degrees] C and Development of the Accu Core(TM) Subsurface Sampling/Storage Device for VOC Analysis

Sorini, Susan S., John F. Schabron, and Joseph F. Rovani Jr., Western Research Institute. WRI-04-R007, OSTI: DE00833485, 45 pp, 2004

Soil sampling and storage practices for volatile organic analysis must be designed to minimize loss of volatile organic compounds (VOCs) from samples. The En Core(TM) sampler is designed to collect and store soil samples in a manner that minimizes loss of contaminants due to volatilization and/or biodegradation. ASTM D 6418, "Standard Practice for Using the Disposable En Core Sampler for Sampling and Storing Soil for Volatile Organic Analysis," describes use of the En Core sampler to collect and store a soil sample of approximately five grams or 25 grams for VOC analysis. Prior to the study described in this report, D 6418 specified sample storage in the En Core sampler at 4 {+-} 2 degrees C for up to 48 hours; at -12 {+-} 2 degrees C for up to 14 days; or at 4 {+-} 2 degrees C for up to 48 hours, followed by storage at -12 {+-} 2 degrees C for up to five days to minimize loss of volatile compounds due to volatilization and/or biodegradation. The study described in this report was conducted to evaluate the performance of the disposable En Core sampler to store low concentrations of VOCs in soil at -7 {+-} 1 degrees C and -21 {+-} 2 degrees C. Based on new data from the study, a new revision of D 6418 was prepared and balloted in ASTM. The revision, which was approved on February 1, 2004, now specifies sample storage in the En Core sampler at 4 {+-} 2 degrees C for up to 48 hours; -7 to -21 degrees C for up to 14 days; or 4 {+-} 2 degrees C for up to 48 hours, followed by storage at -7 to -21 degrees C for up to five days. The En Core sampler is designed to collect soil samples for VOC analysis at the soil surface. To date, a sampling tool for collecting and storing subsurface soil samples for VOC analysis does not exist. Development of a subsurface VOC sampling/storage device was initiated in 1999. This device, which is called the Accu Core(TM) sampler, is designed so that a soil sample can be collected below the surface using a dual-tube penetrometer and transported to the laboratory for analysis in the same container. Prototype devices have been tested for their performance in storing soil samples containing low concentrations of VOCs. Evaluation of the various Accu Core(TM) prototypes and the design selected for additional validation testing are described in this report.

http://www.osti.gov/bridge/product.biblio.jsp?query_id=3&page=0&osti_id=833485

Vibrational Frequencies and Structural Determination of Dicyanodifluorosulfur
Jensen, James O., U.S. Army, Edgewood Chemical and Biological Center, Aberdeen Proving Ground, MD.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 61 No 11-12, p 2766-2770, Sep 2005

The normal mode frequencies and corresponding vibrational assignments of dicyanodifluorosulfur were examined theoretically using the Gaussian03 set of quantum chemistry codes. Each of the vibrational modes was assigned to one of six types of motion predicted by a group theoretical analysis utilizing the C_{2v} symmetry of the molecule. A set of uniform scaling factors was derived for each type of motion. Predicted infrared and Raman intensities are reported.

Vibrational Frequencies and Structural Determination of Phosphorous Tricyanide
Jensen, James O., U.S. Army, Edgewood Chemical and Biological Center, Aberdeen Proving Ground, MD.

Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy, Vol 60 No 11, p 2537-2540, Sep 2004

The normal mode frequencies and corresponding vibrational assignments of phosphorous tricyanide were examined theoretically using the Gaussian98 set of quantum chemistry codes. Each of the vibrational modes was assigned to one of four types of motion predicted by a group theoretical analysis. A uniform scaling factor was derived for each type of motion. Predicted infrared and Raman intensities are reported.

Water Catchment Areas: Tools for Management and Control of Hazardous Compounds
Track, T. (DECHEMA e.V., Research Co-ordination, Germany), S. Setford, D. Barcelo, J. Wijdenes, P. Werner, H.P. Rohns, E. Hitsch, and A. Brun.

Sustainable Management of Soil and Groundwater in Urban Areas, 2-4 October 2002, University of Mining and Metallurgy, Cracow, Poland. Umweltbundesamt/Federal Environment Agency, Austria. CP-033, p 93-97, 2003

The development and implementation of a coordinated monitoring strategy, linking general early warning pollution sensors (e.g., for hydrocarbons) with quantitative, sensitive, and specific immunoassay test kits (e.g., for BTEX and MTBE) will allow environmental directives and quality standards to be applied and enforced. Beneficiaries include the general population, which is provided with a safer cleaner water product, and water companies, who are able to monitor water quality on a frequent and routine basis. Legislators/enforcers will also have access to the technology and thus would be able to implement stringent programs designed to safeguard the local water resource.

http://www.image-train.net/products/papers/CM2_watch.pdf

Weapons in the New Cold War: Companies Race to Develop Innovative Devices to Thwart Terrorists

Maloney, Lawrence D.

Design News, 21 Nov 2005

Terminology such as backscatter, iris scans, millimeter waves, and "MicroHounds" is just a small sampling of the growing glossary of terms describing a burst of new technology conceived to serve the needs of homeland defense. Companies are moving forward on a range of technologies, from biometrics and bomb detection to video surveillance and RFID. The author briefly discusses some of these sensing innovations.

