

Western Research Institute

2006 Publications

Fallgren, P.H. and S. Jin. 2006, "Interactions Between BTEX Biodegradation and Barium Mobilization in Groundwater," *Proc. The Sixteenth Annual AEHS Meeting and West Coast Conference on Soils, Sediments and Water*, March 13-16, 2006, San Diego, CA.

Abstract: Benzene, toluene, ethylbenzene, and xylenes (BTEX) are common contaminants of concern in groundwater. Previous studies indicate that BTEX may be readily degraded by sulfate-reducing bacteria (SRB) under sulfate reducing conditions. SRB may reduce sulfate in barite (BaSO_4) during the biodegradation of BTEX, resulting in the mobilization of toxic barium ions (Ba^{2+}). Groundwater samples were collected from a site in Oklahoma, where dissolved Ba has been detected at elevated concentrations. The groundwater contains BTEX and low amounts of sulfate. A microcosm study was conducted in the laboratory to investigate the feasibility of precipitating dissolved Ba and preventing it from remobilization by amending sufficient amounts of sulfate. Partial precipitation of dissolved Ba (from ~2300 to ~800-900 $\mu\text{g/l}$) was observed in the microcosms of active sulfate reduction but no amendment of sulfate. Concentrations of dissolved Ba decreased to 160-200 $\mu\text{g/l}$ in the sulfate-amended microcosms. Although majority of barium is presumed to be precipitated in barite, the dissolved Ba precipitation may also be partially attributed to the complexation of barium with carbonate (BaCO_3) and the formation of BaS . Sulfate reduction associated with biodegradation of lower concentrations of benzene and toluene did not affect soluble barium concentrations in the microcosms. BTEX amendments were added to elevated amounts to determine the influence of sulfate reduction on barium mobilization. Current results indicate that when dissolved sulfate concentration is adequate Ba is not mobilized, and free barium is immobilized even with elevated concentrations of BTEX and SRB activity. Studies are ongoing to determine if depriving SRB of dissolved sulfate would result in Ba mobilization from BaSO_4 . Keywords: Kentucky blue grass, grass straw gasification, on-farm gasification

Farrar, M.J., P.M. Harnsberger, K.P. Thomas, and W. Wisler. "Evaluation of Oxidation in Asphalt Pavement Test Sections after Four Years of Service." *Proc.*, International Conference on Perpetual Pavement, September 13-15, 2006, Columbus, Ohio.

Abstract: This paper is concerned with a hot-mix asphalt pavement validation site constructed in Arizona in 2001. Four asphalts from different sources but of similar Superpave performance grade were used to construct the sections at the site. The crude oil source used to produce the asphalts is the only significant variable from section to section. Sampling and testing at the Arizona site is ongoing with the objective being to evaluate the physiochemical changes that occur in situ. For this study, four-year old field aged cores collected in 2005 were sectioned into 13-mm increments and the viscosity of the extracted asphalts was compared to the predicted viscosity of each asphalt based on: (1) the Global Aging System, which is an integral part of the NCHRP 1-37A Mechanistic Empirical Design Guide; and (2) a Pressure Aging Vessel (PAV) model developed under NCHRP 9-23. The aging, in terms of extracted viscosity that has occurred over the four-year period is substantially greater than predicted by the Global Aging System, particularly in the top 13 mm of pavement. A methodology is suggested that allows for

comparison of data obtained using the Global Aging System with that of the PAV model and the actual field aged viscosity.

Huang, S.C., 2006. "Rheological Characteristics of Crumb Rubber-Modified Asphalts with Long-Term Aging." *International Journal of Road Materials and Pavement Design*, 7 (Special Edition): 37-56.

