Short Courses

Short courses will be offered on Sunday, before the Conference begins, and on Wednesday, during the afternoon break in the program. Courses are open to both Conference registrants and nonregistrants. To register, go to **www.battelle.org/chlorcon** and register on line or use the form on page 65. Note: The maximum discounts apply to fees paid by February 29. Prospective course attendees should preregister no later than March 15—classroom space allocations and production of materials will be determined by the number registered for each course by that date. If insufficient registrations are received for a given course by March 15, the course will be canceled, with registrants' fees being transferred to other courses selected by the registrants or refunded. Course registrations will be accepted after March 15 if space is available. Course registration cancellations received by March 31 will be refunded less a $10 service fee. No refunds will be made after March 31, but paid no-shows will receive all course materials. Substitutions will be accepted at any time, preferably with advance notice. Course materials will include the instructors' presentation slides and other supporting materials as appropriate to the course, such as references from the literature, reprints, files, or publicly available software. Participants will not require laptops for any course.

Sunday, May 20, 2012
8:00 a.m.–5:00 p.m.

(1-hr lunch break on own)

Development and Use of Air Action Levels at Remediation Sites

Instructors: Bart Eklund, CIH, and Jill Hedgecock (URS Corporation)

Objective: Scientists, engineers, risk assessors and others who perform, manage, oversee, or regulate environmental remediation work will benefit from attending this workshop.

Overview: Site cleanups typically are performed to address potential adverse impacts to human health or the environment. However, the remediation process itself may result in immediate adverse impacts via the air pathway. Air action levels can be used to minimize air quality issues during remediation activities and typically are developed as part of an ambient air monitoring program. This workshop will explain the development and use of air action levels, including both long-term fenceline action levels and shorter term action levels used to ensure that the long-term levels are not exceeded. Long-term action levels are based on standard risk assessment procedures. For shorter-term action levels, the development must balance the need to perform the remediation work in a timely and cost-effective manner with the necessity of protecting both the on-site workers and the off-site community. The use of tiered action levels will be emphasized, so that air quality concentrations are addressed in a progressive manner. The fallacy of considering only concentration or using only one action level will be discussed, with emphasis on the need to address the duration of potential exposure, averaging period for monitoring data, use of net ground level values, and site geometry. Various pollutants will be considered, including particulate matter, metals, volatile organic compounds, semivolatile organic compounds, and odors. Specific examples and calculation approaches will be presented for various categories of pollutants. Air monitoring programs to demonstrate compliance with the air action levels will be described and specific examples shown. The elements to be covered include establishing or identifying (a) program goals, (b) target compounds, (c) sampling period and frequency, (d) number and location of samplers, (e) sampling and analysis methods, (f) network operations, (g) quality assurance, and (h) data management and reporting. The use of emission controls will be discussed in relation to air action levels. Among the topics to be covered are temporary structures, water sprays, emission control foams, wind barriers, and operating rate adjustment. The pros and cons of each approach will be discussed along with typical control efficiencies.

Draft Agenda:

1. Air action levels and their relationship to air monitoring, health & safety, and emission control programs
2. Regulatory and nonregulatory drivers
3. Health versus nuisance concerns
4. How conservative is safe enough?
5. Development of project-duration air action levels for particulate matter, VOCs, SVOCs, metals and other nonvolatiles
6. Development of short-term air action levels for particulate matter, VOCs, and odor
7. Use of surrogates; use of tiered levels
8. Air monitoring for worker exposure
9. Fenceline air monitoring for community exposure
10. Use of emission controls for area and line sources
11. Q&A session

Challenges of Groundwater Remediation in Fractured Rock and Karst Aquifers

Instructors: Neven Kresic, Ph.D.; Peter Thompson; and Scott Calkin (AMEC Environment & Infrastructure, Inc.)

Objective: Present experience gained over the past 20 years in characterization of karst and fractured bedrock settings, with a focus on remedial design and implementation challenges.

Overview: The workshop will cover data collection and evaluation methods, such as 3-D visualization of karst and discretely fractured bedrock systems and the assessment of mass partitioning between nonaqueous and aqueous phases within secondary fractures and primary rock porosity. The workshop will highlight lessons learned concerning the challenges and, in some cases, the technical impracticability, of source area remediation in fractured bedrock and karst settings.

Draft Agenda:

1. Role of borehole geophysics and interwell testing in the detailed characterization of fractured bedrock source areas
2. Characterization of depth-discrete high-transmissivity features (fractures, karst conduits), including flow rates entering/leaving different intervals
3. Assessment of and limitations imposed on remediation by matrix diffusion
4. Implementation strategies for conservative and partitioning interwell tracer tests to evaluate the presence of and hydraulic accessibility of residual DNAPLs
5. Design and implementation of tracer studies for remediation purposes; use of borehole electrical resistivity tomography to monitor tracers and effectiveness of remedial systems
6. Importance and role of high-transmissivity features for evaluating feasibility of different remedial alternatives (ISCO, P&T, bioremediation)
7. Use of numeric and time-series models for remedial design including Conduit Flow Process for Modflow
8. Case studies of remediation failures and successes in discretely fractured and karst environments

Raising Leadership to Your Level of Authority

Instructor: Gregory L. Stevens (Velociteach)

Objective: Provide training for individuals who have minimal project management experience and training and who wish to deepen their knowledge of the terms, definitions, knowledge areas, and process groups involved in project management.