<http://www.designnews.com/article/CA6282015.html>

When It Comes to Speciation, "To Label or Not To Label? That Is the Question"

Buckley, B., W. Johnson, Q. Tu, E. Fisher, and R. Xie, Rutgers Univ., Piscataway NJ.

NEMC 2005: the 21st Annual National Environmental Monitoring Conference, 25-27 July 2005, Washington, DC. Abstracts.

EPA method 6800 allows the analyst to monitor changes in the chemical species during sample transport, storage, processing and even analysis. Using stable isotopes allows multiple spiking solutions to be added to the sample, each labeling a different chemical species. But what are the limitations to the method? (1) It requires mass spectrometric measurement of each of the chemical species. (2) It is not applicable to analytes with only one isotope (monoisotopic). (3) It can be very expensive to perform. Using recovery percentages is a viable alternative to method 6800 for those who use optically based detection techniques. For the more frugal analyst, it may present an alternative worth exploring and for someone looking at either As or Mn, it is the only way to check for interconversion. The drawback is that it does not allow the analyst to observe species cycling, if it occurs. This presentation focuses on the use of recovery percentages to monitor for species interconversion and its application to arsenic and mercury speciation.

WRI Announces a New Instrument to Screen for Common Contaminants

Western Research Institute News Release, 5 December 2005

Western Research Institute, Laramie, WY, announces that Bacharach Inc. of New Kensington, PA, has acquired a license to manufacture and sell the X-Wand, a hand-held instrument developed at WRI for screening halogenated volatile organic compounds (HVOCs) in soil and water. HVOCs are introduced into the environment through degreasing and dewaxing activities, dry cleaning solvents, aerosol propellants, refrigerants, and fumigants. The patent-pending instrument is expected to provide a quick, reliable and economical method for identifying and measuring this common class of contaminants. HVOC contamination in the United States is widespread at military sites and industrial sites. The VOC field screening tools most widely available today do not specifically detect halogenated VOC pollutants, and those that do require special training and handling. Costs can be prohibitive for portable instruments that accurately identify and measure individual volatile pollutants. X-Wand uses a heated diode sensor, the same type used to detect refrigerant leaks, for rapid evaluation of soil or water. Its detection limit for, trichloroethene (TCE), is about 1 part per billion--comparable to that of EPA-approved laboratory methods. Use of the device is described in the standard method, ASTM D7203. X-Wand requires very little training to use. Bacharach, Inc. designs, manufactures, and services advanced equipment for the measurement and detection of gases and liquids, with sales and service centers in five countries. The X-Wand is expected to be available for purchase in 2006.

SBIR AND OTHER GRANTS

U.S. Department of Energy

Automated Impedance Tomography for Monitoring Permeable Reactive Barrier Health (DOE 2005 SBIR Phase 2)

LaBrecque, Douglas, Principal Investigator, dlabrecque@mpt3d.com

Multi-Phase Technologies, LLC, Sparks, NV 89436; 775-425-9606

DOE Grant DE-FG02-04ER84013

\$651,504

Permeable reactive barriers (PRBs) are an important treatment option for groundwater remediation, but reliable methods are not available to monitor or predict their long-term behavior. The large-scale implementation of reactive barriers will require a means of monitoring their long-term integrity. For example, gaps can occur in the placement of the reactive material, particularly when construction methods such as jetting or deep soil mixing are used. This project will develop a reliable method to verify placement and monitor the effectiveness of permeable reactive barriers. The approach will use arrays of inexpensive electrodes, coupled to autonomously operating hardware and software, to characterize the barrier and determine its effectiveness. In Phase I, column studies using ZVI and apatite PRB materials were performed. Numerical modeling showed that a monitoring configuration, consisting of boreholes spaced at 2 m intervals along the upstream face of the barrier, could be tuned to detect age-spots of 2x3 m in size. Existing instrumentation was modified to provide autonomous operation using solar power, and a reliable, low-overhead protocol for two-way communications was implemented. In Phase II, a full scale field validation for an existing, instrumented PRB will be performed. Web-based, automated geophysical monitoring systems will be enhanced, and software for imaging the temporal signature of an aging PRB will be developed. The automated monitoring system should find use in more than 100 permeable reactive barriers that will have been installed in North America by the time this project is completed.

A Compact WDXRF Analyzer for Real-Time Monitoring of Heavy Metal Contaminants (DOE 2005 SBIR Phase 1)

Gao, Ning, Principal Investigator, ngao@xos.com

X-Ray Optical Systems, Inc., East Greenbush, NY 12061; 518-880-1500

DOE Grant DE-FG02-05ER84308

\$99,964

Existing technologies for long-term and continuous monitoring of heavy metal contaminants in DOE tanks or landfills either have the required detection sensitivity but are not field deployable, or are field deployable but lack the detection sensitivity. This project will develop a compact, multi-element, x-ray analyzer that can perform automatic real-time measurements in the field with a laboratory level of detection sensitivity. The analyzer will be a unique wavelength-dispersive x-ray fluorescence system that employs advanced x-ray optics to significantly enhance system efficiency and thereby achieve superior performance with a low-power x-ray source. A benchtop system will be built in Phase I to experimentally demonstrate the feasibility of the proposed approach. Different samples containing elements of DOE interest

will be analyzed, and the system performance will be evaluated. The analyzer should be a solution for the real-time monitoring of heavy metal contamination in DOE tanks or landfills. The proposed approach also should find application in other environmental-related research and industries, such as metal contamination in soils, subsurface sediments, and groundwater. Additional applications include thin film analysis in the semiconductor industry, industrial process monitoring (for microelectronics, composite, ceramics, etc.), forensics, geochemistry, and medicine.

