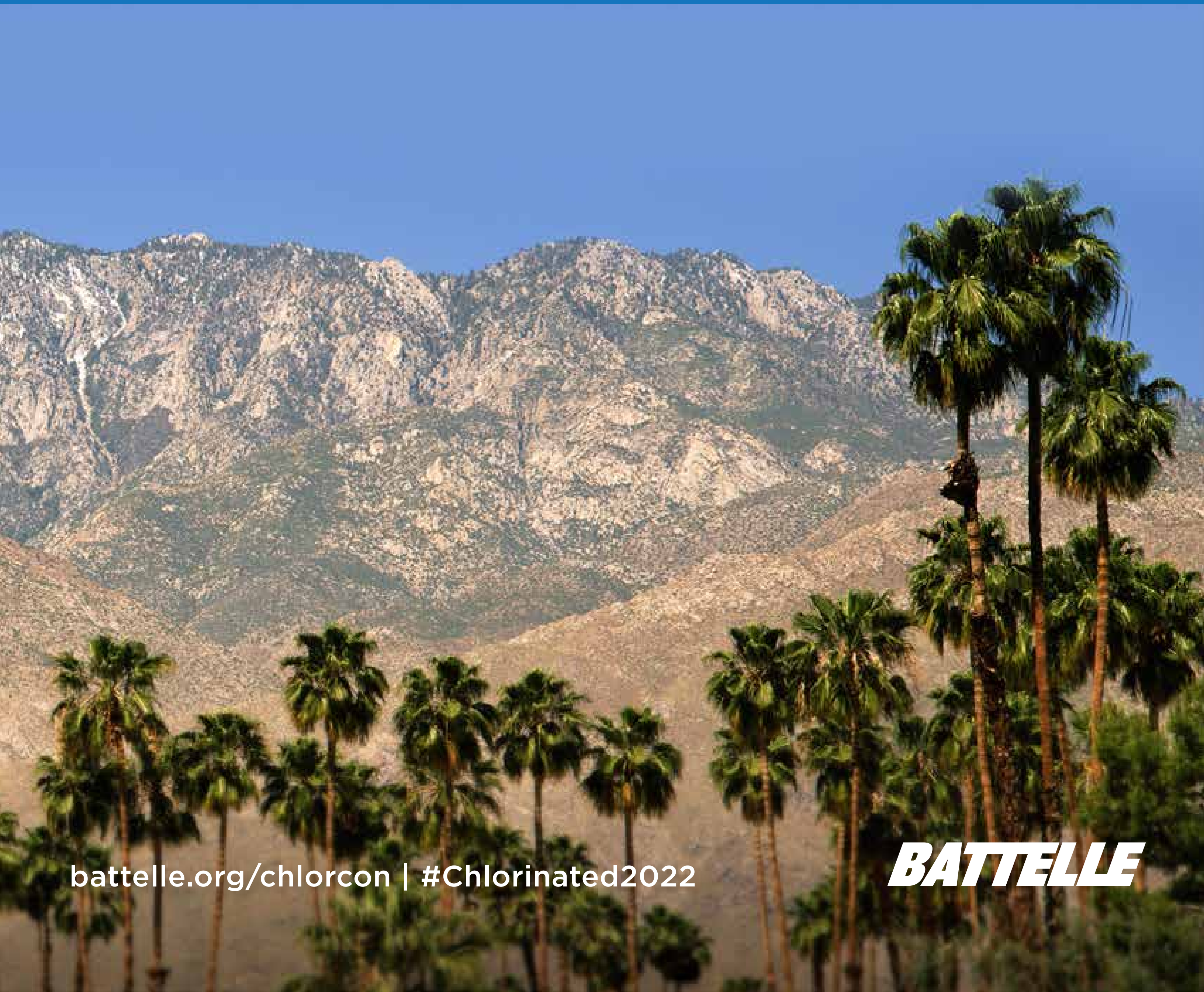
Twelfth International Conference on the Remediation of Chlorinated and Recalcitrant Compounds

Preliminary Program

May 22-26, 2022 | Palm Springs, California



battelle.org/chlorcon | #Chlorinated2022

BATTELLE

The Conference is organized and presented by Battelle.

Battelle's environmental engineers, scientists and professionals offer focused expertise to government and industrial clients in the U.S. and abroad. Combining sound science and engineering solutions with creative management strategies, Battelle works with clients to develop innovative, sustainable, and cost-effective solutions to complex problems in site characterization, assessment, monitoring, remediation, restoration, and management. Every day, the people of Battelle apply science and technology to solving what matters most. At major technology centers and national laboratories around the world, Battelle conducts research and development, designs and manufactures products, and delivers critical services for government and commercial customers. Headquartered in Columbus, Ohio, since its founding in 1929, Battelle serves the national security, health and life sciences, and energy and environmental industries.

Conference Sponsors

As the Conference organizer and presenter, Battelle gratefully acknowledges support of the following Conference Sponsors. Their financial contributions help defray general operating costs of planning and conducting the Conference. The corporate descriptions they provided appear on pages 108-116.

For details about sponsorship opportunities, see the Conference **Sponsors and Exhibitors** page.

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wintersunchem.com | Booth #817

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GENERAL INFORMATION

The Twelfth International Conference on Remediation of Chlorinated and Recalcitrant Compounds will be conducted May 22-26, 2022, in Palm Springs, California. The Conference is organized and presented by Battelle. Sponsors include other leading organizations active in site remediation research and application. Attendance is expected to be 1,500 to 1,700 scientists, engineers, regulators, and other environmental professionals representing universities, government site management and regulatory agencies, and R&D and manufacturing firms from around the world.

The Exhibit Hall, the Welcome Reception, and display of the Group 1 Posters will open Sunday evening, May 22. The Conference Program will begin Monday morning, May 23, when Conference Chairs, Michael Meyer and Carolyn Scala, both of Battelle, will conduct the Plenary Session. The Plenary keynote speaker, Craig Leeson, will discuss, “Lessons from Documenting the Stories from Today’s Biggest Environmental Problems and Those Working to Solve Them.” Craig is an award-winning filmmaker, journalist, and explorer. He will explain his findings from traveling around the world and interviewing some of today’s leading change-makers on the problems our planet and people are facing. Craig brings a mix of science and boots on the ground insights highlighting the solutions entrepreneurs, business executives, celebrities and international leaders are creating.

The Conference will also host a compiled screening of Mr. Leeson’s films *A Plastic Ocean* and *The Last Glaciers* on Tuesday afternoon. The screening, “Changing the World, One Documentary at a Time,” will include descriptive commentary throughout, provided by Mr. Leeson, and conclude with a Q&A session.

The technical program, to be held Monday afternoon, May 23, through Thursday, May 26, will consist of more than 1,300 platform and poster presentations in nine concurrent technical tracks compiled from 82 breakout sessions and six panel discussions.

Sessions and panels are organized according to major topic areas that will address the innovative application of existing and new technologies and approaches for characterization, treatment and monitoring of chlorinated and other recalcitrant compounds and emerging contaminants in various environmental media. Risk, regulatory, site management/closure and sustainability issues associated with these technologies will be discussed. Presentations will emphasize field applications, case studies and site closure, but fundamental research and laboratory, pilot and modeling studies also are included.

Additional technical information will be provided by exhibits from more than 100 companies and government agencies engaged in remediation-related activities. Twenty-one short courses are scheduled and will be conducted all-day Sunday and Tuesday afternoon.

A Career Kickstarter, organized and hosted by Clemson University alumni, for students and young professionals is scheduled from 1:00-3:00 p.m. on Sunday afternoon. Pre-registration is required for this event, see the **Student Participation** page for details.

A Student & Young Professional Reception will be held on Monday evening after the Group 1 Poster Reception that will enhance networking and career development opportunities for students.

Receptions and other meals offered throughout the Conference will afford attendees numerous opportunities to meet informally with one another.

Program at a Glance

Sunday, May 22, 2022

- 8:00 a.m.–5:00 p.m. Short Courses
- 1:00–3:00 p.m. Career Kickstarter
- 3:00–9:00 p.m. Registration Desk Open
- 6:00–9:00 p.m. Welcome Reception, Exhibits, Poster Group 1 Display

Monday, May 23, 2022

- 7:00–8:00 a.m. Continental Breakfast
- 8:30–10:00 a.m. Plenary Session
- 10:30 a.m.–12:00 p.m. General Lunch
- 12:10–4:20 p.m. Platform Presentations
- 2:30–3:00 p.m. Afternoon Beverage Break
- 4:30–6:30 p.m. Group 1 Poster Presentations and Reception

Tuesday, May 24, 2022

- 7:00–8:00 a.m. Continental Breakfast
- 10:00–11:00 a.m. Morning Beverage Break
- 8:00 a.m.–1:50 p.m. Platform Presentations
- 1:50 p.m. Technical Program Recesses
- Lunch on own, general lunch not provided
- 2:00–6:00 p.m. Short Courses
- 3:00 p.m. Film Screening with Craig Leeson

Wednesday, May 25, 2022

- 7:00–8:00 a.m. Continental Breakfast
- 9:30–10:00 a.m. Morning Beverage Break
- 8:00 a.m.–4:20 p.m. Platform Presentations
- 11:30 a.m.–1:00 p.m. General Lunch
- 2:30–3:00 p.m. Afternoon Beverage Break
- 4:30–6:30 p.m. Group 2 Poster Presentations and Reception

Thursday, May 26, 2022

- 7:00–8:00 a.m. Continental Breakfast
- 9:30–10:00 a.m. Morning Beverage Break
- 8:00 a.m.–4:20 p.m. Platform presentations
- 11:30 a.m.–1:00 p.m. General Lunch
- 2:30–3:00 p.m. Afternoon Beverage Break
- 4:30 p.m. Closing Reception

Location and Schedule

All events will be held at the **Palm Springs Convention Center** (277 North Avenida Caballeros, Palm Springs, CA 92262) and adjoining **Renaissance Palm Springs Hotel** (888 East Tahquitz Canyon Way, Palm Springs, CA 92262). Room blocks with group rates for Conference attendees are available at the Renaissance Palm Springs Hotel (connected to the Convention Center) and the **Hilton Palm Springs** (400 E Tahquitz Canyon Way, Palm Springs, CA 92262) located approximately one block away from the Convention Center.

Exhibits, the Group 1 Poster Display, and the Welcome Reception will open Sunday, May 22, at 6:00 p.m. The technical program will be conducted Monday, May 23, through Thursday, May 26. A half-day recess will be held Tuesday afternoon, May 24. Short courses will be held all-day Sunday, May 22, and Tuesday afternoon, May 24, during the technical program recess.

Technical Program Overview

The technical program will be comprised of more than 1,300 platform and poster presentations in 82 sessions, along with six panel discussions. The sessions and panels are organized according to the following major topics:

- Remediation Technology Innovations
- Assessing Remediation Effectiveness
- Green and Sustainable Remediation
- Addressing Challenging Site Conditions
- Fractured Rock and Complex Geology
- Petroleum and Heavy Hydrocarbon Site Strategies
- Per- and Polyfluorinated Alkyl Substances (PFAS)
- Metals
- Vapor Intrusion
- Characterization, Fate and Transport
- Advanced Diagnostic Tools
- Technology Transfer and Stakeholder Communications
- International Environmental Remediation Markets
- Emerging Contaminants

Platform and Poster Presentations. Platform sessions will begin Monday afternoon and conclude Thursday; poster sessions will be conducted on Monday and Wednesday evenings. Platform and poster presentations scheduled as of February 18, are listed by session on pages 17-84.

Abstract Submission

Abstracts were due August 31, 2021. Because of the outstanding response to the Call for Abstracts the technical program is at capacity and no new abstracts are being accepted for review. Our thanks to everyone who submitted an abstract.

Panel Discussions. Six panel discussions will be incorporated into the technical program. Panel descriptions and moderators' and panelists' names appear on the pages indicated below.

- Thermal Remediation Technology Updates: Seven Experts Discuss Four Years of Innovations in 100 Minutes (page 20)
- Investigating and Remediating a Major Chlorinated Solvent DNAPL Site (page 42)
- Should We Develop PFAS Ambient Levels: Why and How? (page 50)
- Monitored Natural Source Zone Depletion (page 63)
- How Can Genetically-Modified Organisms Safely Solve Environmental Challenges? (page 77)
- Remediation Geology, Remediation Hydrogeology, and Process-Based Conceptual Site Models to Support Complex Site Remediation (page 82)

See the following pages for additional information:

- Pages 15-16: Poster Sessions in each of the two poster groups.
- Pages17-84: Titles and authors for the presentations in each session. Titles beginning with an asterisk (*) are to be presented as poster presentations.
- Pages 86-95: Short Course descriptions for the courses offered on Sunday and Tuesday.
- Pages 97-106: Learning Lab descriptions for the demonstrations offered Monday-Thursday.
- Pages 116-117: Overview of the platform sessions and panels to be conducted each day. Times for exhibits, breakfasts, lunches, and receptions.

Proceedings. The proceedings will be made available online approximately 2 months after the Conference to registrants who paid standard industry, government, or student rates. Past years' proceedings are available on the Conference website under the **Publications** tab. Proceedings papers are no longer requested, however, all technical program abstracts will be included along with a PDF version of the Power Point presentation for most platform presentations and some

Final Program & Abstract Collection. This Preliminary Program lists all presentations scheduled as of February 18. It is subject to revision (*e.g.*, changes of presenters, withdrawals) in the months leading up to the Conference. To assist participants in planning their time while at the Conference, the following program information resources will be available online by May 6, 2022:

- Final Program
- Abstracts for all scheduled presentations, available only through the Conference mobile app

Email notifications will be sent to all who have registered and paid by the date above, providing links to the resources. A printed copy of the Final Program will be provided with registration material. Because of the size of the program—six panels and more than 1,300 platform talks and poster presentations—it is strongly recommended that each participant review the online version of the Final Program and abstracts prior to the Conference.

Short Courses. As of February 18, there are 21 short courses scheduled for presentation. Courses will be offered on Sunday, May 22, from 8:00 a.m.-5:00 p.m., and on Tuesday afternoon, May 24, during the recess in the program. Courses are open to both Conference registrants and individuals who will not be attending the Conference program. Discounts apply for early registration and payment.

See pages 86-95 for short course descriptions and scheduling information.

Education Sponsor

ITRC — Interstate Technology Regulatory Council

itrcweb.org | Booth #101

Program Committee

Conference Chairs

Michael Meyer, PMP, RG, LEG, LHG (Battelle)

Carolyn Scala, PE (Battelle)

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Paul Randall (U.S. EPA)

Mike Riggle, PG (USACE)

Kent Sorenson, Ph.D., PE (Allonia)

Rick Wice, PG (Battelle)

Exhibits, Internet Café & Learning Lab

Exhibits. Exhibit booths will be provided by more than 100 organizations that conduct remediation activities or supply equipment used in such work. Exhibits will be on display from 6:00 p.m. Sunday evening through 1:00 p.m. Thursday afternoon.

Click **here** to be directed to a list of current Exhibitors.

Internet Café. Computers and charging outlets are available to participants who wish to check email during Exhibit Hall hours Sunday–Thursday in the Internet Café, located in the Learning Lab area of the Exhibit Hall.

Internet Café Sponsors

CLEAN VAPOR

cleanvapor.com | Booth #709

integral consulting inc.

integral-corp.com | Booth #1016

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Learning Lab. The Learning Lab will consist of hands-on demonstrations highlighting specific technologies, tools, and software.

See pages 97-106 for an overview of Learning Lab descriptions. The schedule will be available in the Final Program.

Learning Lab Sponsors

BURNS McDONNELL

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RAMBOLL

ramboll.com | Booth #923

Meals, Breaks, & Receptions

For the convenience of Conference participants, the meals, breaks, and light receptions seen to the right will be provided on site at no additional cost to program registrants and exhibit booth staff. All food functions will be served in or near the Exhibit Hall.

Food function times are subject to change in the months leading up to the Conference and the final schedule will be available in the Final Program. If registrants wish to bring guests to meals, guest tickets can be purchased at the Conference Registration Desk; guest tickets will be priced equal to the cost incurred by the Conference for each meal.

Food & Beverage Sponsors

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Food Service Times

Breaks in the technical program between sessions may not correspond with food service times. If you wish to attend specific food functions, please plan your schedule accordingly.

Continental Breakfast
Monday-Thursday, 7:00–8:00 a.m.

Morning Beverage Break
Tuesday, 10:00–11:00 a.m.
Wednesday–Thursday, 9:30–10:00 a.m.

Lunch
Monday, 10:30 a.m.–12:00 p.m.
Tuesday, lunch not provided.
Wednesday–Thursday,11:30 a.m.–1:00 p.m.

Afternoon Beverage Break
Monday, Wednesday, and Thursday, 2:30–3:00 p.m.

Welcome Reception
Sunday, 6:00–9:00 p.m.

Poster Group 1 Presentations & Reception
Monday, 4:30–6:30 p.m.

Poster Group 2 Presentations & Reception
Wednesday, 4:30–6:30 p.m.

Closing Reception
Thursday, 4:30–5:00 p.m.

Student Participation

University students, through Ph.D. candidates, are encouraged to attend the Conference and will find participation valuable to their career development. In addition to the technical information gained by attending presentations and visiting exhibits, students will be able to meet and talk with environmental professionals representing a wide range of work experience and employers. Recruitment is a major focus of many participating Exhibitors and Sponsors and the Conference will provide an unprecedented opportunity for student job-seekers.

Student Paper Competition. Paper submissions were due October 29, 2021. The winning paper will be scheduled for presentation at the Conference. The winner is awarded at the Plenary Session and will receive complimentary registration and a financial award to help cover travel and related costs.

Student Paper Winner

Bosen Jin (University of California, Riverside/USA)
Anaerobic Biotransformation and Biodefluorination of Chlorine-Substituted Perfluorinated Carboxylic Acids

(Session E2, Platform)

Congratulations!

Student Networking Event. To help students get acquainted, a Student Networking Reception will be held Monday evening, following the Group 1 poster presentations. Additional details will be emailed to student registrants by May 6, 2022.

Career Kickstarter. A Career Kickstarter, organized and hosted by Clemson University alumni, for students and young professionals is scheduled from 1:00-3:00 p.m. on Sunday afternoon. Pre-registration is required for this event, see the **Student Participation** page for details.

Student Event Sponsors

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tetratech.com | Booth #1011

Sponsors and Additional Sponsorship Opportunities

As the Conference organizer and presenter, Battelle gratefully acknowledges the support of all Sponsors recognized throughout the program; their financial contributions help defray general operating costs of planning and conducting the Conference.

Sponsorship opportunities are still available. See the **Conference Sponsors & Exhibitors** page for details.

Conference Registration

The technical program registration fees seen below cover admission to all platform and poster sessions, exhibits, group lunches, receptions, daily continental breakfasts, and refreshment breaks. Each technical program registrant will also receive the proceedings, which will be available in digital form after the Conference.

Registration Terms & Conditions. The full list of registration terms and conditions can be found on the Conference website on the **Registration** page. Registration terms and conditions are subject to change without notice and are applicable to all levels of registration, including booth staff and Sponsor/Exhibitor waived and discounted registrants. No one under 18 years of age will be admitted to any Conference event unless registered as a student, valid college or university student ID required at check-in.

Note: You must OPT-IN during the registration process if you wish to be included in Conference Registration Lists.

Program Participant Registration Required

No financial assistance is available to support registration or other costs of attending the Conference. All presenting authors (platform and poster), session chairs, and panel moderators/ participants are expected to register and pay the applicable technical program registration fees. This policy is necessary because registration fees are the major source of funding for the Conference and a significant percentage of registrants will make presentations or chair sessions. No exceptions are made to this policy.

Registration Type	Paid by March 25, 2022	Paid after March 25, 2022
Industry	$955	$1025
Gov./Univ.*	$730	$830
Student**	$440	$490

The university fee applies to **full-time faculty and other teaching and research staff, including post-doctoral students. ** The student fee is reserved for **full-time students through Ph.D. candidates** whose fees will be paid by their universities or who will not be reimbursed for out-of-pocket payment. Documentation of current enrollment is required.*

Payment. Payment is required to confirm registration. Checks will be accepted for registrations made through March 25, 2022. Beginning March 26, 2022, payment can be made only by major credit card. Purchase orders will not be accepted. Fees are not transferable to other Battelle Conferences. Conference information meant for attendees only (*e.g.*, links to mobile apps, abstracts, and registration lists) will only be sent to individuals who are paid in full.

Cancellations & Refunds. Registration cancellations and refund requests must be received in writing on or before the "cancellation requested date" below to qualify. Paid no-shows will receive all the materials covered by their registration fees. Refunds will be processed to the credit card used for payment if cancellation requested within 30 days of payment, otherwise, the refund will be processed by check. A $150 service fee applies to each cancelled registration. By registering for the Activity, you agree to the following registration cancellation refund policy:

By registering for the Activity, you agree to the following registration cancellation refund policy:

- Cancellation requested on or before December 10, 2021: 75% of the registration fee.
- Cancellation requested December 11, 2021, through March 25, 2022: 50% of the registration fee.
- Cancellation requested after March 25, 2022: No refunds.

Photo ID Required

A valid, government-issued PHOTO ID (driver's license/passport/student ID), that matches the name on the badge, will be required for verification upon check-in and/or to request a badge reprint for lost or forgotten badges. Only the attendee named on the badge may pick up his or her badge and registration materials.

Booth Staff, Sponsor/Exhibitor Discounted Technical Program Registration

The Organization ID associated with the company's booth reservation will be required to register discounted sponsor/exhibitor technical registrants and booth staff. It can be found in the booth reservation confirmation email.

Only those registered for the technical program will be admitted to technical sessions. **Anyone making a platform or poster presentation or chairing a session must be registered for the technical program.** Technical program registrants may staff the exhibit booth as needed.

Persons registered as "booth staff" are not eligible to attend technical sessions unless registered for the technical program. Anyone found to be attending technical sessions without the proper registration credentials will be charged a full conference technical registration fee ($1,025).

See the **Registration** page for additional details and registration links for the categories below.

Booth Staff Registration. Booth staff are defined as the employees of the Exhibiting company who will be attending the Conference solely to work in the booth. Booth staff registration must be done online. All booth staff must be registered online by April 22, 2022. Booth staff will be admitted to food functions that take place in the Exhibit Hall and may attend the Plenary Session. Booth staff are eligible for upgraded technical program registration ($700/each) up to the maximum technical upgrade totals shown in the **Exhibitor Terms and Conditions**.

Booth staff badges are not transferable to other individuals and may not be traded/swapped with technical program registrants to avoid technical registration fees. Please do not complete a booth staff registration and a technical program registration for the same person.

Sponsor/Exhibitor Discounted Technical Program Registration. A certain number of booth staff, determined by booth size, are eligible for an upgraded technical program registration ($700/each) and registration must be completed online.

Attendee List Opt-in

When registering for the technical program, you must OPT-IN to be included in Conference attendee lists by checking the appropriate box on the registration form. Leaving the box unchecked will result in your name not being included in attendee lists.

Conference Venue & Hotels

The Conference technical program will be conducted at the Palm Springs Convention Center and adjoining Renaissance Palm Springs Hotel.

The Palm Springs Convention Center participates in a comprehensive environmental program designed to utilize best practices in water conservation, energy efficiency, waste diversion, and air quality. The in-house catering partner, Savoury's, utilizes biodegradable products, locally grown food, and donates excess food to local assistance programs. It also participates in the City of Palm Springs' pilot composting program.

COVID-19 Venue Requirements. Current COVID-19 requirements for the city of Palm Springs can be found here: **https://www.palmspringsca.gov/government/covid-19-updates**. The Chlorinated Conference meets the definition of a "mega event" as defined by the State of California—Health and Human Services Agency, California Department of Public Health.

The COVID-19 pandemic is evolving daily. Battelle is committed to producing an onsite event that will be protective of human health and comply with venue and state safety guidelines that may be in place at the time of the event. Recommendations and requirements may change at any time based on the current state of the pandemic at the time of the event and the **Health & Safety** page will be updated with requirements for attendance as necessary.

Hotel Reservations. Group room blocks are available at the Renaissance Palm Springs Hotel and nearby Hilton Palm Springs. A percentage of rooms will be available at the prevailing U.S. Government per diem rate (plus tax) for U.S. federal, state, and local government employees. The rate is not valid for government contractors. Government ID required at check-in. Links to online reservations for group and government group rates are available on the on the **Venue & Hotels** page.

Conference Hotel

The Chlorinated Conference only has group rate agreements with the Renaissance Palm Springs Hotel and Hilton Palm Springs. We have not partnered with any travel agency or third-party for travel/hotel discounts. If you receive a call or email offering assistance in making or changing hotel reservations, we advise caution. The Chlorinated Conference has no agreement with any organization to contact participants and offer reservation assistance, nor have we provided contact information to anyone for this purpose. **Please use only the reservation links provided on the Venue & Hotel page to make reservations.**

Palm Springs

Within easy walking distance of the Convention Center, you will find restaurants, shops, and attractions such as Village Fest, a street fair held every Thursday evening. The downtown area displays the mid-century modern architecture the city is famous for, and the street names recall its roots as a getaway spot for the stars of Old Hollywood.

Just minutes from downtown, you can take the Palm Springs Aerial Tramway 2,643 feet up to Mount St. Jacinto State Park, where extensive hiking trails branch out in all directions. Explore the terrain of the Greater Palm Springs area by bike, Jeep, or hot air balloon. Visit Joshua Tree National Park, where two distinct desert ecosystems—the Mojave and the Colorado—come together, and the canyons of the San Andreas Fault await you. Learn more at **www.visitpalmsprings.com**.

Contact Information

Program details and presenter, session chair, and panelist coordination:

Gina Melaragno (Battelle)
chlorcon@battelle.org
phone 614.424.7866

Sponsorship, exhibits, registration, and hotel information:

Susie Warner (The Scientific Consulting Group)
chlorinated2022@scgcorp.com
301.670.4990 phone
301.670.3815 fax

TECHNICAL PROGRAM

The technical program will begin on Monday afternoon, May 23, after the Plenary Session. It will continue with the 82 breakout sessions and six panel discussions through Thursday afternoon. The breakout sessions and panels are organized into the following thematic tracks:

- **Remediation Technology Innovations (Sessions A1-A8 and B1-B10)**
- **Assessing Remediation Effectiveness (Sessions C1-C8)**
- **Green and Sustainable Remediation (Sessions C9-C11)**
- **Addressing Challenging Site Conditions (Sessions D1-D6)**
- **Metals (Sessions D7-D9)**
- **Per- and Polyfluorinated Alkyl Substances (PFAS) (Sessions E1-E8 and F1-F6)**
- **Vapor Intrusion (Sessions F7-F9)**
- **Technology Transfer and Stakeholder Communications (Sessions G1-G2)**
- **Petroleum and Heavy Hydrocarbon Site Strategies (Sessions G3-G7)**
- **Advanced Diagnostic Tools (Sessions G8-G10)**
- **International Environmental Remediation Markets (Sessions G11)**
- **Characterization, Fate and Transport (Sessions H1-H7)**
- **Emerging Contaminants (Sessions I1-I4)**
- **Fractured Rock and Complex Geology (Sessions I5-I9)**

Plenary Session Schedule

Monday, May 23, 8:30-10:00 a.m.

Welcome and Opening Remarks
Conference Chairs:
Michael Meyer, PMP, RG, LEG, LHG (Battelle)
Carolyn Scala, PE (Battelle)

Presentation of Student Paper Awards

Lessons from Documenting the Stories of Today's Biggest Environmental Problems and Those Working to Solve Them
Craig Leeson—award-winning filmmaker, journalist, and explorer

Craig Leeson is a passionate oceans and mountain explorer, surfer, diver, aviator and an award-winning filmmaker, television presenter, news correspondent, and entrepreneur. He is the director, explorer/narrator, and writer of the multi-award-winning documentary feature film *A Plastic Ocean* (released 2017) and the producer/director/writer of *The Last Glaciers* (due for release on IMAX 2022). *A Plastic Ocean* was ranked the number one documentary on iTunes in the U.S., the U.K., and Canada shortly after its release. Craig is the 2021 Australian of the Year award recipient.

Craig is the CEO of Leeson Media International, Leeson Global Media and Ocean Vista Films and founder of the I Shot Hong Kong Film Festival. He is the Sustainability Partner to BNP Paribas, an advisor to The Klosters Forum, and was Cathay Pacific's first Change-maker Award recipient. He has advised governments around the world on environment issues and was instrumental in helping frame and introduce legislation banning single use plastics to the Colombian and Mexican congresses. He has also advised and worked with the Asian Development Bank on oceans and single-use plastics-related issues and helped ADB's president launch a US$5billion global healthy oceans initiative in Fiji. He has worked with the world's major broadcasters as a producer and foreign correspondent, including BBC, CNN, Bloomberg, PBS, National Geographic Channel, Discovery Channel, Bio Channel, Universal, Al Jazeera and the Seven Network. He began his career as a newspaper journalist before moving to radio and television as a news correspondent and anchor for ABC TV Australia and later for ATV, RTHK and Star News (Hong Kong).

He has won 17 awards for *A Plastic Ocean*, which has been translated to more than 25 languages and was released on Netflix by Leonardo di Caprio. The film was simultaneously screened on Amazon and iTunes. A Plastic Ocean has been publicly screened in cinemas and at public events in over 70 countries on 6 continents. There have been over 2000 screenings globally hosted by government agencies, non-profits, schools, universities, individuals, multilateral institutions, corporations, aquariums, and others, including the Smithsonian Institute, the Australian and UK Parliaments and the Mexican senate. The film was only the second chosen to be screened in the US Senate (*An Inconvenient Truth* the first) and was selected by the Senate as one of 50 showcase films to be screened in 55 US embassies around the world. A shorter 22-minute version of the film was premiered at the UN General Assembly, in conjunction with the Permanent Mission of Colombia, in 2018 in New York City, to more than 500 people. The film counts among its patrons UNESCO. His new feature film, *The Last Glaciers*, will be screened globally by IMAX and is slated for release in 2021.

Poster Group Schedule

Poster sessions are divided into two groups for display and presentation as shown below. Presenters will be at their posters during the designated presentation times to discuss their work. Light refreshments will be provided during the poster presentations.

Poster Group 1
Display: Sunday 6:00 p.m.–Tuesday 1:00 p.m.
Presentations: Monday 4:30–6:30 p.m.

A1. Emerging Remediation Technologies

A2. Abiotic and In Situ Biogeochemical Processes: Applications and Lessons Learned

A3. ZVI: 25 Years of Groundwater Remediation Applications

A4. Combined Remedies and Treatment Trains

B1. In Situ Technologies: Lessons Learned

B2. Thermal Conductive Heating: Best Practices and Lessons Learned

B3. Thermal Conductive Heating: Case Studies

B4. In Situ Chemical Oxidation: Optimized Design Approaches and Lessons Learned

B5. Injectable Activated Carbon Amendments: Lessons Learned and Best Practices

B6. Innovations in ZVI Amendment Formulations and Applications

C1. Remedial Design/Optimization: Applications of Mass Flux and Mass Discharge

C2. Remedy Implementation: Assessing Performance and Costs

C3. In Situ Activated Carbon-Based Amendments: Assessing Effectiveness and Performance

C4. Compound-Specific Isotope Analysis: Case Studies in Evaluating Remedy Performance

C5. Site Closure: Models Used to Estimate Cleanup Timeframes

C6. Data Analytics: Use of Advanced Decision Analysis Tools, Including AI and Machine Learning for Improved Analysis, Optimization and Decision Making

C7. Optimizing Remedial Systems

D1. Large, Dilute and Commingled Plume Case Studies

D2. Landfill Assessment and Remediation

D3. Adaptive Site Management: Lessons Learned for Site Characterization and Remedy Implementation

D4. Evaluating Surface Water/Groundwater Interactions: Innovative Monitoring Approaches and Modeling Applications

D5. DNAPL Source Zone Remediation: Lessons Learned

D6. Low-Permeability Zone Challenges, Permeability Enhancements, and Case Studies

E1. Advances in the Analysis of Non-Target Per- and Polyfluorinated Alkyl Substances (PFAS)

E2. PFAS and Bugs: The Search Continues

E3. Ex Situ PFAS Treatment: Soils/Solids and Other Waste Streams

E4. PFAS Human Health and Ecological Risk Assessment and Toxicity

E5. Managing PFAS at Publically-Owned Treatment Works (POTWs)

E6. Ex Situ PFAS Water Treatment Technologies

F1. PFAS Fate and Transport Properties

F2. PFAS Conceptual Site Model Approaches

F3. PFAS Program Management in a Rapidly Changing Regulatory Environment

F4. PFAS Source and Forensic Considerations

G1. Expedite Site Closure: Innovative Strategies and Approaches

G2. Practice of Risk Communication and Stakeholder Engagement

G3. Heavy Hydrocarbons: Characterization and Remediation

G4. Natural Source Zone Depletion

H1. Improvements in Site Data Collection, Data Management, and Data Visualization

H2. Conceptual Site Models: Improvements in Development and Application

I1. Explosives, Perchlorate

I2. Advances in 1,4-Dioxane Biological Treatment Technologies

I3. 1,4-Dioxane Remediation Challenges

The poster presentations below will be on display Sunday-Thursday near the Registration Desk.

***Evolution of the U.S. Environmental Consulting Industry from 1990 to the Present.** *W.H. DiGuiseppi and D. Maslonkowski.* William DiGuiseppi (Jacobs/USA)

Poster Group 2
Display: Wednesday 7:00 a.m.–Thursday 1:00 p.m.
Presentations: Wednesday 4:30–6:30 p.m.

A5. Permeable Reactive Barriers: Best Practices and Lessons Learned

A6. Thermally Enhanced In Situ Degradation Processes at Sub-Boiling Temperatures

A7. Horizontal Wells: Applications and Lessons Learned in Site Characterization and Remediation

A8. Electron Donors: Innovations for Biodegradation

B7. Innovative and Optimized Amendment Delivery and Monitoring Methods

B8. Monitored Natural Attenuation: Innovative Monitoring Approaches/Lines of Evidence and Lessons Learned

B9. Advanced and Synthetic Biological Treatment Applications

B10. Electrical Resistance Heating: Best Practices and Lessons Learned

C8. Setting Cleanup Goal End Points: When Are We Done?

C9. GSR Best Practices and Nature-Based Remediation Case Studies

C10. Climate Resilience and Site Remediation

C11. Aligning Remediation Goals with Environmental, Social, and Governance (ESG) Considerations

D7. Precipitation and Stabilization of Metals

D8. Mining and Uranium Site Restoration

D9. Managing Chromium-Contaminated Sites

E7. PFAS Site Characterization

E8. In Situ PFAS Treatment Approaches

F5. PFAS: Groundwater Treatment Case Studies

F6. Ex Situ PFAS Destruction Technologies

F7. Advances in Vapor Intrusion Investigations

F8. Vapor Intrusion Mitigation and Effectiveness

F9. Vapor Intrusion Risk Assessment and Site Management

G5. In Situ Remediation of Petroleum Hydrocarbons

G6. LNAPL Recovery/Remediation Technology Transitions

G7. LNAPL Sites: Understanding and Managing Risks

G8. Environmental Forensics: Site Characterization and Source Determinations

G9. Remote Sensing, Drones, and Other Unmanned Systems for Remote Monitoring and Site Assessments

G10. Using Omic Approaches and Advanced Molecular Tools to Optimize Site Remediation

G11. International Remedy Applications: Regulatory and Logistical Challenges of Remediation Abroad

H3. Advanced Geophysics and Remote/Direct Sensing Tools and Techniques

H4. Advanced Sampling and Analysis Tools and Techniques

H5. Groundwater Modeling: Advancements and Applications

H6. MIP/HPT/LIF/UVOST—Realtime HRSC Tools and Techniques

H7. HRSC Suites of Tools to Improve CSMs

I4. Microplastics, Pharmaceuticals, and Other Emerging Contaminants

I5. Technical Impracticability: Challenges and Considerations for Evaluation of Fractured Rock Sites

I6. Depositional Environments and Stratigraphic Considerations for Remediation

I7. Process-Based Conceptual Site Models (CSMs) for Informing Remediation

I8. Advances in the Application of Geologic Interpretation to Remediation

I9. Remediation Approaches in Fractured Rock and Karst Aquifers

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***Evolution of the U.S. Environmental Consulting Industry from 1990 to the Present.** *W.H. DiGuiseppi and D. Maslonkowski.* William DiGuiseppi (Jacobs/USA)

Breakout Sessions and Panels

All presentations scheduled as of February 18, 2022, are listed below in alphabetic order by title. In each entry, the author list appears in italics, followed by the name and affiliation of the person scheduled to give the presentation.

Each title beginning with an asterisk (*) is to be presented as a poster presentation.

The schedule is subject to revision (changes of presenters, withdrawals) in the months leading up to the Conference. To assist participants in planning their time, the Final Program and abstracts will be made available online by May 6, 2022. All applicable attendees preregistered by that date will receive an email providing links to the resources.