Abstract: SHRP asphalts AAD-1 (less-compatible) and ABD (more compatible) were mixed with crumb rubber, and their rheological properties were studied as a function of long-term oxidative aging. Master curves were constructed by shifting the aging time-frequency data to assist in the interpretation. The results show that the stiffness effect of crumb rubber to asphalt AAD-1 is greater than for asphalt ABD. Addition of crumb rubber to both asphalts AAD-1 and ABD reduced viscosity build-up with aging. In addition, rubber modification dramatically increased the elasticity of both asphalts. It is possible that rubber modification will improve rutting resistance because of the increased viscosity and elasticity at high temperatures and improve thermal cracking and fatigue resistance by either decreasing viscosity or lowering viscosity build-up with aging at low temperatures.

Huang, S.C., and R.E. Robertson, 2006. "Rheology of Thin Asphalt Film in Contact with Aggregate." *International Journal of Road Materials and Pavement Design*, 7 (2): 179-200.

Abstract: A specially designed shear viscometer fixture was built to investigate the physical properties of thin asphalt films between aggregate plates. Viscosities were measured using the specially designed fixture in an Instron instrument. The properties of thin asphalt films are not predictable from thick (1.0 mm) films on steel plates, which are used in the current Superpave[®] specification. Rheological properties of thin films (20 microns thick) of neat SHRP asphalt AAD-1, PAV-aged AAD-1 (20 hours at 100°C), and decanedicarboxylic acid-modified AAD-1 were determined at 25°C using the specially designed fixture. Atomic force microscopy (AFM) was applied to investigate the surface roughness profiles of different substrates, including glass and aggregate plates. It was found that the roughness of the glass plate was only 20nm disparity in height, approximately one one-thousandth of the film thickness being studied. The AFM profiles of the polished aggregate plates used in the study showed that they had a surface roughness of approximately two microns, i.e., approximately ten percent of the film thickness. The results showed that thin film physical properties are dependent upon asphalt composition, aggregate type, oxidation, and asphalt modification. Separately, preliminary results from a water soaking experiment show that the specially designed fixture may be a useful tool for the characterization of moisture damage.

Huang, S.C., A.T. Pauli, A. Beemer, and R.E. Robertson, 2006. "Influence of Crumb Rubber on the Fatigue Performance in Asphalt Pavement." *Proc.*, 10th International Conference on Asphalt Pavements, Quebec, Canada, August 12-17, 2006.

Abstract: Two different PG-grade of asphalts were mixed with crumb rubber, and their rheological and morphological properties were studied as a function of long-term oxidative aging to better understand the physicochemical basis for the performance related rheological properties of rubberized asphalts. The results show that the stiffness effect of crumb rubber on one asphalt is higher than on the other. Addition of crumb

rubber to both asphalts reduced viscosity buildup with aging. In addition, rubber modification dramatically increased the elasticity of both asphalts. Furthermore, atomic force microscopy (AFM) was applied to investigate the fundamental internal structural morphology of asphalt-rubber interaction at the interfacial regions with oxidative aging. It was found that crumb rubber appears to be digested when mixed with acid-rich compatible asphalt as a function of oxidative aging. It was also found that rubber-modified asphalt had better viscous flow properties than unmodified asphalt. It could then be predicted that the aged, rubber-modified asphalt would be more resistant to fatigue cracking.

Jin, S., P.H. Fallgren, L.A. Johnson, and M.W. Stearnes, 2006, "Use of SRB from Activated Sludge in "Bio-Masking" of AMD Source Materials." *Proc. The Sixteenth Annual AEHS Meeting and West Coast Conference on Soils, Sediments, and Water*, March 13-16, 2006, San Diego, CA.