Development of HydroImage: A User-Friendly Hydrogeophysical Characterization Software Package (DOE 2005 STTR Phase 1)

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Geomatrix Consultants, Inc., Oakland, CA 94612-3027; 303-534-8722. Partnered with Lawrence Berkeley National Laboratory, Berkeley, CA

DOE Grant DE-FG02-05ER86244

\$100,000

Although high-resolution geophysical measurements have been proven to be valuable for characterizing the subsurface at contaminated DOE sites, the data are not yet in routine use. The obstacles are twofold: (1) the potential inconsistency between interpretations of geophysical data and conventional pointwise lithologic and hydrogeologic data, and (2) the lack of comprehensive tools to logically utilize all data to assist in making coherent interpretation. This project will develop a user-friendly software that utilizes state-of-the-art Bayesian estimation and geostatistical methods to facilitate the use of high-resolution geophysical measurements for estimating hydrogeological parameters. Phase I will focus on the development of HydroImage, a software for integrating high-resolution crosshole geophysical tomographic data and borehole hydrogeological measurements. The software will combine the following subsystems to allow an investigator to efficiently and cost-effectively perform data analysis and make coherent interpretations: (1) a user-friendly interface, including visualization and data output capabilities; (2) a geostatistical integration subsystem; (3) a geophysical inversion subsystem; (4) a petrophysical and scale matching subsystem; and (5) a Bayesian integration subsystem.

A Fiber Optic Multipass Raman Probe and Instrumentation for Monitoring Flammable Gases in High Level Waste Tanks (DOE 2005 SBIR Phase 1)

Bello, Job M., PI, bello@eiclabs.com

EIC Laboratories, Inc., Norwood, MA 02062-2612; 781-769-9450

DOE Grant DE-FG02-05ER84278

\$99,974

DOE has 280 underground tanks used to process and store over 90 million gallons of high-level radioactive chemical waste. The conditions in the tanks are conducive to the formation of flammable gases such as hydrogen, ammonia, and methane, as well as fire accelerants (oxidizers) such as nitrous oxide. An accumulation of these flammable gases above their lower flammability limit (LFL) increases the risk of fire and explosion. To mitigate these risks, this project will develop an in situ probe capable of detecting concentrations below the LFL. In particular, a Raman instrument with a fiber optic probe head will be developed for deployment inside the tanks, in order to monitor the concentration of these hazardous gases. In Phase I, an

efficient multipass Raman gas cell will be built that will significantly improve the sensitivity of conventional Raman gas measurements. The cell will be connected via fiber optics to a remote spectrograph/detector. A Raman instrument configuration will be used to determine the cell's ability to detect and monitor the concentration of selected flammable tank gases. In addition to the monitoring of underground tanks, the Raman probe should have commercial applications in air pollution monitoring, where the probe could be used for monitoring the release of hazardous gases from industrial sites for regulatory purposes.

High Resolution Acoustic Solute Transport Sensor (DOE 2005 SBIR Phase 1)

Heyman, Joseph S., Principal Investigator, keena@lunainnovations.com

Luna Innovations Inc., Blacksburg, VA 24060-6657; 540-552-5128

DOE Grant DE-FG02-05ER84286

\$99,993

Many damaging and hazardous organic and inorganic compounds, chemicals, mineral salts, nutrients, radionuclides, and metals are carried in solution into the shallow subsurface system and released into streams. The pathways and extent of contaminant transport in subsurface environment must be determined to guide remediation activities. A vector groundwater flow monitor, tailored for the subsurface geophysics, would validate hydrogeological models and reduce the uncertainty associated with non-invasive, long-term monitoring of contaminant transport parameters. This project will develop an acoustic phase-locked digital system that will enable better than parts-per-million accuracy in seconds of use to determine the Doppler phase shift that accompanies the vector flow of water between two well points. Phase I will design, build, and test a Digital Pulse-Phase Lock loop system for the prediction of flow parameters associated with contaminant transport in subsurface geometries. Laboratory validation tests will be conducted in a simulated field environment. Preliminary field tests will be conducted to prove volume mapping of hydrogeological processes. The shallow water flow monitor should be a valuable tool for remediation efforts, from identifying the need for remediation to the long term monitoring of a site to check for future contamination. Other possible applications include the analysis of deep wells for the disposal of liquid wastes and the monitoring oil wells for contaminants. Knowledge of the transport and dispersion of contaminants would provide timely safety measures in any liquid storage area.