A1. Emerging Remediation Technologies

Platforms Monday | Posters (*) Monday Evening
Chairs: Stewart Abrams (Langan Engineering & Environmental Services, Inc.) and Stephen Koenigsberg (Koenigsberg Consulting)

***Analysis of the Densification of the Polymer Solution on Displacement Efficiency of DNAPL.** *A.H.M. Alamooti, S. Omirbekov, S. Colombano, H. Davarzal, F. Lion, A. Ahmadi, D. Cazaux, B. Paris, A. Joubert, and J. Maire.*
Amir Hossein Mohammadi Alamooti (BRGM [French Geological Survey]/France)

***CAT 100: In Situ Chemical Reduction without Depletion of Metallic Iron.** *S. Noland.*
Scott Noland (Remediation Products, Inc./USA)

***Chlorinated Hydrocarbon Diffusion through Poly(vinyl alcohol) Hydrogels.** *C.J. Silsby, M.F. Roll, K.V. Waynant, J.G. Moberly, and J.R. Counts.*
Carson Silsby (University of Idaho/USA)

***Combination of Enhanced Reductive Dechlorination and Aquifer Thermal Energy Storage: Pilot Test.** *M. Christophersen, L. Bennedsen, B.B. Thrane, N. Tuxen, J. Flyvbjerg, B. Godschalk, M. Henssen, N. Hoekstra, and T. Grotenhuis.*
Mette Christophersen (Ramboll Denmark/Denmark)

Constructed Wetlands Pilot Test for Treatment of a Complex Mixture of Contaminants at a NAPL-Impacted Site in Brazil. *P. Barreto, J. Arthur, C. Martins, P. Rego, C. Mowder, D. Austin, E.E. Mack, P. Carvalho, and R. Silva.*
Paola Barreto Quintero (Jacobs/USA)

***Copper Removal of Deep-Sea Mining Tailings Treated by Chemical Extraction with Aluminum Sulfate.** *G. Lee and K. Kim.*
Kyoungrean Kim (Korea Institute of Ocean Science and Technology/South Korea)

***Enabling NAPL Remediation through Surfactant-Enhanced Product Recovery.** *D. Socci and G. Dahal.*
Dan Socci (EthicalChem/USA)

***Foam as a Blocking Agent to Enhance Remediation Efficiency in Heterogeneous Source Zones: Lessons from Three Field Tests.** *O. Atteia, E. Verardo, C. Portois, and N. Guiserix.*
Olivier Atteia (Bordeaux University/France)

***Graphene Oxide Composite Membranes as Alternatives for Water Treatment.** *S.G. Zetterholm, C. Griggs, J. Mattei-Sosa, and L. Gurtowski.*
Sarah Grace Zetterholm (U.S. Army ERDC/USA)

Graphene Oxide–Zirconium Hydroxide (GO–$ZrO(OH)_2$) Nanocomposite: Effectively Removes Heavy Metals from Aqueous Solutions. *L.P. Lingamdinne, J.R. Koduru, J.S. Choi, S.H. Lim, J.K. Yang, Y.Y. Chang, and Y.S. Chang.*
Lakshmi Prasanna Lingamdinne (Kwangwoon University, South Korea)

***Groundwater Flow and Transport Modeling: A Sustainable Hydraulic Source Isolation System.** *L. Mu, R. Silva, J. Henderson, and M.C. Lemes.*
Linlin Mu (ERM/USA)

***Integrating Multi-Technology Surfactant-Enhanced Bioremediation and Oxidation Approaches for Petroleum Hydrocarbon Remediation.** *D. Socci and G. Dahal.*
Dan Socci (EthicalChem/USA)

***Investigations on Microbial Chain Elongation Substrate Type, Substrate Ratio, and End Product for Chlorinated Solvent Reductive Dechlorination.** *A. Robles, M.I. Silverman, and A.G. Delgado.*
Aide Robles (Arizona State University/USA)

New Integrated Biogeochemical/Electrochemical Method for Remediation of Contaminated Groundwater. *E. Elgressy, G. Elgressy, T. Lizer, and W. Moody.*
Troy Lizer (Provectus Environmental Products, Inc./USA)

***Real-Time Monitoring of EBR Pilot Project.** *M.D. Brourman and J.S. Wright.*
Mitchell Brourman (Field Data Solutions/USA)

***Reductive Degradation of Persistent Organic Pollutant Lindane by Alkaline Cold-Brew Green Tea.** *C.-W. Wang, S.-C. Chang, and C. Liang.*
Chi-Wei Wang (National Chung Hsing University/Taiwan)

***Risk-Based and Biotechnology Alternatives to Address Natural Gas Emissions from Leaking Oil and Gas Wells.** *G.A. Ulrich, T. Coulombe, W. Morrison, B. Marjanovic, and A. Cahill.*
Glenn Ulrich (Parsons Corporation/USA)

Simultaneous Treatment of Heavy Metals and Chlorinated Solvents in Groundwater. *A. Seech, D. Leigh, and J. Molin.*
Alan Seech (Evonik Active Oxygens, LLC/USA)

Study of a Reductive Bioelectrochemical Reactor for Perchloroethylene Removal in Synthetic and Real Contaminated Groundwaters. *E. Dell'Armi, M. Zeppilli, M. Majone, and M. Petrangeli Papini.*
Edoardo Dell'Armi (University of Rome "La Sapienza"/Italy)

***Subsurface Grouting and Groundwater Control by Injectable Silica Gels.** *L. Zhong, S. Saslow, and M.V. Snyder.*
Lirong Zhong (Pacific Northwest National Laboratory/USA)

Successful Technologies for Remediation of Groundwater: Lessons Learned from Past Experiences. *J.T. Wilson.*
John Wilson (Scissortail Environmental Solutions, LLC/USA)

There's a Method to This Madness: Dynamic Groundwater Recirculation (DGR™). *M.W. Killingstad, J. Roller, J. Wahlberg, and S.T. Potter.*
Marc Killingstad (Arcadis/USA)

Transitioning from Active Remedies to Monitored Natural Attenuation. *C.J. Newell, D.T. Adamson, and J.T. Wilson.*
Charles Newell (GSI Environmental, Inc./USA)

***Treatment of Organic and Inorganic Contaminants in Groundwater from a Former Landfill Using a Novel Sustainable Electrocoagulation Process.** *E. Bergeron.*
Eric Bergeron (Golder Associates/Canada)

***Understanding the Thermal Behavior of a Wide Range of Recalcitrant Compounds.** *N. Weber, S. Stockenhuber, C. Delva, A. Abu Fara, J. Lucas, J. Mackie, M. Stockenhuber, E. Kennedy, C. Grimison, T. Truong, and I. Brookman.*
Nathan Weber (University of Newcastle/Australia)

Using UV/AOP to Mineralize PCBs in Groundwater. *J. Haney and D. Conley.*
John Haney (Hart Crowser, a Division of Haley & Aldrich/USA)

A2. Abiotic and In Situ Biogeochemical Processes: Applications and Lessons Learned

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Steve Livingstone (Porewater Solutions) and John Wilson (Scissortail Environmental Solutions, LLC)

***Abiotic and Biotic Source Area Treatment of TCE and Daughter Products with ZVI and Electron Donor.** *A.A. Cuellar, M.S. Kovacich, B.K. Loffman, and J. Walbert.*
Michael Kovacich (Tetra Tech, Inc./USA)

Abiotic Dechlorination by Natural Ferrous Minerals. *C.E. Schaefer, D. Nguyen, E. Berns, and C. Werth.*
Charles Schaefer (CDM Smith, Inc./USA)

***Actual Decay of Tetrachloroethene (PCE) and Trichloroethene (TCE) in a Highly Contaminated Shallow Groundwater System.** *D. Pierri.*
Dorota Pierri (AGH University of Science and Technology/Poland)

Biogeochemically Enhanced Treatment of Chlorinated Organics and Metals. *D. Leigh, A. Seech, and J. Molin.*
Daniel Leigh (PeroxyChem, LLC/USA)

***Biological and Geochemical Groundwater Treatment Using Recirculation for Distribution to Prevent Excavation.** *R.E. Mayer, C. Johnson, and J. Perkins.*
Robert Mayer (APTIM Federal Services/USA)

***Can Less Remediation Be More Effective? Combining Targeted Soil Excavation with Passively Dispersed Reductive Amendment in a Source Area over Fractured Bedrock.** *R.S. Powell.*
R. Scott Powell (EnviroForensics, LLC/USA)

***Characterization of Governing Mechanisms for Enhanced Attenuation of Toluene Contamination in a Shallow, Fractured Dolostone Aquifer.** *S. Shafieiyoun, B.L. Parker, N.R. Thomson, R. Aravena, E.A. Haack, D.T. Tsao, and K.E. Dunfield.*
Saeid Shafieiyoun (University of Guelph/Canada)

Combined Enhanced Biotic-Abiotic Transformation of Carbon Tetrachloride and Chloroform at the Field Scale: A Biogeochemical Perspective. *S.D. Justicia-Leon, J. Martin Tilton, C. Divine, S.M. Ulrich, D.L. Freedman, and K. Clark.*
Shandra Justicia-Leon (Arcadis/USA)

***Degradation of Chlorinated Solvents by Reactive Iron Minerals in Redox Transition Zones from a Site with Historical Contamination.** *X. Yin, H. Han, D.E. Fennell, J. Dyer, R. Landis, S. Morgan, and L. Axe.*
Xin Yin (New Jersey Institute of Technology/USA)

Development of a ^{14}C Assay to Quantify Abiotic Transformation Rates for Chlorinated Ethenes in Water Supply Aquifers. *D.L. Freedman, A.A. Ramos Garcia, A. Pullen, J.T. Wilson, B. Wilson, and T. Kuder.*
David Freedman (Clemson University/USA)

***Full-Scale Application in Italy of a Combined ISCR and ERD Technology for the Treatment of an Aerobic Aquifer Impacted with Tetrachloromethane and Chloroform.** *A. Leombruni, M. Mueller, F. Lakhwala, and D. Leigh.*
Alberto Leombruni (PeroxyChem, LLC/Italy)

In Situ Biogeochemical Reductive Dechlorination: Performance in Complex Low Permeability Formation. *J. Studer and N. Glenn.*
James Studer (InfraSUR, LLC/USA)

In Situ Geochemical Stabilization (ISGS) of DNAPL: Bench-Scale and Pilot-Scale Demonstration Results. *D. Gray, T. Vannest, S. Lucas, J. Mueller, G. Booth, C. Walecka-Hutchinson, T. Tambling, and J. Sprague.*
Doug Gray (AECOM/USA)

***Laboratory and Field Validation of Min-Traps for Collection and Analysis of Reactive Iron Sulfide Minerals for Abiotic CVOC Degradation.** *S.D. Justicia-Leon, S.M. Ulrich, J. Martin Tilton, D. Liles, C. Divine, D. Taggart, and K. Clark.*
Shandra Justicia-Leon (Arcadis/USA)

***Limited Bedrock Injection Volume Nets Substantial Concentration Reductions.** *H. Kilts, D. Good, S. Grillo, and F. Lakhwala.*
Heather Kilts (Groundwater & Environmental Services, Inc./USA)

Mineral Phases from In Situ Biogeochemical Processes: The Key to Abiotic Natural Attenuation? *P.G. Tratnyek, A.S. Pavitt, and R.L. Johnson.*
Paul Tratnyek (Oregon Health & Science University/USA)

***Roadmap to Analytical Documentation of Reactive Mineral Formation and Metals Precipitation In Situ: With or Without Drilling.** *E.W. Carter, C.E. Divine, S.M. Ulrich, S. Justicia-León, J. Martin Tilton, D. Liles, D. Taggart, and K. Clark.*
Erika L. Williams Carter (Arcadis/USA)

Using a ^{14}C Assay to Measure Abiotic Degradation of TCE by Magnetic Materials in Aquifer Sediment from the Western USA. *J.T. Wilson, B. Wilson, D.L. Freedman, and A. Ramos Garcia.*
John Wilson (Scissortail Environmental Solutions, LLC/USA)

A3. ZVI: 25 Years of Groundwater Remediation Applications

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Stephanie Fiorenza (ARCADIS) and Paul Tratnyek (Oregon Health & Science University)

***Application of the Novel Sulfidated Iron Nanoparticles (S-nZVI) on a Site Heavily Polluted by Trichloroethene (TCE).** *J. Slunsky, P. Skacelova, O. Lhotsky, A. Wiener, and J. Oborna.*
Jan Slunsky (NANO IRON, s.r.o./Czech Republic)

*** Evaluation of the Seven-Year Operation of a Funnel and ZVI Gate System for Containment of VOCs and Chromium(VI) Contamination.** *W. Gevaerts, J. Matha, and T. Gisbert.*
Wouter Gevaerts (Arcadis/Belgium)

***Full-Scale Remediation of Chlorinated Solvents in Farum Gydegård Electrical Substation Using ERD and nZVI.** *J.U. Bastrup, S.K. Schultz, D. Isager, and M. Rydam.*
John Ulrik Bastrup (Geo/Denmark)

***Fundamental Advances in Environmental Science and Engineering from over 25 Years of Research on ZVI and PRBs.** *P.G. Tratnyek.*
Paul Tratnyek (Oregon Health & Science University/USA)

***In Situ Enhanced Reductive Dechlorination and Bioremediation Pilot Study in a Deep, Consolidated Aquifer.** *J. Graber and E. Siegel.*
Emily Siegel (Roux Associates, Inc./USA)

***Laboratory Evaluations of ZVI: Impacts of Particle Size, Loading Rates, Sulfidation, Compounds Treated, and Combinations with Organic Substrates.** *M.D. Lee and R.L. Raymond.*
Michael Lee (Terra Systems, Inc./USA)

Long-Term Performance Update on the 17-Year Anniversary of the First Full-Scale EHC® Injection PRB. *J. Molin, A. Seech, J. Valkenburg, R. Oesterreich, and J. Son.*
Josephine Molin (Evonik/USA)

The Practitioner's Perspective of Zero-Valent Iron as a Pragmatic Media for Contaminant Remediation: It's Not 1995 Anymore! *S.D. Warner and C.J. Ritchie.*
Scott Warner (BBJ Group/USA)

***Rapid Remediation of cVOC Plume via In Situ Anaerobic Bioremediation and Chemical Reduction under a GFPR.** *M. Chavan, E. Smith, and L. Rebele.*
Manasi Chavan (Ramboll US Consulting, Inc./USA)

Somersworth Superfund ZVI PRB: Over 20 Years of Performance Monitoring. *A. Przepiora, S. O'Hara, S. Wadley, and S. Huda.*
Shahen Huda (Geosyntec Consultants/USA)

***Sulfidated ZVI: The Latest Development of ISCR from Laboratory to Field.** *D. Fan, J. Wang, N. Durant, P. Tratnyek, G. Lowry, and H. Feng.*
Dimin Fan (Geosyntec Consultants/USA)

***Treating Chlorinated Pesticides and Organic Explosive Compounds in Soil with ZVI/Organic Carbon Reagents: 25 Years of Lessons Learned.** *A.G. Seech.*
Alan Seech (Evonik Active Oxygens, LLC/USA)

A Twenty-Five Year Examination of Zero Valent Iron for Groundwater Remediation: The Elizabeth City, North Carolina Case Study. *R.T. Wilkin, T.R. Lee, R.W. Puls, D.W. Blowes, C. Kalinowski, J.M. Tilton, and L.L. Woods.*
Richard Wilkin (U.S. Environmental Protection Agency/USA)

***When Failure Is Not an Option: Bench-Scale Study and Targeted Activated Carbon-Based Injection Program Leads to Repair of an Aging ZVI PRB.** *B. Tunnicliffe.*
Bruce Tunnicliffe (Vertex Environmental, Inc./Canada)

***Zero Valent Iron: Myths, Misconceptions, and Results from 20 Direct Push Injections.** *J.M. Tillotson, J.M. Tilton, R. Oesterreich, and S. Justicia-Leon.*
Jason Tillotson (Arcadis/USA)

Panel Discussion—Wednesday, Track A

Thermal Remediation Technology Updates: Eight Experts Discuss Four Years of Innovations in 100 Minutes

Moderators
Grant Geckeler (ISOTEC)
Erin Hauber (U.S. Army Corps of Engineers)

Panelists
Steffen Griepke (TerraTherm)
Gorm Heron (TRS Group)
Clayton Campbell (McMillan-McGee)
Jonah Munholland (Arcadis)
Xiaosong Chen (GEO)
Dave Liefl (Savron)

Innovations and technological advancements in thermal remediation have rapidly progressed since this conference last convened in 2018. New thermal innovations have allowed remediation far deeper than one hundred feet below ground surface (bgs), reduced the carbon footprints of in situ thermal remediation (ISTR) projects, expanded thermal remediation to previously untreated contaminants and contaminant mixtures, treated sludges generated by other remediation techniques, and even resulted in new methods of heating contaminated media.

The six panelists will each present a 10-minute overview of the thermal remediation innovations they have developed and applied since 2018. Technology topics will include:

1. Combined remedies and phased approaches using thermal treatment
2. Low temperature thermal advancements
3. Novel developments in ex situ thermal remediation
4. Electromagnetic inductive heating technology
5. Applying ISTR at depths exceeding 100 ft bgs
6. Treatment of per- and polyfluoroalkyl substance (PFAS) compounds

The moderators will then guide the panelists and audience through an interactive discussion based on the panelists' presentations and the following themes:

1. Green and sustainable remediation impacts of thermal innovations
2. Lessons learned (not every innovation is perfect the first time)
3. Future opportunities for research, development, and demonstration
4. Discussion of market trends and insights
5. Audience interactions and questions

A4. Combined Remedies and Treatment Trains

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Jim Cummings (U.S. Environmental Protection Agency) and James L'Esperance (Northrop Grumman)

***Adapting a Remedy to Achieve Site Closure for a Challenging, Century-Old, New York Brownfield Site.**
M. Dooley and L. Riker.
Maureen Dooley (REGENESIS/USA)

Application of Multiple Remediation Techniques to Achieve Full Site Closure Abroad. *M. van den Brand, G. Heron, J. van Rossum, and H. Boden.*
Marco van den Brand (HMVT/Netherlands)

Bioaugmentation after Thermal Conductive Heating and Comparison with Conventional Bioaugmentation in Passaic Formation. *L. Zeng, M. Wenrick, S. Abrams, L. Antonetti, and J. Smith.*
Lingke Zeng (Langan/USA)

***Case Study of Bioremediation and ISCR at a Chlorinated Solvents Site in Southern California.** *J. Sankey.*
John Sankey (True Blue Technologies, Inc./USA)

***Closure in California is Achievable: Successful Remediation of Chlorinated Solvents in Groundwater and Soil via Combined Technologies of ISCO and SVE.** *T. Etter, B. McDaniel, A. Simons, S. Rowlands, B. Marvin, and P. Brookner.*
Andy Simons (Geosyntec Consultants/USA)

***Combined In Situ Thermal Desorption, Enhanced Reductive Dechlorination, and Vapor Intrusion Mitigation at a Former Manufacturing Facility.** *M. Nemecek, J. Zentmeyer, P. Tomiczek, III, and S. Koenigsberg.*
Matt Nemecek (Civil & Environmental Consultants, Inc./USA)

Combined In Situ Treatment Methods and Technologies Reduce Mass at a Large DNAPL Solvent Site. *M. Mazzarese and G. Simpson.*
Mike Mazzarese (AST Environmental, Inc./USA)

***Combined Remedial Technologies and Regulatory Tools Applied to CVOCs in Overburden and Fractured Bedrock.**
W.B. Silverstein.
William Silverstein (GEI Consultants, Inc./USA)

Combined Remedial Technologies: Electrical Resistance Heating (ERH) Bioremediation Injections and Groundwater Extraction with Activated Carbon Treatment and Soil Vapor Extraction (SVE) and Soil Removal. *J.R. Kane.*
John R. Kane (Kane Environmental, Inc./USA)

***Combined Remediation of VOCs, 1,4-Dioxane, and Cr(VI) Using ISCO followed by ERD.** *W. Bee, J. Neuhaus, C. Lenker, and V. Ramalingam.*
Walter Bell (Tetra Tech/USA)

***Combined Remediation Technologies for a Complex PCE-Contaminated Site in Brazil.** *A.C. Gatti, R. Campos, G.D.C. Mello, and M.Q. Omote.*
Anderson Gatti (Ramboll Environ/Brazil)

***Combined Remedies Evaluation to Treat Residual Contamination at a Former MGP Site.** *J. Bergman, H. Nord, P. Elander, S. Moeini, J. Molin, and B. Smith.*
Jonny Bergman (RGS Nordic/Sweden)

***Combined Remedy: In Situ Chemical Reduction and Enhanced Bioremediation Injection at a Superfund Site.** *J. Graber and E. Siegel.*
Emily Siegel (Roux Associates, Inc./USA)

***Combined Technologies Remediate Chlorinated Solvents in a Dense Industrial/Residential Neighborhood with Off-Site Commingling Plumes.** *M. Hudock, K. Kinsella, and D. Winslow.*
Marc Hudock (GZA GeoEnvironmental, Inc./USA)

Combining In Situ Thermal Treatment and In Situ Chemical Reduction to Leverage Synergistic Processes. *G. Booth, K. Lauer, R. Hogdahl, and R. Simon.*
J. Greg Booth (Woodard & Curran/USA)

Combining Slurry-Supported Soil Excavation, Air/Biosparging, and Enhanced Reductive Dechlorination to Accelerate Remediation of a Commingled Plume with LNAPL. *M. Perlmutter, J. Persons, K. Rosebrook, M. Strong, and D. Williamson.*
Mike Perlmutter (Jacobs/USA)

***Denmark's First Full-Scale Application of Combined In Situ Chemical Oxidation and Solidification/Stabilization for Remediation of a DNAPL Source Area.** *N.D. Durant, C. Robb, T.H. Jorgensen, L. Nissen, N.E. Bordum, and A. Toft.*
Neal Durant (Geosyntec Consultants/USA)

***Evaluation and Implementation of ISS-ISCO at a Dry Cleaner Site.** *J.W. Parker and W. Lang.*
Joel Parker (Hamp, Mathews and Associates/USA)

***Evaluation of Strategies for Treatment of Complex Waste Mixtures at an Industrial Site in South America.** *D.L. Freedman, J. Jimenez, J. Henderson, E.E. Mack, M.C.S. Lemes, and P. Barreto.*
David Freedman (Clemson University/USA)

Excavation, Groundwater Extraction, In Situ Bioremediation, and In Situ Chemical Oxidation to Treat Large Commingled cVOC Plumes. *R.E. Mayer, J. Koelsch, K. Chambers, and M. Gunderson.*
Robert Mayer (APTIM Federal Services/USA)

***In Situ and Ex Situ Remedial Components Combined to Support a Permanent Solution for a Massachusetts Site.** *M. Wade, K. Dyson, J. LeClair, and J. Spadt.*
Marilyn Wade (Brown and Caldwell/USA)

***In Situ Chemical Oxidation followed by Enhanced Reductive Dechlorination for Treatment of Chlorinated Solvents in Groundwater.** *S. Dore, D. Cusick, D. Pope, R. Thomas, and J. Wasielewski.*
Sophia Dore (GHD/USA)

In Situ Chemical Reduction and Enhanced Anaerobic Bioaugmentation to Treat Groundwater TCE Plume Commingled with Cr(VI). *J. Leu, J. Goepel, D. Griffiths, and K. Diller.*
Jim Leu (Parsons Corporation/USA)

***Injectable Activated Carbon Permeable Reactive Barrier to Address Mass Flux from TCE Source Area beneath Buildings.** *E. Blodgett, T. Beaster, A. Danielson, S. Filby Williams, and J. Tracy.*
Eric Blodgett (Barr Engineering Co./USA)

Innovative Treatment of a Large, Dilute, and Commingled Plume Using a Solar-Powered In Situ Bioremediation and Phytoremediation System. *M.G. Sweetenham, F.J. Krembs, S.L. Lombardo, and G. Risse.*
Fritz Krembs (Trihydro Corporation/USA)

***Low-Cost Thermal Remediation for Persistent LNAPL in a Chemical Facility in São Paulo State, Brazil.** *G.D.C. de Mello, A.R. Cervelin, and G.I. Correa.*
Gustavo de Mello (Ramboll/Brazil)

Management of a PCE Plume in an Urban Area with Complex Hydrogeological Settings Using a Combined Strategy with Physical, Chemical, Biological and Natural Processes. *M. Petrangeli Papini, C. Nielsen, L. Ledda, P. Ciampi, P. Goria, M. Carboni, E. Alesi, M. Donati, and E. Bartsch.*
Marco Petrangeli Papini (University of Rome "La Sapienza"/Italy)

***Microbial Population Changes following Thermal and Enhanced In Situ Bioremediation Treatment Train.** *E.J. Bishop, A.K. Murphy, J. Fager, and S. Gupta.*
Elizabeth Bishop (Haley & Aldrich, Inc./USA)

Optimized Reagent Blends for a Combined ISCO-ISS Remedy. *B.A. Smith and B. Desjardins.*
Brant Smith (Evonik Active Oxygens/USA)

***Remediation in a High Complexity Site: Successful Combination of Different Technologies in a Chlorinated Solvent Contaminated Area.** *S. Aluani, C. Spilborghs, F. Tomiatti, N. Nascimento, and G. Siqueira.*
Sidney Aluani (SGW Services/Brazil)

***Selection Criteria for the Application of EISB, ISCR, or as a Combined Remedy.** *B. Elkins and L. Ross.*
Brad Elkins (EOS Remediation LLC/USA)

Selection of Combined Treatment Remedy Approaches Based on Site Constraints and Redevelopment Timelines: Three Case Studies. *M. Temple, P. Kakarla, and P.M. Dombrowski.*
Mike Temple (In-Situ Oxidative Technologies, Inc./USA)

***Sequential In Situ Treatment of BTEX, MTBE, and TBA in an Unconfined Aquifer.** *F. Vakili and R. McGregor.*
Fatemeh Vakili (Dragun Corporation/USA)

***Simple and Flexible Clears Efficient Path to Closure.** *M.W. Miner, T. Chaturgan, and P. Randazzo.*
Michael Miner (Brown and Caldwell/USA)

***TCE Treatment in Shallow Groundwater by Sequencing SVE, Chemical Oxidation and Enhanced Reductive Dechlorination.** *R. Bunker, J. Spadaro, and F. Krembs.*
Jack Spadaro (Wood/USA)

***Use of Remediation Train and Dynamic CSM to Remediate an Area Impacted by Solvents and Oils.** *C.D. Maluf, C.V. Witier, A.R. Cataldo, and J.C. Moretti.*
Cristina Deperon Maluf (Ambscience Engenharia Ltda/Brazil)

A5. Permeable Reactive Barriers: Best Practices and Lessons Learned

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Bruce Henry (Parsons) and
Clint Jacob (Landau Associates, Inc.)

Application of Integrated Remedial Approaches to Address an Off-Site 4,000-foot 1,2-DCA Plume under Developed Properties. *B. Vanderglas, D.R. Griffiths, R.J. Stuetzle, and B. Wilkinson.*
Brian Vanderglas (Parsons/USA)

***Bench-Scale Testing for Zero-Valent Iron Bedrock Application.** *L. Crawford, M.C. Marley, and D. Keane.*
Dennis Keane (XDD Environmental/USA)

***Characterization of Heterogeneous Treatment Zones Using Direct Mass Flux Measurements.** *C. Sandefur, C. Lee, and R. Hardenburger.*
Craig Sandefur (REGENESIS/USA)

***Construction of a Pilot-Scale In Situ Permeable Reactive Barrier along a Tidally Influenced Shoreline.** *A. Weinstein, M. Wade, K. Dyson, and J. Spadt.*
Andrew Weinstein (Brown and Caldwell/USA)

***Eliminating Contaminant Flux through Combined Sorption-Enhanced Anaerobic Bioremediation and In Situ Chemical Reduction Treatment in a Barrier.** *R. Moore, O. Miller, and E. Blodgett.*
Ryan Moore (REGENESIS/USA)

Evaluating Permeability and Treatment Enhancements to a Zero-Valent Iron Permeable Reactive Barrier. *D. Freedman, H. Wang, J. Peeples, and L. Lehmicke.*
James Peeples (T&M Associates/USA)

***Increasing the Confidence Level of Long-Term Passive PRB Remedies.** *D.L. Schnell.*
Deborah Schnell (GeoSierra Environmental, Inc./USA)

***Optimization Study for Chlorinated Solvent Permeable Reactive Barriers.** *B.M. Henry, E. Heyse, and C. Hewitt.*
Bruce Henry (Parsons/USA)

***Performance and Life Cycle of a Full-Scale Biowall System to Treat Chlorinated Solvents in Groundwater.** *D.R. Griffiths, B. Badik, T. Belanger, J. Moore, and C. Gallo.*
Dan Griffiths (Parsons/USA)

***Permeable Reactive Barrier Approaches to Reduce the Flux of Metals and CVOCs into Sediments and Surface Water.** *L. Hellerich, N. Hastings, J. Markey, Z. Smith, K. Lauer, and D. MacDonald.*
Lucas Hellerich (Woodard & Curran/USA)

***Removing Nitrogen from Groundwater: Evaluating Biokinetics of Denitrification for Effective Treatment.** *V.L. Gonsalez, C.A. Ramsburg, and P.M. Dombrowski.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***Scoping Tools for Construction of Passive Reactive Capture Systems.** *W. Slack, C. Ross, and D. Baird.*
William Slack (FRx, Inc./USA)

Successful Cut-Off of a Chlorinated Solvent Plume in Denmark via a ZVI PRB Installed by DPT. *N.D. Durant, A. Przepiora, L. Nissen, T.H. Jorgensen, and O. Mikkelsen.*
Neal Durant (Geosyntec Consultants/USA)

***Twenty-Year Performance Review of Funnel and Gate Remedies to Address PCBs in Groundwater at a Closed Landfill in Michigan.** *F.W. Blickle.*
Frederick W. Blickle (Horizon Environmental Consultants, Inc./USA)

***Unclogging Clogged EVO Injection Wells in a Saline Environment.** *V. Hosangadi, P. Chang, B. Shaver, and M. Pound.*
Pamela Chang (Battelle/USA)

***Understanding a Site's Conceptual Site Model to Prolong the Life Expectancy of an In Situ ZVI PRB.** *D.L. Schnell.*
Deborah Schnell (GeoSierra Environmental, Inc./USA)

Use of a Horizontal Colloidal Activated Carbon Permeable Reactive Barrier to Control Vertical Mass Loading into a Sandstone Aquifer. *K. Gaskill, B. Kappen, W. Fassbender, and D. Davis.*
Keith M. Gaskill (REGENESIS/USA)

A6. Thermally Enhanced In Situ Degradation Processes at Sub-Boiling Temperatures

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Christopher Hook (Tetra Tech, Inc.) and James Wang (Geosyntec Consultants)

***Advancements in Thermal In Situ Sustainable Remediation (TISR^SM^) Utilizing Solar and Waste Heat Integrated Systems to Treat Saturated Source Zone Soil.** *D. Rosso, J. Munholland, D. Randhawa, and J. Wyckoff.*
Derek Rosso (Arcadis/USA)

***Design Tool for Low-Temperature Solar Thermal Remediation Systems.** *R.W. Falta, A. Ornelles, and C. Divine.*
Ronald Falta (Clemson University/USA)

***Evaluation of In Situ Thermal Hydrolysis of Haloalkanes.** *J.D. Cole, J. Krueger, G. Dyke, and J. Strunk.*
Jason Cole (Jacobs/USA)

Heat Speeds Up Hydrolysis of Munitions Constituents: Low Temperature ERH Pilot Study. *L. Soos, E. Crownover, C. Thomas, B. Morris, M. Maxwell, K. Cottrell, C. Crane, L. Kessler, and C. Williams.*
Lauren Soos (TRS Group, Inc./USA)

Heated Water Recirculation to Enhance In Situ Abiotic and Biotic Degradation. *F.J. Krembs, C. Carlson, S. Quint, R. Hefner, M. Mercier, A. Sansom, Q. Le, N. Geibel, and M.C. Maxwell.*
Fritz Krembs (Trihydro Corporation/USA)

Microbes and Heat: How Hot Is too Hot? A Retrospective Look at Thermal Sites. *D. Nelson, J. Byrd, and J. Baldock.*
Kevin Morris (ERM/USA)

***Spatial and Temporal Staging of Heating and Vapor Treatment Strategies for DNAPL Sites with Highly Volatile Organic Compounds.** *X. Chen, R. D'Anjou, A. Swift, S. Guan, W. Guan, and C. Winell.*
Xiaosong Chen (Geo Inc./USA)

***Thermal In Situ Sustainable Remediation (TISR^SM^) to Enhance Bioremediation and Accelerate Treatment at the Former Colorado Department of Transportation (CDOT) Materials Testing Lab (MTL) Facility.** *J.L. Manley, C.E. Divine, K.L. Heinze, D. Rosso, S.D. Andrews, and T. Santangelo-Dreiling.*
Jesse L. Manley (Arcadis/USA)

***Thermal Soil Mixing and ZVI Injection Using Large Diameter Augers at a Former Drycleaner.** *J.C. Brown and M.C. Crews.*
Jesse Brown (Golder Associates, Inc./USA)

***Thermal Treatment and Bioremediation: Successful Combined Remedies at Multiple Sites.** *A. Fortune, S. Griepke, and J. LaChance.*
Alyson Fortune (TerraTherm/USA)

***Thermally Enhanced In Situ Bioremediation of Soil and Groundwater Contaminated with Chlorinated Ethenes in Japan.** *Y. Yamazaki, T. Nakashima, Y. Furukawa, T. Shimizu, N. Okuda, X. Tian, I. Suzuki, and T. Kobayashi.*
Yuji Yamazaki (TAKENAKA Corporation/Japan)

Thermally-Enhanced Soil Vapor Extraction and Enhanced Aerobic Bioremediation. *S. Crawford, L. Crawford, and M.C. Marley.*
Scott Crawford (XDD Environmental/USA)

***Treatability and Design for Thermally Enhanced Bioremediation.** *D. Keane, M.C. Marley, L. Crawford, K. Cowan, and A. Fortune.*
Dennis Keane (XDD Environmental/USA)

***Use of In Situ Thermal Desorption at a Confidential Site in Washington, DC.** *J. Kehs, C. Christian, J. Travis, and A. Patil.*
Jimmy Kehs (Tetra Tech, Inc./USA)

A7. Horizontal Wells: Applications and Lessons Learned in Site Characterization and Remediation

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Andrew Madison (Golder Associates, Inc.) and Mike Sequino (Directional Technologies, Inc.)

Application of Horizontal Injection Wells to Enhance In Situ Reductive Dechlorination of a Source Zone. *A. Madison, J. Gutsche, B. Phillips, C. Elofson, and M. Kozar.*
Andrew Madison (Golder Associates, Inc./USA)

***Changing Long-Standing Conceptual Site Models and Risk Perception with High Resolution Contaminant Distribution (HRCD).** *L.I. Robinson, E.R. Piatt, S.S. Koenigsberg, and W.F. Wiley.*
Lance Robinson (EN Rx, Inc./USA)

***Chlorinated Vapor Mitigation with Horizontal Vapor Extraction Wells Prevents Interior Disruption of Residential, Commercial, and Industrial Sites.** *T. Will and M. Sequino.*
Tomas Will (Directional Technologies, Inc./USA)

***Combined Innovative Remedial Technologies to Facilitate Active Remediation System Replacement and Property Transfer.** *D. Gray, G. Arbogast, and A. Lee.*
Doug Gray (AECOM/USA)

***Delivering the Goods: How Horizontal Wells Delivered ISCO Success under Challenging Conditions.** *M. Pena, C. Spooner, J. Wright, and M.W. Killingstad.*
Maria Pena (Arcadis/USA)

***Design and Construction Aspects of Horizontal Reactive Media Treatment (HRX™) Wells.** *M. Lubrecht, C. Divine, J. Wright, and D. Ombalski.*
Michael Lubrecht (Ellingson - DTD/USA)

***Distribution Analysis of the Injection of In Situ Chemical Reduction Amendments via Discrete Intervals of a Horizontal Well.** *J.G. Long and R.W. Blackmer.*
Joshua Long (Equipoise Corporation/USA)

***Horizontal Biosparging of Jet Fuel Plumes Expedites DoD Site Remediation.** *G. Atik, D. Forse, T. Will, and M. Sequino.*
Tomas Will (Directional Technologies, Inc./USA)

Horizontal Groundwater Control Wells for Large-Scale Remediation beneath CCR Ponds and Impoundments. *K. Carlton and D. Richardson.*
Kyle Carlton (Geosyntec/USA)

The Horizontal Reactive Treatment Well (HRX Well®) for Effective Long-Term In Situ cVOC and PFAS Mass Discharge Control at Two Sites. *C.D. Divine, J. Wright, J. McDonough, J. Wang, M. Kladias, C. Griggs, M. Lubrech, D. Ombalski, K. Gerber, M. Crimi, and M. Riggle.*
Craig Divine (Arcadis/USA)

Horizontal SVE and Steam Injection for Aerobic/Anaerobic Source Zone Depletion in Mixed LNAPL with JP5/TCE/TCA under an Active Building at Naval Air Station North Island. *V. Hosangadi, P. Chang, R. Mennis, K. Asam, and M. Pound.*
Pamela Chang (Battelle/USA)

***Soil Vapor Extraction Using a Horizontal Remediation Well to Remediate Biogenic Methane and VOCs: A Two-Year Review.** *S. Bailey and M. Pate.*
Sam Bailey (Kleinfelder/USA)

***Strategic Use of Horizontal Injection Wells to Design a Bioremediation/ZVI Permeable Reactive Barrier.** *G. Cronk.*
Gary Cronk (JAG Consulting Group/USA)

***Use of a Horizontal Well for Amendment Injection for In Situ Biotreatment of an Inaccessible Area at a Chlorinated Solvent Superfund Site.** *M.L. Alexander.*
Matthew Alexander (Texas A&M University-Kingsville/USA)

A8. Electron Donors: Innovations for Biodegradation

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Raphi Mandelbaum (LDD Advanced Technologies, Ltd.) and J. Mark Nielsen (Ramboll)

Application of Novel Amendment via Forced Advection Delivery for Rapid Anaerobic Dechlorination of TCE-Impacted Groundwater. *M.M. Mejac, S.W. Tarmann, M.W. Hahn, and D.A. Schlott.*
Mark Mejac (Ramboll/USA)

***Biotic/Abiotic Remediation of DNAPL Source and Plume Using Innovative Solid Substrates in Source Excavation Backfill.** *J.K. Green and C.L. Jacob.*
Jenny Green (Landau Associates, Inc./USA)

***A Coupled Adsorption and Biodegradation (CAB) Process Employing Polyhydroxybutyrate and Biochar as Bio-Based Materials for TCE-Contaminated Groundwater Bioremediation.** *M.M. Rossi, N. Amanat, M. Petrangeli Papini, and B. Matturro.*
Marta M. Rossi (Sapienza University of Rome/Italy)

***Enhanced Control of Microbial Activity and Substrate Delivery via Inhibitors for In Situ Contaminant Treatment.** *J.P. Skinner, S. Palar, C. Allen, N.M. Hamdan, A.G. Delgado, and M. Chu.*
Justin Paul Skinner (Arizona State University/USA)

The Enhanced Reductive Dechlorination of Dissolved Phase Trichloroethene in Methanogenic Groundwater Downgradient of a Former Industrial Facility. *M. Scalzi, W. Meese, and I. Connor.*
Michael Scalzi (Innovative Environmental Technologies, Inc./USA)

***Evolving In Situ Bioremediation of a Former TCE Vapor Degreaser Source.** *E.M. Waibel, E. Ives, and C.L. Jacob.*
Erin M. Waibel (Landau Associates/USA)

Formulating and Comparing Carbon Substrates with Bioaugmentation for Full-Scale In Situ Bioremediation of Chlorinated Solvents. *L. LaPat-Polasko, R. Britton, T. Silverman, and L. Gross.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

***Microbiome Composition Resulting from Different Substrates Influences Trichloroethene Dechlorination Performance.** *W.Y. Chen and J.H. Wu.*
Wei-Yu Chen (National Chen Kung University/Taiwan)

***Modified Emulsified Vegetable Oil Formulations for Site-Specific Challenges.** *P.M. Dombrowski, F. Hostrop, M. Lee, and R. Raymond, Jr.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***PHA from Mixed Culture as an Innovative Source of Electron Donors for Sustainable Bioremediation: Preliminary Studies and Scaleup.** *N. Amanat, M.M. Rossi, M. Majone, M. Petrangeli Papini, and B. Matturro.*
Neda Amanat (Sapienza University of Rome/Italy)

Stimulation of Native Organohalide-Respiring Microbial Consortia with Bio-Based Compounds: Results from an Italian Aquifer. *M. Bertolini, S. Zecchin, R. Zanetti, G.P. Beretta, L. Ferrari, G. Carnevale, and L. Cavalca.*
Martina Bertolini (Università degli Studi di Milano/Italy)

B1. In Situ Technologies: Lessons Learned

Platforms Monday | Posters (*) Monday Evening
Chairs: Holly Holbrook (AECOM) and
Prasad Kakarla (In-Situ Oxidative Technologies [ISOTEC])

Biorecirculation Best Practices: Lessons Learned from Design, Construction, and Operation of Two Large Temporary Systems. *J.T. Bamer, M.R. Lamar, R. Subramanian, J.M. Trump, I. Tanaka, and A.F. Reed.*
Jeff Bamer (CDM Smith, Inc./USA)

***Dry Cleaner Groundwater Impacts Emanating from Groundwater Divide.** *W. Smith, R.J. Kondelin, and J. Rossi.*
William Smith (Environmental Alliance, Inc./USA)

***Evaluating the Effect of Salinity on In Situ Biological Reduction of a 1,2-DCA Plume.** *I. Pelz, A. Chemburkar, A. Breckenridge, J. Kerl, and D. Leigh.*
Isaac Pelz (ERM/USA)

***Implementation of Large-Scale In Situ Remediation Programs during the COVID-19 Pandemic.** *T. Eilber, M. Temple, and P. Dombrowski.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***In Situ Bioremediation by the Lowest Bidder: What Could Go Wrong?** *H. Benfield and C. Ferrell.*
Cari Ferrell (Tetra Tech, Inc./USA)

***In Situ Remediation of Chlorinated VOCs Using an Innovative Ozone Sparging Approach.** *T. Carlson and H. Cox.*
Trevor Jason Carlson (Geosyntec Consultants/Canada)

***Injection of Gaseous Carbon Dioxide to Neutralize High pH Groundwater.** *C.D. Hand, L.M. McGaughey, and W.M. Young.*
Charles Hand (Wood/USA)

Iterative Design and Characterization Program to Overhaul Remedial Strategy for Cr(VI) and TCE Plumes under Superfund and Liability Transfer. *B.J. Lazar, Y. Kunukcu, and N.M. Rabah.*
Brendan Lazar (TRC Companies, Inc./USA)

Laboratory- and Field-Scale Testing for Thermal Remediation: Why, Where, and How. *E.L. Davis.*
Eva Davis (U.S. Environmental Protection Agency/USA)

***Large-Scale Bioremediation via Biobarrier and Recirculation Systems for a TCE-Contaminated Site near Sao Paulo, Brazil.** *T. Meneguzzo, G. Borges, G.D.C. de Mello, and M. Mejac.*
Thais Helena Meneguzzo (Ramboll/Brazil)

***Lessons Learned during a Quarter Century of Injecting Solid Remedial Amendments.** *W.W. Slack, A.M. Baird, and D.E. Knight.*
Drew Baird (FRx, Inc./USA)

Lessons Learned: Treatment of a New Jersey CVOC Plume in Urban Geology with Combined Remedy Approach. *J.P. Chiappetta.*
Joseph Chiappetta (ECC Horizon/USA)

***Lessons Learned: Using Geochemical Data to Better Assess Performance following Field Applications.** *J. Molin and B. Smith.*
Josephine Molin (Evonik/USA)

***Methane Generation from EVO Injections in Shallow Groundwater.** *V. Hosangadi, P. Chang, B. Shaver, and M. Pound.*
Pamela Chang (Battelle/USA)

Novel Applications of Anaerobic Bioremediation for In Situ Remediation of Arsenic. *J. Chambert, G. Ulrich, S. Aube, and P. Feshbach-Meriney.*
Julien Chambert (Parsons Corporation/USA)

***Observations and Lessons Learned from Laboratory and Field Application of Carbohydrate-Activated Persulfate.** *P. Kakarla, Y. Chin, M. Temple, W. Caldicott, and P. Dombrowski.*
Prasad Kakarla (In-Situ Oxidative Technologies [ISOTEC]/USA)

Off-Site Chlorinated Solvent Plume Reaching Municipality's Water Dam: Successful Approach to Management and Remediation. *S. Aluani, F. Tomiatti, C. Spilborghs, N. Nascimento, and E. Pujol.*
Sidney Aluani (SGW Services/Brazil)

Pilot Test for In Situ Aerobic Bioremediation of Complex Mixture of Contaminants at a NAPL-Impacted Site in Brazil. *P. Barreto, J. Arthur, L. Trento, P. Rego, C. Mowder, E.E. Mack, P. Carvalho, and R. Silva.*
Paola Barreto Quintero (Jacobs/USA)

***Pilot Tests in DNAPLs' Contaminated Area: Primary Techniques Enhanced by Secondary Techniques.** *L.T.M. Cruz, C. Gonçalves, B. Pavan, C. Granzotto, and O. Vitor.*
Leonardo Tadeu Marquesani Cruz (CPEA - Consultoria, Planejamento e Estudos Ambientais/Brazil)

Pilot-Scale Evaluation of Three In Situ Treatment Technologies at a Former MGP Site. *B.T. Clement, P. Karkarla, M. Dotto, K. Kobran, and W. Caldicott.*
Benjamin Clement (Burns & McDonnell/USA)

Remediation of Chlorinated Ethenes Plume in Denmark by Retardation and Enhanced Biodegradation: Challenges and Lessons Learned. *D. Harrekilde, L. Bennedsen, N. Tuxen, M.M. Broholm, C.B. Ottosen, A.S. Fjordboege, and G. Leonard.*
Dorte Harrekilde (Ramboll/Denmark)

***Remediation of Chlorinated Solvents in Harsh Environments: Enhanced Reductive Dechlorination in a Low pH, High Dissolved Oxygen Concentration Surficial Aquifer.** *M.S. Apgar and F.P. Wilson.*
Michael S. Apgar (Fishbeck/USA)

***Scaled Bioaugmentation Injection Strategy for Remediation of Mixed Chlorinated VOCs in a Fractured Shale Aquifer.** *K. Kelly, B. Bond, L. Zeng, S. Abrams, M. Morris, and I. Wolfe.*
Kevin Kelly (Langan/USA)

***Searching for a Deeper Understanding of Chlorinated Ethene Inhibition: A Comparison of Laboratory Studies, Guidance Values, and Field Results.** *S.D. Justicia-Leon and R. Oesterreich.*
Shandra Justicia-Leon (Arcadis/USA)

***Who Let the Gunk Out? A Broad Survey of EVO Sites.** *M. McCaughey, M. Schnobrich, R. Oesterreich, A. Wadhawan, and D. Liles.*
Matthew McCaughey (Arcadis/USA)

B2. Thermal Conductive Heating: Best Practices and Lessons Learned

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Jennifer Kingston (Haley & Aldrich, Inc.) and Rubens Spina (Geoklock)

Analysis of Work Coil and Casing Dynamics for Induction Heating Applications. *E. Reid.*
Edwin Walter Reid (McMillan-McGee Corporation/Canada)

***Chasing Bedrock: Adapting to Highly Undulating Bedrock Surfaces When Installing Thermal Remediation Systems.** *S. Griepke and J. LaChance.*
Steffen Griepke (TerraTherm Inc./USA)

***Designing Thermal Conductive Heating Soil Remediation for a Mixed Contamination Chemical Dump Site.** *S. Eriksen, J. Holm, and J. Brix.*
Søren Eriksen (Krüger A/S/Denmark)

***Direct Comparison of Competing ISTR Extraction Strategies.** *P.R. Hegele, B.C.W. McGee, and S.A. Bryck.*
Paul Hegele (Arcadis/Canada)

***Ex Situ Treatment of SVOC- and PFAS-Containing Soil.** *G. Heron, D. Oberle, and E. Crownover.*
Gorm Heron (TRS Group, Inc./USA)