Abstract: Our previous studies employed sulfate-reducing bacteria (SRB) to mitigate acid mine drainage (AMD) from a coal mine. SRB-containing sludge collected from a wastewater treatment plant in southern Tennessee was inoculated to biologically 'mask' pyrite from oxidation. In this study, we identified and characterized SRB from sludge samples collected from several sewage treatment plants in the region to evaluate their applicability for AMD source control. Baseline characterizations indicate that SRB exist in activated sludge from the selected sewage treatment plants. Population enumeration and species identification are underway. Microcosms containing AMD water were established with activated sludge as the inoculum. SRB activities were evaluated under different adjusted pH thresholds. SRB activity in the microcosms was determined by monitoring increases in pH and sulfate depletion. Enumeration of SRB suggests significant increases in SRB numbers over time. In AMD water at initial pH values of 3.5 or above, pH increased to the 7.0-8.0 within two months and remained constant during the months following. AMD with an initial pH of 2.3 appeared to prohibit SRB activity; however, SRB activities resumed in some microcosms after a lag time of four months. Biofilms were observed on the surfaces of pyrite, serving both as a barrier to oxidation of pyrite and as a means of maintaining reducing conditions. Results from this study suggest that SRB from activated sludge are able to resume their metabolic activities when exposed to anaerobic conditions and are able survive in a low pH growth environment. Sewage sludge amendment appears to be a cost-effective source of SRB in the "bio-masking" of AMD sources.

Jin, S., J.S. Cooper, P.H. Fallgren, and M.W. Stearns. 2006. "Biological Source Treatment of Acid Mine Drainage." *Proc. Billings Land Reclamation Symposium*, June 6-9, 2006, Billings, MT.

Abstract: Acid mine drainage (AMD) originates from mining operations with oxidation of metal sulfides. The oxidizing process releases protons and generates acidity. A biological source treatment (BST) technique has been developed to address AMD at its source. The BST technique utilizes sulfate-reducing bacteria (SRB) and substrate amendments to establish an intracellular and/or extracellular biogeochemical formation on the surface of metal sulfide, shielding them from being oxidized. SRB transfer

electrons from organic substrates to sulfate and form sulfide. This process consumes protons and raises pH, while dissolved metals are precipitated with sulfide. Laboratory studies have shown that effluent/solids from wastewater treatment plants contain adequate populations of SRB as the inoculum for BST applications. In laboratory studies, the pH of AMD samples increased from <4.0 to >7.0 and stabilized in the neutral pH range for more than 20 months with one treatment. A field pilot study of the BST technique was conducted at a reclaimed coal mine in central Tennessee. Results to date indicate a significant increase in pH in the testing area, stabilizing in the pH range from 6.0 to 7.0, from the initial acidic readings. Decreases in sulfate and increases in sulfide concentrations confirm valid sulfate-reducing activity. Electromagnetic surveys were conducted in the field pilot test to identify AMD source and assist in monitoring the performance. Data from both the laboratory and field studies demonstrate that BST process is an innovative technology that can be applied in suitable sites and offer a cost-effective and long-term treatment of AMD.

Jin, S., and J. Jin, 2006. "Co-degradation of LNAPL and DNAPL in Groundwater," *Proc. Fifth International Conference on Remediation of Chlorinated and Recalcitrant Contaminants*, May 22-25, 2006, Monterey, CA.

Abstract: In this study, TCE served as the model dense non-aqueous phase liquid (DNAPL). Diesel range hydrocarbons were the representative light non-aqueous phase liquid (LNAPL). Denitrification was enhanced to degrade LNAPL into smaller organic compounds and final product of carbon dioxide. This pathway consumes electron acceptors and shifts the system towards more reduced, lower redox conditions, under which reductive dechlorination of DNAPL may occur. Small organic compounds from the LNAPL degradation may serve as substrates, facilitating reductive dechlorination of DNAPL and other "low-redox" pathways such as sulfidogenesis. In the groundwater contaminated by both petroleum constituents and TCE, nitrogen nutrients were added to reach the C:N balance and enhance petroleum hydrocarbon biodegradation. At the same time, the nitrogen amendments may also feed the process of TCE reductive dechlorination. Data obtained to date demonstrate that complete depletion of both LNAPL and DNAPL are achievable under the in-situ conditions, demonstrating an enhanced co-biodegradation.