In Situ Optical Monitor for Waste Tank Gases (DOE 2005 SBIR Phase 1)

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DOE Grant DE-FG02-05ER84307

\$100,000

DOE waste storage tanks require continuous monitoring of species in solid, liquid, and gaseous phases. Gas-phase species of interest include ammonia, methane, and carbon dioxide. This project will develop in situ optical sensors that will selectively and sensitively detect these species along with the moisture in the waste tank headspace. The sensors will take advantage of a rugged, compact, path length enhancement method and inexpensive near-infrared lasers. A similar technique will be used to quantify molecular hydrogen in the tank headspace. In Phase I, an optical spectrometer for detection of ammonia, methane, carbon dioxide, and moisture will be

constructed based on a single common sample cell. The sensitivity of the spectrometer for each species will be quantified by concentration challenge experiments. Concurrently, an indirect method for determination of molecular hydrogen concentration will be evaluated. The technology should provide high-performance in a rugged, compact package. The spectrometer can be manufactured inexpensively relative to existing devices of comparable performance. Price, performance, and physical advantages are anticipated for a variety of gas detection applications, including atmospheric monitoring, environmental monitoring, regulatory compliance, process gas analysis, and breath diagnostics.

Multigas Sensor for Waste Monitoring (DOE 2005 SBIR Phase 1)

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Southwest Sciences, Inc., Santa Fe, NM 87505-3993; 505-984-1322

DOE Grant DE-FG02-05ER84303

\$100,000

Storage of radioactive wastes at many DOE facilities generates hazardous and explosive gases. Sensitive and selective monitoring of these gases is required to ensure the safe operation of storage facilities. This project will develop technology for multiple gas measurement using laser absorption spectroscopy. The automated, self-calibrated, and self-checking sensor approach will use no consumable chemicals and require little maintenance. Phase I will identify the best spectral regions for the measurement. Laboratory experiments will be conducted to show the feasibility of obtaining high sensitivity and wide dynamic range. Methods to reduce the sample volume will be investigated. Commercial applications are expected to include hazardous gas detection at industrial facilities, natural gas leak detection, and environmental monitoring for greenhouse gas detection, particle formation, and nitrogen cycle studies.

Novel Fiber Sensors for Contaminant Monitoring Applications (DOE 2005 SBIR Phase 1)

Jiao, Hong, Principal Investigator, h.jiao@lgrinc.com

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DOE Grant DE-FG02-05ER84285

\$99,985

DOE has a need to characterize and monitor the soils, subsurface sediments, and groundwater to determine various contaminant levels. In particular, new in situ technologies are urgently needed to detect, monitor, and quantify gas or liquid contaminants in DOE tanks or landfills. This project seeks to address this problem by using fiber-optics-based sensors, due to their simplicity, miniature size, geometrical flexibility, and low cost. Moreover, their ruggedness enables their possible deployment in harsh environments. In Phase I, a novel cavity-enhanced absorption technique known as Integrated Cavity Output Spectroscopy (ICOS) will be employed to develop a novel fiber based sensor. The sensor will be used to record concentration measurements of multiple gases including ammonia, methane, and carbon dioxide in DOE tanks or landfills. Ultrahigh sensitivity (an enhancement factor up to 10,000) is expected, along with increased accuracy, repeatability, and specificity in real time. In addition to measuring ammonia, methane, and carbon dioxide, this highly sensitive fiber sensor should be extremely well suited for measuring CO₂ and CO₂ isotope ratio in atmospheric research, for monitoring CO and NO in

power plants and chemical plants, and as a multi-species analyzer capable of measuring a wide range of environmentally significant species, including nitrogen compounds, sulfur compounds, ammonia, and dioxins.

Portable Dual Probe XRF and Gamma-Ray Analyzer for Environmental Contamination Monitoring (DOE 2005 SBIR Phase 1)

Feng, Liangyuan, Principal Investigator, larryf@radiantdetectors.com

Radiant Detector Technologies, LLC, Northridge, CA 91324-3576; 818-280-0745

DOE Grant DE-FG02-05ER84297

Amount: \$100,000

DOE requires effective, highly sensitive devices for real-time monitoring of the contamination of soils, subsurface sediments, biofilms, and groundwaters. The devices must be field deployable at low cost with enhanced ability to monitor processes at finer levels of resolution. This project will develop a unique, battery-operated, portable, dual-probe X/gamma-ray spectrometer. The dual probe will consist of a thick silicon multi-cathode detector (TSMCD) and a p-i-n cadmium telluride detector to provide highly efficient, selective, and sensitive detection of all metal and radionuclide contaminants of concern. Phase I will fabricate the two detectors and construct relevant spectrometer packages. Existing laboratory equipment will be used to test and evaluate the detectors against current prevailing technologies. The practical detection limits for all the contaminants will be determined by using standard reference materials. The detection system should open up markets and opportunities in environmental monitoring, process control, mining, geochemical mapping, geological exploration, alloy sorting, and other areas where similar real-time, in situ analyses are required.