Fractured Crystalline Bedrock: Is Thermal an Option or Are We Wrong? *N. Ploug, J. Holm, N. Törneman, F. Engelcke, A. Bank, and S.G. Nielsen.*
Niels Ploug (Krüger A/S/Denmark)

In Situ Thermal Remediation in Hazardous (Classified) Areas. *J. Galligan, S. Frost, T. Miner, J. Wattu, G. MacLeod, N. Stone, K. Crowder, and C. Jaggie.*
James Galligan (TerraTherm Inc./USA)

In Situ Thermal Remediation Market Review from 1988 to 2020. *M. Klemmer, J. Munholland, P. Hegele, J. Gattenby, and J. Horst.*
Mark Klemmer (Arcadis/Australia)

New Approach for Simulating the Vaporization and Removal of Volatile Organic Compounds by Thermal Conductive Heating at Field Scale. *Q. Xie, K.G. Mumford, and B.H. Kueper.*
Qianli Xie (Queen's University/Canada)

Non-Routine Volatile and Semi-Volatile Organic Vapor Monitoring at Thermal Remediation Sites: Lessons Learned. *A. Fortune, S. Griepke, R. McLeod, A. Rezendes, and N. Bryson.*
Alyson Fortune (TerraTherm/USA)

***Practical Considerations for Effective Air Monitoring during In Situ Thermal Treatment.** *J.D. Cole, J. Krueger, S. Pratt, J. Arthur, and B.F. Thompson.*
Jason Cole (Jacobs/USA)

***Reducing Uncertainties of In Situ Thermal Treatment through Pilot Testing.** *J.D. Cole, J. Arthur, and C. Mowder.*
Jason Cole (Jacobs/USA)

***Target Temperatures Required for Successful ISTR of Organo-Thiophosphorus Pesticides: A Discussion.** *X. Chen, R. D'Anjou, A. Swift, S. Guan, W. Guan, and C. Winell.*
Xiaosong Chen (Geo Inc./USA)

***Thermal Conduction Heater Design Considerations for High Thermal Flux Heaters in Dry Soils.** *C.F. Campbell and J.L. Schmitke.*
Clayton Campbell (McMillan-McGee Corporation/Canada)

Thermal Design and Best Practices: Real-Time Solutions to Unexpected Challenges Encountered during Thermal Conductive Heating Projects. *S. Griepke, J. LaChance, N. Ploug, and P. Negrao.*
Steffen Griepke (TerraTherm Inc./USA)

***Thermal Remediation: An Effective Solution for Rapid Brownfield Redevelopment.** *J. Galligan, S. Griepke, and J. LaChance.*
James Galligan (TerraTherm Inc./USA)

***Trial and Error: Lessons Learned from the Largest High Temperature ISTR Cleanup of MGP Waste in Saturated Zone Conditions.** *X. Chen, R. D'Anjou, A. Swift, S. Guan, W. Guan, and C. Winell.*
Xiaosong Chen (Geo Inc./USA)

B3. Thermal Conductive Heating: Case Studies

Platforms Tuesday | Posters (*) Monday Evening
Chairs: James Baldock (ERM) and Cary Brown (AECOM)

***Evaluation of Mechanisms Causing Elevated Groundwater Temperatures: Seven Years after Completing In Situ Thermal Treatment.** *R. Thompson, G. Heron, M. Gefell, J. Goin, J. Holden, and B. Thompson.*
Rowan Thompson (GEI Consultants, Inc./USA)

***In Situ Soil Treatment of Total Petroleum Hydrocarbons in a Residential Area of Social Interest.** *J. Seeman, T.L. Gomes, and A. Perencin.*
Thiago Gomes (TRS Doxor/Brazil)

***In Situ Thermal Desorption: Case Study for Soil Polluted by a Cocktail of Contaminants.** *Y. Ourrid, K. Pacella, J. Haemers, and J. Halen.*
Joaquim Halen (Haemers Technologies/Belgium)

In Situ Thermal Remediation to Accelerate Site Redevelopment: Construction to Demobilization in 9 Months. *M. Dotto, P. Kakarla, W. Caldicott, G. Geckeler, S. Thompson, M. Lambert, and R. Ciukurescu.*
Matt Dotto (ISOTEC/USA)

Integrated Thermal Desorption of SVOCs Using Heating Network and Vapor Recycling. *X. Chen, R. D'Anjou, A. Swift, S. Guan, W. Guan, and C. Winell.*
Xiaosong Chen (Geo Inc./USA)

Rehydration of an In Situ Thermal Treatment Zone following Heating to 100°C: Safety, Logistics and Outcomes. *B. Schultz, J. Fairweather, R. D'Anjou, I. Cowie, and C. Winell.*
Ben Schultz (Orica/Australia)

***Site Closure Achieved following In Situ Thermal Conductive Heating Despite Residual Soil Vapor above Remedial Goals.** *D.R. Croteau.*
Darren Croteau (Terraphase Engineering, Inc./USA)

Thermal Conductive Heating of Chlorinated Solvents in Crystalline Rock in Varberg, Sweden: Lessons Learned during Investigations, Delineation, and the Procurement Process. *A. Bank, P. Hübinette, and L. Nilsson.*
Fredric Engelke (Relement Miljö Väst AB/Sweden)

Thermally-Enhanced Chemical Oxidation and Pump and Treat at Chlorinated Phenols Site in Eastern China. *A. Small, A. Wei, P. Song, W. Sun, and L. Wei.*
Andrew Small (TRS Group, Inc./USA)

B4. In Situ Chemical Oxidation: Optimized Design Approaches and Lessons Learned

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Nancy Hsu (Wintersun Chemical) and Brant Smith (Evonik Active Oxygens)

Achievement of Regulatory Closure at a VOC-Impacted Site Using Soil Mixing with Sodium Persulfate. *M. Perlmutter and E. Filc.*
Mike Perlmutter (Jacobs/USA)

***Advantages of Multiple Interval Oxidant Injection for Remediation of TCE.** *E.B. Hollifield and J.G. Byrd.*
Edward B. Hollifield (Environmental Resources Management/USA)

***Carbohydrate (CH) Activation of Persulfate: Evaluation of Safe Application Mix Ratios.** *P. Kakarla and Y. Chin.*
Prasad Kakarla (In-Situ Oxidative Technologies [ISOTEC]/USA)

***Change Management to Address ISCO Implementation Challenges: High Water Table, Low Permeability, and Adjacent Storm Sewers.** *C. Sayler and B. Marvin.*
Claire Sayler (Geosyntec Consultants, Inc./USA)

In Situ Chemical Oxidation Bench-Scale Column Testing Using Base-Activated Potassium Persulfate. *S. Dworatzek, J. Roberts, and K. Ashworth.*
Sandra Dworatzek (SiREM/Canada)

***ISCO Injection Approach in Shallow, Low Permeability Soils with Subsurface Utilities: Optimizing Oxidant Efficiency Using Dynamic Implementation Strategy.** *R. Hogdahl, G. Booth, and M. Pietrucha.*
Russell Hogdahl IV (Woodard & Curran/USA)

***ISCO of Really-High-Concentrations of MTBE and TBA in Groundwater Using Activated Persulfate.** *A.A. Rees, M. Ben-Tzour, J.M. Duffey, and B. Bulkin.*
Assaf Rees (AECOM/USA)

ISCO Using Sequential Activation Methods for Sodium Persulfate for Treatment of PCP and DRO. *A.A. Rees, D.C. Phelps, P.M. Dombrowski, P. Karla, and M. Tempe.*
Assaf Rees (AECOM/USA)

***Laboratory Studies Evaluating Ferrous Sulfide as New Activator for Persulfate.** *M.D. Lee, T. Pac, and R.L. Raymond.*
Michael Lee (Terra Systems, Inc./USA)

***Large-Scale Plume, Nano-Scale Solution: Remediation of CVOC Using Sodium Persulfate and Ozone Nanobubbles.** *G.N. Garcia, A.R. Cervelin, F.A. Campello, G. Van den Daele, G.D.C. de Mello, S.S. Steiner, and M. Bárbara.*
Gerd Van den Daele (Ramboll/Brazil)

***Lessons Learned from Injecting More than 100 Tons of Potassium Persulfate.** *A.M. Baird, D.E. Knight, and J. Lowe.*
Drew Baird (FRx, Inc./USA)

Lessons Learned from Multiple Technology Evaluation to Treat Residual Contamination at a Former MGP Site. *J. Bergman, H. Nord, P. Elander, S. Moeini, J. Molin, and B. Smith.*
Jonny Bergman (RGS Nordic/Sweden)

***Maximizing Effectiveness and Longevity of Activated Persulfate Oxidation Soil Mixing for the Remediation of Petroleum Hydrocarbons.** *L. Zeng, M. Wenrick, A. Boodram, S. Abrams, M. Spievack, S. Sherman, and V. Yarina.*
Matthew Wenrick (Langan/USA)

Optimizing Activated Persulfate Application to Address Density Effects and Geological Inhomogeneities at the Kaergaard Plantation Megasite. *L.F. Bennedsen, M. Christophersen, T.H. Jørgensen, L. Nissen, L. MacKinnon, F. Solano, N.D. Durant, J.F. Christensen, I.H. Olesen, and L. Lévy.*
Lars Bennedsen (Ramboll/Denmark)

***Remedial Safety in In Situ Chemical Oxidation: Crucial to Success.** *M. Lee, T. Pac, J. Byrd, E. Cohen, M. Crimi, P. Dombrowski, B. Duffy, and D. Schnell.*
Tim Pac (Terra Systems, Inc./USA)

***Soil Blending of Chemical Oxidants Accelerates Site Closure.** *D. Cline, R. Lamphier, P. Hicks, and B. Smith.*
Donna Cline (Terracon Consultants Inc./USA)

Successful Treatment of Trichloroethene in Deep Fractured Bedrock Using ISCO Recirculation. *J. Hickey, J. LeClair, J. Marolda, J. Spadt, and K. Dyson.*
Joseph Hickey (Brown and Caldwell/USA)

B5. Injectable Activated Carbon Amendments: Lessons Learned and Best Practices

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Scott Noland (Remediation Products, Inc.) and Kristen Thoreson (REGENESIS)

***Application in Italy of EHC Plus Technology: Rapid Contaminant Reduction and Accelerated Bioremediation Using an Injectable Reagent Containing Activated Carbon.** *A. Leombruni, M. Mueller, and F. Lakhwala.*
Alberto Leombruni (PeroxyChem, LLC/Italy)

***BOS 100® Successfully Treats PCE Source Areas: Lessons Learned from Remediation at an Active Facility.** *M. Reiter, A. Marinkovic, M. Stiller, J. Harshman, P.M. Dombrowski, M. Mazzarese, and K. O'Neal.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***Challenge Posed by High TCE and TDS Groundwater Plume Treatment.** *K.K. Miskin, A.E. McGrath, B. Eisenberg, and J. Roberts.*
Kevin Miskin (Stantev/USA)

***Dynamic Interactions between Sorption and Biodegradation: Implications for Long-Term Performance of Activated Carbon-Based Technology for In Situ Groundwater Remediation of Chlorinated Solvents.** *D. Fan, J. Wang, J. Pignatello, and B. Kjellerup.*
Dimin Fan (Geosyntec Consultants/USA)

Fiscally Responsible Characterization and Remediation of a DNAPL and Solute Plume in Low-Permeability Clay. *B. Brab and K. Thompson.*
Bill Brab (AST Environmental/USA)

***Groundwater Remediation Using In Situ Carbon Amendments: Analytical Challenges and Solutions.** *H.L. Lord.*
Heather Lord (Bureau Veritas/Canada)

***In Situ Injections in Remote Locations.** *T. Sorrells.*
Tree Sorrells (Alpine Remediation, Inc./USA)

Injectable Activated Carbon Amendments: Lessons Learned and Best Practices from Solicited Expert Experience with Examples. *E.J. Winner.*
Ed Winner (Remedial Products, Inc./USA)

***Long-Term Fate of Non-Degradable Contaminants Adsorbed to Injectable Activated Carbon in Source Treatments: Impacts of Natural Weathering.** *J. Birnstingl and C. Sandefur.*
Jeremy Birnstingl (REGENESIS/USA)

A Novel In Situ Carbon (ISC) Injection Technology Suited to Site Closure. *J.K. Sheldon and T. Herrington.*
Jack Sheldon (Antea Group/USA)

***Pilot-Scale Treatment of a Commingled Plume with Innovative Trap and Treat Technology.** *P. Kakarla, T. Musser, A.* Haryani, and N. Thacker.
Prasad Kakarla (In-Situ Oxidative Technologies [ISOTEC]/USA)

***Remediation of a Trichlorofluoromethane Groundwater Plume Using PlumeStop® Liquid-Activated Carbon™.** *R. Thompson.*
Rob Thompson (Antea Group/USA)

Results of Several Activated Carbon Installations. *T. Sorrells.*
Tree Sorrells (Alpine Remediation, Inc./USA)

Site Assessment, Design Considerations, and Performance Results from a Colloidal Activated Carbon Barrier Application at a Large Chlorinated Plume in Texas. *T. McMillan, V. Mustafin, J. Snyder, C. Lee, and C. Ortiz.*
Teri McMillan (EA Engineering, Science, and Technology, Inc., PBC/USA)

***Successful Use of Liquid Phase Carbon for Groundwater Remediation at Two Superfund Sites.** *B. Thompson, T. Majer, J. McCusker, A. Hoffmann, D. Lipson, F. Beetle-Moorcroft, J. Holden, and M. Gefell.*
Bruce Thompson (de maximis, inc./USA)

*** Trichloroethylene Removal by Regenerative Adsorption Particles Made of Polymetallic Oxides on Activated Carbon.** *S.S. Chou, T.C. Hsu, Y.F. Lai, H. Ho, B.N. Wang, Y.T. Wu, I.H. Chen, S.H. Huang, and H.C. Chien.*
Shanshan Chou (National Yang Ming Chiao Tung University, /Taiwan)

B6. Innovations in ZVI Amendment Formulations and Applications

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Scott Hubbard (Wintersun Chemical) and Dan Nunez (REGENESIS)

***Abiotic Destruction of Chlorinated Alkanes Using Catalyzed ZVI: Including 1,2,3-TCP, 1,2-DCP, and 1,2-DCA.** *G. Booth, N. Lapeyrouse, and C. Yestrebsky.*
J. Greg Booth (Woodard & Curran/USA)

From Bare to Sulfidated nZVI Particles: How the Surface/Chemical Modification of Iron Nanoparticles Influences Their Performance at Field Sites Polluted by CHCs and Cr(VI). *J. Filip, M. Brumovský, J. Oborná, J. Semerád, J. Slunský, P. Lacina, and O. Lhotský.*
Jan Filip (Palacký University/Czech Republic)

***Best Practices for the Design and Dosing of Permeable Reactive Barriers Incorporating Sulfidated Zero Valent Iron.** *J. Freim and J. Birnstingl.*
John Freim (REGENESIS/USA)

***Colloidal Zero-Valent Iron Injection for Enhanced Biotic/Abiotic Degradation of a TCE DNAPL Source.** *C.L. Jacob and E.M. Waibel.*
Clint Jacob (Landau Associates, Inc./USA)

***Evaluation of ZVI and Ferric Sulfate for Arsenic Remediation Supports Design of a Permeable Reactive Barrier (PRB).** *J. Smith, D. Graves, C. Towns, and L. Dorman.*
Duane Graves (SiREM/USA)

***In Situ Chemical Reduction (ISCR) for Remediation of Groundwater Impacted by Chlorinated Solvents Using ZVI and Antimethanogenic Amendments (Brazil Site).** *D. Nogawa, J. Paul, L. Bragg, S. Aluani, E. Pujol, F. Tomiatti, C. Spilborghs, G. Siqueira, J. Mueller, and W. Moody.*
Daniel Nogawa (Golder Associates/Brazil)

Innovative ZVI Application for Sustainable Remediation of Chlorinated Solvent Plumes. *K. Rügge, M. Dreyer, L. Brabæk, T.H. Jørgensen, J. Wang, D. Fan, N. Durant, R. Thalund-Hansen, P.L. Bjerg, M.T. Hag, and N. Tuxen.*
Kirsten Rugge (COWI/Denmark)

***An ISCR Reagent and Its Application in Remediation of Vinyl Chloride-Contaminated Groundwater.** *S. Zhang and C. Wang.*
Sailor Zhang (Shanghai Greenment Environmental Technology Co., Ltd./China)

***Novel Composite Materials for the In Situ Remediation of Aged Chlorinated Contaminant Plumes.** *J. Bosch, S. Sühnholz, A. Fischer, K. Kuntze, M. Mueller, A. Georgi, and K. Mackenzie.*
Julian Bosch (Intrapore GmbH/Germany)

Old ZVI and New ZVI: Enhanced Reductive Dechlorination and PlumeStop® Form Effective Backstop to ZVI PRB. *T. Huff, J. Bowie, D. Sarr, S. Haitz, M. Burns, and A. Bakenne.*
Timothy Huff (WSP/USA)

Performance Advantages Provided by the Combined Use of Sulfidated Zero Valent Iron and Other Synergistic Remediation Amendments. *J. Freim.*
John Freim (REGENESIS/USA)

***Remediation of Heavy Metal Contaminated Acidic Groundwater Using Sulfidated Nanoscale Zerovalent Iron: Batch and Column Tests.** *Y.G. Kang, Y.S. Chang, and I.G. Song.*
Yoon-Seok Chang (POSTECH/South Korea)

***Stepwise Strategies Involved in the Conceptual Development of a Full-Scale System for Chlorinated Compound Bioremediation: Bench and Pilot Test Studies.** *D.T. Ramos, B. Brandizzi, C. Nogueira, S. Julia, M. Brito, and C. Mowder.*
Débora Toledo Ramos (Worley/Advisian/Brazil)

Sulfidated Zerovalent Iron: An Innovative ISCR Technology for Discrete Source Remediation. *A. Danko, D. Fan, H. Rectanus, N. Durant, P. Tratnyek, and R. Johnson.*
Dimin Fan (Geosyntec Consultants/USA)

***Use of Zero Valent Iron for Removal of Hexachlorocyclohexanes from Dump Leachate: From Laboratory Test to Large-Scale Prototype.** *J. Nemecek, J. Zeman, F. Eichler, P. Hrabak, and M. Cernik.*
Jan Nemecek (Technical University of Liberec/Czech Republic)

***Using Rapid Investigation Tools to Select and Implement an In Situ Remediation Approach for Carbon Tetrachloride.** *R.B. Shah, J.D. Liebig, and F. Lakhwala.*
Raj Shah (Consultech Environmental, LLC/USA)

B7. Innovative and Optimized Amendment Delivery and Monitoring Methods

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Will Moody (Provectus Environmental Products, Inc.) and William Slack (FRx, Inc.)

***Biosparging for Remediation of Substituted Nitroaromatic Compounds and Remote Monitoring Using Multi-Depth Real-Time Sensors.** *C. Mowder, B. Carling, J. Blotevogel, A. Hanson Rhoades, K. Karimi Ashkarani, J. Spain, and A. Hartten.*
Carol Mowder (Jacobs/USA)

***A Critical Review of Bioaugmentation Best Practices: What We Really Know versus What We Have Just Accepted.** *R. Oesterreich and S. Justicia-Leon.*
Ryan Oesterreich (Arcadis/USA)

Cross-Borehole Resistivity Tomography: Can It Be Used to Plan and Monitor In Situ Remediation? *R. Thalund-Hansen, P.L. Bjerg, L. Levy, T. Bording, A.V. Christiansen, K. Rügge, M. Dreyer, L. Brabaek, M.T. Hag, and N. Tuxen.*
Rasmus Thalund-Hansen (Technical University of Denmark. DTU Environment/Denmark)

***Development of an Innovative In Situ Remediation Technique Using Polymer Gel as a Reagent Carrier: Results at Field Scale.** *J. Maire, A. Joubert, L. Mansuelle, I. Bouzid, N. Fatin-Rouge, H. Bertin, S. Colombano, H. Davarzani, F. Laurent, and M. Broquaire.*
Julien Maire (SERPOL/France)

***The Devil Is in the Details: Practical Considerations for Successful Horizontal Injection Well Design.** *J. Wright, M. Killingstad, C. Spooner, and M. Pena.*
Jesse Wright (Arcadis/USA)

Direct-Push Jet Injection for Enhanced Treatment of Chloropicrin in Low-Permeability Soils. *C.S. Martin, R.E. Scott, C.M. Greene, and C.M. Ross.*
Chris Martin (Geosyntec Consultants/USA)

***Facilitating In Situ Remediation of Deep DNAPL and Dissolved-Phase cVOC Impacts in Challenging Lithology Using an Innovative Multi-Step Injection Approach.** *B. Tunnicliffe.*
Bruce Tunnicliffe (Vertex Environmental, Inc./Canada)

***Fundamentals of Applying Subsurface Direct-Current (DC) Electric Fields for In Situ Remediation and Geo-Environmental Applications.** *D.B. Gent and J. Wang.*
David B. Gent (U.S. Army Corps of Engineers Engineer Research & Development Center/USA)

***Hydraulic Building Blocks for Enhanced Groundwater Remediation.** *L.J. Sather, E.J. Roth, J.P. Crimaldi, R.M. Neupauer, and D.C. Mays.*
David Mays (University of Colorado Denver/USA)

***Impressive Models and Photographs of Subsurface Carbon Slurry Injectate Distribution: How We Did It and Why It Matters.** *B. Brab and R. Boyle.*
Bill Brab (AST Environmental/USA)

***Innovative Monitoring and Visualization Approaches in a Recirculatory ISCO System.** *S.W. Murphy, S.L. Warner, S.N. Jacobson, B.A. Green, L. Daubert, and S. Gallo.*
Sean W. Murphy (Sanborn, Head & Associates, Inc./USA)

***Lessons Learned about Activated Carbon Injections on a Site in Wyoming.** *T. Sorrells and J. Skogman.*
Tree Sorrells (Alpine Remediation, Inc./USA)

***Limitations and Lessons Learned in Adjusting ORP and Extreme pH for ISCR-Driven Groundwater Remediation of VOCs and Metals.** *T.J. Patterson and R. Srirangam.*
Thomas Patterson (Roux Associates, Inc./USA)

***Methodology and Lessons Learned Conducting In Situ Bioremediation Using Emulsified Vegetable Oil in Phoenix, Arizona.** *J. Rackow, T. Titus, and M. Morales.*
Jeff Rackow (Arizona Department of Environmental Quality/USA)

***Monitoring Substrate Injection Distribution for Successful Remediation Outcome.** *T. Halihan, S.W. McDonald, and C. Pickens.*
Todd Halihan (Oklahoma State University/USA)

***Optimizing Injection and Monitoring of Electron Donors and Bioaugmentation Cultures for In Situ Bioremediation.** *J.D. Roberts, C. Scales, P. Dennis, and S. Dworatzek.*
Jeff Roberts (SiREM/Canada)

Practical Approaches to ISCO Delivery Promote Informed Dosing Calculations across Multiple Sites. *B.R. Hoye and J.R. Hesemann.*
Brian Hoye (Burns & McDonnell/USA)

***Predicting Site Biogeochemistry Influence on EVO Fouling and Injection Well Failure.** *A. Wadhawan, M. Schnobrich, and M. Hay.*
Amar Wadhawan (Arcadis/USA)

***Searching for In Situ Remediation Alternative Addressing Complex Geology: EK-Enhanced In Situ Remediation of Contaminant Source Mass.** *J. Wang, T. DeJournett, S. Cushing, E. Tollefsrud, D. Scheer, and J. Jevnisek.*
James Wang (Geosyntec Consultants/USA)

***The Transition to Colloidal from Micro-Scale Solids with Further Optimization through Automated Injection.** *E.D. Cooper.*
Eliot Cooper (Cascade Remediation Services/USA)

Utilizing Permeability Enhancements for In Situ Remediation of 1,4-Dioxane with Propane Biosparging. *J. Saling and D. Favero.*
Jacelyn Saling (Arcadis/USA)

B8. Monitored Natural Attenuation: Innovative Monitoring Approaches/Lines of Evidence and Lessons Learned

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Grant Carey (Porewater Solutions) and Rodrigo Coelho (Geoklock)

***^{14}C Assays to Derive Degradation Rates in Support of MNA.** *M. Burns, P. Robertson, C. Myers, and D. Sarr.*
Matthew Burns (WSP/USA)

***Abiotic Natural Attenuation of Chlorinated Ethenes: Role of Redox Active Fe Mineral Phases.** *M.M. Scherer, D.E. Latta, C. Chelsvig, T. Robinson, A. Neumann, P.G. Tratnyek, and R. Johnson.*
Michelle Scherer (University of Iowa/USA)

Biodegradation of Vinyl Chloride and cis-Dichloroethene in Aerobic and Suboxic Microcosms Using Environmental Samples from Naval Air Station North Island, IR Site 9. *P.M. Richards, J.M. Ewald, W. Zhao, T.E. Mattes, H.V. Rectanus, D. Fan, N.D. Durant, and M. Pound.*
Timothy Mattes (University of Iowa/USA)

***Chlorinated Solvent Biodegradation in Low pH Aquifers.** *P.B. Hatzinger, R. Rezes, E. Farquharson, K.-H. Chu, N. Szwast, and D. Freedman.*
Paul Hatzinger (APTIM/USA)

***MBTs for MNA.** *F.E. Loeffler, A.L. May, S.R. Campagna, F. Kara Murdoch, R.W. Murdoch, K.H. Kucharzyk, P.B. Hatzinger, J.T. Wilson, and M.M. Michalsen.*
Frank Loeffler (University of Tennessee/USA)

Monitored Natural Attenuation for Phthalates in a Former Industrial Site. *L.T. Kimura and E.V. Freire.*
Lucas Takeshi Kimura (EBP Brasil Consultoria e Engenharia Ambiental Ltda./Brazil)

Natural Attenuation Evaluation of Commingled CVOC and 1,4-Dioxane Plume in Fractured Bedrock Influenced by Pump and Treat. *L. Zeng, A. Boodram, S. Abrams, J. Ameye, A. Smith, and B. Koto.*
Lingke Zeng (Langan/USA)

***ORP Kit: A New Tool for Predicting Contaminant Degradation through Improved Reduction Potential Measurement.** *C. Kocur, D. Fan, A. Pavitt, R. Johnson, and P. Tratnyek.*
Chris Kocur (Royal Military College of Canada/USA)

Quantifying Natural Attenuation Capacity of Groundwater Systems: Comparison of Methods and Lessons Learned. *M.A. Widdowson.*
Mark Widdowson (Virginia Polytechnic Institute and State University/USA)

***Simultaneous Aerobic and Anaerobic Biodegradation of Vinyl Chloride under Low Dissolved Oxygen Conditions.** *W. Zhao and T.E. Mattes.*
Weilun Zhao (The University of Iowa/USA)

***Successful Application of Long-Term Monitoring Optimization.** *E.M. Huntley, G.E. Rieger, C.B. Myers, and M.J. Gentoso.*
Erin Huntley (WSP/USA)

***Transition to Monitored Natural Attenuation for a CVOC Plume after 28 Years of Pump and Treat: Lessons Learned.** *J.A. Ricker and D.C. Winchell.*
Joseph Ricker (WSP USA, Inc./USA)

***Using Depth-Discrete, High-Resolution Biogeochemical Methods to Assess Degradation Mechanisms Occurring in a Mixed Organic Plume in Fractured Sedimentary Bedrock.** *G.T. Hook, B.L. Parker, S. Shafieiyoun, J. Bulova, J.R. Meyer, R. Aravena, F. Loeffler, and S.R. Campagna.*
Glen T. Hook (University of Guelph/Canada)

***Using qPCR Assays for Oxygenase Enzymes to Predict Rate Constants for Cometabolism of TCE in Aerobic Groundwater.** *J.T. Wilson, B. Wilson, D. Taggart, D.L. Freedman, and J. Mills, IV.*
John Wilson (Scissortail Environmental Solutions, LLC/USA)

B9. Advanced and Synthetic Biological Treatment Applications

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Elizabeth Edwards (University of Toronto) and Frank Loeffler (University of Tennessee)

***Anaerobic Microbial Degradation of Dichloromethane.** *G. Chen, R.W. Murdoch, S.R. Campagna, E.S. Seger, E.E. Mack, and F.E. Loeffler.*
Gao Chen (University of Tennessee/USA)

***Avoiding a cis-DCE Stall during the ERD of TCE DNAPL in Bedrock Groundwater via Biostimulation Alone.** *K.C. Armstrong and G. Bell.*
Kent C. Armstrong (TerraStryke Products, LLC/USA)

***The Benefits of Using Antimethanogenic Reagents for Chlorinated Solvent Remediation in Solid and Liquid Amendments.** *A. Lowy, W. Moody, and T. Lizer.*
Andy Lowy (Provectus Environmental Products/USA)

***Biokinetics Modeling on the Syntrophic Growth of Anaerobic Benzene-Degrading Enrichment Cultures under Methanogenic Conditions.** *J. Liang, S. Guo, X. Chen, C.R.A. Toth, E.A. Edwards, and B.E. Sleep.*
Jingzhi Liang (University of Toronto/Canada)

***Bioremediation 4.0: What Procaryotic Microbes Can Really Accomplish and the Roll Quorum Sensing and Signaling (QSS) Plays.** *K.C. Armstrong and K. Rapp.*
Kent C. Armstrong (TerraStryke Products, LLC/USA)

***Characterization of a Predicted Necromass-Recycling Bacterium and Its Impact on Benzene Degradation in a Methanogenic Benzene-Degrading Enrichment Culture.** *X. Chen, C.R.A. Toth, S. Guo, F. Luo, O. Molenda, J. Liang, J. Howe, and E.A. Elizabeth.*
Xu Chen (University of Toronto/Canada)

***Demonstrating Bioaugmentation to Enhance Anaerobic Benzene, Toluene and Xylene Biodegradation in the Field.** *S. Dworatzek, J. Webb, E. Edwards, N. Bawa, S. Guo, C.R.A. Toth, K. Bradshaw, and R. Peters.*
Sandra Dworatzek (SiREM/Canada)

***Evaluation of ERD Enhanced Formulations on cVOC Removal Efficiency and Biofilm Formation.** *F. Kara Murdoch, K. Armstrong, and K.H. Kucharzyk.*
Fadime Kara Murdoch (Battelle/USA)

Exploring the Frontier of Bioremediation with High-Throughput Synthetic Biology. *K. Sorenson and D. Saran.*
Kent Sorenson (Allonnia/USA)

***Field Testing Reductive Dechlorination Bioaugmentation Cultures in a Low pH Groundwater Setting.** *D.L. Freedman, H. Wang, and R.L. Lehmicke.*
David Freedman (Clemson University/USA)

***Increasing the Rate of Anaerobic Benzene Degradation in Enrichment Cultures.** *S. Guo, J. Liang, C.R.A. Toth, X. Chen, F. Luo, B.E. Sleep, E.A. Edwards, B.C. McLaren, and N. Thomson.*
Shen Guo (University of Toronto/Canada)

***Living Room, Transportation, and Community: The Overlooked Infrastructure in Subsurface Microbial Biodegradation.** *E.J. Winner.*
Ed Winner (Remedial Products, Inc./USA)

***Separating Emulsification from Degradation in the Bioremediation of Soil-Associated Arochlors.** *R.N. Sambrotto and D. Tanner.*
Ray Sambrotto (Allied Microbiota/USA)

Stimulating and Sustaining Reductive Dechlorination Using In Situ Bioreactors. *K. Clark, D. Taggart, S. Rosolina, K. Sublette, and E. Raes.*
Kate Clark (Microbial Insights, Inc./USA)

***Systems Biology Unravels the Naphthenic Acid Degradome in Oil Sands Process Wastewater.** *P. Chenougian, V. Yadav, B. Gramlich, and D. Saran.*
Dayal Saran (Allonnia/USA)

Vinyl Chloride and 1,4-Dioxane Metabolism by Pseudonocardia dioxanivorans CB1190. *A.L. Polasko, Y. Miao, I. Kwok, K. Park, J.O. Park, and S. Mahendra.*
Shaily Mahendra (University of California, Los Angeles/USA)

Vinyl Chloride Detoxification by a Novel Anaerobic Bacterium. *G. Chen, F. Kara Murdoch, Y. Yang, J. Yan, and F.E. Loeffler.*
Gao Chen (University of Tennessee/USA)

B10. Electrical Resistance Heating: Best Practices and Lessons Learned

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Michael D. Basel (Haley & Aldrich, Inc.) and Troy Lizer (Provectus Environmental Products, Inc.)

***Application of ERH on a Large Site.** *B.A.M. Ribeiro, T.L. Gomes, and J. Seeman.*
Bruno Ribeiro (TRS Doxor/Brazil)

***Bench-Scale Electrical Resistance Heating and Heat-Enhanced Microcosm Studies to Establish Endpoints for Thermal Treatment.** *P.R. Hegele, D.A. Rountree, C. Wong, and J. LaChance.*
Paul Hegele (Arcadis/Canada)

***Defining Success for In Situ Thermal Remediation with NAPL Mass beyond the Limits of Treatment.** *D. Warren, R. Boyd, C. Blundy, E. Crownover, and K. Novello.*
Daniel Warren (TRC Companies, Inc./USA)

***Electrical Resistance Heating Trials: Lessons Learned at a Site in Germany.** *R. Meinke, O. Kohnen, M. Stumbaugh, and S. van Wert.*
Robert Meinke (ERM/Germany)

***Enhanced Field Screening Tools and Pilot Test Development in Support of Complex Remediation at a Confidential Superfund Site.** *L. Stauch, P. Joyce, and M. Palmer.*
Lynette Stauch (TRS Group, Inc./USA)

Experimental Study of Mass Transfer from Contaminant-Water Vapor Bubbles to Groundwater during Thermal Remediation. *D.A. Rountree, T. Lombardo, and A. Doxtator.*
David Rountree (McMillan-McGee Corporation/Canada)

***Flexible Electrical Resistance Heating Design and Implementation under an Active Auto Repair Shop.** *J. Root, L. Stauch, W. Carroll, and J. Harrington.*
Jeffrey Root (TRS Group, Inc./USA)

From Concept to Post-Performance: Lessons Learned from Three Thermal Projects in New Jersey. *S. Gupta.*
Sunila Gupta (Haley & Aldrich, Inc./USA)

***A Geological Engineering Perspective of In Situ Thermal Remediation.** *J.P. Yoder, M. Basel, and J. Kingston.*
Jarrod Yoder (Haley & Aldrich, Inc/USA)

How Good are Thermal Models? *J. Baldock, J. Dinham, R. Meinke, O. Kohnen, and F. Coelho.*
James Baldock (ERM/United Kingdom)

***In Situ Thermal Remediation Technologies: TCH versus ERH: Which Is Best and Why?** *J. Galligan, S. Griepke, and J. LaChance.*
James Galligan (TerraTherm Inc./USA)

***In Situ Thermal Remediation to Reduce TCE with Rapidly Increasing Water Table.** *M. Wallace, J. Feild, E. Crownover, and C. Blundy.*
Matthew Wallace (Wood/USA)

***Integrated Remediation System in Residential Neighborhood: ERH and SVE at a Former Industrial Laundry Site.** *C. Calderon, B. Agostinho, and D. Danezi.*
Carlos F. Ferreira da Silva Calderon (EBP Brasil Consultoria e Engenharia Ambiental Ltda./Brazil)

***Lessons Learned: ERH-MPE System Operations and Performance Assessment.** *K.M. Kolibas, A.C. Bumb, and R.C. Peterson.*
Amar Bumb (APTIM Federal Services/USA)

***Mitigating Risk from Subsurface Metal Discovered during an ERH Installation.** *N. Dumaresq and B. McGee.*
Nicholas Dumaresq (McMillan-McGee Corp./Canada)

Power Density: Why It Rules and How to Maximize It. *E. Crownover and G. Heron.*
Emily Crownover (TRS Group, Inc./USA)

***Remediation of 1,4-Dioxane Using Electrical Resistance Heating.** *L. Stauch and E. Crownover.*
Lynette Stauch (TRS Group, Inc./USA)

***Thermal Remediation of Impacted Clay Layer and In Situ Hydrolysis of 1,2-DCA at a Former Industrial Site in Brazil.** *R. Zeitune, S. Hart, R. Feig, M. Klemmer, R. Santini, L. Valle, and F. Silveira.*
Raoni Zeitune (Arcadis/Brazil)

C1. Remedial Design/Optimization: Applications of Mass Flux and Mass Discharge

Platforms Monday | Posters (*) Monday Evening
Chairs: Joseph Quinnan (Arcadis) and Craig Sandefur (REGENESIS)

Application of Innovative Groundwater Flow and Flux Measurement Methods to Inform In Situ Remediation Design and Remediation Endpoints. *B.A. Green, C.H. Maldenar, J.D. Munn, S.L. Warner, A.E. Ashton, S.W. Murphy, B.L. Parker, S.W. Chapman, and L. Daubert.*
Bradley A. Green (Sanborn, Head & Associates, Inc./USA)

Application of Stratigraphic Flux and the PFAS Mobile Lab to Characterize Migration Pathways and Source Strength. *P. Curry, J. Quinnan, and M. Rossi.*
Patrick Curry (Arcadis/USA)

***Assessing Remedial Success Using Contaminant Mass Flux: A Comparison of Two Approaches.** *R. Meinke and K. Schnell.*
Robert Meinke (ERM/Germany)

***Conceptual Site Model Innovations: 4-D Contaminant Mass Flux and Volumetric Analyses.** *T. Kremmin, T. Andrews, W. Nolan, and A. Brown.*
Todd Kremmin (Jacobs/USA)

***Coupling ESS and Numerical Models to Maximize Mass Flux Reduction and Certainty of Performance.** *G. Kenoyer, R. Cramer, C. Plank, J. Hesemann, and C. Chang.*
Galen Kenoyer (Burns & McDonnell/USA)

***Dynamic Remedy Operation to Address Evolving Mass Flux Patterns.** *J.W. Roller, S.T. Potter, F. Lenzo, and D. Scillieri.*
Jonathan Roller (Arcadis/USA)

***Enhanced Monitored Natural Attenuation to Reduce Contaminant Flux to a Tidal Estuary.** *J. Nemesh.*
Joseph Nemesh (Tetra Tech/USA)

***Evaluation of Benzene Mass Discharge Using the Transect Method to Support Remediation System Shutdowns.** *S. Stromberg and K. Waldron.*
Scott Stromberg (Orion Environmental, Inc./USA)

Flux-Informed Remedy Optimization: The Next Generation of Applied Modeling. *S.T. Potter, M. Killingstad, and M.P. Kladias.*
Scott Potter (Arcadis/USA)

Improving Reactive Zone Performance by Combining Plume Dimension Analysis and Passive Flux Tool Studies. *C. Lee and C. Sandefur.*
Chris Lee (REGENESIS/USA)

***Mass Discharge and Cleanup Timeframe Estimates at Complex DNAPL Sites Using Upscaled Modeling of DNAPL Dissolution.** *L. Stewart, M. Widdowson, J. Chambon, R. Deeb, M. Kavanaugh, and J. Nyman.*
Julie Chambon (Geosyntec Consultants/USA)

Performance-Based Mass Discharge Assessment Program to Inform Remedy Transition and Site Closure. *M.A. Harclerode, C.F. Silver, T.W. Macbeth, E.C. Ashley, and H. Brown.*
Melissa Harclerode (CDM Smith, Inc./USA)

Remediation Hydraulics 10 Years Later: What We Learned and What's Next. *F.C. Payne, J.A. Quinnan, and S.T. Potter.*
Fred Payne (Arcadis/USA)

Remediation Modeling of Complex NAPL Sites Using Technology-Specific NAPL Dissolution Rates. *L. Stewart, M. Widdowson, J. Chambon, R. Deeb, and M. Kavanaugh.*
Lloyd Stewart (Praxis Environmental Technologies, Inc./USA)

Remedy Optimization through Mass Flux and Mass Discharge Evaluation. *L. Zeng, A. Boodram, S. Abrams, E. Dieck, A. Quinn, E. Seelman, and S. Ciambruschini.*
Lingke Zeng (Langan/USA)

***Sequence Stratigraphy and Mass-Flux Evaluation to Estimate Risk to a Public Drinking Water Source.** *C. Canfield, J. Weidmann, C. Turner, and C. Payne.*
Colleen Canfield (Haley & Aldrich, Inc./USA)

Stratigraphic Flux®: A Mass Flux Approach for Focused Cleanup. *J. Vilar, A. Bustamante, G. Andrade, A. Miranda, B. Rocha, A. Martinho, J. Smith, J. Overgord, K. Haymond, and J. Quinnan.*
Julio Vilar (Arcadis/Brazil)

***Understanding Mass Flux: From MPE System to MNA.** *R. Klinger, J. Foster, W. Pence, M. Annable, J. Langenbach, A. Brey, and A. Ramsey.*
Rachel Klinger (Geosyntec Consultants/USA)

***Upfront Design Verification Testing and Predictive Modeling Used for Achieving Remediation Goals.** *C. Lee and D. Nunez.*
Chris Lee (REGENESIS/USA)

***Use of Mass Flux to Guide Decision Making in Plume Management.** *C.J. Mulry and F. Will.*
Christopher Mulry (GES, Inc./USA)

C2. Remedy Implementation: Assessing Performance and Costs

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Jackie Saling (Arcadis) and
George Walters (U.S. Air Force)

***A Comparison of In Situ Bioremediation Substrates (HFCS and EVO) for Use in a Heterogeneous Aquifer.** *P.R. Hsieh and A. Cerruti.*
Patrick Hsieh (Dalton Olmsted & Fuglevand/USA)

***The Effects of Source Removal and Secondary Source Area Treatment on Project Cost and Life Span.** *E. Meyers, N. Scroggins, and L. Davies.*
Ed Meyers (HSW Consulting/USA)

***Evaluation of In Situ Chemical Reduction as a Treatment Remedy for Recalcitrant Nitro-Aromatic Compounds.** *C. Montero, C. Macon, and B. Lundy.*
Charles Montero (Wood/USA)

***Evaluation of Pump-and-Treat System with Horizontal Wells on Surface Water Quality.** *G. Lilbaek, A. Christensen, K. Weber, N. Larsson, U. Winnberg, and K. Forsberg.*
Gro Lilbæk (NIRAS/Denmark)

***A Fresh Approach: Identifying Practical, Cost-Saving Solutions to Optimize the Long-Term Remedial Strategy.** *P.G. Robertson, M. Burns, S. Haitz, and C. Myers.*
Pamela Robertson (WSP/USA)

Increasing Treatment Certainty while Controlling Remediation Cost: Case Studies Using Hydraulic Fracturing to Deliver Amendments at Low-Permeability and Weathered Bedrock Sites. *C.M. Ross, C. Shores, T.E. Kuehster, and D.M. Baird.*
Chapman Ross (FRx, Inc/USA)

Proven On-Site Thermal Desorption Technology Minimizing Environmental Impact and Cost on Large-Scale Remediation Project. *R. Martin.*
Rob Martin (Clean Earth/USA)

***Quantitative Assessment of Sustained Treatment following In Situ Bioremediation at Chlorinated Solvent Sites.** *T.M. McGuire, D.T. Adamson, and K.L. Walker Jr., and M. Rysz.*
Travis McGuire (GSI Environmental Inc./USA)

***Remedial System Operation and Maintenance Is Not Cruise Control.** *A. Stark, B. Caldwell, and R. McCarthy.*
Alexandra Stark (EnSafe Inc./USA)

The Use of Steam Propagation Tests and Thermal Modeling to Develop In Situ Thermal Remediation Design Parameters. *G. Mackey, M. Dawes, A. Salvador, C. Hurdle, J. Baldock, and J. Dinham.*
Graham Mackey (ERM/USA)

Value Engineering for Propane Biosparging of 1,4-Dioxane. *A.C. Lorenz, A.G. Krevinghaus, and D. Favero.*
Andrew Lorenz (Arcadis/USA)

C3. In Situ Activated Carbon-Based Amendments: Assessing Effectiveness and Performance

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Scott Haitz (WSP) and
Ed Winner (Remedial Products, Inc.)