Overview: This is a one-day version of the three-day "Project Management Basics" class taught by a certified instructor from Velociteach, LLC., a Registered Education Provider (R.E.P.) for the Project Management Institute (PMI). The class is completely aligned with PMI's *Project Management Body of Knowledge* (*PMBOK®*) *Guide*. PMI was the first organization to offer a credential specifically for project managers. For more information about PMI and Velociteach, see **www.pmi.org** and **www.velociteach.com**. Class participants will receive 8 PDUs that can be applied toward PMI certification or continuing education requirements.

Draft Agenda:

1. Introduction—*how course integrates with project management across industry; the value of project management training; managing projects that are simple or complex*
2. The basics: What is "Project Management"?—*context, definitions, roles: building a common understanding and language; the big picture; history of PM; the players in a project environment; the Iron Triangle: scope, schedule, and budget; constraints foster creativity*
3. Scope management: Defining the goals and boundaries of the project—*the pre-flight checklist; documenting requirements and needs; identifying stakeholders; identifying project requirements; communicating the scope; the work breakdown structure; the change control system*
4. Schedules and resources—*determining tasks required to create the deliverables; sequencing; estimating resources needed for each task; estimating project duration (**Note:** This one-day course will not cover development of Project Network Diagrams or Critical Path.)*
5. Building the project budget—*developed logically from the schedule and resources; costs (internal/external; direct/indirect; tracking charged time) (**Note:** This one-day course will not provide instruction on Earned Value Management.)*
6. Managing Risk—*risk identification; building a risk register; analysis of likelihood and impact; setting appropriate schedule and budget reserves*
7. Communication—*fundamentals of successful communications; identify and overcome barriers and filters; interactive examples of common miscommunication; the communications management plan; communicating with the customer and the team; tracking and accountability; constructive feedback loops; lessons learned from the Alpha PM Study*
8. Leading the team—*traits of strong leaders; identifying unique leadership qualities; team building; identifying and maximizing team strengths; the project review*
9. Course review and wrap-up—*document personal plan for improvement; opportunities for growth; lessons learned about your strengths, weaknesses, and tendencies and about practical tools and techniques*

Vapor Intrusion: Learning the Current Approaches for Conceptualization, Assessment, Evaluation, Monitoring, and Mitigation

Instructors: Lilian Abreu, Ph.D.; Amy Goldberg Day; and Richard Studebaker (ARCADIS US, Inc.) Mathew Plate and Henry Schuver, Ph.D. (U.S. EPA)

Objective: Present information on collecting, evaluating, and interpreting data on vapor intrusion. The intended audience includes environmental professionals; state and federal regulators engaged in vapor intrusion issues; property developers; and community stakeholders.

Overview: To address the growing awareness and public concern about vapor intrusion, this short course will focus on questions related to conceptualizing vapor intrusion and developing a sampling strategy to assess the potential presence of subsurface volatile organic compounds (VOCs) entering homes and other buildings. How should information in support of a vapor intrusion investigation be collected? What type of information (lines of evidence) should be collected? What types of decisions should be made based on available data? What is the evidence for the efficacy of chemical-based assessments? What are the public health benefits of alternative assessment/decision frameworks? What are some mitigation options for suspected vapor intrusion?

Draft Agenda:

1. Introduction
2. Vapor intrusion conceptualization—*examples to illustrate how different site and building conditions influence VOC distribution in the subsurface and the indoor air of structures near soil and groundwater contaminated with VOCs*
3. Multiple lines of evidence—*U.S. EPA's approach*
4. Designing a sampling strategy—*steps in developing a sampling strategy; selection of analytical and sampling method*
5. Data interpretation and human health risk evaluation
6. Risk management decision
7. Benefits of alternative approaches to chemical-based assessments—*the efficacy of traditional chemical-based vapor intrusion assessments; the public health benefits of alternative approaches (e.g., using naturally occurring tracers like radon)*
8. Monitoring and mitigation system evaluation and design—*the best practices for designing mitigation systems for current and future buildings*
9. Overview of vapor intrusion guidance—*discussion of documents from the U.S. EPA and several U.S. states*
10. Q&A

SUNDAY, MAY 20, 2012
8:00 A.M.–12:00 NOON

Measurement and Use of Mass Discharge and Mass Flux to Improve Decisions at Contaminated Sites—An ITRC Course

Instructors: Naji Akladiss, PE (Maine Dept of Environmental Protection)
Tamzen Macbeth, Ph.D., PE (CDM)
Chuck Newell, Ph.D., PE (GSI Environmental Inc.)
Alec Naugle, PG (California Regional Water Quality Control Board)

Objective: Provide information about various methods and potential uses of mass flux and mass discharge to support decision making at contaminated sites. Practitioners, regulators, and others working on groundwater sites should consider this course.

Overview: This course provides valuable insights into the use of mass flux and mass discharge to improve remedial efficiency and reduce site management costs. The basis is "Use and Measurement of Mass Flux and Mass Discharge," a document prepared by ITRC in 2010 and available as MASSFLUX-1 at **www.itrcweb.org**. A copy of the document will be provided on CD to course participants. This course includes a description of the concepts, uses, and measurement methods for mass flux and mass discharge, as well as a review of case studies demonstrating the benefits of using these data for site management. Most decisions at contaminated groundwater sites are driven by measurements of contaminant concentration. Decisions can be improved by using mass flux and mass discharge estimates to assess contaminant load into an aquifer. Evaluating and managing contaminant loads often provides a framework for better-informed management decisions regarding site prioritization, remedial design, and optimization. Mass discharge-based interim remedial goals are often more realistic for complex sites containing residual sources of contamination. The use of mass flux and mass discharge is increasing and will accelerate as field methods improve and practitioners and regulators become familiar with their applications, advantages, and limitations. The decision to collect and evaluate mass flux data is site specific. It should consider the reliability of other available data, the uncertainty associated with measurements, the specific applications of the data, and the cost-benefit of collecting mass flux and mass discharge measurements.