Remote In-Situ Monitoring of Metal Contaminants in Groundwater with a Compact Grazing-Incident Monochromatic Microbeam X-Ray Fluorescence Analyzer (DOE 2005 SBIR Phase 2)

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X-Ray Optical Systems, Inc., East Greenbush, NY 12061; 518-880-1500

DOE Grant DE-FG02-04ER84122

\$749,315

Analysis of radionuclide and metal contaminants in groundwater during the monitoring of DOE sites is typically done off-site, using plasma mass spectroscopy or optical emission spectrometry. These analysis techniques are not suitable for automated field use because they require control gas or vacuum to function. A simple, robust, non-destructive analysis technique is required for in situ remote monitoring applications. This project will develop a grazing-incident-monochromatic micro x-ray fluorescence (GI-MMXRF) analysis system that, when combined with an innovative dried spot sample preparation system, will offer high sensitivity and automated sample preparation. The combination of low power GI-MMXRF and ink jet printing technology makes this an approach that can be readily adapted for remote monitoring or in situ applications. In Phase I, a doubly-curved crystal optic was designed for use with an existing x-ray fluorescence analysis setup. A lab setup of the sample deposition system demonstrated GI-MMXRF detection at parts-per-billion (ppb) levels. A detailed conceptual design of a field-deployable system was developed. In Phase II, the optics will be further developed to increase sensitivity and reliability, and system optimization will be performed to decrease system size,

weight, power, and cost. Measurements with contaminated and base ground water samples will be used to demonstrate remote, unattended field operation.

Soil and Subsurface Contaminant Sensor System Based on Self-Sensed Microcantilever Arrays (DOE 2005 SBIR Phase 1)

Whitten, Ralph, Principal Investigator, rwhitten@nevadanano.com

Nevada Nanotech Systems, Inc., 695 Sierra Rose Drive, Reno, NV 89511; 530-368-2870,

<http://www.nevadanano.com>

DOE Grant DE-FG02-05ER84291

\$99,949

In this project, compact, low-cost, low-power arrays of microcantilevers will be integrated into small sensor packages. The sensors will be highly sensitive and selective to mercury vapor and will be integrated into cone penetrometers for soil and subsurface mercury detection. In Phase I, a small array of piezoelectric self-sensing microcantilevers will be field tested to selectively detect mercury vapor in soil. Phase II will integrate an optimized cantilever array design into a cone penetrometer as a single, field-testable system. Low-cost mercury sensors and alarms, designed to perform like smoke sensors or carbon monoxide alarms, should find widespread use by government agencies, corporations with manufacturing operations that involve or release mercury, health and safety personnel such as hazmat teams, police and fire personnel, and corporate and academic safety officers. The sensor system should also be adaptable to sensing other chemicals or chemical mixtures.

Time-Lapse 3D GPR Characterization and Monitoring of Near-Surface Groundwater and Contaminant Flows (DOE 2005 SBIR Phase 1)

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4th Wave Imaging Corporation, Aliso Viejo, CA 92656-9786; 949-916-9787

DOE Grant DE-FG02-05ER84266

\$100,000

Near-surface groundwater and contaminant plumes threaten to contaminate the U.S. potable groundwater supply. Such contaminant plumes need to be located, characterized, and monitored over time to identify situations where remediation is required and to ensure the recovery of contaminants in such operations. This project will utilize ground penetrating radar (GPR) technology to characterize and monitor these contaminant plumes. In Phase I, time-lapse, 3-D GPR imaging of contaminant plumes will be performed, and quantitative estimates of the contaminant properties (e.g., saturation/concentration levels) will be made. A time-lapse synthetic GPR data set will be developed and used to test novel methods for imaging, inversion, and uncertainty analysis of contaminant plume property distributions. Time-lapse seismic data processing and inversion/saturation estimation, already successful in the monitoring of petroleum reservoirs during oil production, will be adapted to the processing and inversion of time-lapse, three-dimensional GPR data for groundwater contaminant applications.

An Ultra-Precise System for Electrical Resistivity Tomography Measurements (DOE 2005 SBIR Phase 1)

LaBrecque, Douglas J., Principal Investigator, dlabrecque@mpt3d.com

Multi-Phase Technologies, LLC, Sparks, NV 89436; 775-425-9606

DOE Grant DE-FG02-05ER84289

\$99,350

One of the most widely used geophysical methods for monitoring flow within the shallow subsurface is electrical resistivity tomography (ERT). The latest generation of ERT systems can monitor data to a precision of around 1%, allowing in situ changes to be interpreted within a few percent. In turn, subsurface temperature changes can be monitored to within a few degrees Centigrade, low levels of tracers--only slightly higher than background variations--can be tracked, and fracture propagation on a site of several thousand square meters can be watched. This project will make the necessary improvements to hardware and data collection procedures to push the current precision of ERT an additional order of magnitude. Phase I will investigate modifications to a number of interdependent systems and explore reductions in both random and systematic noise sources. Random noise will be reduced by implementing long data averaging periods (through the use of autonomous systems) and by improving stacking algorithms to address specific non-stationary noise problems (such as electrode corrosion). Systematic noise will be reduced by improving hardware design at several levels (including isolation of transmitter and receiver paths), improving calibration (using temperature stabilization and higher precision components), and identifying electrode materials that have more stable aging characteristics. The order-of-magnitude improvement in ERT measurement precision should enhance the overall effectiveness in existing monitoring applications without significantly increasing costs.