***Addressing Key Issues in the Treatability Testing, Numerical Modeling, and Application of Activated Carbon Remedies for Sediment Remediation.** *M.A. Ajemigibitse, J. Collins, and J. Hull.*
Moses Ajemigbitse (AquaBlok, Ltd./USA)

***Busting through to Closure Standards on Hydrocarbon Plumes with a Microscale-Activated Carbon with Soluble Electron Acceptors.** *T. Herrington and P. Erickson.*
Todd Herrington (REGENESIS/USA)

Combining Field Experience with Modelling for Engineering Management of In Situ Activated Carbon Remedial Installations. J. *Birnstingl and C. Sandefur.*
Jeremy Birnstingl (REGENESIS/USA)

***Does Activated Carbon Enhance Biodegradation Rates of Petroleum Hydrocarbons in Anaerobic Systems?** *B.C. McLaren, A.E. Schneider, A. Marrocco, N.R. Thomson, L.A. Hug, R. Aravena, E.A. Edwards, C.R.A. Toth, S. Dworatzek, and J. Webb.*
Bill C. McLaren (University of Waterloo/Canada)

Impact of Anaerobic Biofilm Formation on Sorption Characteristics of Powdered Activated Carbon. *G.R. Rocha Diaz de Leon, N.R. Thomson, C.R.A. Toth, and E.A. Edwards.*
Griselda R. Rocha Diaz de Leon (University of Waterloo/Canada)

***In Situ Remediation of DNAPL Source and Plume at an Active Industrial Facility with Innovative Enhanced Reductive Dichlorination Technology.** *G.G. Ceriani.*
Gabriele Giorgio Ceriani (Ejlskov A/S/Denmark)

***The Overlooked and Revealed: Evidence for Microbial Biodegradation on Activated Carbon.** *A.D. Peacock and E.J. Winner.*
Aaron Peacock (Microbac Laboratories, Inc./USA)

Particulate Carbon Amendment Injection into a Fractured Granitic Bedrock Aquifer for Treatment of CVOCs. *S.D. Richardson, D.M. Hart, and C.M. Mok.*
Stephen Richardson (GSI Environmental, Inc./USA)

***Persistence Saves the Day: Robust Characterization and Injection Techniques Lead to Successful Activated Carbon-Based PRB for Petroleum Hydrocarbons.** *B. Tunnicliffe and M. Mazzarese.*
Bruce Tunnicliffe (Vertex Environmental, Inc./Canada)

Staying Nimble on Urban Brownfield Remediations is Key to Successful Closure: Addressing Field Complications in Stride. *J. Good, J. Hayes, V. De Paula, S. Abrams, M. Dooley, and A. Miller.*
Joseph Good (Langan Engineering & Environmental Services/USA)

***Towards a Better Understanding of Activated Carbon-Based Amendments for In Situ Treatment of Petroleum Hydrocarbons in Anaerobic Groundwater Systems.** *A.L. Marrocco, B.C. McLaren, A.E. Schneider, N.R. Thomson, L.A. Hug, R. Aravena, E.A. Edwards, and C. Toth.*
Andrea Marrocco (University of Waterloo/Canada)

Treatment of a Chlorinated Groundwater Plume Using Iron-Impregnated Carbon. *A.R. Taylor and J.R. Lanier.*
Agnes R. Taylor (SME/USA)

C4. Compound-Specific Isotope Analysis: Case Studies in Evaluating Remedy Performance

Platforms Tuesday | Posters (*) Monday Evening
Chairs: James Feild (Wood) and Ramona Iery (U.S. Navy)

Assessment of an Integrated Approach to Evaluate Biodegradation after Injection of Activated Carbon and Bioamendments. *C.B. Ottosen, M.M. Broholm, P.L. Bjerg, D. Hunkeler, J. Zimmermann, N. Tuxen, G. Leonard, and D. Harrekilde.*
Mette Broholm (Technical University of Denmark/Denmark)

***Assessment of Anaerobic Biodegradation of bis(2-chloroethyl) Ether in Groundwater Using Carbon and Chlorine Compound-Specific Isotope Analysis.** *D.C. Segal, T. Kuder, and R. Kolhatkar.*
Daniel Segal (Chevron/USA)

***Compound-Specific Isotope Analysis Data Visualization Methods.** *S. Rosolina and D. Taggart.*
Sam Rosolina (Microbial Insights, Inc./USA)

Field Validation of the Solvent-Based Sampling Method for Collecting Gas-Phase VOC and Performing Compound-Specific Isotope Analysis. *D. Bouchard, M. Marchesi, D. Hunkeler, R. Aravena, and T. Buscheck.*
Daniel Bouchard (Contam-i-sotopes/Canada)

***How Carbon and Chlorine Isotopes Combine Forces to Elucidate a Natural Attenuation Investigation.** *N. Durant, H.V. Rectanus, D. Fan, P.M. Stang, E. Rosen, and M. Pound.*
Heather Rectanus (Geosyntec Consultants/USA)

How to Find the Most Convenient Remediation Strategy at a Former Industrial Site. *A. Fischer, K. Kuntze, H. Eisemann, and A. Beckmann.*
Anko Fischer (Isodetect GmbH/Germany)

***Insights into EISB Remedy Performance, Degradation Mechanisms, and Degradation Rates Using a Comprehensive CSIA Dataset.** *C. Cheyne, J. Konzuk, C. Gale, C. Coladonato, and B. Goodwin.*
Carol Cheyne (Geosyntec Consultants International, Inc./Canada)

***The Integrated Approach of Biological Molecular Tools (BMTs) and Compound-Specific Isotope Analysis (CSIA) for the Remediation of Eni's Sites.** *I. Pietrini, G. Carpani, M. Baric, L. Poppa, F. Villani, G. Bonfedi, M. Marchesi, and L. Alberti.*
Ilaria Pietrini (Eni S.p.A./Italy)

***Pilot-Scale In Situ Treatment of Chlorinated Solvent Source Zone: Treatment Performance and Injection Design Assessed with Compound-Specific Isotope Analysis (CSIA).** *D. Bouchard, T. Fulmer, and D. Alden.*
Daniel Bouchard (Contam-i-sotopes/Canada)

***Using Molecular Tools and Compound-Specific Isotope Analysis in Parallel for Natural Attenuation Assessment.** *P. Dennis, S. Mancini, J. Konzuk, C. Cheyne, A. Fisher, and K. Kuntze.*
Philip Dennis (SiREM/Canada)

C5. Site Closure: Models Used to Estimate Cleanup Timeframes

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Frederick Day-Lewis (Pacific Northwest National Laboratory) and Mark Kleiner (Weston Solutions, Inc.)

***Accelerating the Path to Site Closure Using a Three-Dimensional Visualization Tool and Two-Dimensional Spreadsheet Model to Revise the Conceptual Site Model and Predict Extent of Groundwater Impacts.**
M.G. Sweetenham and A. Riffel.
Fritz Krembs (Trihydro Corporation/USA)

Application of New Modeling Tool to Estimate the Cleanup Time in Highly Heterogeneous Aquifers with Matrix Diffusion. *D.K. Burnell and J. Xu.*
Daniel Burnell (Tetra Tech, Inc./USA)

Modeling Depletion of Mixed NAPLs to Evaluate Risk to Groundwater and Remediation Timeframe. *R.K. Sillan.*
Randall Sillan (AECOM/USA)

***Modeling Evaluation and Uncertainty Analysis of Remediation Timeframe at a Former Uranium Mill Site Using an Iterative Ensemble Smoother.** *R.D. Kent, R.H. Johnson, A. Laase, and J. Nyman.*
Ronald D. Kent (RSI EnTech, LLC/USA)

***Modeling the Variability in Remedy Complete Attainment Due to Variable Groundwater Conditions.** *M.L. Alexander.*
Matthew Alexander (Texas A&M University-Kingsville/USA)

Necessary Geochemical Data for a Uranium Reactive Transport Model to Simulate Cleanup Timeframes and Achieve Site Closure at the Monticello, Utah, CERCLA Site.
R.H. Johnson, R.D. Kent, A. Reynolds, and J. Nyman.
Raymond Johnson (RSI EnTech, LLC/USA)

Pursuing a Mass Flux-Based Site Closure Using the Three-Compartment Model. *J. Wahlberg, S. Potter, J. Roller, and J. Shonfelt.*
Jennifer Wahlberg (Arcadis/USA)

***Quantifying the Certainty of Remedial Success: Rethinking the Predictive Modeling Paradigm.** *P. Khambhammettu, M. Killingstad, M. Kladias, and S. Potter.*
Prashanth Khambhammettu (Arcadis/USA)

***A Simple Method to Estimate Groundwater Cleanup Time with Back Diffusion.** *R.C. Borden and K.Y. Cha.*
Robert Borden (EOS Remediation/USA)

***Technology Transitions and Site Closure: Use of Multiple Free Software Tools for Multiple Lines of Evidence Approach.** *K.L. Walker and T.M. McGuire.*
Kenneth Walker (GSI Environmental, Inc./USA)

C6. Data Analytics: Use of Advanced Decision Analysis Tools, Including AI and Machine Learning for Improved Analysis, Optimization and Decision Making

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Nick Machairas (Haley & Aldrich, Inc.) and Victor Vanin Sewaybricker (Geoklock)

Advancements in Environmental Data Science Frameworks: Integrating Data Sources, Analytics, and Stakeholder Access. *A. Forsberg, J.R. Butner, M. Germon, T. Palaia, A. Sidebottom, and R.J. Stuetzle.*
Adam Forsberg (Jacobs/USA)

***Application of Machine Learning in the Site Characterization of a U.S. EPA Superfund Site, the Jadco-Hughes Facility.**
A. Harrington and J. Dalton.
Anna Harrington (Azimuth1/USA)

***An Artificial Intelligence and Machine Learning (AI/ML) Approach to Mine Documents, toward Faster and More Predictable Site Closures.** *J.R. Eller and J. Srivastava.*
Jonathan R. Eller (GHD/USA)

Benefits of an Integrated Data Information, Visualization, and Analytics System for Environmental Site Management.
V.L. Freedman, C.D. Johnson, and P.D. Royer.
Vicky Freedman (Pacific Northwest National Laboratory/USA)

***Biogeochemical Characterization Optimization through Application of Machine-Learning Algorithms and Molecular Biological Tools.** *S.J. Sorsby, A. Madison, D. Taggart, K. Clark, R.E. Beckham, and T. Key.*
Skyler Sorsby (Golder Associates/USA)

***California Gold (Standard): Use of the GeoTracker Database for Project Management, Public Right to Know, and Contaminated Site Research.** *L. Beckley, S. McMasters, M. Cohen, S. Rauch, and T. McHugh.*
Lila Beckley (GSI Environmental, Inc./USA)

***Can Artificial Intelligence Lead to Better Portfolio Management?** *J.R. Eller, B. Roberts, and J. Srivastava.*
Jonathan R. Eller (GHD/USA)

***Data Science: A New Approach for the Use of High-Resolution Tools.** *A.F. Pessoa and V.V. Sewaybricker.*
Atila Ferreira Pessoa (EBP/Brazil)

***Development of Screening-Level Vapor Intrusion Models Using Statistical and Machine Learning Algorithms.** *H. Singh, R. Leatherbury, and M. Kleiner.*
Harvinder Singh (Weston Solutions, Inc./USA)

***Digitalizing the Field-to-Lab Data Workflow for BP's Global Remediation Portfolio.** *P. Neelappa and R.L. Bothun.*
Rikka L. Bothun (ddms, inc./USA)

Harnessing the Power of Big Datasets to Optimize Bioremediation. *D. Taggart, K. Clark, and S. Rosolina.*
Sam Rosolina (Microbial Insights, Inc./USA)

***Machine Learning for Portfolio Management.** *J. Dalton, A. Harrington, and R. Velazquez.*
Jason Dalton (Azimuth1/USA)

***OPytimization: A Python Library to Perform Spatio-Temporal Optimization in Long-Term Monitoring Sites.** *A.F. Pessoa and V.A. Malagutti.*
Atila Ferreira Pessoa (EBP/Brazil)

***Remediation Liability Allocation Using Monte Carlo, Risk Magnitude, and GIS.** *T.M. McGuire, C.J. Newell, and K.L. Walker, Jr.*
Travis McGuire (GSI Environmental Inc./USA)

***Use of Monte-Carlo Analysis to Evaluate Remedy Costs for Chlorinated Solvent Sites.** *J.A. Berndt.*
James Berndt (August Mack Environmental/USA)

Using Advanced Data Analytics to Reduce Management Cost, Compliance and Operational Risks of a Groundwater Source Control Remedy. *E. Whiting, B. Robinson, T.J. Slater, K. Deeny, and M. LeFrancois.*
Erica Whiting (ERM/USA)

C7. Optimizing Remedial Systems

Platforms Wednesday | Posters (*) Monday Evening
Chairs: David Becker (U.S. Army Corps of Engineers) and Lucas Hellerich (Woodard & Curran)

***Can Biological Treatment Work on Chemical Soup? Results from Ex Situ Biological Treatment of 1,4-Dioxane, BCEE, BCEM, 1,2,3-TCP, DCA, and 2-Chloroethanol.** *M. Klemmer, A. Harmon, J. Forbort, R.J. Stuetzle, and R. Wenzel.*
Mark Klemmer (Arcadis/Australia)

Combining and Optimizing Remedies Spatially and Temporally to Lower the Cost of Thermal Remediation. *T. Kinney, L. Soos, C. Blundy, and C. Thomas.*
Thomas Kinney (GHD/USA)

Evaluation of Remediation Flow Cell System Remediating Trichloroethylene at a Superfund Site in the Southwestern United States. *J. Bartos, P. Jeffers, R. Landis, S. Koehne, E. Marks, and N. Goulding.*
John Bartos (EHS Support/USA)

Evolution of Groundwater Treatment Systems: From Design and Installation to Post-Closure. *J.A. Boylan.*
John A. Boylan (RSI EnTech/USA)

Financial Forecast Tools for Remediation: Can You Afford to Change Your Cleanup Remedy? *P. Favara and J. Butner.*
Paul Favara (Jacobs/USA)

Improving Remedial Outcomes: Lessons Learned from Pre-Application Assessments at 50 Sites. *C. Sandefur, R. Hardenburger, and C. Lee.*
Craig Sandefur (REGENESIS/USA)

***Innovative SVE Design to Allow Optimum Operation to Remediate PCE in Heterogeneous Soil.** *B. Tabatabai. J.T. Raumin, J.M. Perry, and H. Amini.*
Hassan Amini (GSI Environmental, Inc./USA)

ITRC Regulatory Guidance: Optimizing Injection Strategies and In Situ Remediation Performance. *D.A. Scheer, T. MacBeth, and J. Waldron.*
Tamzen Macbeth (CDM Smith/USA)

Keys to Success from 20 Years of Optimization. *M.A. Barba, J.D. Horin, and J. Santillan.*
Michael Barba (Noblis/USA)

***Lessons Learned from an Accelerated Groundwater Source Reduction Program for Cr(VI) and TCE via a Liability Transfer Program at a Superfund Site.** *N.M. Rabah, B.J. Lazar, and Y. Kunukcu.*
Nidal M. Rabah (TRC Environmental Corporation/USA)

***Numerical Simulations for Optimizing an In Situ Injection Remedial Design.** *M. Beck, J.W. Schuetz, G. Ulrich, and P. Feshbach-Meriney.*
Melanie Beck (Parsons/USA)

***Optimization of Hydraulic Plume Control and Mass Flux under Highly Variable Groundwater Flow Conditions Using MODALL.** *J.W. Roller, S.T. Potter, M. Schnobrich, C. Elmendorf, E. Moosbrugger, and J. Cosgrove.*
Jonathan Roller (Arcadis/USA)

***Optimizing Enhanced In Situ Biodegradation of Low Levels of Chlorinated Ethenes in Complex Hydrogeology.** *L. LaPat-Polasko and J. Donovan.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

***Optimizing Injection-Based Remediation in Bedrock: Lessons from DNAPL Remediation by Chemical Oxidation.** *P.M. Dombrowski, P. Kakarla, and M. Temple.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***Performance Evaluation and Optimization of the Pump and Treat System for a Large Commingled Plume in Southern California.** *L. Wang, T. Zielinski, C. Bucklin, A. Vaidya, T. Dolan, J. Zhang, and M. Wright.*
Li Wang (California Department of Toxic Substances Control/USA)

***Personnel Optimization: Substituting Technology for Staffing on Long-Term O&M Projects.** *K.M. Lienau.*
Kevin Lienau (GES/USA)

***Pilot Test as a Way to Introduce New Technologies in Sweden.** *P. Johansson.*
Per Johansson (WSP/Sweden)

Preventing LNAPL Migration to Adjacent Receptors during Thermal Treatment Using Steam: A Case Study Monitoring External Heat Migration and Variations in Groundwater Conditions Outside the Treatment Area. *C. Rockwell, K. Hadley, and S. Griepke.*
Cathy Rockwell (Woodard & Curran/USA)

***The Salt Life: Reductive Dechlorination of Chlorinated Ethenes and Ethanes in Saline Groundwater.** *C.J. Voci and J.D. Roberts.*
Christopher Voci (Terraphase Engineering Inc./USA)

***Stratigraphic Sequencing and Refinement of the Conceptual Site Model to Optimize an Existing Pump-and-Treat System.** *E.B. Dieck, B. Bond, and R. Lees.*
Eric Dieck (Langan/USA)

***Taking the Guesswork out of Dynamic Remedy Design: Leveraging Transient Mass Flux for Enhanced Performance.** *S.T. Potter, A. Horneman, M.P. Plenge, C. Riis, J. Wahlberg, and M. Killingstad.*
Scott Potter (Arcadis/USA)

C8. Setting Cleanup Goal End Points: When Are We Done?

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Matthew Alexander (Texas A&M University-Kingsville) and Ronnie Britto (Tetra Tech, Inc.)

***Apparent Total Petroleum Hydrocarbons (TPH) in Uncontaminated Soils: Quantification, Identification, and Implications for TPH Regulation.** *A.G. Delgado, S.V. Sundar, A. Nitzky, E.M. Miranda, P. Dahlen, N. Sihota, and R. Mohler.*
Anca Delgado (Arizona State University/USA)

Application of a Tool and Process to Determine SVE Endstate. *C.D. Johnson, K.A. Muller, M.J. Truex, D.J. Becker, C.M. Harms, J. Popovic, and G. Tartakovsky.*
Christian Johnson (Pacific Northwest National Laboratory/USA)

***Arsenic Oral Bioavailability and Site-Specific Direct Contact Criteria Development for Soils at a Former Orchard, Now City Park.** *P.J. McCall and M.F. Gillie.*
Patti McCall (Tetra Tech, Inc./USA)

***Cleanup and Redevelopment of a Former Transformer Manufacturing Facility under a Risk-Based TSCA Cleanup Application.** *D. Gandhi and M.K. King.*
Deepa Gandhi (EKI Environment & Water, Inc./USA)

***Defining Cleanup Goals Based on DNAPL Mobility in Soil.** *M. Palmer, L. Stauch, K. King, K. Hewlett, and P. Joyce.*
Mike Palmer (de maximis, inc./USA)

***Ignore at Your Own Risk? Risk-Based Screening Levels for TPH and HOPs in Fresh and Degraded Plumes of Petroleum-Contaminated Water.** *R. Brewer, M. Heskett, and M. Rigby.*
Roger Brewer (Hawaii Department of Health/USA)

The Impact of Adding Chemicals of Emerging Concern to CERCLA Site Cleanup Requirements. *G.L. Kirkpatrick.*
Gerry Kirkpatrick (Environmental Standards, Inc./USA)

Past Performance Does Not Guarantee Future Results: Evaluation of Remedy Performance Using Long Monitoring Records. *T.E. McHugh, C.J. Newell, L.M. Beckley, S.R. Rauch, G. DeVaull, and M. Lahvis.*
Thomas McHugh (GSI Environmental, Inc./USA)

***Technical Impracticability: Lessons Learned during the Implementation of Corrective Action in a Lacustrine Clay-Rich Environment.** *D. Litz and G. Crockford.*
Darby Litz (TRC/USA)

***The Thermal Remediation System Has Been Turned Off: How Will Groundwater Concentrations Respond?** *E.L. Davis.*
Eva Davis (U.S. Environmental Protection Agency/USA)

***Use of a Visual Cleanup Standard for PCB Bulk Product Paint Abatement under a Risk-Based TSCA Cleanup Application.** *A.C. Aranha, D.H. Gandhi, and M.K. King.*
Alexandra C. Aranha (EKI Environment & Water, Inc./USA)

Using Multiple Lines of Evidence to Determine Success of In Situ Thermal Remediation. *L. Stauch, J. van Rossum, M. van den Brand, and H. Boden.*
Lynette Stauch (TRS Group, Inc./USA)

C9. GSR Best Practices and Nature-Based Remediation Case Studies

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: David Burns (OPEC Systems P/L) and William DiGuiseppi (Jacobs)

Accelerating Cleanup, Reducing Costs, and Increasing Sustainability at Travis Air Force Base. *J. Gamlin and L. Duke.*
Jeff Gamlin (Jacobs/USA)

***Adaptive Remedial Design at a Former Smelter Superfund Site Results in Increased Green and Sustainable Remediation Opportunities.** *M. Crawford and J. Hesemann.*
Matt Crawford (Burns & McDonnell Engineering Co. Inc./USA)

***Adaptive Utilization of Natural Site Conditions to Facilitate Effective Remediation: Be Like Water.** *T.J. Patterson.*
Thomas Patterson (Roux Associates, Inc./USA)

Challenges with Green Remediation Planning. *S.A. Sheldrake and M.A. Harclerode.*
Sean Sheldrake (CDM Smith, Inc./USA)

***Concentrated Solar: Sustainable Energy Source for Thermal Remediation.** *D.C. Segal, C.W. Lam, C. Trujillo, and K. Linden.*
Daniel Segal (Chevron/USA)

***Do Landfills Still Need Compressed Air?** *M. Bertane.*
Mark Bertane (Blackhawk Technology Company/USA)

***Evaluating Native and Naturalized Plant Species for the Phytoextraction of DDT and Dieldrin at a National Park in Ontario, Canada.** *B. Zeeb, R. Bergin, and A. Rutter.*
Barbara Zeeb (Royal Military College of Canada/Canada)

***A Five-Year Review: Annual Monitoring, Performance Trends and New Sampling Approaches to Optimize an Endophyte-Enhanced Hybrid Poplar Phytoremediation Program for TCE at an Arid, Fractured Bedrock Site.** *J.Duffey, D. Rowe, E. Pearson, C. Serlin, J. Freeman, G. O'Toole, and C. Cohu.*
Johnston Duffey (Ramboll US Consulting/USA)

***Full-Scale Remediation of Chlorinated Solvents in Ørnegård Electrical Substation Using Enhanced Reductive Dechlorination with Organic Molasses.** *J.U. Bastrup, S.K. Schultz, D. Isager, and M. Rydam.*
Sofie Kamille Schultz (Geo/Denmark)

In Search of PFAS Hyperaccumulation in Plants. *B.J. Harding, M. Zenker, and F. Barajas.*
Barry Harding (AECOM/USA)

***In Situ Thermal Remediation Application in South Africa: Incorporating Sustainable Elements.** *N. Moller, S. McKeown, M. Nel, and J. Baldock.*
Nadine Moller (ERM/South Africa)

***Maximizing Sustainable Actions for a Site Closure in Brazil.** *J. Vilar, A. Bustamante, G. Andrade, A. Miranda, B. Rocha, A. Martinho, J. Smith, J. Overgord, and K. Haymond.*
Julio Vilar (Arcadis/Brazil)

***Measuring Remediation's Influence on United Nations Sustainable Development Goals.** *C. Walecka-Hutchison, J. McKinnon, M. Germon, and B. Collins.*
Claudia Walecka Hutchison (The Dow Chemical Company/USA)

***Phytoremediation Experiences at Multiple Sites for Treatment of 1,4-Dioxane and Other Recalcitrant Compounds.** *F.J. Krembs, M.G. Sweetenham, S. Lombardo, and K. McDonald.*
Fritz Krembs (Trihydro Corporation/USA)

***Proof That the Most Aggressive Remedial Action Can Also Be the Greenest.** *I. Lo, M. Harclerode, G. Stuesse, and M. Ryan.*
Ian Lo (CDM Smith, Inc./USA)

***Recent Advances in Subgrade Biogeochemical Reactors with Treatment of ~15 mg/L of 1,2-DCA to near Non-Detect Levels.** *C. Walecka-Hutchison, J. Gamlin, J. Strunk, R.J. Stuetzle, and A. Sidebottom.*
Claudia Walecka Hutchison (The Dow Chemical Company/USA)

***Repurposing Infrastructure for Engineered Natural Treatment of Contaminated Groundwater.** *K. Waltermire, D. Thomas, N. Cavaleri, and J. Bays.*
Kendra Waltermire (Jacobs/USA)

Seven Years of Using Endophyte-Assisted Phytoremediation Systems for Contaminated Groundwater Removal and In Situ Degradation. *J.L. Freeman, C.M. Cohu, G. O'Toole, J.G. Burken, S.L. Doty, S. Rock, J.E. Landmeyer, D. Rowe, E. Pearson, D. Oram, R. Haughy, and B. Searcy.*
John Freeman (Intrinsix Environmental/USA)

***Sustainable PHYTO-INTEGRATED® Remediation System to Treat Chlorobenzene-Contaminated Groundwater in a Saprolite/PWR Aquifer in South Carolina.** *E.B. Hollifield and J.G. Byrd.*
Edward B. Hollifield (Environmental Resources Management/USA)

***Sustainable Remediation via Bioelectrochemical Degradation at an Active Facility Impacted by Petroleum Products.** *L. Zeng, A. Boodram, M. Spievack, S. Sherman, V. Yarina, S. Abrams, and S. Jin.*
Lingke Zeng (Langan/USA)

***Tackling Groundwater Remediation Leads to Water Conservation, Wildlife Habitat Restoration, and Engagement with the Surrounding Community.** *C. Rockwell, K. Lauer, and K. Elich.*
Cathy Rockwell (Woodard & Curran/USA)

***Validating a Green and Sustainable LNAPL Recovery/ Remediation Technology.** *C.J. Vandegrift and S. Bouzrara.*
Christopher Vandegrift (Antea USA Inc./USA)

C10. Climate Resilience and Site Remediation

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Thomas K. O'Neill (New Jersey Department of Environmental Protection [Retired]) and Paul Randall (U.S. Environmental Protection Agency)

***ANTHYM: The Anthrohydrologic Conceptual Model for Groundwater Remedy Design under Climate Change.** *S.D. Warner and C.J. Ritchie.*
Scott Warner (BBJ Group/USA)

***Climate Change Analysis of Remedies for Terrestrial Operable Units at Naval Base Kitsap Bremerton, Bremerton, WA.** *J. Gryzenia, S. McKnight, B. Mintz, J. Vandever, and G. Burgess.*
Steve McKnight (AECOM/USA)

***Climate Crisis: The Burntfields Reality.** *R.I. Thun.*
Roy Thun (GHD/USA)

The Evolution of GSR: Comparing ITRC's 2021 Sustainable Resilient Remediation Guidance to ASTM's 2021 Standard Guide for Remedial Action Resiliency to Climate Impacts. *R.I. Thun.*
Roy Thun (GHD/USA)

***Greenhouse Gas Calculator Focused on Site Evaluation and Restoration Projects in Brazil.** *C. Shibata, G. Sarauza, N. Takahashi.*
Natalia Takahashi (Arcadis/Brazil)

Implementing Greener Cleanup Best Management Practices at a Complex, Dynamic Groundwater Remediation Site. *C.J. Ritchie and M. Sosa.*
Christopher Jackson Ritchie (Ramboll/USA)

Integrating Resilience into Massachusetts Remediation Sites. *C. Rockwell, M. Wade, and K. Marra.*
Cathy Rockwell (Woodard & Curran/USA)

***More Sustainable In Situ Remediation in Bedrock and Quantifying Actual Footprint Reduction with SiteWise™.** *P.M. Dombrowski, P. Kakarla, M. Dotto, J. Tartaglia, F. Hostrop, and D. Raymond.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

Robust Groundwater Risk Assessment of Chlorinated Ethenes Using Solute Transport Modelling and Climate Change Scenarios. *G.L. Søndergaard, L. Bennedsen, B.B. Thrane, B. Neuman, A.T. Bentzen, and J.F. Christensen.*
Gitte Lemming Søndergaard (Ramboll/Denmark)

***Sustainable and Resilient Remediation at the Intersection of Climate Variability and Contaminated Site Management.** *K.A. Morris and V. Kolluru.*
Kevin Morris (ERM/USA)

C11. Aligning Remediation Goals with Environmental, Social, and Governance (ESG) Considerations

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Paul Favara (Jacobs) and Richard L. Raymond, Jr. (Terra Systems, Inc.)

***A Beyond-Technique Approach to Overcome Lack of Regulation for a Large-Scale Brownfield Remediation in Chile.** *E. Undurraga, S. Rotella, C. Quiroga, M. Szanto, L. Álvarez, S. Donghi, M. Seeger, R. Orellana, J.P. Davit, and R. Victor.*
Esteban Undurraga (Inmobiliaria Las Salinas/Chile)

Combating International Brain Drain: The Social Benefits of Sustainable Remediation. *M. Lemes, M. Harclerode, and J. Henderson.*
Maria Cristina Lemes (CDM Smith, Inc./USA)

Contaminant Bioavailability: Toward a Sustainable and a More Science-Based Remediation Approach. *F. Abo.*
Fouad Abo (GHD/Australia)

***High-Resolution Investigation as a Key Element for the Sustainable Approach of the Remediation of Contaminated Sites.** *C. Jorge, C. Malta-Oliveira, S. Souto, and M. Evald.*
Celeste Jorge (Laboratório Nacional de Engenharia Civil - Lisboa/Portugal)

***Phytoremediation in Paradise: Remediation of Soil Fumigants in Hawaii.** *G. Zimmerman.*
Gary Zimmerman (Golder Associates member of WSP/USA)

***Remediation as Resource Recovery: Opportunities in the Copperbelt Region of Zambia.** *P. Chisala, C. Switzer, and J. Renshaw.*
Precious Chisala (University of Strathclyde/Scotland)

***A Successful Brownfield Cleanup Site.** *B.J. Parekh and D. Winslow.*
Bhuvnesh Parekh (GZA GeoEnvironmental, Inc./USA)

Sustainable Remedial Approach: Construction of a Recreational Park in an Off-Site Area to Mitigate Risk. *M. Naves, L. Buve, A. Chaves, and V. Martins.*
Matheus Naves (ERM/Brazil)

Sustainable Remediation of Contaminated Sites While Minimizing Project Expenditures. *F. Achour and A. Amarandos.*
Farid Achour (GSI Environmental Inc./USA)

***Using Sustainable Remediation to Align with Corporate ESG Goals.** *M. Schlosser and M. Harclerode.*
Megan Schlosser (CDM Smith/USA)

D1. Large, Dilute and Commingled Plume Case Studies

Platforms Monday | Posters (*) Monday Evening
Chairs: Diana Cutt (U.S. Environmental Protection Agency) and John Williams (The Boeing Company)

***Adaptive Strategies for In Situ Remediation of a Large Chlorinated Hydrocarbon Plume via ERD: A Railyard Case Study.** *L. Thomas, J. Coughlin, and D. Gabardi.*
Dawn Gabardi (Arcadis/USA)

Building a Robust Geochemical Model to Evaluate and Manage a Large, Dilute, Commingled Plume. *K. Leslie, T. Macbeth, E. Ehret, J. Dougherty, M. Gamache, and T. Cook.*
Karla Leslie (CDM Smith/USA)

Complex Contaminant Transport within Folded Sediments and Integrated Threat Reduction Using Packer Isolation Methodology. *C.G.A. Ross, J.D. Schwall, R.A. Niemeyer, and S.P. Netto.*
Christopher G.A. Ross (Engineering Analytics, Inc/USA)

***Cost-Effective Remediation of a 60-Acre Chlorinated Solvent Groundwater Plume Using a Non-Emulsified Vegetable Oil Substrate.** *J.H. Hesemann.*
John Hesemann (Burns & McDonnell/USA)

***El Nino/Southern Oscillation-Induced Precipitation Events Causing Groundwater Elevation and Trichlorethylene Spikes at a Superfund Site.** *J. Bartos and D. Gallagher.*
John M. Bartos (Virginia Tech/USA)

***Environmental Site Investigation and Combined Remediation Strategy for a Complex CVOC Site Neighboring Sensitive Receptors in Brazil.** *G. Van den Daele, J.R. Cury, M.H. Roldan, G. de Mello, G.N. Garcia, A.R. Cervelin, and F.A. Campello.*
Gerd Van den Daele (Ramboll/Brazil)

Evaluation and Remediation of a Large Commingled Chlorinated Solvent Plume in the New Jersey Coastal Plain. *M. Khan and L. Agrios.*
Mazeeda Khan (U.S. EPA/USA)

How Groundwater Modeling Helped Remediation Design for Contaminant Plumes Impacting Los Angeles' Municipal Supply Wells. *M. Trudell, M. Hendrie, S. Winners, N. Blute, C. Cotton, T. Rother, and K. Wells.*
Steve Winners (Advisian/USA)

***Less Bucks for Your Bang: Gauging Network Optimization for Improved Hydraulic Management of Large-Scale Plumes.** *M.W. Killingstad, J. Wang, J. Roberts, and J. Fourie.*
Marc Killingstad (Arcadis/USA)

***Past, Present and Future Predictions: Understanding the Behavior of Contamination at a Complex Former Manufactured Gas Plant.** *S.C. Faber, D.C. Aydin, J. Gerritse, and J.A. van Leeuwen.*
Suzanne Faber (Utrecht University/Netherlands)

Remediation of Large-Scale PCE-Impacted Groundwater: Integration of Tailored Amendments and Injection Approaches. *M.M. Mejac, J.M. Metzger, and D.M. Lis.*
Mark Mejac (Ramboll/USA)

***Sweet Success: Remediation of a Large TCE Groundwater Plume within a Major Aquifer in Southeast Texas.** *J.M. Skaggs.*
Jonathan Skaggs (GSI Environmental Inc./USA)

***Treatment of a Large, Dilute Plume Using Permeable Reactive Barriers in Low pH Aquifer.** *P.M. Dombrowski, P. Kakarla, M. Temple, T. Musser, and D. Guilfoil.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***A Unique Application of Dynamic Groundwater Recirculation (DGR™) in a Highly Transmissive Aquifer.** *P. Barnett, J. Ferry, E. Fortner, C. Grogan, J. Roller, and M. Schnobrich.*
Everett Fortner (Arcadis U.S./USA)

Panel Discussion—Monday, Track D

Investigating and Remediating a Major Chlorinated Solvent DNAPL Site

Moderator
Bruce Thompson (de maximis, inc.)

Panelists
Bernard Kueper (Queens University)
Michael Gefell (Anchor QEA)
Gorm Heron (TRS Group)
Julie Sueker (ARCADIS)
Jeffrey Holden (GEI Consultants)

This panel will address the evolution and application of "state-of-the-art" practices over more than 25 years of investigation and remediation at the Solvents Recovery Service of New England, Inc. Superfund Site. This work has included planning for a protracted (>100 years) operations and maintenance period. Significant themes to be discussed include:

1. Dense, nonaqueous phase liquid (DNAPL) site concepts, including avoiding NAPL zone expansion during site work, using multiple lines of evidence for source zone delineation, understanding and using bedrock structure and hydraulics, evaluating the effects of matrix diffusion, and the utility of models;
2. Implementing in situ thermal remediation and assessing effects of post-treatment "residual" heat;
3. Application of monitored natural attenuation to a complex, multicomponent groundwater plume;
4. Optimizing long-term operations and maintenance, including adaptive management to address per- and polyfluoroalkyl substances (PFAS); and
5. Effectively integrating regulatory oversight and coordination.

D2. Landfill Assessment and Remediation

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Matthew Ambrusch (Langan) and Omer Uppal (Haley & Aldrich, Inc.)

***Biogenic Heat from Municipal Solid Waste Suggests a Two-Stage Process in Elevated Temperature Landfills.** *D. Graves, J. Smith, and A. Rocha.*
Duane Graves (SiREM/USA)

***Comparison of Geochemical and Arsenic Speciation Conditions to Evaluate Potential Landfill Impacts to Groundwater.** *D. Gray, M. Chambless, D. Musfeldt, and D. Belote.*
Doug Gray (AECOM/USA)

Computational Optimization of a Landfill Gas Collection System. *A. Boodram, M. Ambrusch, S. Abrams, and L. Adensohn.*
Aroona Boodram (Langan/USA)

***Hybrid Landfill Gas Mitigation System Implementation.** *A. Boodram, S. Abrams, I. Khan, M. Wenrick, and M. Spievack.*
Aroona Boodram (Langan/USA)

***In Situ Treatment of Landfill to Remove 200,000 Pounds of Contaminants in Less Than One Year.** *C. Winell, J. Chen, and R. D'Anjou.*
Carol Winell (GEO/USA)

***Inactive Landfill Initiative: Impact of Emerging Contaminants (PFAS and 1,4-Dioxane) on Drinking Water Sources.** *T. Drachenberg, K. Brooks, H. Budzich, G. Moreau, P. Scharfschwerdt, and S. Weishaupt.*
Thomas Drachenberg (Parsons/USA)

***Innovative Pneumatic Modeling Approach for Designing Cost-Effective Landfill Gas Mitigation Systems.** *M. Ambrusch, A. Boodram, A. Quinn, S. Abrams, J. Ludlow, and J. Stevens.*
Matthew Ambrusch (Langan/USA)

***Landfill Remediation and Redevelopment: A Status Review of the Current Practice and Technology Advancements.** *O. Uppal, P. Bennett, J.W. Little, D. Costantini, C. Tsiatsios, and S.P. Zachary.*
Omer Uppal (Haley & Aldrich, Inc./USA)

***Learnings and Design Considerations from the Application of an Artificial Turf Capping Solution atop Low-Strength Solid Waste Basins.** *G. Foust, R.J. Stuetzle, D. Belote, J. Richardson, and A. Ferrari.*
Gretchen Foust (Jacobs/USA)

***Liquid Hazardous Waste in Historical Municipal Solid Waste Landfills: Investigation, Characterization, and Remediation.** *S. Reinis, H. Farr, and J.F. Ludlow.*
Sigrida Reinis (Langan/USA)

A Novel Approach to Volume Reduction and In Situ Aerobic Treatment of Landfill Leachate. *R. Welch, H. Goldemund, and B.D. Jacobson.*
Regan Welch (Geosyntec Consultants/USA)

***Pasco Sanitary Landfill NPL Site: Regulatory Overview, Design, and Implementation of the Zone A Drum Removal Action.** *M.A. Fleri and J. Massingale.*
Mark Fleri (ENTACT/USA)

Phytoremediation for Management of Leachate at a Closed Landfill. *F.J. Krembs, J. Pruis, M. Morin, R. Spring, and E. Ballenger.*
Fritz Krembs (Trihydro Corporation/USA)

***Pile Foundation Options for Development over Landfill Sites and Their Environmental Impacts.** *J.Y. Uppal and O. Uppal.*
Omer Uppal (Haley & Aldrich, Inc./USA)

***Using a 3-D Visualization-Centered Approach to Accelerate a Landfill Site Remediation.** *J. Jackson.*
Jonah Jackson (Environmental Standards, Inc./USA)

Utilizing 3-D Geophysics for Detailed Mapping of a Deep Landfill Leachate Plume. *J.K. Pedersen, S.S. Nielsen, L. Dissing, T.H. Jorgensen, O.F. Nielsen, J. Albinus, B. Germundsson, J.B. Pedersen, R. Kraghede, and F.E. Christensen.*
Sanne Skov Nielsen (Region of Southern Denmark/Denmark)

D3. Adaptive Site Management: Lessons Learned for Site Characterization and Remedy Implementation

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Tamzen Macbeth (CDM Smith) and Kathleen Stetser (GEI Consultants, Inc.)