McCann, M., R. Anderson-Sprecher, K.P. Thomas, and S.C. Huang, 2006. "Comparison of Moisture Damage in Hot Mix Asphalt Using Ultrasonic Accelerated Moisture Conditioning and Tensile Strength Test Results." *Proc., 2006 Airfield and Highway Pavements Specialty Conference*, Atlanta, Georgia, April 30-May 3, 2006, p. 601-613.

Abstract: Ultrasonic accelerated moisture conditioning (UAMC) has been demonstrated to be a quantitative analysis to evaluate the moisture sensitivity of a hot mix asphalt (HMA) mixture. Data from the UAMC test procedure was evaluated for repeatability and statistically compared to tensile strength test results after one and multiple cycles of freeze-thaw conditioning. UAMC is accomplished by containing a loose sample of HMA on a sieve in a 60°C waterbath while subjecting the sample to ultrasonic energy. As the asphalt recedes from the surface of the aggregate, small particles of the mix are released and drop through the sieve. The percentage of material lost from the sample is recorded for five hours and plotted with respect to conditioning time. The slope of a linear

regression function that is fit to the data represents the rate at which the small particles are released as the asphalt recedes along the surface of the aggregate. The value of the slope has been demonstrated to be a quantifiable representation of the moisture sensitivity for an HMA mixture, and the greater the value the more susceptible the mixture is to moisture damage. Seven mixes were subjected to UAMC. Replicate samples were used to define the UAMC slope of the linear regression function and evaluate the repeatability of the UAMC one-day test procedure. Repeatability was confirmed in six of the seven mixes, and the average UAMC slope for all mixes had a significant relationship to tensile strength test results after one and multiple cycles of freeze-thaw conditioning.

Meyer, J.S., M.J. Suedkamp, J.M. Morris, A.M. Farag, 2006. "Leachability of Protein and Metals Incorporated into Aquatic Invertebrates: Are Species and Metals-Exposure History Important?" *Archives of Environmental Contamination and Toxicology* 50, 79–87.

Abstract: To partially simulate conditions in fish intestinal tracts, we leached six groups of metals-contaminated invertebrates at pH 2 and pH 7, and analyzed the concentrations of four metals (Cd, Cu, Pb, and Zn) and total protein in the leachates. Four of the groups of invertebrates were benthic macroinvertebrates collected from metals-contaminated rivers (the Clark Fork River in Montana and the Coeur d'Alene River in Idaho, USA); the other two groups of invertebrates (one of which was exposed to metals in the laboratory) were laboratory-reared brine shrimp (*Artemia* sp.). Additionally, we fractionated the pH 2 leachates using size-exclusion chromatography (SEC). Protein content was 1.3 to 1.4% higher in *Artemia* than in the benthic macroinvertebrates, and leachability of metals and protein differed considerably among several of the groups of invertebrates. In SEC fractions of the pH 2 leachates from both groups of *Artemia*, Cu and protein co-eluted; however, Cu and protein did not co-elute in SEC fractions of the leachates from any of the benthic macroinvertebrate groups. Although none of the other three metals coeluted with protein in any of the pH 2 leachates, one or more of the metals co-eluted with lower-molecular-weight molecules in the leachates from all of the groups of invertebrates. These results suggest fundamental differences in metal-binding properties and protein leachability among some invertebrates. Thus, different invertebrates and different histories of metals exposure might lead to different availability of metals and protein to predators.

Morris, J.M., J.S. Meyer, 2006. "Extracellular and Intracellular Uptake of Zinc in a Photosynthetic Biofilm Matrix." *Bulletins of Environmental Contamination and Toxicology* 77:30–35.