Draft Agenda:

1. Mass concepts—*why mass estimates are used; definitions and description; uncertainties; advantages and limitations*
2. Measurement methods—*transect method; well capture/pumping methods; passive flux meters; using existing data (isocontours); solute transport models*
3. Uses—*site characterization; potential impacts and exposure evaluation; remediation selection and design; performance monitoring; site prioritization*
4. Regulatory precedence and acceptance
5. Case studies

SUNDAY, MAY 20, 2012
1:00–5:00 P.M.

Environmental Molecular Diagnostic Tools for Site Assessment and Bioremediation Monitoring

Instructors: Frank Loeffler, Ph.D., and Kirsti M. Ritalahti, Ph.D. (University of Tennessee; Oak Ridge National Laboratory)
Erik Petrovskis, Ph.D., P.E. (Geosyntec Consultants)
Elizabeth Edwards, Ph.D., P.E. (University of Toronto)
Carmen Lebron (U.S. Navy)

Objective: Provide an understanding of contemporary tools for environmental molecular diagnostics (EMD) and their application to groundwater samples. The course will enable remediation practitioners to select appropriate EMD tools to gain meaningful information about the site of interest, collect environmental samples for EMD analysis, integrate the results with chemical and hydrogeological site data, and then make informed decisions regarding remedy selection, design and performance criteria.

Overview: EMD data have become a benchmark for obtaining information regarding microbes and genes of interest in groundwater. The EMD approach has improved understanding of the microbiology contributing to contaminant detoxification and the implementation of biological remedies. This course will illustrate common EMD analytical techniques, demonstrate the value of EMD application, and explain how to perform meaningful results interpretation to guide site management decisions. The number of molecular tools that can be used to assess the presence and abundance of organisms of interest is expanding as researchers identify new microbes and genes implicated in specific contaminant transformation pathways. Site managers face critical challenges in maintaining up-to-date knowledge of EMD development, synthesizing site geochemical and EMD data before selecting and designing efficient biological remedies, and addressing site management questions regarding cost and time to closure. This course will discuss current information about the microbiology contributing to the degradation of chlorinated ethenes, chlorinated propanes, chlorinated ethanes, chlorinated methanes, and BTEX. Molecular biological tools that provide information about the degradation of these substances at contaminated sites will be presented, and the information they provide will be brought into context with other site data. The specific benefits of the integrated application of EMD tools and traditional site characterization methods will be highlighted, along with advantages and limitations posed by the different approaches. The measurement of specific isotopes will not be a focus, but the value added by including compound-specific isotope analysis (CSIA) data will be discussed. Data from case studies will be presented to showcase how EMD information can be integrated with commonly acquired geochemical and hydrogeological measurements to make informed decisions regarding remediation options, performance predictions, and enhancement of biological remedies, and how the combined data analysis can support site closure decisions. In addition, ongoing research efforts toward developing site characterization and remediation enhancement tools with increased informational content will be discussed.

Draft Agenda:

1. Molecular biology 101
2. Chlorinated solvent biodegradation—*pathways and genes*
3. Other contaminants (*e.g., BTEX biodegradation pathways and genes)*
4. qPCR analysis
5. Alternate methodologies—*microarrays; microcosm studies*
6. Future technologies—*proteomics; DNA and RNA sequencing*
7. Groundwater sampling methods
8. Case studies
9. Decision making—*rules of thumb; quantitative measures; the multiple-lines-of-evidence approach supporting site closure decisions; data gaps*

Practical Tracer Testing Techniques for Site Characterization and Remediation System Design

Instructors: Craig Divine, Ph.D. and Elizabeth Reece, Ph.D. (ARCADIS US, Inc.)

Objective: Provide information on the increasing practical use and application of tracers by practitioners working at remediation sites.

Overview: Tracers have been broadly utilized for many years in research settings. However, until only recently, tracers were infrequently employed by consultants and practitioners at typical contaminated sites. This change is due in large part to the recognition that the success of many in situ remedial strategies is tied to local-scale hydrogeologic conditions, reagent distribution, and contaminant transport behavior. Consequently, tracers are becoming a standard and cost-effective hydrogeologic characterization tool used by practitioners to obtain basic aquifer characterization information and support development of conceptual site models, calibration of numerical flow and transport models, evaluation of contaminant-related risk, and remediation system design and assessment. The course material will include guidance on the use of tracers to characterize aquifer injectability, understand reagent distribution and utilization, quantify contaminant transport and degradation, and provide a basis for the design and optimization of in situ remediation systems. Additionally, the course will highlight examples of how tracers can be used to measure groundwater and contaminant flux, assess LNAPL mobility, and evaluate hydraulic capture. The course will cover basic terminology and concepts, tracer materials and analytical methods, health, safety and regulatory issues, test design and data interpretation concepts, and specialized applications and new developments.