Adaptative Site Management for a 115-Acre Chlorinated Solvent Plume with Two Separate Source Areas at Kennedy Space Center, Florida. *A. Chrest, R.C. Daprato, M. Burcham, and J. Langenbach.*
Anne M. Chrest (NASA Kennedy Space Center/USA)

Adaptive Management for Remediation of a 3-Mile Hexavalent Chromium Plume in Hinkley, California. *K.M. Sullivan, I. Baker, M.E. Gentile, F. Lenzo, and I. Wood.*
Kevin Sullivan (Pacific Gas and Electric Company/USA)

***Adaptive Site Management to Demonstrate Remedial Success of Chlorinated Ethenes in Groundwater at a New Jersey Site.** *T. Silverman, L.G. Gross, L. Seuss, L. LaPat-Polasko, and R. Britton.*
Thomas Silverman (EHS Support/USA)

***Adaptive Site Management: Lessons Learned, ERH Characterization and Implementation.** *M. Palmer and L. Stauch.*
Mike Palmer (de maximis, inc./USA)

***Air Sparge Pilot Study in the DNAPL Source Zone at Launch Complex 34, Cape Canaveral Space Force Station, Florida.** *D. Johansen, M. Deliz, M. Jonnet, and M. Speranza.*
Mark J. Jonnet (Tetra Tech/USA)

***A Case Study in Adaptive Management: In Situ Thermal Treatment at the Velsicol Superfund Site.** *S. Pratt, T. von Wallmenitch, J. Eluskie, D. Ewing, J. Cole, and T. Alcamo.*
Scott Pratt (Jacobs/USA)

***Case Study: Using Adaptive Management to Balance Changes in the CSM, Applicable Regulations, and Newly Identified Stakeholders.** *S. Cwick.*
Shaun Cwick (Weston Solutions, Inc./USA)

***Deep Soil Remediation of TSCA-Regulated PCBs.** *K. Young, C. Silver, S. Baryluk, and M. Martin.*
Katie Young (CDM Smith, Inc./USA)

***Demonstrating Adaptive Site Management through Combined Treatment Technologies and Expediting Site Closure with Innovative Strategies.** *K.L. Smail and J. Sheldon.*
Kirby L. Smail (Antea Group/USA)

Effectiveness of Adaptive Strategies and Active Stakeholder Engagement: Knowledge Sharing from a Successful 10-Year Performance-Based Remediation Contract. *S. Suryanarayanan, P. Srivastav, and R. Mayer.*
Sowmya Suryanarayanan (APTIM/USA)

***Filling in the Data Gaps at Complex Sites before Focused Remediation: Three Case Studies.** *J. Sankey.*
John Sankey (True Blue Technologies, Inc./USA)

***In Situ Bioremediation of Elevated Levels of Chlorinated Ethenes in Complex Hydrogeologic Conditions.** *L. LaPat-Polasko, A. Polasko-Todd, M. Hayes, and P. Lamont.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

In Situ Treatment of a Commingled Carbon Tetrachloride, Chlorofluorocarbon, and Trichloroethene Groundwater Plume in Fractured Bedrock. *E. Ehret, T. Macbeth, D. Nguyen, T. Cook, S. Ohannessian, D. Janda, and M. Fattahipour.*
Emma Ehret (CDM Smith, Inc./USA)

It Takes Three to Tango: A Well-Choreographed Dance between Site Characterization, Modeling, and Adaptive Management. *M.W. Killingstad, D. Farber, L. Rodriguez, and S.T. Potter.*
Marc Killingstad (Arcadis/USA)

***Lessons Learned following Wildland Fire Site Characterization and Time Critical Removal Action.** *D. Croteau and K. Sherrard.*
Kelsey Sherrard (Terraphase Engineering/USA)

***The Use of Adaptive Management and High-Resolution Site Characterization to Optimize the Remedial Design at a Superfund Site.** *R.A. Wymore, N. Smith, T. Macbeth, and M. Smith.*
Ryan Wymore (CDM Smith, Inc./USA)

Updating Remedial Action Approach and Developing a Path to Site Closure. *T.K. Schott, K.F. Stetser, J.E. Kohl, and M.C. Clifford-Martin.*
Tyler Kenneth Schott (GEI Consultants, Inc/USA)

***Use of Pilot Data and Adaptive Project Management to Design and Implement a Large, Full-Scale EISB/ISCR Remedy.** *M.R. Harkness, P. Freyer, L. Reusser, D. Carnevale, P. Hare, and L. Scheuing.*
Mark Harkness (Ramboll/USA)

Using Three-Dimensional Modeling and Real-Time Field Monitoring for an Optimized Remedial Injection Program at a CVOC-Contaminated Site. *S. Sherman, M. Tulich, and A. Frankel.*
Stephen Sherman (Integral Consulting, Inc./USA)

When Innovative Sciences and Lean Tools Combine to Resolve Aggressive Deadlines and Access Challenges. *K.A. Foster, E. Haddad, J. Kingston, J. Weidmann, and M. Sinnett.*
Keith Foster (Haley & Aldrich/USA)

D4. Evaluating Surface Water/Groundwater Interactions: Innovative Monitoring Approaches and Modeling Applications

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Lisa Lefkovitz (Battelle) and Scott Pittenger (ISOTEC)

***3-D Model of Surface Water as a Guiding Tool for Environmental Monitoring.** *T.F. Noccetti, D.D. Savio and V.S. Ambrogi.*
Talita Favaro Noccetti (EBP Brasil/Brazil)

***Assessing Groundwater-Surface Water Interactions using a Variety of High Resolution Tools and Traditional Methods.** *C.G. Patterson, A. Gavaskar, S.A. Lee, A. Danko, L.F. Lefkovitz, E.M. Kaltenberg, J. Sminchak, and A. Jackson.*
Chris Patterson (U.S. Navy/USA)

***Can Quantifying and Visualizing Canal/Groundwater Interactions at an LNAPL-Impacted Site Lead to a Better Remedy? Yes!** *P. Khambhammettu, J. Wang, S.W. Niekamp, L.A. Eastes, and V.S. Maresco.*
Prashanth Khambhammettu (Arcadis/USA)

***Continuous Water-Level Monitoring to Support the Development of Conceptual Site Models: Case Studies Using Natural and Induced Hydraulic Stresses.** *J.M. Marolda and R.L. O'Neill.*
James Marolda (Brown and Caldwell/USA)

Demonstrating a Toolbox of Technologies for Mapping and Monitoring of Contaminated Groundwater Discharges to Surface Water Background and Objective. *R. Iery, L. Slater, D. Ntarlagiannis, M. Briggs, and F. Day-Lewis.*
Ramona Iery (U.S. Navy/USA)

***Development of a Groundwater Flow and Transport Model to Estimate Solute Loading in the nearby Gaining Stream.** *A. Singhal and C. Stubbs.*
Alka Singhal (RAMBOLL/USA)

***Discharge of Impacted Groundwater to Surface Water: Monitoring and Modeling Methods to Evaluate Risk to Ecological Receptors.** *J. Robb.*
Joseph Robb (ERM/USA)

***Efficient Monitoring of Flow Paths and COC Degradation with 2-D Fluorescence and of LNAPL Migration with 3-D Fluorescence and Passive Samplers.** T.*M. Hurd and M.H. Otz.*
Todd M. Hurd (TMH Tracing/USA)

***Evaluation of Mass Discharge to Surface Water in a Tidally-Influenced Aquifer by Passive Flux Meters.** *H.A. Brown, R. Sillan, and M. Harclerode.*
Holly Brown (AECOM/USA)

***Evaluation of Modeled Infiltration from Retention Ponds to Affect an Air Sparge/Soil Vapor Extraction Remediation System.** *K.I. Pasternak and J.H. Coll.*
Kevin Pasternak (ATC Group Services/USA)

***An Infinite Source of Water? Groundwater/Surface Water Interaction in an Extraction System Design.** *S.W. Niekamp, L.A. Eastes, E.H. Fortner, and V.S. Maresco.*
Scott W. Niekamp (Arcadis/USA)

Mapping Contaminated Groundwater Discharges with Thermal Infrared-Sensing Unmanned Aerial Vehicles. *M.R. Mathioudakis, C.R. Glenn, and D.E. Dores.*
Michael R. Mathioudakis (GSI Environmental Inc./USA)

Measuring Groundwater to Surface Water Emissions on Basalt Embankment with a Novel Partition Sampler. *C.G.J.M. Pijls and D. Giesen.*
C. Pijls (Tauw/Netherlands)

***Phosphorus Loading and Seasonal Mass Balance: Developing a Complex Groundwater-Surface Water Conceptual Site Model.** *J. Peale, M. Leisenring, and M. Gray.*
James Peale (Geosyntec Consultants, Inc./USA)

Use of Distributed Temperature Sensing Technologies in Evaluating Surface Water/Groundwater Interaction. *H. Tahon.*
Heather Tahon (Geosyntec Consultants/USA)

***Using Stream Geochemistry to Determine Groundwater/Surface Water Interactions at a Former Uranium/Vanadium Mill Site.** *A.R. Reynolds.*
Allison Reynolds (RSI EnTech/USA)

D5. DNAPL Source Zone Remediation: Lessons Learned

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Andy Lowy (Provectus Environmental Products) and Heather Rectanus (Geosyntec Consultants)

***Bioremediation Using High and Low Pressure Injection to Address a TCE Source Area at Kennedy Space Center, Florida.** *R.C.Daprato, J. Langenbach, and A. Chrest.*
Rebecca C. Daprato (Geosyntec Consultants/USA)

***Decade-Long Monitoring of Enhanced Dechlorination of TCE Present in Groundwater and MGP Waste DNAPL.**
C. Savoie, E. Bakkom, P. Wiescher, and M. Murray.
Courtney Savoie (Maul Foster & Alongi, Inc./USA)

***Field-Scale Demonstration of Enhanced DNAPL Dissolution during Bioremediation.** *A.D. Fure.*
Adrian Fure (Haley & Aldrich, Inc./USA)

***Full-Scale DNAPL Source Zone Remediation with In Situ Bioremediation.** *A.G.B. Williams, A. Testoff, and K. Kessler.*
Aaron Williams (Montrose Environmental/USA)

***In Situ Bioremediation Remediates Grossly Impacted Site.**
E. Gustafson.
Erik Gustafson (WSP/USA)

In Situ Thermal Remediation of a Highly-Impacted DNAPL Source Zone. *R. Glass, J. van Rossum, J. Binon, T. Keijzer, T. Ruffenach, and B. Souffre.*
Robert Glass (TRS Group/USA)

***Managing DNAPL Source Zones near Surface Water Bodies in British Columbia, Canada: Regulatory and Technical Lessons Learned.** *S.N. Dankevy and A.P. Mortensen.*
Stephen Dankevy (British Columbia Government/Canada)

***Phased Biostimulation/Bioaugmentation of a TCE DNAPL Source Area in Fractured Bedrock with Karst Features.**
K.A. Morris, P. Beyer, and J. Fiacco.
Kevin Morris (ERM/USA)

The Progression of EZVI Technology for In Situ DNAPL Destruction in Saturated and Vadose Soils: Lessons Learned and Recent Advancements. *G. Booth.*
J. Greg Booth (Woodard & Curran/USA)

Sequenced S-ISCO®, ISCO and Bioremediation for Treatment of a Pharmaceutical Waste Mixture: Full-Scale Application.
T.H. Jørgensen, L. Nissen, L. MacKinnon, F. Solano, N.D. Durant, L.R. Bennedsen, M. Christophersen, J.F. Christensen, and I. Holm Olesen.
Leah MacKinnon (Geosyntec Consultants, Inc./Canada)

When Dilution Is the Solution to Pollution: How Mobilizing DNAPL Resulted in a More Successful Injection-Based Remedial Treatment Approach. *C. Martin and M. Murday Pariso.*
Collin Martin (EnviroForensics, LLC/USA)

D6. Low-Permeability Zone Challenges, Permeability Enhancements, and Case Studies

Platforms Wednesday | Posters (*) Monday Evening
Chairs: J. Greg Booth (Woodard & Curran) and Poonam Kulkarni (GSI Environmental Inc.)

***Combining In Situ Chemical Reduction and Big Diameter Vertical Soil Drill as an Alternative Solution for Thermal on a Complex Site Impacted by Chlorinated Solvents (Sao Paulo, Brazil).** *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, N. Nascimento, G. Siqueira, and J. Mueller.*
Sidney Aluani (SGW Services/Brazil)

***Conventional Bioremediation and In Situ Chemical Oxidation Pilot Tests in an Unconventional Setting.**
J.D. Spalding, R. Daprato, M. Burcham, T.N. Creamer, and P. Chang.
James D. Spalding (U.S. Navy/USA)

DPT Jet Injection for Remediation of Low-Permeability Zones: Three Full-Scale Case Studies in Three States.
C.M. Ross, C.S. Martin, C. Shores, W.D. Brady, and D.M. Baird.
Chapman Ross (FRx, Inc/USA)

Enhanced Amendment Delivery into Low Permeability Zone Using Xanthan Gum. *A. Boodram, L. Zeng, M. Wenrick, D. Hopper, S. Abrams, and R. LoCastro.*
Aroona Boodram (Langan/USA)

***Ex Situ Treatment of 345,000 Tonnes of Clay Soil Impacted with CVOCs Using a Novel Treatment Strategy.** M. Cadotte and J. Paquin.
Myriam Cadotte (Sanexen Services Environnementaux/Canada)

***Lacustrine Soil Fracturing for Soil Vapor Extraction Pilot Testing to Enhance Permeability and Mass Reduction of Trichloroethene-Impacted Soils.** *S.F. Calkin, J. Besse, D. Groher, D. Baird, and D. Knight.*
Scott Calkin (Wood/USA)

Low Permeability: ISCO Optimization Using Groundwater Recirculation. *R.D. Desrosiers and B.D. Rach.*
Richard J. Desrosiers (GZA GeoEnvironmental, Inc./USA)

Mitigate Long-Term Back-Diffusion from Low-K Unit with Horizontal ISCO Barriers. *H. Huang, D. Kistner, D. Baird, D. Knight, J. Cibrik, and A. Lee.*
He Huang (AECOM/USA)

Overcoming a Vexing Problem of In Situ Remediation within Complex Geology: EK-Enhanced In Situ Chemical Oxidation.
J. Wang, A. Montgomery, A. Callaway, and J. Ferreira.
James Wang (Geosyntec Consultants/USA)

***Pneumatic Fracturing and Proppant Injection to Facilitate Air Sparge-Soil Vapor Extraction of Chlorinated Ethenes in Low Permeability Geology.** *E. Moskal, M. Gerber, L.N. Favero, W.A. Butler, and G. Jirak.*
Eric Moskal (Cascade/USA)

***Reducing Time of Remediation in Clay and Fractured Rock Sites (Part 1): Fracturing Eyes Wide Open in Low Permeability Conditions.** *G. Guest and L. Kessel.*
Lowell Kessel (C.E.R.E.S. Corporation/USA)

***Reducing Time of Remediation in Clay and Fractured Rock Sites (Part 2): Marrying Permeability Enhancement with Bio-Geo-Chem Reagent Resiliency.** *L. Kessel and G. Guest.*
Lowell Kessel (C.E.R.E.S. Corporation/USA)

Remediation in Low-Permeability Soil: Four Case Studies. *M. Fulkerson, C. Mowder, and M. Perlmutter.*
Mike Perlmutter (Jacobs/USA)

Replacing Pump and Treat with Sustainable In Situ Bioremediation for Chlorinated Solvent Plume in Low Permeability Matrix. *K.A. Morris, J.E. Vondracek, P. Mori, and G. Barozza.*
Kevin Morris (ERM/USA)

Using High-Resolution Characterization and Hydraulic Permeability Enhancement to Improve Remedy Performance in a Downgradient Plume. *N.T. Smith, D. Nguyen, N.L. Smith, R.A. Wymore, S. Garcia, and I. Bowen.*
Nathan Smith (CDM Smith, Inc./USA)

***What Are the Benefits of Steam-Enhanced Extraction in Low Permeability and Fractured Bedrock Settings?** *J. Baldock and J. Dinham.*
James Baldock (ERM/United Kingdom)

D7. Precipitation and Stabilization of Metals

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Arul Ayyaswami (Tetra Tech, Inc.) and Michael Lee (Terra Systems, Inc.)

Assessment of In Situ Chemical Fixation Technologies for Addressing High Arsenic Concentrations in Groundwater. *D.S. Finney and D. Williamson.*
David S. Finney (Jacobs/USA)

***Biogeochemical Stabilization of Divalent Metals: A Comprehensive Multi-Phase Treatability Study.** *R. Srirangam, A. Seech, L. Hellerich, N. Hastings, and Z. Smith.*
Ravikumar Srirangam (Evonik Active Oxygens, LLC/USA)

***Chemical Oxidation of Arsenic in Groundwater.** *C. Yi, N. Rodriguez, A. Breckenridge, and A. Chemburkar.*
Chimi Yi (ERM/USA)

***Combined Remedial Approach Based on Geochemical Stabilization of Copper in a Source Area and Dissolved-Phase Groundwater Plume.** *L. Hellerich and N. Hastings.*
Lucas Hellerich (Woodard & Curran/USA)

***Continuous-Mode Acclimation and Operation of Lignocellulosic Sulfate-Reducing Bioreactors for Enhanced Metal Immobilization from Mining-Influenced Water.** *E.M. Miranda, C. Severson, J.K. Reep, D. Hood, N. Hamdan, A.G. Delgado, S. Hansen, and L. Santisteban.*
Evelyn Miranda (Arizona State University/USA)

***Effectiveness of ZVI and Other Iron-Based Amendments for Arsenic Remediation in Highly Alkaline Groundwater.** *P. Roelen and E. Ives.*
Piper Roelen (Landau Associates, Inc./USA)

***Enhanced In Situ Bioremediation to Sequester and Immobilize Cadmium and Lead in Groundwater.** *S.J. Sorsby, A. Madison, M. Lewis, and C. Hemingway.*
Skyler Sorsby (Golder Associates/USA)

***Feasibility of a Biobarrier to Treat a Molybdenum and Vanadium Plume Core in Highly Permeable Fractured Basalt.** *M.-Y. Chu, N. Tucci, M. Einarson, L. Peterson, and T. Lewis.*
Min-Ying Jacob Chu (Haley & Aldrich, Inc./USA)

***Fluoride Removal from Groundwater through Fluorapatite Precipitation.** *D. Graves, K. Rhonehouse, A. DeSantis, and C. Herin.*
Duane Graves (SiREM/USA)

***In Situ Chemical Immobilization of Arsenic in Groundwater Using Hydrogen Peroxide and Chelated Iron.** *T. Eilber, K. Hartman, and P. Dombrowski.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

In Situ Remediation of Hexavalent Chromium: From Fungicide to Fruit Juice. *C. Lenker, A. Ayyaswami, and J. Batista.*
Carl Lenker (Tetra Tech, Inc./USA)

***In Situ Stabilization of Metals (Nickel, Cobalt and Zinc) in a Former Industrial Facility in Brazil.** *M.Q. Omote, R. Campos, A.C. Gatti, and G.D.C. Mello.*
Mariana Omote (Ramboll/Brazil)

***Introducing a Novel Amendment Technology in the Remediation of Mercury-Contaminated Soils at a Legacy Munitions Production Site.** *D. Gray, D. Griffin, J. Miller, S. Kim, W. Neese, P. Martus, and A. Mickein.*
Doug Gray (AECOM/USA)

Laboratory and Pilot Testing for Removal of Chromium and Nickel from Groundwater. *S. Dore, C. Meincke, D. Pope, R. Thomas, and J. Wasielewski.*
Sophia Dore (GHD/USA)

A Novel Formulation of Reagents for In Situ Remediation of a Commingled Plume of Metals and Chlorinated Solvents in Saprolite and Bedrock Aquifers. *S. Golaski, J. Foster, B. Hardin, P. Hicks, D. Leigh, and A. Seech.*
Stan Golaski (Rogers & Callcott Environmental/USA)

***Overcoming Numerous Site Constraints to Complete Successful Implementation of a Large-Scale In Situ Chemical Reduction (ISCR) Injection Program.** *W. Caldicott, M. Temple, P. Kakarla, T. Musser, and E. Mott-Smith.*
Will Caldicott (In-Situ Oxidative Technologies [ISOTEC]/USA)

***Progress in the Management and Securing of Mercury-Polluted Sites.** *B. Devic-Bassaget and A. Turck.*
Devic-Bassaget Boris (SUEZ Remediation/France)

Treatment of Soil and Groundwater Contaminated with Mercury and Numerous Heavy Metals Using a Mackinawite-Structured Iron Sulfide-Based Reagent. *D.P. Cassidy, T.P. McCullough, J.A. Adams, and L. Kinsman.*
Daniel Cassidy (Western Michigan University/USA)

***Treatment Process for Precipitation of Recalcitrant Organic Arsenic Species.** *W.M. Young, C. Hand, W.J. Malyk, and K. Falk.*
William M. Young (Wood/USA)

D8. Mining and Uranium Site Restoration

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Al Laase (RSI Entech) and Herb Levine (U.S. Environmental Protection Agency)

Biogeochemical Evaluation Strategies to Achieve Sustainable Long-Term Reclamation of Uranium Mines. *M. Hay, K. Ashfaque, and J. Spitzinger.*
Michael Hay (Arcadis/USA)

***Carbon Nitride/MgFe-Layered Double Hydroxide Nanocomposite: One-Pot Solvothermal Synthesis, Adsorption Performance and Mechanisms for Uranium and Cadmium.** *J.R. Koduru, L.P. Lingamdinne, J.S. Choi, G.K.R. Angaru, S.H. Lim, J.K. Yang, and Y.Y. Chang.*
Janardhan Reddy Koduru (Kwangwoon University/South Korea)

***Collaborative Development of Conceptual Remediation Portfolios for an Abandoned Uranium Mill Site.** *P. Lemke, B. Looney, and M. Kautsky.*
Peter Lemke (RSI EnTech LLC/USA)

***Development of an In Situ Leaching Technology for Extracting Residual Uranium from Remediated Soil.** *D.L. Bhojwani and G.P. Anderson.*
Deepak L. Bhojwani (Weston Solutions, Inc./USA)

Evaluating Ongoing Contaminant Sources at a Former Uranium Mill Site: Is a 100-Year Natural Flushing Timeframe Reasonable? *R.H. Johnson, R.D. Kent, and A.D. Tigar.*
Raymond Johnson (RSI EnTech, LLC/USA)

Field Hydrology and Ecology of an Engineered Cover for Uranium Mill Tailings Managed to Enhance Evapotranspiration. *W.J. Waugh, C.H. Benson, W.H. Albright, M.M. Williams, A.D. Tigar, D.L. Holbrook, C.J. Jarchow, and M. Fuhrmann.*
William J. Waugh (RSI EnTech, LLC/USA)

***Gravel Bed Reactors: Semi-Passive Water Treatment of Metals and Inorganics.** *S. Mancini, R. James, and E. Cox.*
Silvia Mancini (Geosyntec Consultants/Canada)

***Reconstructing Historical Three-Dimensional Plume Capture and Performance at an Actively Remediated Former Uranium Mill Site.** *M.S. Morse, P. Schillig, R.D. Kent, P. Lemke, and A. Laase.*
Michael S. Morse (RSI Entech, LLC/USA)

***Risks in Planning and Designing for Mine Closure.** *M. Nahir.*
Michael Nahir (Parsons Corporation/Canada)

Treatability Study for Sequestration of Uranium Using Fish Bone-Derived Hydroxyapatite at the Nuclear Metals, Inc., Superfund Site. *K.M. Belli, D. Adilman, C. Martin, J. Gillow, L. Nielsen Lammers, B. Thompson, N. Hunt, and A. Hoffmann.*
Keaton M. Belli (Geosyntec Consultants/USA)

D9. Managing Chromium-Contaminated Sites

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Will Caldicott (In-Situ Oxidative Technologies [ISOTEC]) and Sandip Chattopadhyay (U.S. Environmental Protection Agency)

A 20-Year Evaluation of Hexavalent Chromium Reduction following Sodium Dithionite Injections. *J.M. Tillotson, E. Carter, and M. Gentile.*
Jason Tillotson (Arcadis/USA)

***Adapting Treatment to Optimize Capture of a Hexavalent Chromium Plume in Perched Aquifer with a Discontinuous Silt Layer.** *P.R. Hsieh and T. Gray.*
Patrick Hsieh (Dalton Olmsted & Fuglevand/USA)

***Development of Mixed Microbial Culture Enriched with Cr(VI)-Reducing Bacteria from Soil.** *S. Mohana Rangan, I. Ibrahim, A. Sachs, A.G. Delgado, and R. Krajmalnik-Brown.*
Srivatsan Mohana Rangan (Arizona State University/USA)

***Effective Source Remediation of Hexavalent Chromium at a Chrome-Plating Operation.** *D.A. Nemetz.*
David A. Nemetz (Shannon & Wilson,Inc./USA)

EVO and Other Amendments for Hexavalent Chromium Treatment. *M.D. Lee and R.L. Raymond.*
Michael Lee (Terra Systems, Inc./USA)

Evolution of In Situ Biological, In Situ Biogeochemical and Abiotic Pilot Studies for Treatment of a Hexavalent Chromium Source Area. *S. Brubaker, G. Ng, T. Simpkin, R. Barber, A. Darpinian, E. Hauber, C. Bonney, S. Nelson, and K. Flynn.*
Sarah Brubaker (Jacobs/USA)

Historical Evaluation of In Situ Hexavalent Chromium Remediation. *J.V. Rouse and R.H. Christensen.*
Jim Rouse (Acuity Environmental Solutions/USA)

***In Situ Chemical Reduction on Metallurgical Industry Impacted by Hexavalent Chromium (Sao Paulo, Brazil).** *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, and J. Mueller.*
Sidney Aluani (SGW Services/Brazil)

In Situ Groundwater Treatment to Address Electroplating Facility Waste Discharging to the Surface. *D. Beck, L. Kozel, A. Cuellar, and P. McCall.*
David Beck (Tetra Tech/USA)

***Investigation and Remediation of a Former Hard Chrome Site with High Salinity and Unusual Geology.** *T.T. Hubbard, W. Caldicott, P. Kakarla, and Y. Chin.*
Thais Hubbard (Troy Risk, Inc./USA)

***ISCR Treatment of Hydraulically Complex Hexavalent Chromium and Chlorinated Volatile Organic Plumes.** *R.D. Desrosiers and B.D. Rach.*
Richard J. Desrosiers (GZA GeoEnvironmental, Inc./USA)

***Managing the Remediation and Redevelopment of a Chromium Plating Operation, Indianapolis, Indiana.** *B.W. Rehm and C. Gill.*
Bernd Rehm (Resolution Partners, LLC/USA)

Natural Attenuation of Hexavalent Chromium at Groundwater-Impacted Sites. *L. Hellerich, R. Hogdahl, M. Pietrucha, and D. Waite.*
Lucas Hellerich (Woodard & Curran/USA)

***Remediation of Hexavalent Chromium Contamination at a Site in Los Angeles by In Situ Chemical Reduction.** *L. Kessel and G. Cronk.*
Lowell Kessel (C.E.R.E.S. Corporation/USA)

***Remediation of Hexavalent Chromium from a Former Chrome Plating Facility Using Ferrous Sulfate and Zero Valent Iron.** *D. Beck and A. Cuellar.*
David Beck (Tetra Tech/USA)

Remediation of Hexavalent Chromium in Groundwater Using In Situ and Monitored Natural Attenuation Techniques in Five Countries. *R.L. Olsen.*
Roger Olsen (CDM Smith Inc./USA)

E1. Advances in the Analysis of Non-Target Per- and Polyfluorinated Alkyl Substances (PFAS)

Platforms Monday | Posters (*) Monday Evening
Chairs: Kavitha Dasu (Battelle) and Janice Willey (U.S. Navy)

***The Analysis for PFAS: An Evaluation of Current Methods, Proposed Methodologies and the Application of New Technologies.** *C.J. Neslund.*
Charles Neslund (Eurofins Lancaster Laboratories Environment Testing, LLC/USA)

***Analysis of Spent Carbon Media from Ex Situ PFAS Treatment Systems in Support of Disposal Decisions: Analytical Challenges and Solutions.** *H.L. Lord.*
Heather Lord (Bureau Veritas/Canada)

Development of an Equilibrium Passive Sampler for Monitoring PFAS. *B.G. Pautler, A. Sweett, F. Salim, M. Healey, J. Roberts, B. Medon, A. Pham, F. Risacher, L. D'Agostino, J. Conder, R. Zajac-Fay, P. McIsaac, A. Patterson, and R. Bitzel.*
Brent Pautler (SiREM/Canada)

***A Holding Time Evaluation of the Stability of "Forever Chemicals" in Wastewater.** *C.J. Neslund.*
Charles Neslund (Eurofins Lancaster Laboratories Environment Testing, LLC/USA)

How to Hit a Moving Target: PFAS Treatment and Analytical Advancements. *K. Pennell, M. Woodcock, K. Manz, E. Crownover, and G. Heron.*
Kurt Pennell (Brown University/USA)

***PFAS Data Validation: A Technical Perspective.** *S. Wilson, S. Denzer, and S. Cuenco.*
Scott Wilson (Laboratory Data Consultants, Inc./USA)

***PFAS, Total Organic Precursors (TOPs) and Total Organic Fluorine (TOF): When to Use One over the Other?** *T. Obal.*
Terry Obal (Bureau Veritas/Canada)

Rapid Quantitative Analysis and Suspect Screening of Per- and Polyfluorinated Alkyl Substances (PFAS) in Aqueous Film-Forming Foams (AFFFs) by Nano-ESI-HRMS. *C. Wu, Q. Wang, H. Chen, and M. Li.*
Chen Wu (New Jersey Institute of Technology/USA)

***Target and Suspect Screening of Per- and Polyfluorinated Alkyl Substances (PFAS) in Municipal Wastewater Samples by Nano-ESI-HRMS.** *C. Wu, Q. Wang, H. Chen, and M. Li.*
Chen Wu (New Jersey Institute of Technology/USA)

Total Organofluorine (TOF) Analysis by Combustion Ion Chromatography: A New Tool for Monitoring PFAS Impacts. *H.L. Lord.*
Heather Lord (Bureau Veritas/Canada)

***What, Exactly, Is Total Organofluorine, and Why Is It Important?** *N. Nigro and J. Gandhi.*
Nick Nigro (Pace Analytical/USA)

E2. PFAS and Bugs: The Search Continues

Platforms Monday | Posters (*) Monday Evening
Chairs: Laurie LaPat-Polasko (Matrix New World Engineering) and John Xiong (Haley & Aldrich, Inc.)

Aerobic Biotransformation and Biodefluorination of Fluorotelomer Carboxylic Acids (FTCAs) in Municipal Wastewater Treatment Sludge. *C. Wu, Q. Wang, H. Chen, and M. Li.*
Chen Wu (New Jersey Institute of Technology/USA)

Student Paper Winner

Anaerobic Biotransformation and Biodefluorination of Chlorine-Substituted Perfluorinated Carboxylic Acids. *B. Jin, S. Che, and Y. Men.*
Bosen Jin (University of California, Riverside/USA)

Biodegradation of PFOS with a Dehalogenating Culture in Site Soil, with and without Chlorinated Solvent Co-Contaminants *M.M. Lorah, K. He, L. Blaney, D.M. Akob, and B.P. Shedd.*
Michelle M. Lorah (U.S. Geological Survey/USA)

***Bioremediation of Per- and Polyfluoroalkyl Substances (PFAS): Is It Feasible?** *J.D. Roberts, S.D. Dworatzek, J. Webb, P. Dennis, and Y. Men.*
Jeff Roberts (SiREM/Canada)

***Biotransformation of Fluoroalkane Sulfonates by *Pseudomonas* sp. strain 273.** *D. Ramirez, Y. Xie, and F.E. Loeffler.*
Diana Ramirez (University of Tennessee/USA)

Biotransformation of Several Per- and Polyfluoroalkyl Substances by Wood-Decaying Fungi. *K. Shah, N. Merino, B. Croze, I. Kwok, Y. Gao, S.S. Kalra, M. Wang, E. Hawley, R.A. Deeb, and S. Mahendra.*
Shaily Mahendra (University of California, Los Angeles/USA)

Defluorination of Perfluorooctanoic Acid (PFOA), Perfluorooctanesulfonic Acid (PFOS), and Other Perfluoroalkyl Acids (PFAAs) by *Acidimicrobium* sp. strain A6. *S. Huang, P.R. Jaffé, and T.A. Key.*
Shan Huang (Princeton University/USA)

***High-Throughput Screening of Enzymes for PFAS Biodegradation.** *D. Saran, K. Sorenson, and M. Shepherd.*
Dayal Saran (Allonnia/USA)

***Microbial Defluorination of Unsaturated Per- and Polyfluorinated Carboxylic Acids under Anaerobic and Aerobic Conditions: A Structure Specificity Study.** *Y. Yu, S. Che, C. Ren, B. Jin, Z. Tian, S. Dworatzek, J. Webb, J. Roberts, J. Liu, and Y. Men.*
Yaochun Yu (University of Illinois at Urbana-Champaign/USA)

***Next Generation Sequencing and Microbiology of PFAS-Laden Surface Water Foams.** *B.J. Harding, M. Jury, and J. Buzzell.*
Barry Harding (AECOM/USA)

***Presence of Solid Phase Can Prevent Inhibition of *Dehalococcoides mccartyi* by Terminal PFAS.** *J.P. Hnatko, J.L. Elsey, C. Liu, L.M. Abriola, K.D. Pennell, J.D. Fortner, and N.L. Cápiro.*
Jason Hnatko (ERM/USA)

Successful Desktop and Field Bioremediation of Perfluoroalkyl Substances. *T.S. Repas, L. Mankowski, and J. Adams.*
Timothy Repas (Fixed Earth Innovations/Canada)

E3. Ex Situ PFAS Treatment: Soils/Solids and Other Waste Streams

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Mack Astorga (Allonnia) and John Santacroce (AECOM)

***A Comprehensive Approach to Characterizing and Cleaning Infrastructure Impacted with Residual PFAS.** *J.D. Anderson, J.R. Lang, P. Storch, and C.P. Theriault.*
John Anderson (Arcadis/USA)

***Determination of PFAS Removal Efficiency by a Non-Destructive Solids Treatment Unit.** *B. Vining.*
Bryan Vining (Enthalpy Analytical LLC/USA)

Ex Situ Stabilization and Solidification (S/S) of PFAS-Contaminated Materials. *D.P. Cassidy, D.M. Reeves, and M. Jury.*
Daniel Cassidy (Western Michigan University/USA)

***Firefighting Foam Transition to Fluorine Free: What Is a Practical PFAS Decontamination Objective?** *P. Storch.*
Peter Storch (Arcadis/Australia)

From Waste to Recyclable Material: New Approaches to Dealing with PFAS-Contaminated Soil. *K. Amstaetter and K. Mittag.*
Katja Amstaetter (CDM Smith Consult GmbH/Germany)

How Much Soil Do You Have: When Does Thermal Become Economical? *E. Crownover, P. Joyce, L. Stauch, G. Heron, P. Stallings, K. Pennell, and W. Woodcock.*
Emily Crownover (TRS Group, Inc./USA)

***Immobilization of PFAS Soils in a Circular Economy: The Current State of Play.** *R. Stewart.*
Richard Stewart (Ziltek Pty., Ltd./Australia)

In Situ and Ex Situ Applications of Surface Active Foam Fraction (SAFF®) Technologies for Treatment of PFAS-Impacted Media. *D.D. Nguyen, C.E. Schaefer, P. Murphy, and D. Burns.*
Dung (Zoom) Nguyen (CDM Smith/USA)

The 'Ins & Outs' of SAFF™ to Remove PFAS, Concentrate Waste for Destruction. *D.J. Burns and P. Murphy.*
David Burns (OPEC Systems P/L/Australia)

***Integrated Soil and Water Process for Treatment of PFAS-Contaminated Source Areas.** *C. Grimison and C. Morrell.*
Charles Grimison (Ventia/Australia)

***Life Cycle Analysis of PFAS Treatment in Spent Fire-Extinguishing Liquids.** *L. Soos, D. Fleming, L. Stauch, J. Buhl, and M. Cornelsen.*
Lauren Soos (TRS Group, Inc./USA)

Mobile Cleanout of AFFF and PFAS in Fire Suppression Systems. *D. Fleming, I. Godinez, L. Stauch, and E. Crownover.*
David Fleming (TRS Group, Inc./USA)

***Organically Bonded Fluorine and PFAS: A Treatment Challenge?** *J. Buhl and M. Cornelsen.*
Jurgen Buhl (Cornelsen Umwelttechnologie GmbH/Germany)

***PFAS in Soil: Alternatives in Germany.** *J. Buhl.*
Jurgen Buhl (Cornelsen Umwelttechnologie GmbH/Germany)

***PFAS Soil Washing as Pre-Treatment with SAFF and Site Destruction.** *D.J. Burns, P. Murphy, and V. Steffansson.*
David Burns (OPEC Systems P/L/Australia)

***Remediation of PFAS-Contaminated Waters and Soils by Foam Fractionation and Gas-Liquid Fluidization.** *A.L. Morrison, J. Wang, S. Wilson, V. Strezov, M.P. Taylor, R.K. Niven, P. Murphy, and D. Burns.*
Robert K. Niven (The University of New South Wales/Australia)

***Small Batch Treatment of PFAS-Impacted Industrial Wastewater.** *K. Wolohan, L. Andrews, B. Angerman, and A. McCabe.*
Katie Wolohan (Barr Engineering Co./USA)

Soil Washing: Sustainable, Cost-Effective Treatment for PFAS Source Zones. *J.A. Quinnan, C. Morrell, and N. Nagle.*
Joseph Quinnan (Arcadis/USA)

Stabilization and Reuse of PFAS-Contaminated Soil to Minimize the Cost and Carbon Footprint of Construction Works. *R. Stewart and H. Hinrichsen.*
Richard Stewart (Ziltek Pty., Ltd./Australia)

***Sustainable Firefighting System Cleanout and Rinsate Treatment Using PerfluorAd®.** *Y. Fang, D. Nguyen, L. Stauch, D. Fleming, E. Crownover, and J. Buhl.*
Yida Fang (CDM Smith/USA)

Panel Discussion—Tuesday, Track E

Should We Develop PFAS Ambient Levels: Why and How?

Moderator
Sheau-Yun (Dora) Chiang, Ph.D., PE (Wood, USA)

Panelists
Grant Trigger (Racer Trust, USA)
Richard Anderson, Ph.D. (U.S. Air Force, USA)
Jinxia Liu, Ph.D. (McGill University, Canada)
Usha Vedagiri (Wood, USA)

Pending Panelist
Kate Emma Schlosser, P.E. (New Hampshire Department of Environmental Services, USA)

Per- and polyfluoroalkyl substances (PFAS) are manmade and ubiquitous in the environment after nearly seven decades of use and release. Local, regional, national and global detections of PFAS in different environmental media are evident and the literature verifies their persistence and mobility. With the advance of analytical techniques, PFAS can now be detected at subpart per trillion levels and even parts per quadrillion range. It is anticipated that the frequency of low-level PFAS detections will rise as more PFAS monitoring is requested by different regulatory agencies. Toxicity of PFAS is not always clear in relationship to long-term bioaccumulation of trace-level PFAS. Should all levels be considered harmful? Can any detections at a site suggest the presence of PFAS sources due to firefighting activities, manufacturing and other PFAS discharges (landfill leachate, wastewater discharges, biosolids)? If not, what is the practice to differentiate site-derived impact versus ambient levels? Is the beneficial reuse of excess construction soils in jeopardy because of ubiquitous background levels of PFAS in urban areas and can land application of biosolids lead to municipal liabilities due to past and future land application of biosolids? Is compost safe to use? Can recognition of background levels of PFAS help sort out what sources of PFAS can be regulated and which cannot practically be restricted?

Many states have now adopted drinking water criteria close to or below 10 ppt for certain PFAS compounds and some states have proposed criteria as low as 0.007 ppt in water. At such levels, detections may or may not relate to site activities. Can such low criteria lead to unnecessary remediation activities following with no clear path on site closure (i.e., achieving remedial goals lower than ambient levels)? Can acceptable PFAS ambient levels be established? The current international practice for developing PFAS background levels has been constrained by inconsistent applications of regulatory 'background definition(s)' for different media and the lack of published robust assessment programs.

This panel will provide interactive discussions on the range of "background" data collected to date and whether ambient levels should and can be established. The panel will also discuss the international experience of developing ambient levels, and the practices that can be considered to provide a more rigorous evaluation of PFAS ambient levels for developing remediation goals and risk management strategy.