Abstract: During daylight, concentrations of free zinc ion (Zn^{2+}) in the interstitial water in photosynthetic biofilm decrease, but the fate of the Zn^{2+} (e.g., changes in Zn speciation, absorption into algal and bacterial cells, adsorption onto cells, or precipitation as Zn-containing minerals) is unknown. We investigated the mechanism of Zn uptake into biofilm in a previous study by measuring vertical profiles of pH and free Zn^{2+} in biofilm using miniaturized ion-selective electrodes (Morris 2005). In that study, Zn^{2+} concentrations decreased from 1.0×10^{-4} to 4.4×10^{-7} M in the biofilm matrix during photosynthesis while pH increased from 6.7 to 9.7. We concluded that the extremely high pH in the biofilm matrix during photosynthesis creates a steep Zn diffusion gradient from the water column into the biofilm through (1) a shift in Zn speciation in the

interstitial water in the biofilm matrix and (or) (2) sorption of Zn to algal and bacterial cells and (or) precipitation of Zn-containing minerals in the biofilm matrix. However, the experimental design of that study did not allow us to conclude whether Zn was accumulating on the inside (i.e., absorbed) or the outside (i.e., adsorbed) of the microbial cells. Therefore, we conducted this experiment under similar conditions with the same biofilm culture and used an EDTA rinse to determine the percentages of internal and external Zn.

Morris, J.M. and J.S. Meyer, 2006. "Photosynthetically Mediated Zn Removal from the Water Column in High Ore Creek, Montana." *Water Air Soil Pollution* 179: 191-395.

Abstract: We collected cobbles covered in biofilm from High Ore Creek, Montana, placed them in 12 transparent PVC plastic chambers, and exposed the chambers to four treatments: Sunlight, Sunlight-occluded, DCMU (photosynthesis inhibited), and Formalin. Total aqueous zinc (Zn) concentrations in the Sunlight treatment decreased during the 4-h experiment and were significantly lower ($P \leq 0.05$) than in the other three treatments, in which the total aqueous Zn concentrations did not decrease significantly. Therefore, we believe photosynthesis in the biofilm played a role in causing total aqueous Zn concentrations in the Sunlight treatment to decrease, and we believe a similar process contributes to diel Zn cycling in High Ore Creek and some other metals-contaminated streams. **Keywords** biofilm, diel cycling, DCMU, diuron, formalin, photosynthesis.

Morris, J.M., A.M. Farag, D.A. Nimick and J.S. Meyer, 2006. "Light-Mediated Zn Uptake in Photosynthetic Biofilm," *Hydrobiologia* 571:361–371.

Abstract: Our experiments conducted under controlled laboratory conditions demonstrate diel uptake and release of zinc (Zn) in lab-cultured biofilm exposed to Zn concentrations that are present in some mining-impacted streams (1–2 mg Zn/l). Specifically, at constant pH, temperature, and aqueous Zn concentrations in the exposure water, biofilm accumulated Zn during the light periods of the phot cycle and released Zn during the dark periods of the phot cycle. The range of Zn uptake measured in biofilm during one light period in these laboratory experiments (0.6–8.3 mg Zn/g dw biofilm) encompassed the estimated Zn uptake (1.5–3.7 mg Zn/g dw biofilm) necessary to attribute aqueous diel Zn cycling in a mining-impacted stream in Montana (High Ore Creek) to uptake in biofilm. This is relevant to in situ studies of diel Zn cycling because we controlled three important parameters that naturally fluctuate daily in the field, thus demonstrating the potential for biofilm to remove large percentages of Zn from some mining-impacted streams. Researchers, modelers, regulators, and reclamation teams working in metals-contaminated streams should be aware of diel metal cycling, because the highest Zn concentrations (and therefore, perhaps the most toxic conditions) in the water column might occur at night, and the greatest exposure of grazers of phototrophs to dietborne Zn might occur during daylight hours. **Key words:** biofilm, diel metal cycling, light, pH, temperature, zinc.

Morris, J.M., E. Snyder-Conn, J.S. Foott, R.A. Holt, M.J. Suedkamp, H.M. Lease, S.J. Clearwater, J.S. Meyer, 2006, "Survival of Lost River Suckers (*Deltistes luxatus*) Challenged with *Flavobacterium columnare* during Exposure to Sublethal Ammonia Concentrations at pH9.5," *Archives of Environmental Contamination and Toxicology* 50, 256–263.