Draft Agenda:

1. Background information—*history, basic terminology and concepts, common tracers, regulatory requirements, health and safety considerations, overview of applications*
2. Tracer testing to support injected reagent in situ remediation—*review of relevant remediation hydraulics; tracer test design and interpretation concepts; examples and practice problems; use of deuterium for ISCO applications, the "double tracer" method; use in continuous-delivery/recirculation systems*
3. Surface water and groundwater/surface water interactions—*mixing zone studies; stream velocity; stream dilution/GSI*
4. Other applications—*dissolved gas tracers; capture zone analysis; single-well techniques; techniques for assessing LNAPL mobility and NAPL saturation; use of surface resistivity and LIF for high-definition mapping*
5. Closing and questions

Integrated DNAPL Site Strategy (IDSS)—An ITRC Course

Instructors: Naji Akladiss, PE (Maine Dept of Environmental Protection)
Wilson Clayton, Ph.D., PE, PG (Trihydro Corporation)
Chuck Newell, Ph.D., PE (GSI Environmental Inc.)
Tamzen Macbeth, Ph.D., PE (CDM)
Heather Rectanus, Ph.D. (Battelle)

Objective: Provide information on development of integrated site remediation strategies or reevaluation of existing remediation strategies. This IDSS training is intended for regulators, remedial project managers, and remediation engineers responsible for sites contaminated by chlorinated solvents. Although the primary focus is on chlorinated solvent-contaminated sites, other types of contaminated sites (e.g., petroleum, mixed contaminants) can use the same fundamental process described in this guidance.

Overview: The course is based on "Integrated DNAPL Site Strategy," a technical and regulatory guidance document prepared by ITRC in 2011 and available as IDSS-1 at **www.itrcweb.org**. A copy of the document will be provided on CD to course participants. Sites contaminated by chlorinated solvents present a daunting environmental challenge, especially at sites with dense nonaqueous-phase liquid (DNAPL) still present. Restoring sites contaminated by chlorinated solvents to typical regulatory criteria (low parts-per-billion concentrations) within a generation (~20 years) has proven exceptionally difficult, although there have been successes. Site managers must recognize that complete restoration of many of these sites will require prolonged treatment and involve several remediation technologies. To make as much progress as possible requires a thorough understanding of the site, clear descriptions of achievable objectives, and use of more than one remedial technology. Making efficient progress will require an adaptive management approach, and may also require transitioning from one remedy to another as the optimum range of a technique is surpassed. Targeted monitoring should be used and re-evaluation should be done periodically, with subsequent modifications when objectives are not being met or when alternative methods offer similar or better outcomes at lower cost. Because the subject matter is complex, the user of this guidance should be familiar with, and practiced in, the latest evolution of site characterization challenges; realistic planning of site restoration; evolving treatment techniques; and methods for evaluating, monitoring, and interpreting mass transport in the subsurface aqueous and vapor phases. The agenda highlights the five important features of an IDSS.

Draft Agenda:

1. Behavior of DNAPLs and chlorinated solvent plumes in the subsurface—*developing a conceptual site model (CSM) based on reliable characterization and understanding of the subsurface conditions that control contaminant transport, reactivity, and distribution*

2. SMART remediation objectives—*objectives and performance metrics that are clear, concise, and measureable*

3. Treatment technologies—*applied to optimize performance and take advantage of potential synergistic effects*

4. Developing a monitoring approach—*based on interim and final cleanup objectives, the selected treatment technology and approach, and remedial performance goals*

5. Remedy evaluation—*periodic reevaluation of the strategy; modification of the approach as appropriate*

Framework and Metrics for Incorporating Sustainability into Remediation Projects

Instructors: Karin Holland (Haley & Aldrich, Inc.)
P. Brandt Butler, Ph.D., PE (URS Corporation)
Stella Karnis (Canadian National Railway)
Ray Lewis (Sunpro, Inc.)
Carol Dona, Ph.D., PE (U.S. Army Corps of Engineers)
Deborah Taege (The Boeing Company)

Objective: Present a sustainable remediation framework and associated metrics that can be applied during the planning and implementation of each phase of remediation. The framework is relevant to sites of varying size and complexity and is complementary to existing regulatory programs. The intended audience includes remediation project managers, consultants, regulators, or anyone interested in integrating sustainability into remediation projects.

Overview: The Sustainable Remediation Forum (SURF) has developed a flexible framework that integrates sustainable concepts throughout the remediation project while continuing to provide long-term protection of human health and the environment and achieving public and regulatory acceptance. Quantitative and qualitative metrics have also been developed for use in conjunction with the framework to evaluate sustainability impacts associated with a project. Published in summer 2011 as two separate documents, the framework and metrics initiatives are the combined contribution of more than 20 environmental professionals, representing site owners, the Department of Defense, and regulatory agencies. This course will present and discuss the SURF framework and metrics and the value offered to intended users. The following topics will be addressed in the course: (1) sustainable remediation framework attributes; (2) description of the framework; (3) the importance of preferred end-use for the site; (4) the framework's approach to evaluation of sustainable practices; (5) revision of the conceptual site model based on the results of the sustainability evaluation; (6) balancing sustainability considerations; (7) integration of the framework within regulatory programs; (8) identification of key stakeholders (9) selection of metrics; and (10) documentation of sustainability efforts. Several examples of the use of the framework and associated metrics will be provided during the course to demonstrate how the framework and metrics can effectively be applied to a range of sites and implemented during different phases of remediation. The intended audience includes remediation project managers, consultants, regulators, and anyone interested in integrating sustainability into remediation projects.

Draft Agenda:

1. Overview of the framework
2. Attributes of the framework
3. Description of the framework
4. Application of the framework
5. Framework's relationship with published sustainable remediation guidance
6. Selection of metrics
7. Illustrative examples

WEDNESDAY, MAY 23, 2012
1:00–5:00 P.M.

Improving Your Remedial Success Rate with Incremental Sampling Methodology Investigation Approaches

Instructors: Robin Boyd, PG (AECOM)
Roger Brewer, Ph.D. (Hawaii Department of Health)
Jason Brodersen, PG (Tetra Tech EM Inc.)
Marvin Heskett (Test America Laboratories Inc.)