E4. PFAS Human Health and Ecological Risk Assessment and Toxicity

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Rosa Gwinn (AECOM) and Loren Lund (Jacobs)

Application of Toxicity-Based, Read-Across Methods for PFAS Hazard Identification in Risk Assessments. *L. Lund, N. Gowadia, and B. Selcoe.*
Loren Lund (Jacobs/USA)

***Comparative Analysis of Health-Based Screening Levels for Site Characterization of Groundwater Impacts at Various PFAS Release Sites.** *R. Arestides, J. Peters, and G. Sikri.*
Ruth Arestides (Haley & Aldrich, Inc./USA)

Contribution of Background PFAS Levels in Soils to Population Level Exposures and Effects on Environmental Risk Assessment. *H.A. Lanza and A.T. Mikkonen.*
Heather A. Lanza (CDM Smith/USA)

***Evaluation of the Development of Health-Based Drinking Water Guidance Values for Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS) in North American Regulatory Jurisdictions.** *I.J. Collins, F.C. Ramacciotti, W.A. Schew, H. Herring, and A. Kliminsky.*
Ian J. Collins (GHD/Canada)

Evaluation of the Reliability of PFAS Ecological Screening Levels. *M. Frenchmeyer, K. Dally, and D. Rigg.*
Meredith Frenchmeyer (Arcadis/USA)

***Human Health Risk Management Implications Using Predicted versus Measured PFAS in Produce near a Military Base.** *A.R. Quintin, T. Cunningham, and L. Tierney.*
Amy Quintin (Wood/USA)

***PFAS Bioaccumulation: Comparison of Field Data to Literature Values for Bioaccumulation in Fruits and Vegetables.** *R. Bodner, A. Herch, and M. Leahy.*
Robert Bodner (ERM Swiss GmbH/Switzerland)

***Protecting Human Health from Consumption of PFOS in Deer Meat.** *A.R. Quintin, A.M. Rodolakis, and M. Coveney.*
Amy Quintin (Wood/USA)

Trends and Findings: Human Blood Serum Levels of PFAS in Relation to Regulatory Target Levels. *U. Vedagiri and S. Tiscione.*
Usha Vedagiri (Wood/USA)

***Uncertainties in Estimation of Bioaccumulation Factors in Risk Assessment Studies Related to Per- and Polyfluoroalkyl Substances (PFAS) Exposure.** *A. Podder, T. Sorell, and J. Claffey.*
Aditi Podder (Brown and Caldwell/USA)

***Variability in Per- and Polyfluoroalkyl Substance (PFAS) Toxicity Values and Its Impact on Evaluating Risk.** *R.J. Kotun.*
Ronald Kotun (Tetra Tech, Inc./USA)

E5. Managing PFAS at Publically-Owned Treatment Works (POTWs)

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Dorin Bogdan (AECOM) and Peter Murphy (OPEC Systems P/L)

Assessing the Release of PFAS from Municipal Wastewater Finished Biosolids through Bench and Field Aging Experiments. *J. Hooper, C. Schaefer, L. Lee, N. Beecher and D.M. Drennan.*
Jennifer Hooper (CDM Smith/USA)

***A Case Study of PFAS in Wastewater Influent and Effluent.** *L.L. Boone.*
Lindsay Boone (Enthalpy Analytical/USA)

In-Depth Characterization of PFAS in Wastewater: A More Comprehensive Analysis. *T. McKnight, C. Neslund, and A. Patterson.*
Taryn McKnight (Eurofins Environment Testing America/USA)

***A Mass Balance Approach to Estimating Background PFAS Concentrations in California Municipal Wastewater Due to Residential and Commercial Discharges.** *S.J. Luis and M. Smith.*
Steve Luis (Ramboll/USA)

PFAS Fate and Transport at a Wastewater Treatment Plant and Collocated Sewage Sludge Incinerator. *I.C. MacGregor, B.A. Seay, A. Frank, S.S. Buehler, M. Austin, R. Krile, G.A. Fenton, J.T. Eastep, J.R. Thorn, M. Schumitz, D.M. Schumitz, D. Heiss, R. Williamson, C. Cucksey, M.W. McCauley, K. Abrams, K. Dasu, W. Fritz, L. Kammer, W.C. Anderson, and C. Adkins.*
Ian C. MacGregor (Battelle/USA)

A Statewide PFAS Assessment of Wastewater Treatment Plants in Michigan: Occurrence and Temporal Variations. *D. Bogdan.*
Dorin Bogdan (AECOM/USA)

E6. Ex Situ PFAS Water Treatment Technologies

Platforms Wednesday | Posters (*) Monday Evening
Chairs: Purshotam Juriasingani (Tetra Tech) and Dung (Zoom) Nguyen (CDM Smith)

***Comparative Evaluation of Fractionation Treatment Technology for PFAS-Impacted Landfill Leachate at Bench and Pilot Scale.** *B. Miatke, C. Theriault, J. Anderson, and D. Liles.*
Baxter Miatke (Arcadis/USA)

Effective Adsorption Removal of Polyfluoroalkyl and Perfluoroalkyl Substances (PFAS) by Reed Straw-Derived Biochar (RESCA). *N. Liu and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

Electrochemical-Based Coagulation and Foam Fractionation for PFAS Treatment. *D. Chiang, Q. Huang, S. Liang, and J. Zhou.*
Dora Chiang (Wood/USA)

***Foam Fractionation Bench-Scale Treatability for Per- and Polyfluoroalkyl Substances Removal.** *C.D. Claros, K.P. Molloy, T.A. Key, and G.L. Ghurye.*
Carlos Claros (CDM Smith/USA)

Lessons Learned through Novel Treatment of PFAS-Impacted Stormwater at a National Guard Base. *B.F. Fletcher, R. Wagner, L. Kammer, D. Close, M.A. Lordemann, J.L. Frehse, and R.J. Subasavage.*
Bryce F. Fletcher (Weston Solutions, Inc./USA)

***Lessons Learned: Design Comparison of a Municipal and Groundwater Treatment Systems Utilizing GAC for the Removal of Perfluoroalkyl Substances in Groundwater.** *B.L. Porter, M.G. Quinlan, G. Watson, M. Powers, and C. Buerkle.*
Benjamin Porter (APTIM/USA)

***New Modified Minerals for Remediation of Long- and Short-Chain PFAS Compounds in Water.** *M. Donovan, D. Wind, C. Bellona, C. Murray, J. Liu, and B. Yan.*
Michael Donovan (CETCO/USA)

Passive Treatment of PFAS-Impacted Stormwater. *J. Cuthbertson, J. McDermott, M. Shore, R. Mora, M. Ajemigbitse, and J. Collins.*
John Cuthbertson (AECOM/USA)

***Performance Evaluation of PFAS Loading/Breakthrough in GAC System.** *D. Chiang, A. Rodowa, J. Field, Q. Huang, D. Pohlmann, A. Bodour, and C. Varley.*
Dora Chiang (Wood/USA)

***PFAS Landfill Leachate Case Study: SAFF40 Commissioning in Sweden (January 2020).** *D.J. Burns, P. Murphy, and V. Steffansson.*
David Burns (OPEC Systems P/L/Australia)

PFAS Treatment with Ion Exchange: A Review of Case Histories and Best Practices for Optimal Economics and Efficiencies. *C. Swanson and F. Boodoo.*
Cathy Swanson (Purolite Corporation/USA)

Process to Separate PFAS from Groundwater Using Colloidal Gas Aphrons. *P.R. Kulkarni, H. Javed, N.W. Johnson, S.D. Richardson, and C.J. Newell.*
Poonam Kulkarni (GSI Environmental Inc./USA)

Removal of PFAS from Groundwater: Comparing an Emerging Novel Adsorbent with a Traditional Granular Activated Carbon. *C.M.G. Carpenter, E. Conti, K. Gruebel, Y. Ling, and M. Payne.*
Corey Carpenter (EKI Environment & Water, Inc./USA)

***Treating PFAS-Contaminated Landfill Leachates Using SAFF: Results from Seven Bench-Scale Trials and Two Full-Scale Projects.** *P. Murphy and H. Hinrichsen.*
Helena Hinrichsen (EnvyTech Solutions AB/Sweden)

Treatment Efficacy and Life Cycle Environmental Impacts of Anionic Resins Used in the Remediation of Per- and Polyfluoroalkyl Substances (PFAS). *A.C. Ellis, T.J. Strathmann, C.P. Higgins, C.E. Schaefer, and T.H. Boyer.*
Anderson C. Ellis (Colorado School of Mines/USA)

***Treatment of a Wide Range of PFAS-Contaminated Waters Using Only Air, Producing Only Concentrated PFAS as Waste.** *P. Murphy and H. Hinrichsen.*
Helena Hinrichsen (EnvyTech Solutions AB/Sweden)

***Ultrasonic Degradation of Per and Polyfluorinated Alkyl Substances: Power Density Effect.** *J. Kewalramani, R. Marsh, P. Juriasingani, and J. Meegoda.*
Jitendra Kewalramani (New Jersey Institute of Technology/USA)

***Use of Rapid, Small-Scale Column Tests for Evaluating PFAS Removal Using Granular Activated Carbons/Anion Exchange Resins.** *D.D. Nguyen and C.E. Schaefer.*
Dung (Zoom) Nguyen (CDM Smith/USA)

***The Versatility of Surface-Modified Clay Adsorbents for PFAS Treatment.** *A. Willett and M. Geary.*
Anna Willett (CETCO - Minerals Technologies, Inc./USA)

E7. PFAS Site Characterization

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Andrew Barton (Battelle) and James Tarr (U.S. Navy)

3M Settlement: Project 1007 PFAS Source Assessment, Fate and Transport in Interconnected Surface Water and Groundwater. *R.A. Higgins, A. Tarara, and A. Gorski.*
Rebecca Higgins (Minnesota Pollution Control Agency/USA)

***Addressing Groundwater-Surface Water Interface Considerations for Per- and Polyfluorinated Alkyl Substances at a Closed Landfill in Michigan.** *F.W. Blickle.*
Frederick W. Blickle (Horizon Environmental Consultants, Inc./USA)

Application of On-Site Analytical Methods for Supporting Large, Adaptive PFAS Site Investigations. *M. Rossi, H. Korb, C. Orth, J. Quinnan, and P. Curry.*
Michael Rossi (Pace Analytical/USA)

A Data Scientist's Look into PFAS Sites. *A. Harrington, J. Dalton, and R. Velazquez.*
Anna Harrington (Azimuth1/USA)

***Complexities in Understanding Multiple Source Areas for Per- and Polyfluoroalkyl Substances (PFAS) in Groundwater.** *G. Calderone.*
Gina Calderone (Tetra Tech/USA)

***Developing Novel Biosensors for PFAS Constituents.** *D. Saran, K. Sorenson, and A. Meyer.*
Dayal Saran (Allonnia/USA)

***Development and Testing of the Sentinel™ Passive Sampler for PFAS Measurement in Environmental Waters.** *E.W. Carter, C. Divine, P. Edmiston, H. Hartmann, C. Hefner, R. Hershberger, D. Liles, R. Prigge, K. Toth, and M. Riggle.*
Erika L. Williams Carter (Arcadis/USA)

***Distribution of PFAS in Paper Waste Residuals, Fill, Groundwater and Surface Water at a Former Paper Mill.** *M.S. Kovacich, D.S. Wilson, B.K. Loffman, D.R. Beck, M. Capodivacca, and B.W. Giese.*
Michael Kovacich (Tetra Tech, Inc./USA)

Evaluating PFAS Sample Bias in High Turbidity Environments Using Passive Sampling Methods: Pilot Studies. *K. Shields and E. Palko.*
Katelynn Shields (Integral Consulting Inc./USA)

***Implementation of Geospatial Analytical Tools to Improve Fate and Transport Evaluations and Risk Communication at PFAS Investigation Sites.** *M. Radford, M. Brown, L. Cook, and K. Murphy.*
Maggie Radford (Jacobs/USA)

Innovative Approach to Assessing Vadose Zone Transport of PFAS Using Lysimeters. *J.B. Feild, S. Gormley, R.H. Anderson, R. Krebs, M. Helton, and H. Albertus-Benham.*
James Feild (Wood/USA)

***Investigation of PFAS Impacts in Multiple Media at Portland International Airport (PDX), Oregon.** *H. Gosack.*
Heather Gosack (Apex Companies, LLC/USA)

***A Novel Real-Time PFAS Sensor with High Selectivity and Sensitivity Meeting Federal and State Regulatory Limits.** *L. Zhenglong, Y.H. Cheng, C. Chande, J.M. Torgeson, J. Schmid, C. Divine, J. McDonough, E. Houtz, R.K. Motkuri, and S. Basuray.*
Sagnik Basuray (New Jersey Institute of Technology/USA)

***Per- and Polyfluoroalkyl Substances in Products Used during Monitoring Well Installation.** *M.C. Rigby, T. Mehraban, S.J. Rembish, and K.L. LaPierre.*
Mark Rigby (Parsons/USA)

***PFAS Site Characterization in Soil and Groundwater at a California Airport.** *A.J. Lizzi and K.F. Gilbert.*
Anthony Lizzi (Ninyo & Moore/USA)

***PFAS: Smart Characterization for an Emerging Contaminant.** *P. Curry, J. Quinnan, and M. Rossi.*
Patrick Curry (Arcadis/USA)

A Screening Tool to Measure Total Extractable Organofluorine in Per- and Polyfluoroalkylated Substances (PFAS)-Contaminated Media. *K. Dasu, C. Cucksey, D. Siriwardena, P. Denen, and S. Allen.*
Kavitha Dasu (Battelle/USA)

Stratigraphic Flux-Based Approach during Adaptive Characterization at Multiple Large PFAS Plumes in Variably Complex Geologic Settings. *M. Spurlin, J. Quinnan, P. Curry, T. Darby, J. Nail, C. Shepherd, and M. Rossi.*
Matt Spurlin (ARCADIS/USA)

Traditional versus Incremental Sampling Methodology for Characterization of a Historical AFFF Release Area. *J.T. Bamer, D.N. Wintle, H.A. Lanza, R.A. Merrick, and D.D. Nguyen.*
Jeff Bamer (CDM Smith, Inc./USA)

E8. In Situ PFAS Treatment Approaches

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Daniel Cassidy (Western Michigan University) and Dora Chiang (Wood)

Anion Exchange Permeable Adsorptive Barrier (PAB) for In Situ PFAS Immobilization and Removal. *D. Lippincott, P. Hatzinger, G. Lavorgna, C. Schaefer, Z. Nguyen, F. Boodoo, and A. Danko.*
David Lippincott (APTIM/USA)

***Bench-Scale Treatability Study Results for Treatment of PFOA and PFOS Commingled with Volatile Organic Compounds in Groundwater.** *L. Cook, S. Grieco, J. Persons, and D. Gustafson.*
Laura Cook (Jacobs/USA)

***Degradation and Mechanism of Hexafluoropropylene Oxide Dimer Acid by Thermally-Activated Persulfate in Aqueous Solutions.** *X. Ding and X. Song.*
Xin Song (Chinese Academy of Sciences/China)

***Evaluation of Treatment of MGP-Impacted Soils and Groundwater Commingled with PFAS Using ISCO.** *P. Kakarla, Y. Chin, W. Caldicott, K. Paradise, and M. Pierdinock.*
Prasad Kakarla (In-Situ Oxidative Technologies [ISOTEC]/USA)

***Factors Affecting the In Situ Immobilization of Per- and Polyfluoroalkyl Substances by Activated Carbon.** *S. Gilak Hakimabadi, A. Taylor, A. Pham, N.R. Thomson, and B. Sleep.*
Seyfollah Gilak Hakimabadi (University of Waterloo/Canada)

***Field-Scale Demonstration Data Verifying Reduced PFAS Leachability over Time Following In Situ Soil Stabilization.** *J. McDonough, J. Lang, R.H. Anderson, D. Liles, and A. Baumeister.*
Jeffrey McDonough (Arcadis/USA)

***Five-Year Results from a Full-Scale In Situ Program to Treat PFAS-Impacted Groundwater Using Colloidal Activated Carbon.** *R. McGregor.*
Rick McGregor (InSitu Remediation Services Ltd./Canada)

A Greenhouse-Scale Remediation Study of PFAS and Metals in Stormwater by 10 Oregon Native Plants. *R. Hilliard, B. Parker, J. Field, S. Simonich, and T. Radniecki.*
Richard F. Hilliard (Oregon State University/USA)

***Green Remediation Benefits Lead to Multi-Phase, In Situ Activated Carbon Treatments at New York Brownfield Site.** *M. Dooley and A. Miller.*
Maureen Dooley (REGENESIS/USA)

***In Situ Ion Exchange Resin Regeneration for PFAS Treatment.** *M.L. Oster, G.W. Adamson, D.M. Stein, and J.A. Claffey.*
Jim Claffey (Brown and Caldwell/USA)

In Situ PFAS Extraction by Foam Fractionation Utilizing Multi-Azimuth High Permeability Propped Vertical Planes. *D.L. Schnell, G. Hocking, and G. Filbey.*
Deborah Schnell (GeoSierra Environmental, Inc./USA)

***In Situ PFAS Treatment Using Colloidal Activated Carbon: A Comprehensive Summary of Performance from 20+ Project Sites.** *S. Wilson and J. Birnstingl.*
Scott Wilson (REGENESIS/USA)

In Situ Remediation of PFAS-Contaminated Groundwater Using Sorptive Media in a Constructed Treatment Lagoon. *M.S. Apgar, D.G. Greene, and F.P. Wilson.*
Fernanda P. Wilson (Fishbeck/USA)

In Situ Stabilization and Solidification (ISS) to Reduce PFAS Leaching from Contaminated Soils. *D.P. Cassidy, D.M. Reeves, and M. Jury.*
Daniel Cassidy (Western Michigan University/USA)

***In Situ Thermal Treatment of Per- and Polyfluoroalkyl Substances in the Vadose Zone.** *R. Iery, B. DiGuiseppi, J. Cole, A. Struse, N. Fitzgerald, H. Rectenwald, G. Heron, E. Crownover, and L. Stauch.*
Ramona Iery (U.S. Navy/USA)

***In Situ Treatment of PFAS in Groundwater and Other Tall Tales.** *C. Nelson, D. Reynolds, Y. Shrestha, R. Spehar, A. Danko, and A. DaCruz.*
Christopher Nelson (eMinus, LLC/USA)

***Investigation and Remediation of AFFF: A Case Study.** *R.D. Desrosiers and B.D. Rach.*
Richard J. Desrosiers (GZA GeoEnvironmental, Inc./USA)

***ISS of Source Areas Contained with Per- and Polyfluorinated Alkyl Substances: Is It Possible?** *P.R. Lear.*
Paul Lear (Forgen/USA)

***Management and Remediation of AFFF-Related Per- and Polyfluoroalkyl Substances.** *T. Tyler and H. Lynch.*
Edward (Ted) Tyler (Cardno now Stantec/USA)

PFAS Reductions in Groundwater Maintained below EGLE's Proposed MCLs for 2.5 Years by Colloidal Activated Carbon Barrier at a Michigan National Guard Site. *R. Moore and P. Lyman.*
Ryan Moore (REGENESIS/USA)

Potential Enhanced Retention Processes to Manage PFAS Plumes in Groundwater. *C.J. Newell, D.T. Adamson, P.R. Kulkarni, and S.D. Richardson.*
Charles Newell (GSI Environmental, Inc./USA)

Results from Six In Situ Pilot-Scale Tests for the Treatment of PFAS-Impacted Groundwater. *R. McGregor.*
Rick McGregor (InSitu Remediation Services Ltd./Canada)

***TCH Removes PFAS from Soil: But Where Does It Go? Removal and Fate of PFAS during Thermal Soil Remediation.** *S. Eriksen, N. Ploug, A. Schultz, and S. Griepke.*
Søren Eriksen (Krüger A/S/Denmark)

F1. PFAS Fate and Transport Properties

Platforms Monday | Posters (*) Monday Evening
Chairs: Kristen Freiburger (Shannon & Wilson, Inc.) and Maureen Leahy (ERM)

***Covalent Incorporation of Fluorine into Cellular Lipids in *Pseudomonas* sp. Strain 273.** *Y. Xie, G. Chen, A.L. May, S.R. Campagna, and F.E. Loeffler.*
Yongchao Xie (University of Tennessee, Knoxville/USA)

***Critical Review of PFAS Fate and Transport: Finding Paths through the Fog of Uncertainty.** *M. Shayan and M. Harvey.*
Mahsa Shayan (AECOM Techincal Services/USA)

***Determination of Experimental Henry's Law Constants for 15 Poly- and Per-Fluoroalkyl Substances (PFAS) Using Static Headspace Analysis.** *I. Abusallout and D. Hanigan.*
Ibrahim Abusallout (CDM Smith/USA)

Evaluation of Stormwater Management Systems for the Removal of Per- and Polyfluorinated Substances. *T. Hussain, B.A. Rao, C. Gomez-Avilla, H. Zhou, D. Sackey, N. Kumar, J. Guelfo, and D.D. Reible.*
Tariq Hussain (Texas Tech University/USA)

Experimental and Modeling Investigations on Accumulation of PFAS at the Air and NAPL-Water Interface. *M. Arshadi, S. Liao, C. Liu, K.D. Pennell, and L.M. Abriola.*
Masoud Arshadi (Tufts University/USA)

How Can We Determine Site-Specific Soil Remedial Goals Which Are Realistic for PFAS? *A. Lee, S. Corish, and G. Avakian.*
Amanda Lee (Sage Environmental Services/Australia)

***In Silico Prediction of Fate and Risk-Determining Properties of Per- and Polyfluoroalkyl Substances (PFAS).** *T.L. Torralba-Sanchez, O. Dmitrenko, D.M. Di Toro, and P.G. Tratnyek.*
Tifany Torralba-Sanchez (Mutch Associates, LLC/USA)

Management and Mitigation of Per- and Polyfluoroalkyl Substances (PFAS) Leaching from Concrete. *T.A. Key, J. Mueller, P. Thai, C. Barnes, S. Porman, and J. McDonough.*
Trent Key (ExxonMobil Environmental and Property Solutions Company/USA)

A Mass-Based, Field-Scale Demonstration of PFAS Retention within AFFF-Associated Source Areas. *D.T. Adamson, C.J. Newell. P.R. Kulkarni, A. Nickerson, C. Higgins, J. Field, A. Rodowa, P.C. de Blanc, J. Popovic, and J. Kornuc.*
David T. Adamson (GSI Environmental Inc./USA)

Multi-Media PFAS Investigation at an Airport with a History of AFFF Use and a Deep Water Table, Palm Springs, California. *S. Van Glubt and D. Conley.*
Sarah Van Glubt (Haley & Aldrich/USA)

Partitioning and Storage of Per- and Polyfluoroalkyl Substances Considering Precursors and Multi-Bilayer Supramolecular Assemblies in Unsaturated and Saturated Zones of Fire Training Areas. *I. Ross.*
Ian Ross (Tetra Tech/United Kingdom)

***Per- and Polyfluoroalkyl Substances (PFAS) and Solid Matrices: Fractionation between Phases and Influences of Solid Properties on PFAS Recovery.** *O. Cawdell, J. Fox, and M. Maier.*
Oliver Cawdell (Vista Analytical Laboratory/USA)

PFAS Leaching in an AFFF-Impacted Source Area. *C.E. Schaefer, D. Nguyen, S. O'Hare, G. Lavorgna, D. Lippincott, E. Christie, J. Field, S. Shea, and C.P. Higgins.*
Charles Schaefer (CDM Smith, Inc./USA)

PFAS Retention in a Weathered Petroleum LNAPL. *C. Gurr, K. Molloy, Y. Fang, S. Fiorenza, and A. Kirkman.*
Chris Gurr (CDM Smith, Inc./USA)

***PFAS Transport in the Presence of Trapped Air Bubbles: Laboratory Column Experiments and Mixture Effects.** *J.E.F. Abraham, K.G. Mumford, D.J. Patch, and K.P. Weber.*
Kevin Mumford (Queen's University/Canada)

***Retention of PFAS in Groundwater at Freshwater/Saltwater Interfaces.** *C.J. Newell, D.T. Adamson, B.Y. Li, H. Hort, D.F. Roff, and M. Pound.*
Charles Newell (GSI Environmental, Inc./USA)

F2. PFAS Conceptual Site Model Approaches

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Kent Sorenson (Allonnia) and Rick Wice (Battelle)

***Advanced Data Analytics to Differentiate PFAS Sources and Transport Pathways.** *T. Belanger, B. Badik, D.R. Griffiths, J.T. Moore, and C.T. Gallo.*
Todd Belanger (Parsons Government Services/USA)

Assessing the PFAS Conceptual Site Model. *D. Chiang, A. Rodowa, J. Field, Q. Huang, D. Pohlmann, A. Bodour, and C. Varley.*
Dora Chiang (Wood/USA)

***Conceptual Site Model and Numerical Model for a Conceptual Drinking Water Supply Plan: Addressing PFAS Contamination in Fourteen Communities.** *J. Feild, K. Quast, S. Shaw, S. Thomas, H. Albertus-Benham, A. Dahlmeier, R. Higgins, and G. Krueger.*
James Feild (Wood/USA)

Developing a Framework for Monitored Natural Attenuation at PFAS Sites. *D.T. Adamson, C.J. Newell. P.R. Kulkarni, J.A. Connor, J. Popovic, and H. Stroo.*
David T. Adamson (GSI Environmental Inc./USA)

***Development of PFAS Fate and Transport Model Using Novel Isomers and Carbon-Chain Length Ratios.** *D. Bogdan.*
Dorin Bogdan (AECOM/USA)

Evaluation of Conservative PFAS Groundwater Plume Lengths at AFFF-Impacted Military Bases. *E. Ehret, J. Olmsted, E. Goldberg, and E. Hong Luo.*
Emma Ehret (CDM Smith, Inc./USA)

***Risk Assessment Challenges Associated with Atmospheric Transport of PFAS.** *L. Trozzolo.*
Laura Trozzolo (TRC Companies, Inc./USA)

***A Robust PFAS Fate and Transport Model for a Chrome-Plating Facility.** *J. Cuthbertson, J. Buzzell, B. Hoare, and D. Bogdan.*
John Cuthbertson (AECOM/USA)

Simulation of the Air Deposition Pathway to PFAS Groundwater Contamination. *A. Janzen, E. Christianson, D. Dahlstrom, E. Edwalds, and R. Wuolo.*
Evan Christianson (Barr Engineering Company/USA)

***Using Regulatory Classifications to Assess the Impact of Different Land Use Types on Per- and Polyfluoroalkyl Substance Concentrations in Stormwater Pond Sediments.** *J.L. Olmsted, A. Ahmadireskety, B. Ferreira Da Silva, N. Robey, J.-C.J. Bonzongo, J.A. Bowden, and J.J. Aristizabal-Henao.*
Jenny Olmsted (CDM Smith/USA)

F3. PFAS Program Management in a Rapidly Changing Regulatory Environment

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Rula Anselmo Deeb (Geosyntec Consultants) and Shalene Thomas (Wood)

***Building a Community-Specific PFAS Cycle to Inform Program Management and Communications.** *M.A. Harclerode, A. Miller, E.M. Spargimino, C. Larson, and G. Tivnan.*
Melissa Harclerode (CDM Smith, Inc./USA)

***Case Study: PFAS Management Plan for Airport Construction Projects.** *S.R. Nelson, C. Stefanelli, and K. Cappenter.*
Steve Nelson (City of Austin/USA)

A Cost-Benefit Evaluation of PFAS Drinking Water Treatment. *K. Musgrove, T. Sorell, and J. Claffey.*
Kristen Musgrove (Brown and Caldwell/USA)

***Emerging Contaminant Sampling for Sampling Sake.** *J. Good, J. Hayes, and S. Abrams.*
Joseph Good (Langan Engineering & Environmental Services/USA)

Impact of Current and Future PFAS Regulations on Manufacturing and Supply Chains. *M.C. Leahy, K. Sellers, and D. Nelson.*
Maureen Leahy (ERM/USA)

Implication of Per- and Polyflouroalkyl Substances (PFAS) and Other Emerging Contaminants to the Management of Excess Soil during Infrastructure Projects. *D.B. Smith and J. Hannaford.*
Douglas Bruce Smith (GHD/Canada)

***The PFAS Challenge and the Response of Drinking Water Systems.** *M.C. Leahy, J. Byrd, and M. Dawes.*
Maureen Leahy (ERM/USA)

***PFAS Site Characterization in an Ever Evolving Regulatory World.** *E. Palko and S. Helgen.*
Erin Palko (Integral Consulting, Inc./USA)

***Procurement and Risk Management Strategies for Large-Scale Drinking Water PFAS Removal.** *C. Parker, J. Hester, L. Clark, and R. Pope.*
Jim Claffey (Brown and Caldwell/USA)

***Remediation of PFAS-Impacted Soil: Has Technology Outpaced Regulation?** *An Australian Perspective. J. Ho.*
Jonathan Ho (AECOM/Australia)

Status of Regulatory Oversight of PFAS Contamination Investigations in the Santa Ana Region. *M. Behrooz.*
Mona Behrooz (California Regional Water Quality Control Board/USA)

***TRI-Listed PFAS: What We Know about These Chemicals.** *L. Kemp, J. Lang, and K. Onesios-Barry.*
Kathryn Onesios-Barry (Arcadis U.S., Inc./USA)

F4. PFAS Source and Forensic Considerations

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Michael Bock (The Intelligence Group) and Zachary Neigh (AECOM)

***Applicability of Diverse Investigative Techniques for PFAS Remedial Investigations and Conceptual Site Model Development.** *M.D. Machusick and M.B. Vest.*
Matthew D. Machusick (Leidos/USA)

Compound-Specific Stable Isotope Analysis to Determine Sources and Sinks of PFAS. *K. Kuntze, A. Fischer, L. Qian, S. Sühnholz, S. Kümmel, and A. Georgi.*
Kevin Kuntze (Isodetect GmbH/Germany)

***A Defensible Multiple-Lines-of-Evidence Approach for PFAS Source Identification and Liability Allocation.** *J.M. Fenstermacher, E.S. Wood, J. Pietari, and J. Wilkinson.*
Jim Fenstermacher (Ramboll/USA)

Development of a Forensics-Based Approach to Evaluating Impacts of PFAS Contamination in the Environment. *C.J. Neslund.*
Charles Neslund (Eurofins Lancaster Laboratories Environment Testing, LLC/USA)

***An Evaluation of Potential Background PFOS and PFOA Concentrations in California Groundwater.** *K.R. Robrock and B. Drollette.*
Kristin Robrock (Exponent, Inc./USA)

***Forensic Tools for Differentiating PFAS Sources.** *E.F. Houtz, A. Horneman, and J. Burdick.*
Erika Houtz (Arcadis/USA)

***Identification of Aqueous Film-Forming Foam Chemical Fingerprints from Product Concentrates.** *A.H. Love, R. Maxwell, and B. Harris.*
Adam Love (Roux/USA)

***Importance of a Comprehensive Evaluation in PFAS Source Identification and Discrimination: Products, Manufacturers and Precursors.** *S.F. Gormley.*
Sean Gormley (Wood/USA)

***LNAPL, 1,4-Dioxane and PFAS: Chemical Partitioning in a Complex Source Mass.** *P. Curry, A. Villhauer, and D. Favero.*
Patrick Curry (Arcadis/USA)

***Pattern Recognition of Large-Scale PFAS Forensic Signature Variations to Identify Emergent Properties of Environmental Fate and Transport.** *Z.R. Neigh, M. Borgens, R. Gwinn, N.A. Tavantzis, T. Amentt Jennings, N. Lancaster, and T. Bryant.*
Zachary Neigh (AECOM/USA)

***PFAS Data Forensic Analysis: California Case Study.** *M. Shayan, Z. Neigh, and R. Gwinn.*
Mahsa Shayan (AECOM Techincal Services/USA)

***PFAS Forensics: What Are Data Patterns Telling Us?** *C.S. Koll, J. Sheldon, and K. Angel.*
Caron Koll (Antea Group/USA)

***PFAS in Landfill Leachate: Extent and Patterns from Recent Studies.** *B. Chandramouli.*
Bharat Chandramouli (SGS Canada/Canada)

PFAS Signature®: A Forensic Approach for PFAS Source Tracking. *K. Dasu, L. Mullins, B. Seay, D. Friedenberg, S. Dufek, and J. Thorn.*
Kavitha Dasu (Battelle/USA)

***PFAS Sleuthing at Ambiguous Release Areas: Combining Tools and Resources for a Fuller Picture.** *C. Mitchell, R. Gwinn, B. Packer, J. Edgerly, and T. Peck.*
Claire Mitchell (AECOM/USA)

***PFNA-Dominated Groundwater Contamination Associated with AFFF Use and Manufacturing.** *S. Helgen, E. Palko, and C. Hutchings.*
Steven Helgen (Integral Consulting, Inc./USA)

***Source Identification and Management of PFAS in Stormwater.** *J. Pietari, J. Wilkinson, and E.S. Wood.*
Jaana Pietari (Ramboll/USA)

***Stack Sampling of PFAS Compounds in Air Emissions from Stationary Sources.** *W. Fritz.*
Wesley Fritz (Weston Solutions, Inc./USA)

***Statewide Assessment of Agricultural Fields Impacted by Biosolids.** *D. Bogdan.*
Dorin Bogdan (AECOM/USA)

The Unique Challenges Associated with Applying Statistical Fingerprinting to PFAS. *M.J. Bock, N. Rose, and T. Negley.*
Michael Bock (The Intelligence Group/USA)

F5. PFAS: Groundwater Treatment Case Studies

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Paul Erickson (REGENESIS) and Nathan Hagelin (Wood)

***Evaluation of Short-Chain Per- and Polyfluoroalkyl Substance Removal via Adsorptive Treatment Technologies.** *S.C. Crawford, L.B. Crawford, M.C. Marley, R. Thomas, S. Dore, F. Taylor, J. Occhialini, T. McKnight, and N. Farmer.*
Scott Crawford (XDD Environmental/USA)

Field Demonstrations of Enhanced Contact Plasma for PFAS Destruction: Lessons Learned. *S. Mededovic Thagard, T.M. Holsen, S.D. Richardson, and P.R. Kulkarni.*
Thomas Holsen (Clarkson University/USA)

***From Bench to Field: Foam Fractionation and Electrochemical Oxidation Performance on Source Zone and Plume PFAS Treatment.** *J.R. Beattie, M.A. Harclerode, M.J. Salvetti, S.F. Baryluk, D.D. Nguyen, and Y. Fang.*
Jessica Beattie (CDM Smith/USA)

***Immediate and Effective PFAS Treatment in Bedrock Aquifer at a Hazardous Site.** *G. Iosue, J. Dziekan, L. Strobridge, and C. Wade.*
Glenn Iosue (REGENESIS/USA)

Improved Longevity and Selectivity of PFAS Groundwater Treatment: Super-Fine Powdered Activated Carbon and Ceramic Membrane Filter (SPAC-CMF) System. *J.A. Quinnan, T. Reid, J. McDonough, and C. Bellona.*
Joseph Quinnan (Arcadis/USA)

***In Situ Carbon-Based PFAS Immobilization and Beyond: Case Study at a Suspected AFFF Site in Alpena, Michigan.** *L. Mankowski, J. Adams, and T. Repas.*
Leonard Mankowski (Wood/USA)

The In Situ Treatment of TCE- and PFAS-Impacted Groundwater Using Anaerobic and Sorptive Techniques. *R. McGregor and L. Benevenuto.*
Rick McGregor (InSitu Remediation Services Ltd./Canada)

***Installation, Commissioning and Operation of an Injectable In Situ Permeable Reactive Barrier to Prevent the Advection of Per- and Polyfluoroalkyl Substances at a UK Airport.** *G. Leonard, J. Shore, and S. George.*
Gareth Leonard (Regenesis/United Kingdom)

***Large Full-Scale In Situ Remediation of PFAS in Groundwater Using PlumeStop™.** *R. Mora, J. Cuthbertson, J. Buzzell, S. Krenz, R. Moore, K. Gaskill, and A. Kavanaugh.*
Rebecca Mora (AECOM/USA)

***Passive Remediation: Cleaning Up PFAS-Impacted Surface Water.** *M. Vanderkooy, C. Shores, B. Hodge, and M. McMaster.*
Matt Vanderkooy (Geosyntec Consultants/Canada)

***PFAS Groundwater Remediation Case Study: Surface-Active Foam Fractionation (SAFF40).** *D.J. Burns, P. Murphy, and J. Heffer.*
David Burns (OPEC Systems P/L/Australia)

***PFAS Treatment Pilot Study Using Granular Activated Carbon at Kennedy Space Center, Florida.** *M. Deliz, M. Jonnet, and M. Speranza.*
Mark J. Jonnet (Tetra Tech/USA)

***Successful Pilot Test for the In Situ Treatment of PFAS at an Alaska Airport.** *K. Freiburger, M. Nadel, A. Punsoni, R. Hardenburger, and C. Sandefur.*
Kristen Freiburger (Shannon & Wilson, Inc./USA)

What Is the Best Treatment Configuration for My PFAS Groundwater Treatment System? Lessons Learned from Six Years of Research and Development. *N. Hagelin, B. Newman, S. Woodard, and D. Woodward.*
Nathan Hagelin (Wood/USA)

F6. Ex Situ PFAS Destruction Technologies

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Matthew Burns (WSP) and Michael Shen (Wintersun Chemical)

***Destruction of Per- and Polyfluoroalkyl Substances (PFAS) in a Continuous Supercritical Water Oxidation Reactor.** *B.R. Pinkard, S.J. Moore, A.L. Purohit, and I.V. Novosselov.*
Brian Pinkard (University of Washington/USA)

***Destruction of PFOS: Are pH Adjustment and Ozone the Answer? How Can You Tell?** *G. Trigger, S. Dore, R. Thomas, and B. Landale.*
Beth Landale (GHD/USA)

Destructive PFAS Technology Niche and Life Cycle Costs for Water Treatment. *T.W. Macbeth, M. Harclerode, N. Pica, J. Bamer, C. Schaefer, D. Nguyen, P. Murphy, and D. Burns.*
Tamzen Macbeth (CDM Smith/USA)

Development of a Supercritical Water Oxidation Technology to Treat Per- and Polyfluoroalkyl Substances in Impacted Media. *S. Rosansky, C. Scheitlin, J. Stowe, and K. Dasu.*
Stephen Rosansky (Battelle/USA)

***Electrochemical Degradation of PFAS Mass in Redundant Stocks of AFFF Concentrate and First Flush Wash Water: Pilot-Scale Field Demonstration.** *R. Casson and S. Liang.*
Rachael Casson (AECOM/Australia)

***Electrochemical Oxidation of AFFF and PFEAs in Still Bottoms Generated after Anionic Exchange Resin Column Regeneration.** *Y. Fang, C. Schaefer, P. Meng, D. Knappe, S. Choyke, C. Higgins, and T. Strathmann.*
Yida Fang (CDM Smith/USA)

Field Demonstration of Pilot-Scale Treatment System Using Novel Sorbents and Sonolysis Reactor for PFAS Removal. *P.R. Kulkarni, B. Nzeribe, D.T. Adamson, S.D. Richardson, S. Mahendra, S. Kalra, J. Blotevogel, A. Hanson, G. Dooley, S. Maraviov, and J. Popovic.*
Poonam Kulkarni (GSI Environmental Inc./USA)

***Low Temperature Thermal Decomposition of PFAS and Amendments for Enhanced Mineralization.** *P. Koster van Groos, P. Hedman, A. Soto, E. Farquharson, C. Condee, T. Johnson, T. Myers, M. Dunlap, and A. Pham.*
Paul Koster van Groos (APTIM/USA)

PFAS Destruction in Concentrated Waste Streams with Hydrated Electrons. *J. Xiong.*
John Xiong (Haley & Aldrich, Inc./USA)

Pilot-Scale Ball Milling of PFAS-Impacted Soil from a Firefighting Training Area: Key Operational Parameters. *N. Battye, D. Patch, D. Roberts, K. Weber, L. Turner, B. Kueper, S. Marconetto, T. Lyon, and B. Harris.*
Nicholas Battye (Environmental Sciences Group/Canada)

***A Smoldering Solution to PFAS.** *D. Major, A. Duchesne, J. Brown, L. Kinsman, G. Grant, J. Gerhard, B. Harrison, D. Patch, and K. Weber.*
David Major (Savron/Canada)

***A Sustainable Treatment Train Approach for Complete Destruction of PFAS in Contaminated Water.** *N. Pica, T. Macbeth, J. Bamer, C. Schaefer, and T. Burgesser.*
Tamzen Macbeth (CDM Smith/USA)

***Ultrasonic Degradation of Per- and Polyfluorinated Alkyl Substances: Power Density Effect.** *J.A. Kewalramani, R. Marsh, and J.N. Meegoda.*
Jitendra Kewalramani (New Jersey Institute of Technology/USA)

F7. Advances in Vapor Intrusion Investigations

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Christopher Glenn (Langan) and Mark Kram (Groundswell Technologies, LLC)

***Accounting for Dilution in Large Buildings during Building Pressure Cycling for Vapor Intrusion Testing.** *K.E. Hallberg, B. Thompson, L. Levy, E. Keene, T. Lewis, E. Ross, R. MacLure, and T. Walker.*
Keri Hallberg (Jacobs/USA)

***Approximating Steady-State Conditions with the Results from Soil Gas Sampling May be Subject to Bias Depending on the Method Selected.** *L. Kessel.*
Lowell Kessel (Beacon Environmental Laboratory/USA)

***Can You See Me Now? Evaluation of Field Instruments for On-Site Vapor Intrusion Investigations.** *L. Beckley, C. Patterson, T. Lewis, and T. McHugh.*
Lila Beckley (GSI Environmental, Inc./USA)

***Evaluating Chronic Human Health Risk Using Passive Samplers.** *S. Thompson, P. Michalski, L. Coyne, and C. Kuhlman.*
Shannon Thompson (212 Environmental Consulting, LLC/USA)

***Evaluating the Potential for Mercury Vapor Intrusion.** *N.S. Wanner.*
Nate Wanner (Cox-Colvin & Associates, Inc./USA)

***Evaluation of the Vapor Intrusion Pathway at a Non-Residential Facility.** *D. Litz and S. Metz.*
Darby Litz (TRC/USA)

***Evolution of Vapor Intrusion Assessment and Expected Future Trends.** *C.A. Cox and L.A. Chilcote.*
Craig Cox (Cox-Colvin & Associates, Inc./USA)

***Gases Fluxes to Atmosphere: Soil Diffusion Parameters and Rainfall Effect.** *I. Delsarte, G. Cohen, M. Momtbrun, P. Höhener, and O. Atteia.*
Isabelle Delsarte (InnovaSol, Bordeaux INP/France)

***Identification of Preferential Vapor Intrusion Pathways: Lessons Learned from Sun Devil Manor.** *C. Holton, D. Mali, and T. McAlary.*
Chase Holton (Geosyntec Consultants, Inc./USA)

The Importance of Sanitary Sewers as the Expected Preferential Pathway in Vapor Intrusion Evaluations. *C.A. Cox.*
Craig Cox (Cox-Colvin & Associates, Inc./USA)

***Multiple Lines of Evidence in a Vapor Intrusion Pathway Investigation at a Large Former Manufacturing Building: Reducing the Mitigation Footprint.** *B. Schwie, E. Blodgett, and J. Bankston.*
Brad Schwie (Barr Engineering Co./USA)

New Understanding and Benefits by Applying Mass Discharge Test in Vapor Intrusion Studies. *T.S. Jepsen, P. Loll, S.T. Sørensen, N. Muchitsch, M. Flyhn, M. Hag, and M.G. Møller.*
Trine Skov Jepsen (Dansk Miljørådgivning A/S/Denmark)

Non-Target Chemicals as Source Area Tracers: Two Case Studies Using Freon-113 to Assist PCE/TCE/TCA Plume Delineation. *S.R. Irvin and R.H. Christensen.*
Steven Irvin (Acuity Environmental Solutions, LLC/USA)

***A Novel Electronic Canister Controller.** *P. Larsen, H.E. Tjelum, T. Poulsen, P. Loll, and K.B. Nielsen.*
Poul Larsen (Dansk Miljoradgivning A/S/Denmark)

Overcoming Shortcomings of Traditional Vapor Intrusion Sampling Approaches via Continuous Automated Monitoring and Response. *B. Hartman, M. Kram, and C. Frescura.*
Blayne Hartman (Hartman Environmental Geoscience/USA)

A Practical Protocol for Integrating Indicator and Tracer Data into Vapor Intrusion Assessments. *K.E. Hallberg, C. Lutes, L. Lund, L. Levy, D. Caldwell, T. Lewis, and T. Walker.*
Keri Hallberg (Jacobs/USA)

Re-Evaluating Vapor Intrusion "Cold Case" Sites Using Rapid, Community-Wide Indoor Air Screening. *J. Mundell, R. Walker, and S. Lisa.*
John A. Mundell (Mundell & Associates, Inc./USA)

***Subslab Soil Gas Sampling Using Various Installation Methods, Sampling Durations, and Sample Volumes: A Case Study.** *J.H. Zimmerman, A.C. Williams, B.A. Schumacher, G. Buckley, V. Boyd, C. Lutes, L. Levy, E.G. Ross, T. Walker, and R.S. Truesdale.*
John H. Zimmerman (U.S. EPA/USA)

***A Streamlined Approach to Evaluating Preferential Pathways: From Investigation to Mitigation.** *A. Friedrich and N. Weinberg.*
Aaron Friedrich (ERM/USA)

***Training Field Staff to Observe and React to the Unexpected: Conducting Quality Vapor Intrusion Investigations.** *G. Buckley, C. Lutes, L. Lund, B. Thompson, L. Levy, K. Hallberg, E. Ross, and T. Walker.*
Gwendolyn M. Buckley (Jacobs/USA)

***Transport of Volatile Organic Compounds (VOCs) Inside Sewer Systems: Modeling Approach and Field Data.** *M. Roghani, N. Rezaei, Y. Li, and K.G. Pennell.*
Mohammadyousef Roghani (Arcadis/USA)