Abstract: The Lost River sucker (*Deltistes luxatus*) is a federally listed, endangered species inhabiting the hypereutrophic waters of Upper Klamath Lake in southern Oregon, USA. High pH (≥ 10) and elevated ammonia concentrations (≥ 1 mg $\text{NH}_3\text{-N/L}$) often occur during blooms of cyanobacteria (*Aphanizomenon flos-aquae*) in the lake, with major fish kills sometimes following a mid- or late-summer “crash” of the cyanobacterial population. Previous histopathology analyses and bacterial sampling indicated that infections of the pathogenic bacterium *Flavobacterium columnare* might contribute to the fish kills. We hypothesized that prior exposure to adverse water quality conditions increases the susceptibility of Lost River suckers to *F. columnare* infections. To test this, we exposed juvenile Lost River suckers to four sublethal ammonia concentrations at pH 9.4 for 62 d. On day 31, fish in half of the aquaria were exposed to *F. columnare*. As expected, survival of the Lost River suckers decreased in aquaria inoculated with *F. columnare*. Ninety-four percent of the fish that died were infected by *F. columnare* in the gills, kidney, or skin, whereas none of the survivors or unexposed control fish was infected. However, contrary to our hypothesis, survival of the fish exposed to *F. columnare* increased significantly ($p < 0.05$) as unionized ammonia concentrations increased. Our results suggest that complex interactions can complicate prediction of the responses of fish to concurrent chemical stressors and bacterial pathogens.

Schabron, J.F. and R. Shah, 2006. “Automated Flocculation Titrimetry to Optimize Distillate Yield and Minimize Fouling,” *Petro Industry News*, August/September, 18-19.

Abstract: The Automated Flocculation Titrimeter (AFT) can be used to provide valuable information about the internal stability of heavy oil, the proximity of pyrolyzed oil to coke formation, and to design blending protocols for oils mixtures related to prevent asphaltene precipitation. It is a versatile tool for the petroleum industry in both upstream and downstream operations.

Schabron, J.F. and J.F. Rovani, 2006. “Rapid On-Column Asphaltene Precipitation and Redissolution,” *Preprints*, Div. of Petroleum Chemistry, American Chemical Society, 54 (1), 218-222.

Abstract: About 40% (w/w) of the heptane asphaltenes in unpyrolyzed petroleum atmospheric or vacuum residua are soluble in cyclohexane. As pyrolysis progresses, this number decreases to below 17% as coke begins to form. Currently, the procedure for the isolation of heptane asphaltenes and the determination of the amount of asphaltenes soluble in cyclohexane spans three days. A more rapid method to measure asphaltene solubility was explored using a novel on-column asphaltene precipitation and redissolution technique. This was automated using high performance liquid chromatography (HPLC) equipment with a step gradient sequence using the solvents: heptane, cyclohexane, toluene:methanol (98:2). Results for original and pyrolyzed residua can be compared with data from the gravimetric method, and the measurement time was reduced from three days to twenty minutes.

Schabron, J.F., J.F. Rovani, Jr., A.T. Pauli, and A. Beemer, 2006. “Initial Studies Using Ultrasonic Spectroscopy for Monitoring Changes in Residua with Pyrolysis,” *Fuel*, 85, 2093-2105.