Objective: Provide information on the application of incremental sampling methodology (ISM) to improve remedial success rate by providing high-quality data for source area characterization.

Overview: The primary cause of remediation failure is inadequate site characterization and poor data quality. Remediation failure is reflected in the field by unplanned over-excavation or by rebound following in situ treatment. This can usually be traced to reliance on a small number of discrete sample points to design the remedial action, often due to budget constraints. The use of incremental sampling methodology (ISM) approaches to characterize source areas will improve your remedial success rate by providing high data quality similar to that typically associated with risk assessments but at a more affordable cost. Incremental sampling focuses on the collection and combination of a large number of increments from well thought-out decision units (DUs) designed to characterize a site with a high degree of confidence. Sample collection must be done in a manner that is both reproducible and unbiased. The laboratory must also process the samples in a manner that preserves the quality of the field effort. Although simple in concept, a successful ISM investigation requires significant planning and an understanding of the advantages and limitations of the approach. This course will focus on soil, although ISM is applicable also to sediment and other media. A brief introduction to sampling theory will be provided, but the course will emphasize the field application of ISM investigations and provide case studies to demonstrate key points and the use of ISM to optimize remedial designs.

Draft Agenda:

1. Decision units—*systematic planning and conceptual site models; DUs for characterization of exposure areas vs. source areas; subsurface DUs; DUs for excavations and stockpiles; case examples*
2. Sampling theory—*heterogeneity and soil; sampling errors; pros and cons of ISM vs. composite vs. discrete samples; collection and use of replicate sample data*
3. Field collection of incremental samples—*ISM challenges in the field; increment layout options; tools and methods for collection of surface ISM samples; tools and methods for collection of subsurface ISM samples; storage and shipping of bulk samples; ISM for VOCs; field DU and ISM sample collection demonstration (weather and location permitting)*
4. Laboratory processing and subsampling—*lab processing steps for non-VOCs; lab subsampling options; processing of ISM samples for SVOC and VOC analysis; QA/QC*
5. Application of incremental sampling to remedial investigations—*why remedial action objectives often are not met; using ISM to characterize source areas and optimize remedial design; case studies*
6. Summary/Q&A

Introduction to Groundwater Remediation Geochemistry

Instructor: Bill Deutsch (Geochemistry Services LLC)

Objective: Provide information about the subsurface processes that can have a major impact on whether or not remediation is a success. The primary audience is remediation project managers, design engineers, site characterization planners, responsible parties, and regulators.

Overview: Remediation doesn't always proceed as expected—more reagent must be added to reach a desired result; the concentration of an initial contaminant of concern decreases in response to treatment but the concentration of a new contaminant increases to a level of concern; unanticipated reactions plug the aquifer, reduce the reactivity of a treatment compound, or affect the pH in a detrimental fashion. Remediation may be ineffective because of unforeseen or insufficiently accounted for geochemical processes that occur naturally in the aquifer or are produced by the introduction of treatment chemicals into the aquifer geochemical system. Proper design of a remediation system requires that the basic geochemical processes be understood and taken into account. Site-specific conditions must be determined by an adequate sampling program. Reactions that treat the contaminant of concern must be evaluated for their individual and interactive impacts on the ambient geochemical system. The anticipated longevity of active remediation and the final environmental condition of the aquifer must also consider the natural system. This course provides an introduction to these topics.

Draft Agenda:

1. Information on geochemical processes affecting remediation—*solution speciation; gas-phase exchange; redox; adsorption/desorption; mineral equilibrium; impact of metals on biodegradation*
2. Geochemical modeling to simulate remediation processes—*conceptual model development; data needs; code types/availability; longevity estimating*
3. Remediation design, complications, and solutions—*Ba,*

Zn, and Mn remediation; O_2 treatment for benzene leading to aquifer acidification; carbonate competition for arsenic adsorption sites; ZVI reaction byproducts

Biofuels: Release Prevention, Environmental Behavior, and Remediation—An ITRC Course

Instructors: Mike Maddigan (Pennsylvania Department of Environmental Protection)
David Tsao, Ph.D. (BP)
Denice Nelson, Ph.D., PG (ARCADIS US, Inc.)
Mark Toso, PG (Minnesota Pollution Control Agency)

Objective: Provide information on the differences between biofuels and conventional fuels—release scenarios, environmental impacts, characterization, and remediation. Audiences for this training include regulators, potentially responsible parties, contractors, and stakeholders with responsibility or interest related to biofuel storage, distribution, releases, or release prevention; inspections of storage and dispensing systems; site investigation and characterization; or spill response and remediation.

Overview: The manufacture and consumption of biofuels and biofuel blends are increasing, in part, due to usage mandates and incentives both in the United States and abroad. This expanded use increases the potential frequency of releases due to increased manufacture, transportation, storage, and distribution. Because biofuels differ from conventional fuels with respect to their physical, chemical, and biological properties, their introduction poses challenges in understanding the potential impacts of releases to the environment. Once released into the environment, these fuels exhibit different environmental behaviors as compared to conventional fuels. The proposed short course is based on the ITRC's *Biofuels: Release Prevention, Environmental Behavior, and Remediation*, a document prepared by ITRC in 2011 and available as BIOFUELS-1 at **www.itrcweb.org**. Like the document, the course will focus on the differences between biofuels and conventional fuels specific to release scenarios, environmental impacts, characterization, and remediation. The trainers will define the scope of potential environmental challenges by introducing biofuel fundamentals, regulatory status, and future usage projections. Participants will learn how and when to use the ITRC biofuels guidance document for their projects. They will understand the differences between biofuel and petroleum behavior; become familiar with the biofuel supply chain, potential release scenarios and release prevention; and learn to develop an appropriate conceptual model for the investigation and remediation of biofuels and select appropriate investigation and remediation strategies.