***Transport of Volatile Organic Compounds (VOCs) to and within Municipal Sewer Systems.** *K. Rüegg, S. Pedersen, and P. Loll.*
Kaspar Ruegg (Central Denmark Region/Denmark)

***Use of Temporal-Spatial Continuous Monitoring Data to Isolate Vapor Intrusion Entry Points and Assess VOC Exposure Dynamics.** *B. Kahl.*
Brian Kahl (Farallon Consulting, LLC/USA)

***Using HAPSITE® to Protect Employee Health during Installation and Refinement of Remedial Measures.** *S.F. Calkin, A.R. Quintin, J. Besse, A.B. Rosenstein, and D.A. Moore.*
Scott Calkin (Wood/USA)

***Using Real-Time Data to Evaluate the Sewer Gas to Indoor Air Pathway.** *A. Friedrich and A. Wallace.*
Aaron Friedrich (ERM/USA)

***Vapor Intrusion Assessment Tools and Sampling Challenges that May Affect Data Quality.** *K. Krieg.*
Kesler Krieg (Pace Analytical/USA)

Vinyl Chloride (VC) in Sewer Systems: A Neglected Problem When Ensuring a Solid Risk Assessment towards Indoor Air? *W. Hyldegaard, K.B. Nielsen, A. Riishoej, E.B. Weeth, and K.B. Mortensen.*
Winnie Hyldegaard (Central Denmark Region/Denmark)

F8. Vapor Intrusion Mitigation and Effectiveness

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Vitthal Hosangadi (NOREAS, Inc.) and Michael Pound (Naval Facilities Engineering Command Southwest)

***Airflow and Pressure Differential Performance Study.** *T.E. Hatton.*
Thomas Hatton (Clean Vapor, LLC/USA)

Effectiveness of Passive Vapor Intrusion Mitigation Systems: An Examination of Key Parameters for Success. *S. Reinis, J. Schaettle, and J.F. Ludlow.*
Sigrida Reinis (Langan/USA)

Evolution and Evaluation of Composite Vapor Intrusion Barrier Systems. *P. Grant, A. Richards, and S. Weiterman.*
Peter Grant (EPRO/USA)

Exposing the Cracks: Challenges Encountered When Installing a Vapor Intrusion Mitigation System. *G.J. Graening.*
Guy Graening (GHD/USA)

Freedom! Open Source Vapor Mitigation System Monitoring. *B. Schwie, A. Janzen, and K. Eisen.*
Brad Schwie (Barr Engineering Co./USA)

***Identifying Impacts to Vapor Intrusion Mitigation Performance Using Continuous Real-Time Monitoring.** *C. Bonniwell, C. Ferguson, and K. Hoylman.*
Chris Bonniwell (Vapor Products Group/USA)

***Implementation of a SVE Remediation System in a Functioning Shopping Mall in São Paulo State, Brazil.** *G.D.C. de Mello, A.R. Cervelin, G.I. Correa, and J.R. Cury.*
Gustavo de Mello (Ramboll/Brazil)

***Innovative Sub-Slab Depressurization System Provides Advantages to the Future Use of a Former Manufactured Gas Plant Site Property.** *R. Rago, D. Kerr, and T. Hatton.*
Richard Rago (Haley & Aldrich, Inc./USA)

***Lessons Learned from Continuous VOC Monitoring during Interim Vapor Intrusion Mitigation.** *B. Thompson, K. Hallberg, L. Lund, E. Ross, and T. Walker.*
Benjamin F. Thomson (Jacobs/USA)

***Lessons Learned: Installing Vapor Intrusion Mitigation Systems in a Variety of Residential and Industrial Settings.** *E. Dulle and E. Ahlemeyer.*
John Hesemann (Burns & McDonnell/USA)

***Long-Term Results of VI Mitigation for Elevated Indoor Air VOCs and High Strength Sub-Slab VOCs at an Active Military Building at Naval Air Station North Island.** *V. Hosangadi, P. Chang, R. Mennis, and M. Pound.*
Pamela Chang (Battelle/USA)

Older Residential Homes: Sub-Slab Depressurization Lessons Learned for Successful Mitigation. *C.E. Regan.*
Catherine Regan (ERM/USA)

***Partial Building Mitigation for Vapor Intrusion at a Large Manufacturing Building Using Multiple Lines of Evidence and Lasers.** *B. Schwie, J. Bankston, and E. Blodgett.*
Brad Schwie (Barr Engineering Co./USA)

***Performance Testing of a New Vapor Barrier Comprising a Metalized Film Membrane.** *K. Thoreson and H. Nguyen.*
Kristen Thoreson (REGENESIS/USA)

***Remediation and Securing of the Sensitive Land Use on a Former Sedimentation Basin Regarding a Sugar Beet Processing Plant in Denmark.** *J. Holm, H. Løjmand, S. Agger, and T.B. Nielsen.*
Helle Løjmand (Geo/Denmark)

Sensors, the Internet, and Automated Data Collection and Response Triggering for Vapor Control and Remedial Optimization. *M.L. Kram, B. Hartman, and C. Frescura.*
Mark Kram (Groundswell Technologies, LLC/USA)

***Soil Vapor Extraction beneath an Occupied Building at an Active Military Installation.** *C. Martin, J.D. Spalding, J. Knight, T.N. Creamer, and P. Chang.*
Chris Martin (Geosyntec Consultants/USA)

Spray-Applied Membranes: Practical Considerations for Use in Vapor Mitigation Systems. *J. Nemesh.*
Joseph Nemesh (Tetra Tech/USA)

***Strategic, Pragmatic, and Iterative Interim Vapor Intrusion Mitigation in a Large Manufacturing Building.** *B. Schwie, E. Blodgett, and J. Bankston.*
Brad Schwie (Barr Engineering Co./USA)

***Strategy to Overcome Sub-Slab Depressurization System Design and Operational Challenges in an Existing Building with Sensitive Tenant Use.** *R. Henke, D. Kaiser, and R. Kovacs.*
Rachel Henke (Roux/USA)

***SVE System Optimization Strategies to Reduce the Impact of Off-Site Sources.** *M. Sederholm, C. Gale, and M. Miller.*
Maya Sederholm (Geosyntec Consultants/USA)

Time Critical Investigation, Performance Assessment, and Retrofit of a Passive Vapor Mitigation System. *J. Gal and M. O'Hearn.*
Justin Gal (Wood/USA)

***The Value and Challenges of Post-Development Sampling Programs to Confirm Effective Installation of Vapor Intrusion Mitigation Systems.** *P.J. Scaramella and J.P. Duffield.*
Peter Scaramella (GSI Environmental/USA)

F9. Vapor Intrusion Risk Assessment and Site Management

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Ryan Miller (Land Science) and Pamela Rodgers (Battelle)

***The Benefits of a Comprehensive Vapor Intrusion Assessment.** *M.V. Robinson and C. Stoker.*
Melissa Robinson (Equipoise Corporation/USA)

cVOCs in Indoor Air Due to Slab Breach with Elevated Impacted Soil Gas What to Expect? Naval Air Station North Island. *V. Hosangadi, P. Chang, R. Mennis, R. Robitaille, and M. Pound.*
Pamela Chang (Battelle/USA)

***Development of a Site-Specific Empirical Attenuation Factor for a Residential Neighborhood in California.** *S.J. Luis, Y. Zhuang, C. Serlin, S. Dergham, and P. Vargas.*
Steve Luis (Ramboll/USA)

***An Empirical Study of Environmental Factors Affecting the Vapor Intrusion Attenuation Factor.** *M.A. Lahvis and R.A. Ettinger.*
Matthew Lahvis (Shell Global Solutions/USA)

***An Evaluation of the Effects of Evolving Regulatory Framework on Vapor Intrusion Conceptual Site Model Development and Risk Identification.** *M. Bono and G. Randall.*
Matthew Bono (EnviroForensics, LLC/USA)

Fate and Transport of Vinyl Chloride at VI Sites. *B. Eklund and R. Rago.*
Bart Eklund (Haley & Aldrich/USA)

***Field and Modeling Study on Vertical Screening Distance Criteria for EDB.** *H. Luo, R. Kolhatkar, C. Gaule, and J. Watterson.*
Hong (Emma) Luo (Chevron/USA)

***Human Health Risk Assessment Considering Bioattenuation of Petroleum Hydrocarbon Vapors.** *K. Guiguer, G. Silva, R. Santos, A. Bustamante, E. Castro, and F. Cavallari.*
Gustavo Cesar Santos Silva (Arcadis/Brazil)

***I'm Stuck on You: Carryover Contamination and Other Quality Assurance Considerations for Passivated Canister Sample Results.** *T.E. McHugh and L.M. Beckley.*
Thomas McHugh (GSI Environmental, Inc./USA)

Incorporating Vapor Intrusion into Human Health Risk Assessments. *L. Lund, M. Bedan, and D. Caldwell.*
Loren Lund (Jacobs/USA)

***Indoor Air Background Levels of Volatile Organic Compounds (VOCs) and Air-Phase Petroleum Hydrocarbons (APH) in Office Buildings and Schools.** *R. Rago, A. Rezendes, J. Peters, K. Chatterton, and A. Kammari.*
Richard Rago (Haley & Aldrich, Inc./USA)

***Latest Developments in TCE Short-Term Indoor Air Standards.** *L. Trozzolo.*
Laura Trozzolo (TRC Companies, Inc./USA)

***Mitigation of Vapor Intrusion Risks under Residential Buildings Using Inclined Vapor Extraction Wells and Inclined Soil Gas Monitoring Wells.** *L.A. Araki, A. Yoshinari, R.L. Franklin, and L.A.G. Adensohn.*
Lina Akiko Araki (EBP BRASIL/Brazil)

***Review of State of Science on Potential Precluding Site Conditions for Application of Vertical Screening Distances for Petroleum Vapor Intrusion.** *I. Hers, M. Lahvis, and P. Jourabchi.*
Ian Hers (Hers Environmental Consulting, Inc./Canada)

Seeing through the Fog: Making VI Risk Decisions in the Presence of Indoor Air Sources. *C.E. Regan, R.J. Fiacco, J. Hancock, and K. Warner.*
Catherine Regan (ERM/USA)

***Stakeholder Lessons and Response Actions for Vapor Intrusion in a Large Active Military Manufacturing Building.** *T.N. Creamer, J.D. Spalding, P. Chang, J. Knight, and R. Daprato.*
Todd Creamer (Geosyntec Consultants/USA)

Tracing Radon to Evaluate VI Potential. *J.M. Buel, S. Noyes, T.J. Brent, R. Kotun, and A. Bernhardt.*
Jennifer M. Buel (Tetra Tech/USA)

Use of Volatile Organic Compound (VOC) Screening Analysis and Ventilation Assessments to Identify and Address Potential Preferential Pathways in a Large Manufacturing Building Basement. *R. Rago, B. Geissler, M. Zlotoff, D. Denyer, and S. Crowell.*
Richard Rago (Haley & Aldrich, Inc./USA)

Using a Phased Approach and Multiple Lines of Evidence to Evaluate Vapor Intrusion at Industrial Buildings with Background Sources. *M. Meyer, L. Goode, D. DeYoung, H. Dawson, and C. Cellucci.*
Lisa Goode (Geosyntec Consultants/USA)

***Vapor Intrusion Potential Control Combined with ISCR Pilot Test at an Industrial Site Impacted by Chlorinated Compounds (Rio Grande do Sul, Brazil).** *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, N. Nascimento, and J. Mueller.*
Sidney Aluani (SGW Services/Brazil)

Vapor Intrusion Risk Evaluation Using Automated Continuous Chemical and Physical Parameter Monitoring. *M. Kram, B. Hartman, C. Frescura, P. Negrao, and D. Egelton.*
Mark Kram (Groundswell Technologies, LLC/USA)

***Vapor Intrusion Risk versus Decision Making: A Los Angeles Case Study.** *Y. Rong.*
Yue Rong (Los Angeles Regional Water Quality Control Board/USA)

***Vapor Intrusion Visualizations and Mapping to Identify Sources of Contamination.** *N.S. Wanner.*
Nate Wanner (Cox-Colvin & Associates, Inc./USA)

G1. Expedite Site Closure: Innovative Strategies and Approaches

Platforms Monday | Posters (*) Monday Evening
Chairs: Michael Singletary (U.S. Navy) and Tomas Will (Directional Technologies, Inc.)

Alternative Approach to Pump and Treat/MCLs and Meeting the New EPA Accelerated Closure Directives: A Sustainable Plume Management Approach Using the Arizona WQARF Model and Adaptive Management. *S. Zachary and E. Pigati.*
Scott Zachary (Haley & Aldrich, Inc./USA)

***Application of In Vitro Soil Bioaccessibility Testing in Support of Risk-Based Cleanup Criteria for a Metals-Contaminated Site.** *A. Amendola, R. Jayasinghe, J. Coughlin, J. Palo, and M. Bergeon.*
Andrea Amendola (Golder Associates Ltd./Canada)

***Application of Multiple Remedial Techniques and Approaches at a Former Pharmaceutical Manufacturing Facility.** *D.J. Russell and C.P. Wong.*
David Russell (AECOM/USA)

***Characterization of Borrow Material Using Incremental Sampling Methodology.** *E.M. Huntley, S.J. Kretschman, and M.E. Fleming.*
Erin Huntley (WSP/USA)

***A Collaborative Stakeholder Success Story: Consent Order Termination at a Pipeline Spill in Rural Idaho.** *B.J. Harding, K. Waldron, W. Pineda, and D. Young.*
Barry Harding (AECOM/USA)

***Comprehensive Closure Strategy by Removing RCRA Listing and Enhancing the Site's Natural Dechlorination Processes.** *K. Ramanand, M. Krishnayya, J. Warburton, and J. Seracuse.*
Karnam Ramanand (Brown and Caldwell, Inc./USA)

***Evidence for Natural Attenuation as a Decisive Factor in the Closure of a Creosote-Contaminated Site.** *F. Volkering, P. Appeldoorn, M. Endel, and P. Timmermans.*
Frank Volkering (Tauw bv/Netherlands)

Facilitating Property Transfer through a Combination of Remediation and Risk Assessment: Three Case Studies. *G. Overbeeke, P. Wilson, W. Lee, L.A. Beese, M. Dotto, and P.M. Dombrowski.*
Gavin J. Overbeeke (AEL Environment/Canada)

Implementing Remediation to Support Fast Track Redevelopment of an Urban Site. *B. O'Neal and P. Dombrowski.*
Brian O'Neal (PES Environmental, an NV5 Company/USA)

Keeping the Vision: A Small Port's Journey to Comprehensive Remediation of a Wood-Treating Site. *J.C. Elliott and L. Olin.*
Joshua Elliott (Maul Foster & Alongi, Inc./USA)

***When is Mass Removal Enough: Remediation of a Chlorinated VOC Plume with DNAPL Source.** *T. Louviere, P. Hsieh, and T. Gray.*
Trevor Wade Louviere (Dalton, Olmsted & Fuglevand, Inc./USA)

G2. Practice of Risk Communication and Stakeholder Engagement

Platforms Monday | Posters (*) Monday Evening
Chairs: Wendy Condit (Battelle) and
Lisa Kammer (Weston Solutions, Inc.)

***Enhance Stakeholder Engagement with Technology-Enabled Solutions that Streamline Environmental Lifecycles.** *J. Orris and J. Ruf.*
Joshua Orris (Antea Group/USA)

***ENVIRO.wiki: Technology Transfer in the 21st Century.** *B. Yuncu, F.J. Hurley, and R.C. Borden.*
Bilgen Yuncu (Draper Aden Associates/USA)

***Fostering Stakeholder and Public Engagement through Innovative GIS and Data Collection Systems during NYC Parks Lead Testing Program.** *E. Trumpatori.*
Evan Trumpatori (Woodard & Curran/USA)

***Hazard Analysis: Remedial System Design, Installation, and Operation Down Range from a Gun Club.** *K.M. Lienau and J. Kennedy.*
Kevin Lienau (GES/USA)

***Liability Risk Management Technology Solutions for Enhancing Stakeholder Engagement and Acquisition Negotiations.** *J. Orris.*
Joshua Orris (Antea Group/USA)

***The Lost Art of Communication: A Method for Effectively Collaborating around Your Contaminant Model with a Dispersed Project Team and Stakeholders.** *S. Buchanan, S. Vanos, G. Plastow, and B. Jordan.*
Sean D. Buchanan (Seequent/USA)

Nantucket Memorial Airport PFAS Risk Communication Case Study. *N.J. Karberg, T.M. Rafter, and G.M. Nugent.*
Noah Karberg (Nantucket Memorial Airport/USA)

***Odor and Emissions Controls and Real-Time Monitoring during Remediation at Two Former Manufactured Gas Plants.** *M. Nabors, T. Steffen, and T. Boom.*
Melissa Nabors (Barr Engineering Co./USA)

***Orange County North Basin Superfund Site: Navigating the Multi-Agency Regulatory Process to Protect Groundwater Quality.** *A.N. Amini, M.S. Gee, and C.A. Nishida.*
A. Nick Amini (California Regional Water Quality Control Board/USA)

The Outrage Effect: Examining the Influence of Public Perception on Emerging Contaminants and Regulations. *D. Nelson, K. Sellers, and N. Weinberg.*
Kevin Morris (ERM/USA)

Preparing for Effective, Adaptive Risk Communication about PFAS in Drinking Water. *S. Baryluk, M. Harclerode, H. Lanza, and J. Frangos.*
Sarah Baryluk (CDM Smith/USA)

***Stakeholder Communication Contributes to Successful Implementation of TCE Bioremediation Remedy in Fractured Rock near a Residential Area.** *C.R. Johnson, J.E. Vondracek, L.A. Seus, and G. White.*
Cassie R. Johnson (EHS Support LLC/USA)

Stakeholder Engagement with a Personal Approach: A Large-Scale Vapor Intrusion Assessment Success Story. *S. Ramsden, S. Gaffin, E. Blodgett, and M. Sands.*
Sara Ramsden (Barr Engineering Co./USA)

When Flying under the Radar Isn't an Option: Effective Stakeholder Engagement to Reduce Non-Technical Risks. *C. Davis and J. Vaillancourt.*
Christine Davis (ERM/USA)

Panel Discussion—Tuesday, Track G

Monitored Natural Source Zone Depletion

Moderator
Rick Ahlers, PE (GEI Consultants, Inc.)

Panelists
Lisa Reyenga, PE (GEI Consultants, Inc.)
Dr. Natasha Sihota (Chevron)
Tom Palaia, PE (Jacobs)
Kyle Campbell, PG (Colorado Department of Labor and Employment, Division of Oil and Public Safety)
Dr. Barbara Bekins (USGS)

The science of natural source zone depletion (NSZD, also known as source zone natural attenuation) has been in practice for a decade and a half. Multiple approaches have been developed to characterize NSZD, and NSZD has been characterized and quantified at many sites. At a large number of sites, site-specific characterization of NSZD has contributed to a conceptual site model sufficient for site closure. At other sites, enough uncertainty remains regarding the long-term effects and effectiveness of NSZD to keep the sites open either for longer-term assessment of NSZD or for rejection of NSZD in favor of other remedial approaches. NSZD, like natural attenuation, is a process that is occurring whether or not it is monitored (although it may be altered by engineered remedies). Like monitored natural attenuation, there are cases where monitored natural source zone depletion (MNSZD) is necessary to reduce uncertainty and increase confidence in the assessment of the site's long-term risk profile.The goal of this panel is to propose answers to (or ways to answer) questions regarding when and where MNSZD is appropriate, including the following questions:

- What characteristics of a site would make MNSZD an alternative to be considered?
- What are the differences between initial NSZD characterization and MNSZD (e.g., measurement approaches/techniques, spatial density)?
- What approaches are or aren't suited to MNSZD?
- What additional information/research is necessary to validate approaches for MNZSD?
- How frequently should data be collected for MNSZD?
- What is an appropriate total duration for MNSZD?
- What broader questions might be answered through MNSZD?
- What additional monitoring would be necessary to answer those broader questions?

Panelists from liability owners, consultants, academia, and regulatory agencies will present their experience with NSZD and their answers to the questions above as well as answers from the audience.

G3. Heavy Hydrocarbons: Characterization and Remediation

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Robert Elliott (Remediation Products, Inc.) and Duane Guilfoil (AST Environmental, Inc.)

Case Study for BOS 200®+ Injection to Remediate Saturated Zone LNAPL at Former Marshall Iron and Metal Site in Michigan. *G. Simpson and J. Gal.*
Gary Simpson (AST Environmental, Inc./USA)

***Crude Oil Spill Site Characterization for Remedial Optimization.** *J. Knapp and J. Pesicka.*
Jacob Knapp (Antea Group/USA)

***Effect of NAPL Mixture Composition and Alteration on ^{222}Rn Partitioning Coefficients: Implications for NAPL Contamination Quantification.** *G.J.V. Cohen, M. Le Meur, M. Laurent, O. Atteia, and P. Höhener.*
Grégory Cohen (G&E/France)

Full-Scale Remediation of the Historic Wood Impregnation Facility Using On-Site Co-Composting. *O. Lhotský, R. Cervinka, and T. Cajthaml.*
Ondrej Lhotsky (DEKONTA a.s./Czech Republic)

***High Mass Hydrocarbon Sites: When NAPL Recovery Governs the Mass Removal during the Thermal Remedy.** *S. Griepke, D. Phelan, J. Galligan, and J. LaChance.*
Steffen Griepke (TerraTherm Inc./USA)

In Situ Smoldering Combustion (STAR) for the Treatment of Contaminated Soils: A Case Study at the Quendall Terminals Superfund Site. *J.D. Cole, A. Summers, G. Grant, L. Kinsman, W. Furguson, and A. Christopher.*
Jason Cole (Jacobs/USA)

***Lessons Learned from Large-Scale Applications of Smoldering Remediation.** *G.P. Grant, D. Major, G. Scholes, C. Murray, D. Liefl, L. Kinsman, W. Ferguson, and G. Sabadell.*
Gavin Grant (Savron/Canada)

Process-Based CSM of a Residual Acid Tar for Remedy Selection. *D. Collins, R. Andrachek, N. Johnson, and A. Partmann.*
David Collins (Stantec/USA)

***Rapid Closure of Heavy Crude Oil Site Using In Situ Bioremediation Technology in Low-Permeability Soil and Fractured Bedrock.** *T.A. Harp.*
Thomas Harp (Remediation Risk Reduction, LLC/USA)

***Rhamnolipids Composition for Oil-Contaminated Soil Remediation.** *A. Sanders, G. Dago, R. Lang, and G. Ren.*
Ginger Ren (Stepan/USA)

***Using Technology to Streamline Decision Making during Emergency Response Activities.** *D. Horne, T. Gustafson, and N. Kilgore.*
Trevor Gustafson (Burns & McDonnell Engineering Company, Inc./USA)

G4. Natural Source Zone Depletion

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Sam Moore (Battelle) and Charles Newell (GSI Environmental, Inc.)

Biosensor Electrodes to Estimate Rate of Biodegradation of Petroleum Hydrocarbons in the Subsurface. *K. Sra, R. Kolhatkar, J. Wilson, S. Burge, E. Taylor, K. Karimi, and T. Sale.*
Kammy Sra (Chevron Technical Center/USA)

***Combining Electrical Resistivity Tomography, CO_2 Flux Measurements, and Subsurface Media Sampling to Delineate Hydrocarbon Impacts and NSZD at a Former Fuel Terminal on Hawaii Island.** *M.R. Mathioudakis, N. Wood, N. Sihota, M. Dieckmann, and M. Wood.*
Michael R. Mathioudakis (Arcadis/USA)

***Comparison of Methods for Assessing NSZD at Paved Fuel Retail Sites.** *J. Smith, B. Koons, S. Gaito, and A. Kirkman.*
Jonathon Smith (AECOM/USA)

***Integrating Natural Source Zone Depletion into Remediation Optimization at a Long-Term LNAPL Site.** *J. Wang, N. Durant, D. Fan, M. Hanna, and W. Kunbargi.*
James Wang (Geosyntec Consultants/USA)

Long-Term Trends in Vadose Zone Gas Concentrations and Fluxes Indicate Changes in Source Zone Oil Composition and Degradation Rates. *J.J. Trost, B.A. Bekins, and G.N. Delin.*
Jared Trost (U.S. Geological Survey/USA)

***Measuring NSZD Rates at Sites with Impervious Surfaces: Are We There Yet?** *J.A. Zimbron.*
Julio Zimbron (E-Flux/USA)

A Metadata Study: Soil Type/Moisture, Seasonal and Site Location Effects on Field-Measured NSZD rates. *J.A. Zimbron and V. Doebley.*
Julio Zimbron (E-Flux/USA)

***Microbial Potentiometric Sensors to Determine the Rate of Degradation of Metabolites/Petroleum Hydrocarbons in Saturated and Unsaturated Soils.** *S.R. Burge, R.G. Burge, K.D. Hristovski, D.A. Hoffman, and E.D. Taylor.*
Scott Burge (Burge Environmental, Inc./USA)

***Natural Source Zone Depletion Estimation with Multiple Permeable Zones and Confined LNAPL.** *L.A. Reyenga and J.M. Hawthorne.*
Lisa Reyenga (GEI Consultants/USA)

***Natural Source Zone Depletion: Getting Past Perception and into Practice.** *T. Palaia and S. Park.*
Tom Palaia (Jacobs/USA)

***A Process-Based Approach to Natural and Enhanced Source Zone Depletion.** *P. Jourabchi and C. Meile.*
Parisa Jourabchi (ARIS Environmental Ltd./Canada)

A Return to the Former Guadalupe Oil Field for Assessment of NSZD. *B. McAlexander, N. Sihota, C. Smith, and J. Eichert.*
Ben McAlexander (Trihydro Corporation/USA)

***Thermal NSZD: Continuous Remote Monitoring of Natural Source Zone Depletion.** *K.L. Walker, P.R. Kulkarni, C.J. Newell, T.M. McGuire, and T.E. McHugh.*
Kenneth Walker (GSI Environmental, Inc./USA)

G5. In Situ Remediation of Petroleum Hydrocarbons

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Arnab Chakrabarti (Terraphase Engineering) and George (Bud) Ivey (Ivey International, Inc.)

Addressing Residual Hydrocarbon Concentrations Using Micron-Scale Carbon Injections at Three North Carolina Sites. *T.A. Tapley and K.E. Moon.*
Tracey A. Tapley (U.S. Army Corps of Engineers/USA)

***Application of an All-in-One ISCO Technology for the Treatment of Hydrocarbons, BTEX and MTBE at a Former Retail Petrol Station in Italy.** *A. Leombruni, M. Mueller, and B. Smith.*
Alberto Leombruni (PeroxyChem, LLC/Italy)

***Bench-Scale Test for the Chemical Oxidation of Total Petroleum Hydrocarbons.** *A.E. Fuse and R. Kumamoto.*
Allan Edrick Fuse (EBP BRASIL/Brazil)

***Combining Traditional and Advanced In Situ Remedial Methods to Address Source Petroleum Hydrocarbon Mass.** *W. Moody, J. Mueller, E. Raes, A. DeGrandis, M. Huff, E. Duggan, and M. Scalzi.*
Will Moody (Provectus Environmental Products, Inc./USA)

***Comparison of Bioeffect Screening Results for Hydrocarbons and Hydrocarbon Oxidation Products.** *B.A. Bekins, J.K. Leet, J.C. Brennan, D.E. Tillitt, I.M. Cozzarelli, J.M. Illig, and D. Martinovic-Weigelt.*
Barbara A. Bekins (U.S. Geological Survey/USA)

***Correlations between Soil Aggregate Pore Architecture to Petroleum Hydrocarbon Bioremediation Endpoints.** *A. Kundu and S. Ghoshal.*
Anirban Kundu (McGill University/Canada)

***Development of a Biogeochemical Conceptual Site Model Using Molecular Biological Tools at a Petroleum Terminal in Pasco, Washington.** *K. Waldron, F. Barajas-Rodriguez, and B. Harding.*
Francisco Barajas-Rodriguez (AECOM/USA)

***Engineering Native Microbes to Remediate Petroleum-Contaminated Sites.** *K.E. French.*
Katherine E. French (BluumBio/USA)

High Impact Petroleum Remediation for a Brownfield Redevelopment Using a Combined Remedy. *L. Zeng, A. Boodram, S. Abrams, P. McMahon, E. Adkins, and M. Burke.*
Lingke Zeng (Langan/USA)

***In Situ Bioremediation of N-methyl-2-pyrrolidone (NMP) and BTEX beneath an Active Oil Refining Facility.** *C. Riis, J.B. Nielsen, A.K. Ludvigsen, S. Dworatzek, E. Cox, and A. Przepiora.*
Charlotte Riis (NIRAS A/S/Denmark)

***In Situ Remedial Design Characterization Using the Optical Image Profiler and Membrane Interface Probe with Hydraulic Profiling (OiHPT-UV and MiHPT).** *J.V. Fontana.*
John Fontana (Vista GeoScience/USA)

Laboratory Demonstration of Successful Anaerobic Benzene, Toluene and *o*-Xylene Bioremediation Using Mixed Bioaugmentation Cultures. *C.R.A. Toth, N. Bawa, S. Guo, E.A. Edwards, J. Webb, C. Scales, K. Finney, and S. Dworatzek.*
Courtney R.A. Toth (University of Toronto/Canada)

***Leveraging Fractures to Access and Treat Recalcitrant In Situ Hydrocarbons.** *W. Slack, C. Ross, and D. Baird.*
William Slack (FRx, Inc./USA)

Long-Term Anaerobic Bioremediation of MGP Contaminants by Iron- and Sulfate-Reducing Bacteria following Combined ISCO/ISS Treatment. *D.P. Cassidy and V.J. Srivastava.*
Daniel Cassidy (Western Michigan University/USA)

***Readily Aerobic Biodegradation Capacity Observed in Deep Anaerobic Soil at a Former Gas Work Site.** *D.C. Aydin, J. Eskes, T. Grotenhuis, and H.H.M. Rijnaarts.*
Dilan Camille Aydin (Wageningen University & Research/Netherlands)

Remediation and Closure of an LNAPL-Contaminated Site Using an Innovative Three-Step Approach from Remedial Design to In Situ Remediation. *G.G. Ceriani.*
Gabriele Giorgio Ceriani (Ejlskov A/S/Denmark)

Soil and Groundwater Bioremediation Using ORC® and Organic Fertilizer at a Tidally-Influenced Site. *H. Benfield, C. Ferrell, and R. Brenner.*
Heather Benfield (Tetra Tech, Inc./USA)

***Steam It: Challenging Waste Oil NAPL Removal in Two Phases Using Steam Enhanced Extraction.** *S. Griepke, J. Wattu, A. Fortune, A. Bonarrigo, C. Rockwell, and S. Luczko.*
Steffen Griepke (TerraTherm Inc./USA)

Subgrade Biogeochemical Reactors for Treatment of Petroleum Hydrocarbon Contamination. *J. Gamlin and L. Duke.*
Jeff Gamlin (Jacobs/USA)

Use of Surfactants and Surfactant-Enhanced In Situ Chemical Oxidation (S-ISCO®) for NAPL Remediation at the Kaergaard Plantation Megasite. *L. MacKinnon, F. Solano, N.D. Durant, L.R. Bennedsen, M. Christophersen, T.H. Jørgensen, B. Germundsson, J. Muff, J.F. Christensen, and I. Holm Olesen.*
Leah MacKinnon (Geosyntec Consultants, Inc./Canada)

***Using Tracer Gases (Sulfur Hexafluoride and Helium) to Assess Radius of Influence of Biosparge Pilot Systems.** *W. Nolan and T. Andrews.*
Wyatt Nolan (Jacobs/USA)

***When It Comes to LNAPL, Activated Carbon May Replace NSZD as the Best Available Closing Technology.** *S. Noland.*
Scott Noland (Remediation Products, Inc./USA)

G6. LNAPL Recovery/Remediation Technology Transitions

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Brad Koons (AECOM) and Stephen Rosansky (Battelle)

***Automated NAPL Thickness Monitoring Using a Pressure Datalogger Deployed at a Variable Depth.** *D. Buckley, S. Gaito, and B. Koons.*
Steven Gaito (AECOM/USA)

***Cleanup of a Daylighted Gasoline Release in a Sand-Filled Tank Hold Utilizing Total Fluid Recovery and a Targeted Surfactant Flood.** *R.S. George and J.S. Poynor.*
R. Steven George (Wright Environmental Services, LP/USA)

A Compendium of Tools and Methods to Support the Optimization and Sustainable Transition of Active Remediation to Natural Attenuation. *I. Hers, P. Jourabchi, and M. Lahvis.*
Ian Hers (Hers Environmental Consulting, Inc./Canada)

***In Situ Bioremediation of Shallow Dispersed LNAPL Plume Travelling under a Major Highway.** *D. Guilfoil, G. Simpson, N. Thacker, and N. Mau.*
Duane Guilfoil (AST Environmental, Inc./USA)

***In Situ Environmental Remediation of Oil (LNAPL) Using Foam as a Blocking Agent.** *A. Vicard and O. Atteia.*
Alexandre Vicard (USA)

***Injection of High-Purity Oxygen into Groundwater to Enhance Bioremediation and Increase LNAPL Recovery at an Active Commercial Port in Southern California.** *S.M. Hash, C.L. O'Neil, and M.P. Purchase.*
Caryn Lee O'Neil (Orion Environmental, Inc/USA)

***Innovative ISCO Solution with Nanobubbles of Ozone and Hydrogen Peroxide for a Large-Scale LNAPL Remediation in a Former Industrial Facility in Brazil.** *R. Campos, M.Q. Omote, and G.D.C. Mello.*
Rafael Campos (Ramboll/Brazil)

Mining Valuable Data from Periodic LNAPL Recovery. *A. Pennington and T. Duffy.*
Andy Pennington (Arcadis US, Inc./USA)

***Modeling Approaches to Support Remedial Decisions at NAPL Sites.** *L. Stewart, M. Widdowson, R. Deeb, M. Kavanaugh, and J. Nyman.*
Lloyd Stewart (Praxis Environmental Technologies, Inc./USA)

***Permeable Reactive Barrier Installation for Prevention of LNAPL Migration into an Adjacent Surface Water Body.** *W. Wright, T. Uhler, C. Smith, D. Pizarro, and N. Thacker.*
Tim Uhler (Groundwater & Environmental Services, Inc./USA)

***Permit Quagmires to Remediation System Installation.** *H. Mishriki and D. Rowlands.*
Hannah E. Mishriki (Antea Group/USA)

***Super Hydrophobic Silane-Modified Carbon Nano Fibers/PDMS Sponge Fabrication for Oil/Water Separation.** *Y.L. Choi, G.K.R. Angaru, P.C. Ashwinikumar, J.K. Yang, and Y.Y. Chang.*
Yu-Lim Choi (Kwangwoon University/South Korea)

Transmissivity-Based Remedial Strategy Development and Implementation for a Large-Scale LNAPL Plume. *M.J. Weidmann, S. Zachary, A. Fure, and R. Keeler.*
Michael J. (Joe) Weidmann (Haley & Aldrich, Inc./USA)

***Use of Tiered Decision-Making Criteria to Assess LNAPL Recovery System Endpoints and Transition to NSZD at an Active Refinery.** *N. Babu, D. Chheda, and D. Collins.*
Naren Babu (Stantec/USA)

***Using LNAPL Transmissivity to Define LNAPL Recovery to the Extent Practicable: But Why 0.1 to 0.8 ft^2/day?** *A. Kirkman, S. Gaito, B. Koons, and J. Smith.*
Steven Gaito (AECOM/USA)

Which Technology and When? A Comparison of Natural versus Mechanical Petroleum Remediation Rates. *T. Palaia.*
Tom Palaia (Jacobs/USA)

G7. LNAPL Sites: Understanding and Managing Risks

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Ranga Muthu (Parsons) and Tom Palaia (Jacobs)

Application of a LNAPL Risk Assessment at a Complex Site: An Innovative Tool for Risk-Based Management in Brazil. *A.C. Chirmici, G.D.C. Mello, and R.G.S. Taga.*
Alyne Cetrangolo Chirmici (Ramboll/Brazil)

Holistic Evaluation Risks and Benefits of Large LNAPL and Petroleum Hydrocarbon Site Closure in California. *R. Ahlers, J. Haworth, and T. Daigle.*
Rick Ahlers (GEI Consultants, Inc./USA)

Managing Compositional-Based LNAPL Risk and Concerns at a Legacy Petroleum-Impacted Site in Phoenix, Arizona. *R. Frank, T. Palaia, and V. Gamez Grijalva.*
Robert Frank (Jacobs/USA)

***Optimization of Monitoring for Diesel-Range Organics in Groundwater.** *W. Westervelt and T. Palaia.*
Win Westervelt (Jacobs/USA)

Risk-Based LNAPL Management at the Former Willow Run Manufacturing Facility. *B. Landale, M. Rousseau, and G. Trigger.*
Matthew Rousseau (GHD/Canada)

***A Shrinking Core Model for Release of Ethanol from Ethanol Fuel Blends.** *Y. Wang and W.G. Rixey.*
Yifei Wang (University of Houston/USA)

***Unified Performance Assessment Metrics for LNAPL Management.** *R. Muthu and A. Kirkman.*
Ranga Muthu (Parsons/USA)

G8. Environmental Forensics: Site Characterization and Source Determinations

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Felicia Barnett (U.S. Environmental Protection Agency) and Sam Rosolina (Microbial Insights, Inc.)