Abstract: Ultrasonic spectroscopy was explored for monitoring microstructure changes

during pyrolysis of petroleum residua. Attenuation and sound velocity measurements were obtained for original and pyrolyzed residua using ultrasonic transducers with frequencies ranging from 1 to 10 MHz. Transducers at 1.0, 2.2, and 3.5 MHz provide signals that can be measured at room temperature. Little useful signal passes the solid samples at room temperature above 4 MHz. Symmetrical amplitude vs. time pulse signals are observed through water, which exhibits essentially no attenuation of ultrasound. When the ultrasound signal passes through a solid residuum sample, however, the raw pulse signal in the time domain shows significant asymmetry. By obtaining fast Fourier transform (FFT) of the time domain waveforms, amplitude vs. frequency spectra are obtained. The FFT spectrum for water is symmetrical. For FFT spectra of solid residua, the higher frequencies are attenuated more than the lower frequencies. Maximum intensities are near 1.1 MHz, regardless of the frequency of the transducer. For the 2.2 and 3.5 MHz transducers, the FFT spectra for all of the residua studied exhibit a shoulder above 1 MHz. The shoulder diminishes early during pyrolysis as the solvation shell structures associated with the suspended particles are destroyed, and the nature of the particles changes. The FFT shoulder begins to grow again as pre-coke particles form.

Sorini, S.S., J.F. Schabron, J.F. Rovani, and T.M. Bomstad, 2007. Validation of a New Method for Screening Soil and Water for TCE Contamination, Environmental Expert (on-line journal) March.

Abstract: ASTM Method D 7203-06, Standard Test Method for Screening Trichloroethylene (TCE)-Contaminated Media Using a Heated Diode Sensor, (ASTM 2006) can be used to screen a sample of soil or water known to contain the halogenated volatile organic compound (HVOC) TCE. The method calls for measuring the TCE concentration in the headspace above the sample using a heated diode sensor device. From this measurement, an estimated concentration of TCE in the sample can be determined. Detection limits are typically in the low parts per billion range, depending on the sample. The method can also be used for screening the headspace above a sample of soil or water to indicate the presence or absence of HVOC contamination in the sample. The heated diode sensor device is selective for HVOCs. Water vapor does not interfere with the performance of the heated diode sensor, and hydrocarbon fuels are not detected by the sensor. This article describes two validation studies that were conducted to evaluate the performance of ASTM Method D 7203. In both studies, the performance of the screening method was evaluated by comparing sample screening data with data generated from analysis of samples collected from the same location at the same time and analyzed in the laboratory using gas chromatography/mass spectroscopy (GC/MS). In both studies, an X-Wand[®] heated diode sensor device was used to perform the ASTM method.

Sorini, S.S., J.F. Schabron, M.M. Sanderson, 2006, "Field Validation of the Accu Core Subsurface Sampler for Sampling and Storing Soil for Volatile Organic Compound (VOC) Analysis." WRI Report to U.S. Department of Defense, Concurrent Technologies Corp.

Abstract: To date there is no commercially available sampling tool for collecting and storing subsurface soil samples for volatile organic compound (VOC) analysis. Current subsurface sampling devices require samples that are collected below the surface be sub-

sampled and transferred to a second container once the samples are brought to the surface. This can result in significant VOC loss. The Accu Core[®] sampler system consists of alternating cylindrical clear acrylic sections and one-inch cylindrical stainless steel sections arranged in clear shrink wrap. The set of alternating acrylic and stainless steel sections in the shrink wrap are designed to fit in a Geoprobe[®] dual-tube penetrometer for collection of continuous soil cores. The Accu Core sampler/storage container consists of one of the stainless steel sections sealed on both ends with air-tight locking end caps. The sampler system is designed so a soil sample can be collected below the surface and transported to the laboratory for analysis in the same container in which it is collected. This eliminates the potential for loss of volatile components from the sample due to sub-sampling and transfer to another container once the sample is brought to the surface.

A field validation study was conducted to evaluate the performance of the Accu Core sampler to store VOC soil samples during transportation to the laboratory for analysis and to compare the performance of the Accu Core with current sampling and storage techniques, all of which require sub-sampling when the soil sample is brought to the surface. The Accu Core sampler system can contain a clear acrylic section having a ½-inch access hole for easy soil headspace screening without violating the integrity of the adjacent stainless steel Accu Core sections. During some of the validation testing, these sections were included in the Accu Core sampler configuration and soil in these sections was screened using a photoionization detector (PID), and for some samples an X-Wand[®] device, to show the usefulness of the sample screening capability provided by the Accu Core system. This report describes the Accu Core field validation study and provides the data that were generated by the study. Conclusions concerning performance of the Accu Core sampling/storage device based on the validation study results are presented.