Using Downhole Probes to Locate and Characterize Buried Transuranic and Mixed Low Level Waste (DOE 2005 SBIR Phase 2)

Steinman, Donald K., Principal Investigator, dksteinman@aol.com

Applied Physics and Measurements, Inc., Missouri City, TX 77459; 281-835-6364

DOE Grant DE-FG02-04ER83902

\$749,907

To safely remove transuranic waste (TRU) and mixed low-level waste buried in the subsurface disposal areas, it is important to anticipate exactly what materials are directly below the surface. This project will develop neutron-based, logging tools that can identify TRU and volatile organic compounds (VOCs) in the vicinity of probe holes, thereby permitting safer retrieval and removal of wastes. Phase I demonstrated that the tools can identify the material, quantify its concentration, and estimate the radial distance to objects. Phase II will (1) modify the tools to perform reliably, (2) characterize the response of the tools to TRU and VOC materials, (3) develop data interpretation methods based on the characterization data, and (4) demonstrate the value to personnel concerned with waste removal. In modified form, these tools should be directly applicable to the metal mining industry as a complement to core drilling.

U.S. Geological Survey Water Resources Research Institute Grants

A Bayesian Framework for Cost Effective Groundwater Monitoring Design (2005 USGS WRI Grant)

Reed, Patrick M., Principal Investigator

Federal Funds: \$18,000 + NF Matching Funds: \$36,000

State Water Resources Research Grant Program, Pennsylvania Project 2005PA43B

Mar 2005 to Feb 2006

The goal of this proposed research is to develop the Adaptive Strategies for Sampling In Space and Time (ASSIST) decision support framework for designing cost-effective long-term groundwater monitoring (LTM) networks. The ASSIST monitoring framework will provide the first adaptive observation system design paradigm that will enhance hydrologic scientists' abilities to (1) balance multiple design objectives while characterizing complex groundwater systems across space-and-time, (2) merge physical model predictions with a broad range of data sources (e.g., indicator contaminant samples, expert knowledge, real-time data series), (3) consider a much broader range of model and data uncertainties, and (4) adapt their objectives and system design to account for advances in real-time sensing. The objectives of this research are to develop the ASSIST methodology to support the cost-effective design of long-term groundwater monitoring networks and to apply the methodology at the Shale Hills experimental watershed located in north central PA within the Valley and Ridge Province of the Susquehanna River Basin. The expected outcome of this proposed research will be a new monitoring design framework that will enhance the ability to cost-effectively characterize the quantity, quality, and susceptibility of groundwater resources within Pennsylvania and throughout the United States. The multiobjective decision support tools will provide stakeholders and policy makers with a better understanding of the value of adding monitoring points into existing networks and allow them to exploit a broader array of information sources. The ASSIST tools will be developed to maximize their general applicability across scientific disciplines, ensuring that they can be used to optimize large-scale investments into a broad array of environmental observation systems (e.g., the CLEANER, CUAHSI, or NEON initiatives).

Detection of E. coli in Source Water Using a Novel Biosensor (2005 USGS WRI Grant)

Cheng, Zhongyang (PI, Auburn Univ.); Tung-shi Huang and Dongye Zhao (Co-PIs).

Federal Funds: \$24,985 + NF Matching Funds: \$49,995

State Water Resources Research Grant Program, Alabama Project 2005AL39B

Mar 2005 - Feb 2006

EPA recommends E. coli as the best indicator of health quality standards. An inexpensive biosensor/technology suitable for field testing is urgently needed for monitoring the quality of source water in real time. Although methods exist for identification of E. coli and many microbial strains in water, determination of the numbers of microbes that actually exist in a given sample still remains a challenge when the microbes are present at relatively low cell counts. Recently, researchers at Auburn University developed a novel type of biosensor based on magnetostriction, which is capable of detecting a few bacteria in a few minutes. The new technology has many advantages over the existing technologies, such as high sensitivity, working well in water, easy deployment, low cost, and suitability for field testing. All the advantages of the new technology have been experimentally demonstrated by the biosensor for

detecting *S. typhimurium* bacteria and *B. anthracis* spores. The technology is based on the magnetostrictive particle (MSP) as the sensor platform and antibody/phage as the receptor. The receptor captures the target bacteria, which results in a change in the resonance frequency of the MSP. The resonance frequency of the MSPs can be remotely/wirelessly determined. That is, the MSP sensor is a wireless sensor. The researchers propose to develop the MSP biosensor for detecting *E. coli* bacteria in source water without pre-treatment for field testing in real time. the commercially available antibody against *E. coli* will be immobilized onto the surface of the MSP as the receptor.