Draft Agenda:

1. Introduction
2. Releases and release prevention
3. Fate and transport
4. Q&A
5. Site investigation
6. Long-term response strategies
7. Q&A

Field Methods to Distinguish between Vapor Intrusion and Indoor Sources of VOCs

Instructors: Thomas McHugh, Ph.D. (GSI Environmental, Inc.)
Erik Dettenmaier, Ph.D., and Kyle Gorder (U.S. Air Force)

Objective: Demonstrate the use of on-site analysis of indoor air samples to identify indoor sources of VOCs and to determine whether vapor intrusion is occurring.

Overview: Indoor sources of VOCs are ubiquitous. As a result, when using indoor air measurements to evaluate vapor intrusion, reliable methods are needed to distinguish between vapor intrusion and indoor sources of VOCs. The course will explore the use of on-site analysis of indoor air samples to identify indoor sources of VOCs. Additional information presented will cover supplemental tools (e.g., building pressure control, radon analysis) that can be used to minimize the effects of spatial and temporal variability on investigation results. The course will cover implementation of the field investigation methods and interpretation of the results as well as method validation and regulatory acceptance. The course will include hands-on exercise where course participants use the HAPSITE GC/MS to find VOC sources through on-site analysis of VOCs in indoor air samples. The course will also feature demonstration of other field investigation equipment used to control and measure building pressure and to measure radon concentrations.

Draft Agenda:

1. Overview of vapor intrusion and indoor sources of VOCs
2. Compound-specific stable isotope analysis
3. Hydrocarbon fingerprinting
4. On-site GC/MS analysis: Overview
5. Hands-on exercise using on-site GC/MS investigation procedure
6. Demonstration of vapor-intrusion field equipment

Horizontal Wells: Enhanced Access for Characterization and Remediation of Chlorinated Compounds and Recalcitrant Compounds

Instructors: Dawn Kaback, Ph.D. (AMEC Environment & Infrastructure, Inc.)
Dan Ombalski, PG (Directed Technologies Drilling)
Paul Querna, PE (PQ Products)
Mike Sequino (Directional Technologies)

Objective: Present information about the potential cost savings and improved efficiency that horizontal wells can provide for environmental remediation systems. The anticipated audience is consulting scientists and engineers, site owners, regulators, other stakeholders, and groundwater professionals.

Overview: Horizontal wells have been successfully integrated into remedial systems at contaminated sites since 1988. Typical sites include those where (1) access is limited by buildings, roads, airport runways or rail yards; (2) offsite access is desired; (3) design requires very close well spacing (i.e., low permeability media); and (4) a low-profile drilling presence is desired. In addition to advances in design of remedial systems using horizontal wells, recent advances in new locating technologies that allow accurate installations in difficult drilling conditions and collection of soil samples under storage tanks, buildings, and landfills will also be discussed. The instructors will provide the basics on horizontal well design, installation, development, and operation. Drawing on their experience in designing and applying innovative tooling and well design to improve remedial performance, they also will present case studies to demonstrate how horizontal wells have provided significant cost and performance benefits. Workshop participants will learn about horizontal well materials development and current regulatory requirements and acceptance. The case studies will cover directional soil sampling and installation of horizontal wells for air sparging, in situ remediation (e.g., bioremediation, chemical oxidation), and product/groundwater recovery. These innovations in remedial designs will be presented to encourage more effective application of enhanced delivery/recovery systems to treat contaminated soil and groundwater.

Draft Agenda:

1. Introduction to horizontal wells
2. Horizontal well design—*means and methods; drilling fluids; well materials; complex bore design; dewatering system*
3. Drilling and well completion—*size and capability of directional drills; locating systems; mud systems*
4. Cost/benefit—*cost factors; environmental sustainability benefits*
5. Case histories
6. Lessons learned discussion

Characterizing and Understanding Remediation Processes In Situ: The In Situ Technological Toolbox

Instructors: Tomasz Kalinowski; Rolf Halden, Ph.D., PE; and Kristin McClellan (Arizona State University) Vic Madrid, PG, CHG, and Anja Verce (Lawrence Livermore National Laboratory)

Objective: Outline contemporary techniques and technologies for generating data that can help decision-makers evaluate the potential efficacy of in situ remediation technologies.

Overview: The environmental cleanup industry continues to move toward implementation of in situ remediation technologies to take advantage of cost-savings over soil excavation and to overcome limitations inherent to pump-and-treat operations. However, in situ technologies present their own associated risks, including uncertainties in performance and potential release of secondary contaminants. Consequently, site-specific evaluations of in situ remediation technologies, a.k.a. treatability studies, are customary before full-scale implementation of a remediation strategy can occur. The first section of the short course outlines challenges faced by in situ remediation technologies, including subsurface heterogeneity, mass transfer limitations and release of secondary contaminants. The first section will also identify what kinds of performance data are necessary to properly evaluate an in situ technology. The next section will examine feasibility tools currently available to address these needs. The course will conclude with a presentation of select case studies showcasing the technologies and illustrating the type and quality of data they produce.