Sorini, S.S., J.F. Schabron, J.F. Rovani, 2006, Research Report on Development and Field Validation of ASTM D 7203, Standard Test Method for Screening Trichloroethylene (TCE)-Contaminated Media Using a Heated Diode Sensor. ASTM International, West Conshohocken, PA, ASTM Research Report D34-1018.

Abstract: ASTM Method D 7203-06, Standard Test Method for Screening Trichloroethylene (TCE)-Contaminated Media Using a Heated Diode Sensor, provides a procedure for screening soil or water known to contain the halogenated volatile organic compound (HVOC), trichloroethylene (TCE), by measuring the TCE concentration in the headspace above a sample of the soil or water using a heated diode sensor device and calculating an estimated concentration of TCE in the sample. Any TCE remaining in the sample is not measured by this method, and any other HVOC present in the sample is reported as TCE. This method can also be used for screening the headspace above a soil or water suspected of containing HVOC contamination to indicate the presence or absence of HVOC contamination in the material. Any HVOC contamination remaining in the soil or water is not detected by the method.

Originally, ASTM Method D 7203-05 was written for application to soil. After the soil method was revised for application to water and the water method was validated, D 7203-05 was revised to include application to water as well as to soil. The method for screening water using a heated diode sensor is similar to the method for screening soil; however, one difference is the length of time specified for the water sample to sit prior to

measuring the headspace above the sample. Timed water experiments were performed to determine the appropriate length of time for a water sample to sit so the HVOC can move from the sample to the headspace. Field validation studies were conducted to evaluate the performance of the heated diode sensor water method to screen water samples collected at a TCE-contaminated site and a vinyl chloride-contaminated site. The screening method was evaluated by comparing the screening data for groundwater samples with gas chromatography/mass spectrometry (GC/MS) laboratory data for samples collected from the same groundwater wells at the same time. The data generated in the study at the TCE-contaminated site show that the method performs well for screening TCE-contaminated water samples to give an estimated TCE concentration in the samples. The screening method gave no false negative or false positive results and provided estimated TCE concentrations that correlate well with the laboratory data. The data generated in the study at the vinyl chloride-contaminated site show the usefulness of the screening method for indicating the presence or absence of HVOC contamination in water.

Thomas, K.P., J.F. McKay, and J.F. Branthaver, 2006, Surfactants in Aged Asphalt and Impact on Moisture Susceptibility of Laboratory-prepared Mixes, *Road Materials and Pavement Design*, 7:4, 477-490.

Abstract: Short-term aging (rolling thin-film oven test) of an asphalt binder resulted in the production of surfactants (surface-active compounds), while long-term aging (pressure aging vessel test) of asphalt binders resulted in the production of not only surfactants but also strong acids. The strong acids were identified as being sulfonic acids. It was proposed that the generation of surfactants and/or sulfonic acids in asphalt binder would promote moisture damage in asphalt-aggregate mixes. The surfactants could act as a detergent and emulsify components of the mix, and sulfonic acids could attack the aggregate surface, thus disrupting the asphalt-aggregate interface. A model compound, p-dodecylbenzenesulfonic acid, which incorporates these two structural features, was used as a modifier in several different mixes. Briquets fabricated from the modified mixes were tested for moisture susceptibility using the freeze-thaw pedestal test. It was observed that those mixes, which were originally not susceptible to moisture damage, were now susceptible. It was also noted that the addition of lime to the aggregates prior to the fabrication of the briquets counteracted the influence of p-dodecylbenzenesulfonic acid.