The Development of a MEMS-Based Integrated Wireless Remote Biosensors (2004 USGS WRRRI Grant)

Ososanya, Esther T. and Wagdy Mahmoud, Principal Investigators

Federal Funds: \$15,000 + NF Matching Funds: \$30,000

State Water Resources Research Grant Program, District of Columbia Project 2004DC56B
Mar 2004 - Feb 2005

The researchers propose the design and implementation of an integrated wireless, low-power embedded biosensor monitoring system for the acquisition and transmission of biological functions from aquatic animals. These signals can be used to measure the stress induced in aquatic animals due to water pollution. A MEMS-based biosensor will be integrated with a mixed-mode ASIC chip comprising of preamplifier, band-pass filter, analog amplifier, D/A module, modulator, transmitter, and a digital controller. The design will integrate MEMS, wireless communication, VLSI, and system-on-chip (BioSilico) technologies in the design of a low power environmental monitoring device. The system will be designed as a battery-powered device. Techniques for analyzing the acquired data will also be developed. The embedded integrated sensors are to be used in the on-line acquisition of myoneural signals from aquatic animals such as bivalve molluscs, blue gill fish, and other fish species. This design is expected to miniaturize several discrete modules and eliminate coaxial cables used in existing biomonitoring setups, and in a significant reduction in the overall system power consumption. A receiver system will monitor the signal transmitted from the sensor device. The receiver system will be designed and built using off-the-shelf components. When completed, the design will automate the process of in situ environmental data gathering needed to monitor the safety of the drinking water resources. Details of the design will be made available through conference and journal papers. The proposed research is a collaboration between the Electrical Engineering Department, Biology, and the Environmental Science Department. Students from Electrical Engineering, Biology, and Environmental Science will work in a multidisciplinary research environment to design the biomonitoring system.

Development of New Technique for Use of Dissolved Helium as Environmental Groundwater Tracer (2005 USGS WRI Grant)

Aly I. El-kadi, Aly I. (PI)

Federal Funds: \$24,000 + NF Matching Funds: \$48,216

State Water Resources Research Grant Program, Hawaii Project 2004HI55B

Mar 2005 to Feb 2006

The proposed study will build on the results of Phase 1 by developing and demonstrating the utility of helium and fluoresce in tracer tests as a method of characterizing the transport properties of aquifers. Through laboratory and field experiments, the researchers will develop the methodology to make more complete characterization of aquifer media transport properties possible. The final methodology developed will have commercial as well as scientific applications. The results of three column experiments will be analyzed to characterize the effects of different detection methods used for each tracer, of contrasting hydraulic conductivity paths, and of contrasting media diffusion properties. Once the data from the column experiments have been analyzed, a field experiment will be done using the same two tracers. This will be a push-pull tracer test. To aid in the design of the field test, a groundwater model will be developed to select the optimum injection rate, the optimum injection duration, and the optimum aquifer rest time. The researchers expect to conduct a minimum three such tests. The first test is to refine the field methodology and gather initial data. Two more tests will be conducted, one in a fractured basalt aquifer and a second in a carbonate caprock aquifer. The exact location of the tests will be negotiated with potential site owners/operators.

Development of an Integrated Methodology to Assess Vulnerability of Groundwater to Pathogen Intrusion Using GIS, Remote Sensing, Neural Networks and Neuro-Fuzzy Methods (2005 USGS WRI Grant)

Dixon, Barnali (PI).

Federal Funds: \$40,790 + NF Matching Funds: \$103,298

State Water Resources Research Grant Program, Florida Project 2005FL100B

Mar 2005 to Feb 2006

Close connection between ground and surface water, which is common in Florida, means that pathogens found in surface water may find their way into groundwater and vice versa. Traditionally, state and county regulators used fixed setback distances for sludge application and septic tank locations for all geologic setting in their jurisdiction to protect our water resources. A study conducted for Ground Water Rule showed that setback distances were found to be quite variable; some were based on science, others were not (EPA, 2003). There is a need to develop a screening tool that (1) provides reliable GW vulnerability estimates at varying watershed scales, (2) requires less extensive site-specific data, and at the same time, is robust when data are uncertain and incomplete, and (3) can be easily updated. The researchers are proposing to develop a spatially explicit method that will provide a vulnerability map for an area based on similar hydrogeological, topographical, climatological, soils, preferential flow pathways, and land use. This approach will attempt to strike a balance between expensive site-specific studies and broad-based, one-size-fits-all policy. In a gross sense, information from soil surveys, hydrogeological parameters, and land use will be incorporated in a screening tool that will provide an indication of the level of risk a particular site may have to groundwater contamination by pathogens. The specific objectives of this proposed research are to (1) innovatively extend the

GW vulnerability mapping at a large watershed scale by developing and adapting a neural network (NN) and neuro-fuzzy models in a GIS platform, (2) use geostatistical methods with well WQ data to generate surface maps showing microbial contamination potential, (3) use VIROLU model that calculates mass of attenuation of microbes probabilistically, as a reference model for the methodology, and (4) correlate predicted vulnerability map(s) developed using the methodology (NN, neuro-fuzzy, and geostatistics) as well as VIROLU with existing microbial monitoring data from the various wells in a GIS for accuracy assessments. This research should contribute to the development of a robust but economically feasible screening tool for mapping spatially explicit risk of groundwater contamination to pathogens. The tool will be available via the Internet to interested individuals, communities, regulatory agencies, and policy makers, and the methodology can be extended to other watersheds.

Lab-on-a-Chip Device for Monitoring Trace Level Arsenic (2005 USGS WRI Grant)

Hylton, Kamilah and Somenath Mitra.