Draft Agenda:

1. Overview
2. In situ remediation: Industry trends
3. Subsurface realities: In situ challenges—*accurate understanding of contaminant fate; differentiation between biological and chemical transformation; release of secondary contaminants; aquifer heterogeneity/outcome variability*
4. In situ characterization technologies—*bug traps; push-pull [single-well]; natural gradient aquifer tests; in situ microcosm; in situ microcosm array (ISMA*)
5. Case studies—*bug traps; push-pull test; ISMA*
6. Summary/Q&A

Utilization of Stable Isotopes in Studying the Fate and Origin of Chlorinated and Recalcitrant Compounds

Instructor: Paul Philp, Ph.D. (University of Oklahoma)

Objective: Provide an introduction to stable isotopes and their potential utilization in studying the origin, fate, and remediation of chlorinated and other recalcitrant compounds, as well as information on general applications of stable isotopes to other areas of environmental studies.

Overview: The first part of the course will introduce the basic concepts of stable isotope geochemistry: what is meant by a stable isotope; how the stable isotope values are determined; isotope standards; instrumentation; bulk stable isotopes; compound-specific isotopes; Rayleigh equation; isotopic enrichment factors; and other basic concepts needed to understand these applications. This part will emphasize the stable isotopes of carbon, hydrogen, chlorine, and nitrogen because these currently are the major isotopes of interest in environmental studies. The second part of the workshop will primarily discuss applications of this technology to studies involving the fate and origin of chlorinated and other recalcitrant compounds. There are two major areas of interest. The first is the use of isotopes as a tool for determining the source of the contaminant; for this application, it is essential that the isotope data are integrated with data from the other commonly used analytical tools such as gas chromatography and gas chromatography-mass spectrometry. The second application is using the extent of isotopic enrichment to measure the onset and extent of degradation of organic compounds present at the site; this includes both natural attenuation and attenuation during remediation of contaminated sites. These applications will cover utilization of carbon, hydrogen, and chlorine isotopes in remediation studies. Determination of chlorine isotopes of individual compounds has become routine only in the past year or so and is an important addition to the toolbox of available techniques. It is as important to discuss why this approach is not always going to be useful or successful as it is to discuss the successful applications. In addition to the above, some general applications of stable isotopes to other areas of environmental studies will be provided.

Draft Agenda:

1. Introduction
2. Stable Isotopes 101—*methodology; fractionation; Rayleigh equation; bulk isotopes; compound-specific isotope analysis*
3. Advances in determination of chlorine isotope compositions of individual chlorinated compounds
4. Integration of isotopic data with GC and GCMS data in environmental studies
5. Isotope effects resulting from physical effects such as volatilization and sorption
6. Quantification of isotope data and incorporation into transportation models
7. Why can we use isotopes in bioremediation/natural attenuation studies with smaller molecules but not larger molecules?
8. Distinguishing source signatures from degradation signatures
9. Specific applications of stable isotopes in studying the origin and fate of chlorinated and recalcitrant compounds
10. Utilization of stable isotopes in studying origin and fate of nonchlorinated compounds in environmental studies
11. Summary

Biogeochemical Reductive Remediation of Chlorinated Solvents and Metals

Instructors: Lonnie Kennedy, Ph.D. (Earth Sciences Services)
Richard Brown, Ph.D. (ERM)
Ramona Darlington, Ph.D. (Battelle)

Objective: Provide information on the practical considerations in using Biogeochemical Reductive Dechlorination (BiRD), a technology that can provide the effectiveness of ZVI at an even lower cost than bioremediation for treatment of chlorinated solvents and metals. One of the instructors, Dr. Kenedy is the originator and patent holder of the BiRD technology.

Overview: Chlorinated aliphatic hydrocarbons (e.g.,TCE, PCE, TCA, TC) and metals are widespread and persistent groundwater contaminants. Commonly used technologies include bioremediation and zero-valent iron (ZVI). Bioremediation is relatively inexpensive but often is incomplete, resulting in persistent and more toxic daughter products. ZVI chemical dechlorination is rapid and produces no daughter products, but it is often a very expensive option. The underlying principle of BiRD is that nearly all clastic sediments have abundant native iron minerals (20 to 200 Kg/m^3) already present in the aquifer matrix as dispersed coatings on sand or silt grains. This iron is usually a Fe(III) oxide, which is nonreactive for contaminants. BiRD is a simple process by which native Fe(III) oxides can be biogeochemically transformed in situ to iron sulfide (FeS), a highly reactive mineral that fully dechlorinates chlorinated solvent compounds with no daughter products and a typical half life of only 30 days (±15). Thus, the process treats chlorinated solvents as effectively as does ZVI but at a cost less than that of bioremediation. Because BiRD is a multidisciplinary approach, the essentials of geology, geochemistry, and microbiology will be addressed. Examples of how BiRD has worked under controlled laboratory and field conditions will be shown. The work flow for determining site suitability and developing an engineered remediation using the BiRD approach will be presented.

Draft Agenda:

1. What is Biogeochemical Reductive Dechlorination (BiRD) and metals remediation?
2. Background science: BiRD is an interdisciplinary treatment approach—*geology; hydrogeology; biogeochemistry; contaminant redox chemistry*
3. Biogeochemical reductive remediation examples—*early examples of BiRD working via intrinsic bioremediation processes; laboratory-scale chlorinated solvent treatment in microcosm and column tests; field-scale examples of BiRD (applications via injection, permeable reactive barrier, and surface bioreactor)*
4. Practical biogeochemical remediation design—*biogeochemical site assessment; analyses of existing and stimulated biogeochemical potential; determination of site suitability for biogeochemical remediation; redox half reactions geochemistry; reactant selection and sources; determination of in situ mass; calculation of remediation reagent quantities; other considerations (e.g., temperature, pH); can preexisting remediation systems be converted to BiRD?*
5. Post biogeochemical reactive barrier monitoring—*sediment and water monitoring procedures and analyses; calculation of contaminant treatment rates; determination of BiRD or biogeochemical mineral reactive zone longevity; reactive zone rejuvenation and modification*
6. Spreadsheet design for BiRD and mineral reactive zone design

Participants may wish to bring laptops to use during the course, but this is optional.