Federal Funds: \$5,000 + NF Matching Funds: \$9,775

State Water Resources Research Grant Program, New Jersey Project 2005NJ87B

Mar 2005 to Feb 2006

This study aims at the development of a low cost, lab-on-a-chip field instrument that is capable of determining the total inorganic arsenic concentration in water samples in a rapid, continuous, reproducible, and accurate manner. The approach also precludes the tedious hydride generation methods used in conventional methodologies. By using a chelating agent and supported liquid membrane extraction (SLME) on a micro-scale platform, the researchers propose to extract and concentrate As from aqueous samples, thus allowing for faster analysis and lower detection limits.

Microbial Degradation of MTBE in Anaerobic Environments (2005 USGS WRI Grant)

Youngster, Laura K.G. and Max Haggblom (Principal Investigators).

State Water Resources Research Grant Program, New Jersey Project 2005NJ86B

Mar 2005 - Feb 2006

Methyl tertiary butyl ether (MTBE) is a gasoline oxygenate added to reduce carbon monoxide emissions and formation of ozone. It has been detected in groundwater and surface water across the United States. MTBE has proven to be recalcitrant in the environment, and EPA currently lists the compound as a possible human carcinogen. This proposal seeks to use molecular approaches to characterize the microbial community structure of enriched anaerobic MTBE-degrading cultures to understand the role of individual anaerobic microbes in MTBE degradation. MTBE degradation, formation of end products, and utilization of electron acceptors will be monitored following previously established procedures. These data will enable the determination of the structure and function of the microbial community in anaerobic MTBE-degrading cultures and guide attempts to enhance MTBE degradation rate. The information gained can be used as a basis to assess natural attenuation potential and to create guidelines for proper management of MTBE-contaminated environments.

Project Extension and Supplemental Funding for Investigating the Influence of Purging on Long-Term Remediation Compliance Monitoring (2005 USGS WRI Grant)

Robbins, Gary A. (PI).

Federal Funds: \$3,077 + NF Matching Funds: \$6,153

State Water Resources Research Grant Program, Connecticut Project 2004CT45B

Mar 2004 - Feb 2006

The objective of this study is to assess the validity of the no-purge sample option for regulatory compliance monitoring. To meet this objective, a field study is being performed at the University of Connecticut Motor Pool, which has a history of gasoline contamination and remediation. Site hydrogeology has been well characterized in three dimensions in numerous past research projects. At the site, two locations with existing monitoring wells in close proximity to clusters of multilevel samplers were initially used for sampling. The absence of BTEX constituents, temporal decreases in MTBE levels following cessation of its use, and the need to change sampling protocols and constituents analyzed required modification of the original field sampling effort. Sampling was curtailed at one of the locations and efforts have focused on obtaining more detailed information at the other location. Because of the decrease in MTBE levels, inorganic constituents were evaluated. After several rounds of sampling, it was found that concentrations obtained for constituents that did not vary with depth were similar irrespective of the sampling protocol. The focus of subsequent sampling rounds was placed on constituents and parameters whose concentration varied with depth (e.g., T, EC, pH, ORP, DI, DO, turbidity, MTBE, Ca, Na, and Cl). To enhance the consistency of field analyses and monitoring purging, a mini-flow cell (FlowBlock) was obtained from Geotech Environmental Equipment, as well as associated ion-specific electrodes. The DEP LUST mobile laboratory is providing GC and GC/MSD analytical assistance at no cost to the project. Sampling has been conducted six times. Amongst the different sampling methods, concentration differences have been found for those constituents that exhibit variations in formation concentration with depth; however, similarities in temporal trends are evident. The researchers are requesting an extension of the project until June 2005, plus additional student support to take 6 more rounds of samples through the winter and spring to increase the data set for performing statistical comparisons. The results of this study will aid in resolving the issue as to whether purging is needed for compliance monitoring. Furthermore, it will aid in helping to interpret monitoring data obtained from wells in consideration of concentration averaging.

Theoretical and Experimental Evaluation of Acetate Thresholds as a Monitoring Tool for In Situ Bioremediation (2005 USGS WRI Grant)

Becker, Jennifer G., Hubert J. Montas, and Eric A. Seagren, Principal Investigators, Univ. of Maryland

Federal Funds: \$29,990 + NF Matching Funds: \$60,068

State Water Resources Research Grant Program (Maryland), Project ID: 2005MD78B

Mar 2005 to Feb 2006

Demonstrating the success of in situ bioremediation can be challenging due to the heterogeneous, dynamic, and inaccessible nature of the subsurface. The consumption of electron acceptors during bioremediation of hydrocarbons and other contaminants can result in shifts in the predominant terminal electron-accepting processes (TEAPs), which may be useful for monitoring. Because traditional assessment tools have disadvantages, an accurate indicator of

TEAPs is still needed. Using an integrated experimental and modeling approach, this study will systematically test the hypothesis that characteristic ranges of acetate thresholds may exist for different TEAPs, hence acetate concentrations may be useful for monitoring bioremediation. Acetate thresholds established by pure microbial cultures that utilize acetate as an electron donor and different TEAPs will be measured experimentally using batch laboratory systems. The importance of kinetic and thermodynamic factors in controlling acetate thresholds will be evaluated using a mechanistic mathematical model. Model parameters will be obtained by fitting the model to the experimental data. The usefulness of acetate thresholds as indicators of bioremediation will be evaluated by measuring acetate concentrations in contaminated sediments and comparing measured values to model-predicted concentrations.