Life Cycle Assessment (LCA) and Other Approaches to Estimating Impacts for Remediation Systems

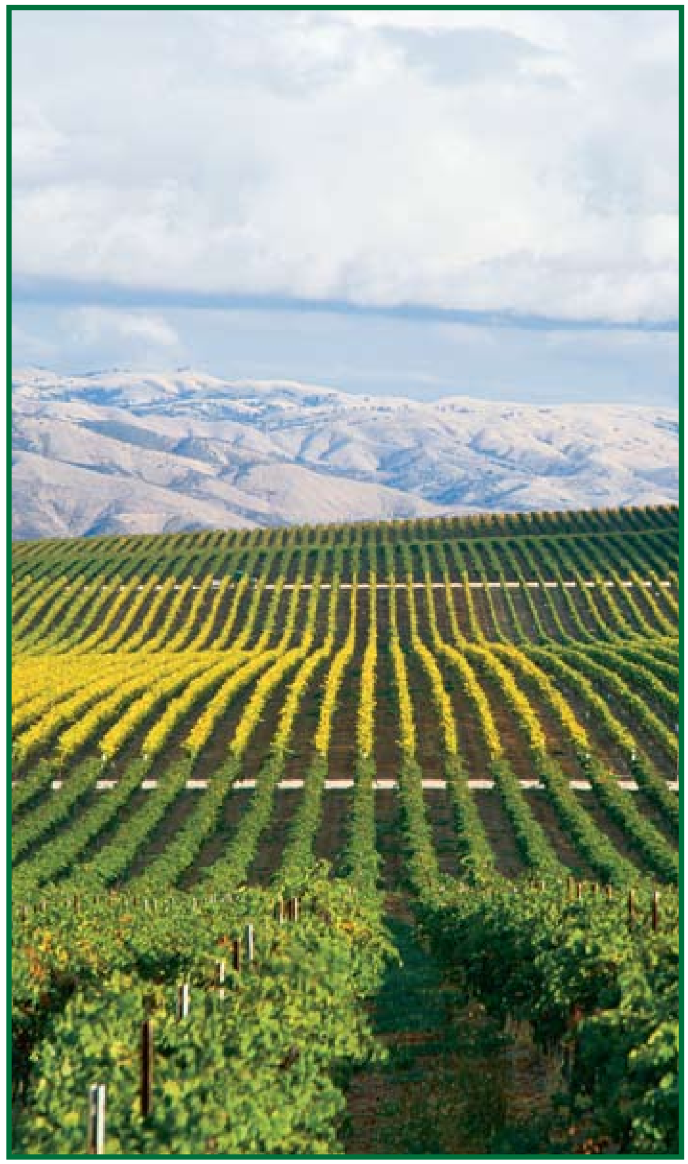
Instructors: Paul Favara, PE (CH2M HILL)
Todd Krieger, PE, LCPAP (DuPont)
Angela Fisher (General Electric)

Objective: This course provides guidance on how to plan and document an LCA and other impact-estimating approaches so that the best value of the results can be recognized and reporting can be conveyed clearly. The intended audience includes remediation project managers, consultants, regulators, and anyone interested in either performing impact assessments for remediation systems or reviewing such assessments performed by others.

Overview: Have you ever wondered how to estimate environmental impacts, or how to apply Life Cycle Assessment (LCA) principles to your remediation project? This course provides attendees with the knowledge necessary to plan and document impact assessments for remediation systems. The focus will be on current impact assessment approaches used in the remediation industry, including LCA and impact assessments that do not address the full "cradle-to-grave" life cycle of the remediation system. The primary focus of this class will be on environmental impacts, but impacts associated with social and economic impacts also will be considered. The content is based on guidance developed by the Sustainable Remediation Forum (SURF). This guidance is the compilation of input from more than 30 environmental professionals representing consultants, site owners, DOD, and regulatory agencies. The following topics will be addressed in this course: (1) setting objectives for the assessment; (2) defining the basis for which comparisons will be made (i.e., the functional unit); (3) defining the boundaries of the assessment to document what is and what is not included in the assessment; (4) establishing the metrics or impact categories that will be estimated for decision making; (5) identifying data for the assessment; (6) completing the assessment computations; (7) conducting sensitivity and uncertainty assessment on results; (8) interpreting the results; and (9) reporting. Several case study examples will be carried through the instruction to demonstrate how the above knowledge can be applied to a range of tools, including SiteWise™, SRT™, SimaPro®, and project-specific spreadsheets. Utilizing the guidance provided in this class will increase stakeholder confidence in sustainability assessment results and provide more complete information for decision making. The guidance was published in the summer 2011 issue of *Remediation Journal*. A publication reproduction of the guidance will be provided to attendees.

Draft Agenda:

1. Overview of available tools
2. Overview of planning and implementing the sustainability assessment
3. Case study overview of four different tools and how the guidance can be applied to a range of tools
4. Answers to frequently asked questions—*What is a Life Cycle Assessment? Do my results rise to the standard of a LCA? What is the easiest way to access data for my assessments? How do I determine which boundaries are appropriate for my study? What resources (cost and schedule) are needed for the different types of assessments? What should be considered in an effective review of a sustainability assessment?*



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