***Application of Diagnostic Tools to Evaluate Remediation Performance at Two Petroleum Hydrocarbon-Contaminated Sites.** *K. Sra, R. Kolhatkar, and E. Daniels.*
Kammy Sra (Chevron Technical Center/USA)

Application of LNAPL Forensic Interpretations for Source Identification and Assessment of a New Release. *D. Chheda, D. Collins, and W. Xiong.*
Dhawal Chheda (Stantec/USA)

***CSIA and Other Lines of Evidence for Multiple Source Identification on a Large Tetrachloroethylene Plume.** *W.M. Takiya, F. Gutierres, and P.L. Lima.*
Willem Mitsuo Takiya (Arcadis/Brazil)

Development of a Molecular Biological Tools Framework to Support Contaminated Site Management. *T.A. Key and A. Madison.*
Trent Key (ExxonMobil Environmental and Property Solutions Company/USA)

Field Applications of Compound Specific Isotope Analysis (CSIA) at Sites Contaminated with Chlorinated Solvents. *L. Brabæk, K. Rügge, B. Grosen, K.S. Grunnet, and K. Sørensen.*
Laerke Brabaek (COWI/Denmark)

***Forensic 1,1,1-TCA Ratio Age Dating as a Defensible Methodology: Insights from Multiple Case Studies.** *B. Bond and I. Wolfe.*
Bob Bond (Langan/USA)

***Forensics for Assessing Commingled 1,4-Dioxane Plumes.** *B. Bond, I. Wolfe, K. Kelly, and M. Morris.*
Bob Bond (Langan/USA)

The Importance of CSM Verification: Implications for Source Identification, Monitoring, and Remediation. *D. Livermore and A. Frankel.*
David Livermore (Integral Consulting, Inc./USA)

***PAH Forensics with Laser-Induced PAH Fluorescence to Differentiate Co-Located Fuel Oil Spills.** *B. Bond.*
Bob Bond (Langan/USA)

***Unsaturated Zone Mass Discharge Testing Used for Refinement of the Conceptual Site Model in a Deep Groundwater Case.** *N. Muchitsch, P. Loll, M. Flyhn, and A. Toft.*
Nanna Muchitsch (DMR A/S/Denmark)

*__Use of Cross National Databases in the Pursuit of Sources to Groundwater Contamination with Pesticides.__ *T. Ljungberg, J.R. Pedersen, J. Pedersen, and S. Roost.*
Thomas Ljungberg (Central Denmark Region/Denmark)

***Using Forensic Analysis to Eliminate the Need for Remediation.** *J.R. Gee.*
John Gee (Weston Solutions, Inc./USA)

G9. Remote Sensing, Drones, and Other Unmanned Systems for Remote Monitoring and Site Assessments

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Michael Brown (Jacobs) and Bryan O'Reilly (Terraphase)

***Conceptual Site Model Development Using an Airborne Geophysical Program to Evaluate Hydro-Stratigraphy, Laramie County, Wyoming.** *P.G. Ivancie and J. Abraham.*
Paul Ivancie (Wood/USA)

In Situ ORP, Pressure, and Temperature Sensors to Better Monitor and Optimize Remedial Actions. *T.J. Simpkin and C. Mowder.*
Tom Simpkin (Jacobs/USA)

Innovation in Environmental Monitoring with Remote Sensing Techniques. *M. Rawitch.*
Michael Rawitch (Ramboll/USA)

***Innovative Unmanned Aerial Survey to Assess Impacts to a Shoreline Landfill.** *M. Meyer, D. Goddard, M. Jones, S. Rosansky, and J. Peach.*
Michael Meyer (Battelle/USA)

An Interdisciplinary Approach to Understanding and Predicting Earth Movements at Steep Pipeline Rights of Way. *F.J. DiGnazio.*
Frank J. DiGnazio (Groundwater & Environmental Services, Inc./USA)

***Inventory of Waste, Using Drone Mapping, along 557.5 Miles of a Mining Company's Railway.** *G. Setti, A. Ibiapino, A.P. Queiroz, and F. Lima.*
Ana Paula Queiroz (Waterloo Brasil/Brazil)

Large-Scale Photogrammetry and Gamma Survey via Unmanned Aerial Vehicle at a Former Uranium Mine, New Mexico. *K. Silver.*
Kirk Silver (Woodard & Curran/USA)

***Supplying Clean Drinking Water in a Rural Pennsylvania Village.** *J.L. O'Reilly, D.V. Linahan, D.M. Lyon, and T. Uhler.*
Jennifer O'Reilly (Groundwater & Environmental Services, Inc./USA)

***Using Hyperspectral Sensors on Unmanned Aircraft Systems to Characterize Mine Tailings, Bauer Tailings Site, Tooele County, Utah.** *H.S. Young, S.R. Dent, T.R. Bragdon, A. Reicks, and R.L. Olsen.*
Howard S. Young (CDM Smith/USA)

***Using Remote Sensing, LiDAR, UAVs and Thermal Infrared Imagery to Efficiently Delineate Areas of Groundwater-Surface Water Exchange in a Large Forested Area in the Eastern United States.** *L. Mastera and B. Shaver.*
Larry Mastera (ERM/USA)

G10. Using Omic Approaches and Advanced Molecular Tools to Optimize Site Remediation

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Kate Kucharzyk (Battelle) and Usha Vedagiri (Wood)

Assessment of Methyl Tert-Butyl Ether (MTBE) Degradation Using Metagenomics and Metaproteomics. *S. Fiorenza, K.H. Kucharzyk, J. Nyvall, and S. Lummus.*
Stephanie Fiorenza (ARCADIS/USA)

***Characterization and Quantification of Anaerobic Microbial Benzene, Toluene and *o*-Xylene Degraders in Three Bioaugmentation Cultures.** *C.R.A. Toth, O. Molenda, F. Luo, C. Devine, S. Guo, E.A. Edwards, S. Dworatzek, J. Webb, and P. Dennis.*
Courtney R.A. Toth (University of Toronto/Canada)

Comparison of Whole Metagenome Sequencing and 16S Amplicons to Monitor Tetracholoroethene Remediation Efforts. *R.A. Reiss and P. Guerra.*
Rebecca Reiss (New Mexico Tech [Emeritus]/USA)

***Hydrochemical Conditions for Aerobic/Anaerobic Biodegradation of Chlorinated Ethenes: A Multi-Site Assessment.** *P. Kozubek, K. Markova, R. Spanek, J. Nemecek, O. Lhotsky, and M. Cernik.*
Petr Kozubek (ENACON s.r.o./Czech Republic)

Identification of Genetic Markers for Anaerobic Dichloromethane Metabolism. *R.W. Murdoch, F. Kara Murdoch, E.E. Mack, G. Chen, M.I. Villalobos Solis, R.L. Hettich, and F.E. Loeffler.*
Robert W. Murdoch (Battelle/USA)

***Microbial Indices for Monitoring and Evaluation of Groundwater and Soil Bioremediation Processes.** *Y. Miao, M.B. Heintz, C.H. Bell, N.W. Johnson, A.L. Polasko, D. Favero, and S. Mahendra.*
Shaily Mahendra (University of California, Los Angeles/USA)

***Next Generation Sequencing Applications for Biodegradation Assessment.** *C. Brown, K. Clark, S. Rosolina, and D. Taggart.*
Casey Brown (Microbial Insights, Inc./USA)

***A Novel High-Throughput qPCR Tool for Bioremediation Monitoring.** *F. Kara Murdoch, R. Murdoch, C. Swift, and F.E. Loeffler.*
Fadime Kara Murdoch (Battelle/USA)

Quantitative Proteomics Approach for Assessing MNA in cVOC-Contaminated Aquifers. *K.H. Kucharzyk, F.K. Murdoch, F.E. Loeffler, J. Wilson, P.B. Hatzinger, J.D. Istok, L. Mullins, A. Hill, R.W. Murdoch, and M.M. Michalsen.*
Fadime Kara Murdoch (Battelle/USA)

***Shifting Perception that "Omics" Is "Too Complicated": Biogeochemical Degradation of ~15+ mg/L of 1,2-DCA to Non-Detect.** *J. Gamlin, S. De Long, S. Mahendra, and Y. Miao.*
Jeff Gamlin (Jacobs/USA)

G11. International Remedy Applications: Regulatory and Logistical Challenges of Remediation Abroad

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Souhail R. Al-Abed (U.S. EPA) and James Henderson (Corteva)

***Applying Electrical Resistance Heating in Highly Occupied Areas.** *T.L. Gomes and J. Seeman.*
Thiago Gomes (TRS Doxor/Brazil)

***Applying Electrical Resistance Heating in One Large-Scale, Low Permeable Site Contaminated by Chlorinated Compounds in China.** *W. Sun, L. Wei, and A. Small.*
Wei Sun (Beijing GeoEnviron Engineering & Technology, Inc./China)

***Bioaugmentation and Biostimulation under Different Redox Conditions on the Degradation of Chlorinated Solvents in Groundwater in a Site in Brazil.** *M.Z. Osaki and J.D. de Jesus Filho.*
Monique Zorzim Osaki (SuperBAC Biotecnology Solutions/Brazil)

***Engineering Design and Removal of TPH-Impacted Soil at an Industrial Site under Deactivation.** *T.F. Noccetti, A.A. Faria, and J.F.W. Castro.*
Talita Favaro Noccetti (EBP Brasil/Brazil)

***Evolution of Environmental Policies for Management of Contaminated Areas in Latin America.** *P. Barreto, S. Prince, J. Henderson, M. Silva, and A. Sandoval.*
Paola Barreto Quintero (Jacobs/USA)

The Evolving Regulatory Framework for Contaminated Site Management in India. *R. Srivastav and T. Simpkin.*
Rajat Srivastav (Jacobs/India)

***In Situ Remediation of Source Chlorinated VOCs at an Industrial Site in Japan.** *M.L. Lamar, C. Franzel, H. Kamemoto, R.L. Olsen, and G. Ebert.*
Michael Lamar (CDM Smith, Inc./USA)

***International Collaboration to Execute a Combined SVE/ISCR Remedy in Brazil.** *J.K. Sheldon, C. Bertolani, and T. Fernandes.*
Jack Sheldon (Antea Group/USA)

***International Collaboration to Transfer Technology Best Practices: A Practitioner's Manual on Direct Push Technology Injection for In Situ Remediation.** *J. Wang, N. Durant, D. Fan, A. Przepiora, N. Tuxen, and M. Hag.*
James Wang (Geosyntec Consultants/USA)

ISCR for Chlorinated Compound Remediation in the Tropics: What to Expect, How to Adjust, Results. *S. Aluani, C. Spilborghs, E. Pujol, F. Tomiatti, J. Mueller, W. Meese, and M. Scalzi.*
Sidney Aluani (SGW Services/Brazil)

Mercury Vapor Intrusion Investigation in a Former Lighting Manufacturing Site and Managing the Current and Future Risk. *E. Piquero, B. Selcoe, J.D. Cole, and B. Thompson.*
Jason Cole (Jacobs/USA)

***NAPL: Does It Matter? What Can We Learn from the Last 15 Years of Remediation?** *A.O. Thomas, K. Leahy, J. Baldock, and L. Wedge.*
Alan O. Thomas (ERM/United Kingdom)

***Not Even Coronavirus Could Thwart Australia's First In Situ Thermal Desorption Cleanup.** *B. Schultz, J. Fairweather, R. D'Anjou, I. Cowie, and C. Winell.*
Ben Schultz (Orica/Australia)

***Optimized Integrated Remediation of a Complex Plume with CHC/Vinyl Chloride Using a Treatment Train.** *K. Menschner and T. Reichardt.*
Karsten Menschner (CDM Smith, Inc./Germany)

***Pilot Test at an Operational Industrial Site: SVE, Air Sparging, and Ozone Injection System.** *D.D. Savio, D.S. Saunite, E. Freire, and T.F. Noccetti.*
Daniel Danezi Savio (EBP Brasil/Brazil)

***Pilot Test of Bioaugmentation and Biostimulation on the Degradation of Persistent Chlorinated Ethenes in Groundwater in a Complex Site in Brazil.** *M.Z. Osaki, B. Soares, and G.D.C. de Mello.*
Monique Zorzim Osaki (SuperBAC Biotecnology Solutions/Brazil)

***Rats for Detection and Delineation of Hydrocarbon-Impacted Soil.** *D.C. Segal, C. Fast, and C. Cox.*
Daniel Segal (Chevron/USA)

***Sodium Persulfate with Integrated Activator Destroys >99% of Trichlorethylene in 5 Weeks at a Manufacturing Facility in Holland.** *M. Mueller and H. Opdam.*
Mike Mueller (PeroxyChem, LLC/Austria)

***The Trend of Bioremediation and the Prospects of Molecular Biological Tool (MBT) Application in Taiwan.** *H.C. Chien, S.H. Huang, I.H. Chen, Y.T. Wu, G.Y. Huang, Y.C. Su, and B.N. Wang.*
Bing-Nan Wang (Sinotech Envrionmental Technology, LTD/Taiwan)

***Urban Regeneration: Managing Complex Social and Regulatory Challenges in Chile.** *J. Henriquez, R. Victor, and J.P. Davit.*
Raul Victor (Golder Associates/Chile)

Using the MIP System with Pre-Probed and Grouted Holes to Enable DNAPL Source Delineation in Consolidated Granite Till. *N. Larsson, A.G. Christensen, F. Nilsson, and E. Bergstedt.*
Nicklas Larsson (NIRAS/Sweden)

H1. Improvements in Site Data Collection, Data Management, and Data Visualization

Platforms Monday | Posters (*) Monday Evening
Chairs: Kira Lynch (U.S. EPA) and Nicklaus Welty (Arcadis)

***3-D Data Visualization and Semi-Analytical Modeling of CVOC Concentration Trends in a Large Plume.** *T.V. Adams and T. Zei.*
Timothy Adams (Roux Associates, Inc./USA)

Advanced Geostatistics to Optimize Sampling Approach for Contaminated Soil Investigations and Remediations. *K. Wyatt, M. Beck, and M. Tonkin.*
Kylah Wyatt (Parsons Corporation/USA)

Applying the CRATES and ORIGEN Web-Based Tools to Visualize and Interpret Environmental Data. *C.D. Johnson, V.L. Freedman, P.D. Royer, T.P. Franklin, J.J. Garza, C.B. Woodford, J.Q. Wassing, J.L. Fanning, V. Molina, E.J. Engel, J.P. Loftus, X. He, and P.K. Tran.*
Christian Johnson (Pacific Northwest National Laboratory/USA)

***Complex Impacted Soil Management Visualization for Real-Time Site Operations.** *W. Nolan, T. Kremmin, A. Biczok, W. Andrae, and T. Andrews.*
Wyatt Nolan (Jacobs/USA)

***Construction and Validation of a Universal Mid-Infrared Soil TPH Calibration for Small-Scale Remediation Activities.** *S. Manning, C. Smith, and T. Zhang.*
Sean Manning (Ziltek Pty Ltd/Australia)

***Data Dashboards as a Digital Tool for Groundwater Remediation: A Case Study from Brazil.** *J. Vilar, A. Bustamante, G. Andrade, A. Miranda, B. Rocha, and A. Martinho.*
Julio Vilar (Arcadis/Brazil)

Incorporating 3-D Visualization of Hydrogeology and Environmental Data Greatly Enhances Communication of Complex Concepts. *J. Youngerman, N. Cass-Hausler, and G. Christians.*
Jean Youngerman (Brown and Caldwell/USA)

***Leveraging 3-D Visualization and Animation Technology to Build a Useful Conceptual Site Model and Design a Cost-Effective Remediation System.** *J. Depa and R. St. John.*
James Depa (Terracon/USA)

***Leveraging Innovative GIS and Data Collection Systems to Test for Lead in NYC's Drinking Fountains.** *E. Trumpatori.*
Evan Trumpatori (Woodard & Curran/USA)

***Mass Estimate for Complex Contaminated Sites.** *P. Rasouli, L.A. Taylor, and C. Stubbs.*
Pejman Rasouli (Ramboll/USA)

Mobile Form Technology and Data Analytics Dashboards for Investigation and Remediation. *C. Crozier.*
Carrie Crozier (Parsons/USA)

Multi-Source Conceptual Models: New 3-D Frontiers Supporting the Remediation Strategies of Contaminated Sites. *P. Ciampi, C. Esposito, M. Petrangeli Papini, and G. Cassiani.*
Paolo Ciampi (University of Rome "La Sapienza"/Italy)

***Navigating the Digital Transformation of Data Collection, Management and Visualization.** *D. De Courcy Bower, M. Eschbaugh, A. Roberts, and S. Wright.*
Meghan C. Eschbaugh (ERM/USA)

Remediation 2.0: Using the Internet of Things on Remediation Projects. *N.R. Welty, J. Gallegos, and C. Hollister.*
Nicklaus Welty (Arcadis/USA)

***Remedy Optimization through Use of a 3-D Model.** *R. Meinke, M. Piepenbrink, K. Mueller, and K. Schnell.*
Robert Meinke (ERM/Germany)

Standardization and Governance: The Key to Digital Transformation of Boring Logs. *R.J. Stuetzle and L. Austrins.*
Robert J. Stuetzle (Dow Chemical Canada ULC/Canada)

State of the Practice: Immersive Technologies in Environmental Remediation. *A. Yanites, N. Welty, and J. Horst.* Allison Yanites (Arcadis/USA)

***Superfund Site Case Studies: Data Visualization for Reduced Project Costs and Enhanced Communication.** *M. Palmer and M. Packard.* Mike Palmer (de maximis, inc./USA)

Update on Soil Processing and Subsampling for Incremental Sampling Methodology. *M.L. Bruce, J.L. Clausen, and W.E. Corl.* Mark Bruce (Eurofins Environment Testing America/USA)

***Web-Based Application for Real-Time Water Level and Well Inspection Documentation.** *S. Blanchard and J. Peeples.* Scott Blanchard (T&M Associates/USA)

***Web-Based Geospatial Viewer and Data Tracking Applications to Support Rapid Soil Vapor Survey Site Characterization.** *E.M. Chapa and J.P. Latham.* Michael Chapa (Weston Solutions, Inc./USA)

H2. Conceptual Site Models: Improvements in Development and Application

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Timothy Goist (WSP) and Benjamin Grove, Jr. (Stantec)

***Adapting Conceptual Site Models to Address Groundwater Monitoring and Remediation Strategies Under Drought Conditions.** *J.S. Aiken, R.J. Davis, and D.M. Levitan.* James Aiken (Barr Engineering Co./USA)

***Challenges of Implementing ISM Soil Sampling for Human Health and Ecological Remedial Investigation at a Former Metals Refinery.** *S. Hellekson and J. Robinson.* Stacey Hellekson (Woodard & Curran/USA)

***A Conceptual Site Model Application to Understanding Groundwater Contamination Anomalies at the City Industries Superfund Site, Winter Park, Florida.** *W.N. O'Steen.* William O'Steen (U.S. Environmental Protection Agency/USA)

***Conventional Investigation + High Resolution: Correct Use of Tools to Decipher a High Complexity Hydrogeological Model.** *N. Nascimento, S. Aluani, F. Tomiatti, R. Moura, G. Siqueira, and S. Spilborghs.* Natália Cristina Nascimento (SGW Services Engenharia Ambiental Ltda./Brazil)

***Data Management Strategies for Continuously Improving a Megasite Conceptual Site Model.** *R.M. Roedel, M. Sousa, E. Galvão, J. Werlang, and E. Fontoura.* Rosialine Marques Roedel (CETREL SA/Brazil)

Development and Testing of Three Alternate CSMs: Things Are Not Always What They First Seem. *P.L. Lepczyk, M.D. Colvin, and D.G. Greene.* Peter Lepczyk (Fishbeck/USA)

***Enhanced Site Characterization and Simulation Using Multiomics Field Data.** *R. Versteeg, R.L. Rubinstein, and A.D. Peacock.* Roelof Versteeg (Subsurface Insights/USA)

Evaluation and Definition of Non-Aqueous Phase Materials Using a Multiple Lines of Evidence Approach. *P. Barreto, C. Mowder, M. Sherrier, W. LeFevre, J. Henderson, P. Rego, and A. Ansara.* Paola Barreto Quintero (Jacobs/USA)

***Furthering Hydrologic Characterization by Visual Mapping of Injection Data.** *A. Kavanagh and D. Davis.* Andrew Kavanagh (REGENESIS/USA)

***Geologic Controls on Vadose Zone Transport in Alluvial Settings.** *C.S. Alger and C. Steedman.* Christopher Alger (Terraphase Engineering/USA)

Groundwater Plume Analytics® Tools for Improved Conceptual Site Models. *J.A. Ricker and D.C. Winchell.* Joseph Ricker (WSP USA, Inc./USA)

High-Resolution Site Characterization to Update a Conceptual Site Model and Optimize In Situ Remediation of Arsenic and Hydrocarbons. *S. Aube, J. Chambert, P. Feshbach-Meriney, and G. Ulrich.* Stephane Aube (Parsons Corporation/USA)

How to Combine Legacy Datasets with HRSC to Develop Flux-Based CSMs. *R. Stuetzle, J. Nail, N. Welty, and M. Klemmer.* Robert J. Stuetzle (Dow Chemical Canada ULC/Canada)

***Identifying a Secondary Source of VOCs, through Passive Vapor Sampling, for Reuse of a Beverage Industry.** *A.P. Queiroz, L. Freitas, G. Setti, and R. Pajewski.* Ana Paula Queiroz (Waterloo Brasil/Brazil)

The Importance of Preliminary Assessment in the CSM: A Case Study. *C.D. Maluf and C.V. Witier.* Cristina Deperon Maluf (Ambscience Engenharia Ltda/Brazil)

***Incremental Sampling Methodology Case Study: Improved Characterization and Cleanup through the Application of ISM following Discrete Sample Collection and Use of Weighted 95UCL Calculation.** *A. Bihler, G. Haet, and J. Brodersen.* Jason Brodersen (Tetra Tech Inc./USA)

Is This Plume Really Ours? Revisiting a 30-Year Old Site Conceptual Model. *D. Quafisi, A. Fure, E. Bishop, A. Murphy, D. Putz, T. West, E. Clement, S. Barker, A. Kunkel, and J. Smith.* Dimitri Quafisi (Haley & Aldrich, Inc./USA)

***The Predictive Power of Sequence Stratigraphy: Developing a Conceptual Site Model for Groundwater from Sparse Data.** *M.R. Shultz, C.P. Plank, and J. Gillespie.*
Mike Shultz (Burns & McDonnell/USA)

***Redeveloping CSM with SMART Characterization® and Stratigraphic Flux™.** *W.M. Takiya, F. Gutierres, and P.L. Lima.*
Willem Mitsuo Takiya (Arcadis/Brazil)

Reducing Estimated DNAPL Volume by 90% with HRSC. *N. Welty, J. Wright, and F. Payne.*
Nicklaus Welty (Arcadis/USA)

Reevaluating the Conceptual Site Model of a Shoreline Chlorinated Solvent Plume in Groundwater. *C. Cellucci, M. Meyer, and D. DeYoung.*
Carlotta Cellucci (U.S. Navy/USA)

***Suite of Innovative Diagnostic Tools Used to Assess Deep Fractured Bedrock Impacts and Support Remedial Design.** *J. LeClair, B. O'Neill, and M. Wade.*
Judith M. LeClair (Brown and Caldwell/USA)

Three-Dimensional Geologic and Contaminant Modeling to Support Site Investigation and Remedial Design. *M. Tulich and T. Martin.*
Mandy Tulich (Integral Consulting, Inc./USA)

Three-Dimensional Visualization and Volumetric Analysis to Update the Conceptual Site Model for a Former Uranium Mill Site. *R.D. Kent.*
Ronald D. Kent (RSI EnTech, LLC/USA)

***Use of Geochemical and Hydraulic Analyses to Investigate and Confirm Counterintuitive Groundwater Migration Pathways and Discharge Areas at a Former MGP Site.** *J.M. Marolda, R.L. O'Neill, and S. Stucker.*
James Marolda (Brown and Caldwell/USA)

Using Advanced Tools and Methods to Develop a Geochemical Model for Remedy Selection of Complex Mixtures of Chlorinated and Nitrated Hydrocarbons. *S. Mancini, S. Kraus, J. Rayner, G. Wealthall, J. Henderson, E. Mack, and L. Ribeiro.*
Silvia Mancini (Geosyntec Consultants/Canada)

***Where'd That Come From? Differentiating Soil Gas, Sewer Gas, and Outdoor Air in Vapor Intrusion.** *N.S. Wanner.*
Nate Wanner (Cox-Colvin & Associates, Inc./USA)

H3. Advanced Geophysics and Remote/Direct Sensing Tools and Techniques

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Lee Slater (Rutgers University Newark) and John Sohl (Columbia Technologies, LLC)

***Application of an Iterative Source Localization Strategy at a Chlorinated Solvent Site.** *E. Essouayed, O. Atteia, and N. Guiserix.*
Elyess Essouayed (Groupe Renault/France)

Application of Nuclear Magnetic Resonance Logging to Develop a Three-Dimensional Model of Aquifer Hydraulic Conductivity to Support Evaluation of Remedial Alternatives. *J.N. Dougherty, T. Cook, M. Gamache, K. Heisen, T. Macbeth, W. Treadway, M. Goldberg, and M. Simon.*
John Dougherty (CDM Smith Inc./USA)

***Capitalizing on Downhole Nuclear Magnetic Resonance Surveys in Remedial Design.** *S. Cadle, J. Jacobs, A. Crockett, D. Grady, and J. Dabbs.*
Sonya Cadle (Tetra Tech, Inc./USA)

***Designing a Treatment Solution Using High Density Site Characterization.** *A.R. Taylor and J.R. Lanier.*
Jeffrey R. Lanier (SME/USA)

Development of a Borehole Electrical Technology for Assessing Diffusion and Dual Domain Mass Transfer. *R. Iery, L. Slater, D. Ntarlagiannis, S. Falzone, F. Day-Lewis, C. Johnson, and N. Terry.*
Ramona Iery (U.S. Navy/USA)

***EPA Method ATP 16130 and GC-MS/MS Approaches for Chlorinated POP Analysis.** *B. Chandramouli and M.C. Hamilton.*
Bharat Chandramouli (SGS Canada/Canada)

Field Testing of a Direct Push Deployed NMR Logging System for Geohydrologic Site Characterization. T.*M. Christy, E. Grunewald, and W. McCall.*
Thomas Christy (Geoprobe Systems, Inc./USA)

***Fluorescence Tracing Techniques Successfully Applied for Wellhead Protection and DNAPL Sources Identification.** *M.H. Otz, I. Otz, T. Gubler, and T.M. Hurd.*
Todd M. Hurd (TMH Tracing/USA)

The Grindsted Plume: Screening for Main Discharge Zones of a Large and Complex Plume with Chlorinated Ethenes and Pharmaceuticals to Grindsted Stream. *D. Harrekilde, B.B. Thrane, J.K. Pedersen, L. Dissing, P.L. Bjerg, M.M. Broholm, C.B. Ottosen, and H. Draborg.*
Dorte Harrekilde (Ramboll/Denmark)

***High-Resolution Contaminant Profiling to Support a Reduced Scope of Remediation at the Cristex Drum Superfund Site, Oxford, North Carolina.** *W.N. O'Steen, J.T. Ferreira, and N. Atashi.*
William O'Steen (U.S. Environmental Protection Agency/USA)

High-Resolution Delineation of Facility-Scale Subsurface Heterogeneity by Hydraulic and Geophysical Tomography. *C.M.W. Mok, T.-C.J. Yeh, W.A. Illman, and B.A. Carrera.*
Chin Man Bill Mok (GSI Environmental Inc./USA)

High-Resolution Redox Monitoring to Evaluate and Optimize the Remediation of Redox-Sensitive Solutes in Dynamic Hydrogeologic Environments. *C.D. Wallace and M.R. Soltanian.*
Corey Wallace (Geosyntec Consultants/USA)

***High-Resolution Site Characterization at Vertically Fractured Bedrock Sites.** *T. Halihan, S.W. McDonald, and K. Spears.*
Todd Halihan (Oklahoma State University/USA)

***Hydrogeologic Mapping of Fluorescent Dye Transport Processes from TCE Source Area through Fractured Bedrock Aquifer.** *J. Drummond, K. Fox, C. Vallone, R. Bower, and B. Rundell.*
Jesse Drummond (EA Engineering, Science, and Technology, Inc., PBC/USA)

Improving Groundwater Contamination Investigations Using the tTEM Mapping Technique. *J. Simensen, F. Jørgensen, C.B. Nielsen, and A. Edsen.*
Jesper Simensen (Central Denmark Region/Denmark)

Investigation of Contaminant Leakage from Mink Mass Graves and Risk to Groundwater and Surface Water. *B.B. Thrane, D. Harrekilde, J.S. Jensen, and C. Moosdorf.*
Britt Boye Thrane (Ramboll/Denmark)

Novel Applications of the Hydraulic Profiling Tool and Tandem Electrical Conductivity Logs for Site Investigation and Remediation. *J.V. Fontana, W. McCall, and A. Kirsch.*
John Fontana (Vista GeoScience/USA)

***A Novel Approach to Characterize a Chlorinated Solvents Plume beneath an Extensive Wetland System.** *P.L. Lepczyk and C.A. Weber.*
Peter Lepczyk (Fishbeck/USA)

***Nuclear Magnetic Resonance Geophysics for High-Resolution Site Characterization, CSM Refinement, and Remedial Design Optimization.** *B.D. Cross.*
Bradley Cross (ERM/USA)

***Nuclear Magnetic Resonance Geophysics for Refined Hydrogeologic CSM Development.** *E.M. Chapa.*
Michael Chapa (Weston Solutions, Inc./USA)

Recent Developments in Nuclear Magnetic Resonance Logging for Site Characterization. *G. Liu, S. Knobbe, J. Butler, E. Grunewald, D. Walsh, and R. Knight.*
Gaisheng Liu (Kansas Geological Survey/USA)

***Review of Conceptual Site Model (CSM) and Remediation Approach after High-Resolution Site Characterization Using Combined OIP and HPT Technologies.** *M. Evald, S. Souto, C. Malta-Oliveira, M. Saturnino, and F. Carvalho.*
Mateus Knabach Evald (FINKLER Ambiental/Brazil)

***Subsurface Temperature Monitoring in In Situ Thermal Remediation Using Fiber Optic Sensing Technology.** *H. Alemohammad, K. Joseph, and D. Alguire.*
Doug Alguire (AOMS Technologies/Canada)

***Technology Post Audit of High-Resolution Site Characterization Data for Successful Remediation.** *S. Frandsen, T. Halihan, and S.W. McDonald.*
Samantha M. Frandsen (Aestus, LLC./USA)

Use of Hyperspectral Imaging to Detect Trichloroethylene and Per- and Polyfluoroalkyl Substances in the Environment. *M.D. Lewis, L. Newman, A. Kenyon, and A.G. Keith.*
Amy Keith (NASA/USA)

Use of Innovative Crosshole Georadar to Understand Contaminant Transport at an Industrial Site Investigation. *B.B. Jensen, M.C. Looms, L. Nielsen, K. Tsitonaki, T.M. Hansen, L. Rosenberg, P.L. Bjerg, and N. Tuxen.*
Bolette Badsberg Jensen (Capital Region of Denmark/Denmark)

H4. Advanced Sampling and Analysis Tools and Techniques

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: John Dougherty (CDM Smith Inc.) and Sean Gormley (Wood)

***Advances in Bio-Trap Samplers for Environmental Site Diagnostics.** *K. Clark, D. Taggart, and K. Sublette.*
Kate Clark (Microbial Insights, Inc./USA)

A Comparison of In-Well Flux Tools to Conventional Approaches to Determine Groundwater Flow for Successful Design of In Situ Treatment Zones. *C. Sandefur and J. Wilson.*
Craig Sandefur (REGENESIS/USA)

***Experimental and Modelling Investigations of ^{222}Rn Profiles in Chemically Heterogeneous LNAPL-Contaminated Vadose Zone.** *G. Cohen, O. Atteia, D. Su, K.U. Mayer, and P. Höhener.*
Grégory Cohen (G&E/France)

***Fake Data? The Need for Sampling Theory in Environmental Characterization and Remediation.** *R. Brewer and M. Heskett.*
Roger Brewer (Hawaii Department of Health/USA)

High-Resolution Passive Sampling of Chlorinated Solvents to Assess the Performance of a Biowall. *U. Garza-Rubalcava, W.A. Jackson, P.B. Hatzinger, G. Lavorgna, P. Hedman, and D. Schanzle.*
Uriel Garza-Rubalcava (Texas Tech University/USA)

***Low-Cost, High-Resolution Investigation to Improve CSM and Remediation Approach in an Industrial Area in Brazil.** *C.D. Maluf, C.V. Witier, and A.R. Cataldo.*
Cristina Deperon Maluf (Ambscience Engenharia Ltda/Brazil)

A New Method for Assessing Back Diffusion of Volatile Organic Compounds in Fractured Bedrock Aquifers. *W.C. Brandon and P.T. Harte.*
William C. Brandon (U.S. EPA/USA)

***A New Passive Contaminant Flux Measurement Device: Development and Testing.** *P. Erickson, S. Nguyen, C. Sandefur, K. Thoreson, and R. Hardenburger.*
Paul Erickson (REGENESIS/USA)

***Push-Ahead Groundwater Sampling and Near Real-Time Field Screening of PCE Concentrations during Deep Drilling.** *Q.G. Bingham, R. Adams, G. Colgan, D. Waite, and J. Cox.*
Quinten Bingam (Haley & Aldrich/USA)

***Real-Time Data through Horizontal Soil Sampling for Optimal Horizontal Vapor Extraction Well Construction and Placement.** *T. Will and M. Sequino.*
Tomas Will (Directional Technologies, Inc./USA)

***Relative Transmissivity within Layered Fractured Rock Aquifer Informed by Hydraulic Head in a Moveable Four-Packer String.** *J.D. Zettl, J.R. Kennel, P. Quinn, and B.L. Parker.*
Julie D. Zettl (University of Guelph/Canada)

***Smart Head: Remote Well Monitoring System for Contaminated Area Evaluation and Full-Scale Remediation Project Design.** *L.A.M. Santos and G.Q. Ferreira.*
Lucas Santos (Reconditec Sistemas/Brazil)

Use of Non-Intrusive Ground-Surface CO_2 Efflux Measurements for Lateral Petroleum NAPL Delineation. *T. Palaia, A. Hachkowski, and N. Mahler.*
Tom Palaia (Jacobs/USA)

***Use of Passive Soil Gas Tools for Fuel Spill Delineation.** *C.J. Mulry and P.A. Reichardt.*
Christopher Mulry (GES, Inc./USA)

H5. Groundwater Modeling: Advancements and Applications

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Jason House (Woodard & Curran) and James Schuetz (Parsons)

***Analytical Model for 3-D Solute Transport of Sequentially Decaying Species with Dual Porosity, Sorption, and Time-Varying Source.** *T. Perina, D. Rojas-Mickelson, and H. Levine.*
Tomas Perina (APTIM/USA)

***Application of Reactive Transport Modeling for In Situ Perchlorate Treatability Design.** *P. Rasouli and C.J. Ritchie.*
Pejman Rasouli (Ramboll/USA)

***Building a Better Mousetrap: The Evolution of MODALL.** *M.W. Killingstad, M.P. Kladias, J. Wang, and S.T. Potter.*
Marc Killingstad (Arcadis/USA)

***Combining Traditional Site Characterization with Modern Uncertainty Analyses to Assess Elevated Arsenic Concentrations in an Access-Constrained Site.** *P. Khambhammettu, M.W. Killingstad, L. Goldstein, J. Wahlberg, and C. Spill.*
Prashanth Khambhammettu (Arcadis/USA)

***An Effective and Efficient Numerical Modeling Approach to Support the Horizontal Reactive Treatment Well (HRX Well®) Design.** *J. Wang, M.P. Kladias, C. Divine, and J. Wright.*
Jack Wang (Arcadis/USA)

***Evaluating Field Measurements for Characterizing Properties and Predicting Dissolution Rates of DNAPL Source Zones.** *A. Prieto, M. Widdowson, and B. Stewart.*
Andres E. Prieto Estrada (Virginia Tech/USA)

***Impact of Matrix Diffusion on the Migration of Groundwater Plumes for Non-Degradable Compounds such as Perfluoroalkyl Acids (PFAAs).** *S.A. Lee, S.K. Farhat, C.J. Newell, B. Looney, and R.W. Falta.*
Sophia Lee (U.S. Navy/USA)

Innovative Concept for Determining the Contaminant Mass Discharge from Sources in Low-Permeable Media. *K. Mosthaf, L. Rosenberg, M.M. Broholm, A.S. Fjordbøge, P.L. Bjerg, G. Lilbæk, A.G. Christensen, V. Rønde, H. Kerrn-Jespersen, and N. Tuxen.*
Klaus Mosthaf (Technical University of Denmark/Denmark)

***Investigations in Areas of Highly Varying Geology as Preparation for In Situ Remediation Design.** *B. Grosen, C. Helweg, K.S. Grunnet, and K. Soerensen.*
Bernt Grosen (COWI/Denmark)

MODALL-U: An Unstructured Grid Tool for Facilitating Remedial Design (Two Case Studies). *P. Khambhammettu, S.T. Potter, M.P. Kladias, M.W. Killingstad, J. Wang, and J. Wahlberg.*
Prashanth Khambhammettu (Arcadis/USA)

New Targets for Improving Contaminant Transport Model Calibration. *A. Laase, R. Kent, and J. Rumbaugh.*
Al Laase (RSI Entech/USA)

PFOA Plume Development and Remediation: Numerical Model Simulations with and without Precursor Impacts. *M.J. Gefell, K. Gustafson, M. Carey, D. Opdyke, H. Huang, D. Vlassopoulos, S. Best, and J. McCray.*
Michael Gefell (Anchor QEA, LLC/USA)

Reactive Transport Capabilities in MT3D-USGS for Simulating Subsurface Contaminant Transport. *V.S. Bedekar, G. Ou, and M.J. Tonkin.*
Vivek Bedekar (S.S. Papadopulos and Associates, Inc./USA)

***Reconstruction of Milling-Era Groundwater Flow Conditions and Advective Transport at a Former Uranium Mill Site.** *P.C. Schillig, R.D. Kent, A. Farinacci, and A. Laase.*
Peter Schillig (RSI EnTech/USA)

***Strategies for Simulating the Complete Transport Pathways of Regional-Scale, Atmospherically-Dispersed Contaminants from Emissions Sources to Groundwater Receptors.** *E. Christianson, D. Dahlstrom, A. Janzen, J. Carter, and R. Wuolo.*
Evan Christianson (Barr Engineering Company/USA)

Unraveling Complexity through Fate and Transport Numerical Simulations in a Tidally-Influenced Heterogenous, Multi-System, Density Driven Regime. *J.W. Schuetz, R.J. Stuetzle, and R.R. Wenzel.*
James Schuetz (Parsons/USA)

***Use of Visual ModFlow for Risk Management at a Former Industrial Landfill.** *L.T. Kimura, F. Gimenes, R. Coelho, and V. Vanin.*
Lucas Takeshi Kimura (EBP Brasil Consultoria e Engenharia Ambiental Ltda./Brazil)

***Using Dual Domain Transport Analytical Solutions to Estimate Risks in Complex 3-D Heterogeneous Media.** *O. Atteia and F. Larroque.*
Olivier Atteia (Bordeaux University/France)

H6. MIP/HPT/LIF/UVOST—Realtime HRSC Tools and Techniques

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Andrew Bullard (CDM Smith, Inc.) and Damon DeYoung (Battelle)

***Advanced Investigation Tools: Enhanced Conceptual Site Model with a Dual OIP and MIP Investigation.** *T. Kremmin, T. Andrews, and D. Downey.*
Todd Kremmin (Jacobs/USA)

***Complete Redefinition of Conceptual Site Model Based on a High-Resolution Site Characterization Approach: A Case Study of a High-Risk Site Contaminated by Chlorinated Compounds.** *S. Souto, C. Malta-Oliveria, M. Evald, M. Saturnino, and F.C.C. de Carvalho.*
Mateus Knabach Evald (FINKLER Ambiental/Brazil)

***Conceptual Site Model Refinement to Support the Change of Use of a Former Industrial Site Impacted with Chlorinated Solvents.** *R. Mori, F. Gimenes, M. Scarance, L. Kimura, M. Nunes, and V. Vanin.*
Roberta Mori (EBP Brasil/Brazil)

***Groundwater Sampling and Real-Time Hydrostratigraphy: A Side-by-Side Comparison of the Hydraulic Profiling Tool and Waterloo Advanced Profiling System.** *J.D. Flattery and W.M. Flinchum.*
Jason Flattery (ERM/USA)

High-Resolution Site Characterization of a Complex Bedrock Setting with DNAPL. *T.A. Harp.*
Thomas Harp (Remediation Risk Reduction, LLC/USA)

High-Resolution Source Area Delineation and Targeted Enhanced Bioremediation at a 1,2-DCA Site. *D.R. Griffiths, B. Vanderglas, R.J. Stuetzle, and B. Wilkinson.*
Dan Griffiths (Parsons/USA)

***Houston, We've Identified the Problem: HRSC of TCE DNAPL at 1960's Era Launch Complex at Cape Canaveral.** *R. St. Germain.*
Randy St. Germain (Dakota Technologies, Inc./USA)

Improvement of the Optical Imaging Profiler (OIP) for the Detection of UV Range Fluorescing Compounds. *T.M. Christy, B. Jaster, and W. McCall.*
Ben Jaster (Geoprobe Systems/USA)

LIF/UVOST Application for Conceptual Site Model Refinement at a NAPL-Impacted Site in Brazil. *K. Campos and J. Vasconcellos.*
Kamilo Campos (Arcadis/Brazil)

***NAPL Investigation Approach Applying Geophysical Methods and LIF/UVOST at a Lubricant Plant in Brazil.** *K. Campos and V. Limeira.*
Kamilo Campos (Arcadis/Brazil)

***Real-Time Investigation to Support Treatability Studies: A Pioneer Field-Campaign in Argentina.** *A. Kuriss, S. Prince, L. Spaccarotella, L. Ribeiro, J. Arthur, P. Barreto, J. Sohl, H. O'Neill, and J. Henderson.*
Anabel Kuriss (Worley/Argentina)

***Redefinition of Remediation Strategy Based on High-Resolution Site Characterization Results.** *S. Souto, C. Malta-Oliveira, M. Evald, M. Saturnino, and F.C.C. de Carvalho.*
Mateus Knaboch Evald (Finkler Ambiental/Brazil)

The Significance of Filling Data Gaps and Developing Good Conceptual Site Models Prior to Remedy Implementation under Fixed-Price, Performance-Based Remediation Contracts. *P. Srivastav, W. Foss, S. Suryanarayanan, and R.E. Mayer, Jr.*
Praveen Srivastav (APTIM/USA)

***Use of Membrane Interface Probe Transects to Locate a Thin Perchloroethylene Plume in an Eloian Sand Aquifer.** *J.A. Berndt.*
James Berndt (August Mack Environmental/USA)

***Using Direct Sensing Tools to Evaluate Remediation Effort on the Site Contaminated by Strongly Mineralized Acidic Groundwater.** *V. Knytl, O. Lhotsky, and T. Cajthaml.*
Vladislav Knytl (DEKONTA, a.s./Czech Republic)

H7. | HRSC Suites of Tools to Improve CSMs

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Gary Colgan (Jacobs) and
Murray Einarson (Haley & Aldrich, Inc.)

3-D Visualization and Analysis of High-Resolution Site Characterization Data to Support Remedial Selection and Design. *E.B. Dieck, L. Zeng, J. Horner, and J. Musco.*
Eric Dieck (Langan/USA)

***Comparison of High-Resolution Site Characterization Tools for Evaluating Aquifer Characteristics and the Extent of Contamination in Groundwater.** *S. Blanchard and J. Peeples.*
Scott Blanchard (T&M Associates/USA)

***Efficiently Implementing High Resolution Site Characterization and Three-Dimensional Modeling to Improve Remedy Performance.** *J.D. Flattery and W.M. Flinchum.*
Jason Flattery (ERM/USA)

Guidance on Building Robust CSMs Using High-Resolution Site Characterization at Complex Air Force Sites. *T.W. Macbeth, K.L. Leslie, T.J. Cook, K. Glover, J. Davis, and G. Rose.*
Tamzen Macbeth (CDM Smith/USA)

***High-Resolution Characterization of a Source Area and Its Downgradient Plume to Optimize Full-Scale ERD Design.** *P.L. Lepczyk, C.A. Weber, and M.D. Colvin.*
Peter Lepczyk (Fishbeck/USA)

High-Resolution Fractured Bedrock Characterization Using Advanced Technology Tools for TCE Source Area. *J. Drummond, K. Fox, C. Vallone, R. Bower, and B. Rundell.*
Jesse Drummond (EA Engineering, Science, and Technology, Inc., PBC/USA)

***High-Resolution Site Characterization of a Trichloroethene (TCE) DNAPL Source Zone.** *D.J. Kekacs, S.M. Blanchard, and J.A. Peeples.*
Daniel Kekacs (T&M Associates/USA)

High-Resolution Site Characterization Using New Groundwater Profiler. *G. Lilbaek, A. Christensen, C. Riis, V. Ronde, N. Tuxen, H. Kerrn-Jespersen, W. McCall, and D. Pipp.*
Gro Lilbæk (NIRAS/Denmark)

***Remedial Design Investigation Using Geoprobe® Groundwater Profiler (GWP).** *S. Pitts, K. Knapp, and F. Stolfi.*
Steven Pitts (Equipoise Corporation/USA)

***Shifting from Traditional to Advanced Investigative Techniques during a Multi-Media Site Characterization.** *M.D. Flanik, H.P. Corley, and B. Glisson.*
Michael D. Flanik (Wood Environment & Infrastructure Solutions, Inc./USA)

Smart Characterization®: An Adaptive Strategy for High-Resolution Investigation to Develop Relative Mass-Flux Based Conceptual Site Models. *L. Santetti, K. Campos, V. Limeira, and V. Souza.*
Kamilo Campos (Arcadis/Brazil)

***Whodunnit, Matrix Diffusion or Reductive Dechlorination? The Case of the Disappearing PCE.** *J. Finegan and G.E. Johnson.*
James Finegan (Kleinfelder/USA)

Panel Discussion—Monday, Track I

How Can Genetically-Modified Organisms Safely Solve Environmental Challenges?

Moderator

Kent Sorenson (Allonnia)

Panelists

Alexandra Dunn (Baker Botts)
Deepti Kulkarni (Sidley)
Todd Kuiken (U.S. Congressional Research Service)
Benjamin Trump (U.S. Army Engineer Research and Development Center and University of Michigan School of Public Health)
Wendy Goodson (Ginkgo Bioworks)

Biology has an incredible capacity to detoxify, degrade and upcycle waste in the environment. While it can no doubt adapt and evolve to handle even the most challenging synthetic chemicals we can throw at it, nature takes decades or centuries on its own. Recent breakthroughs in synthetic biology, machine learning and computing power provide the potential to greatly accelerate biological solutions to issues such as per- and polyfluoroalkyl substances (PFAS) in the environment or large-scale carbon sequestration. New solutions might include everything from microorganisms with improved capabilities developed through adaptive evolution or other forms of mutagenesis, to those engineered to overexpress natural enzymes, to engineered enzymes in biocatalytic applications, or even to novel enzymes expressed in chassis organisms. As rapidly as the technology is advancing, it is important to establish the framework now for how these new solutions can be implemented in the environment to gain the full benefit of what synthetic biology can achieve while ensuring the ultimate goal of protecting human health and the environment. Many lessons can be learned and applied to environmental solutions from the safe application of genetically modified organisms (GMOs) and other advanced biological solutions in agriculture, pest control, infectious diseases, and medicine. This panel will discuss what constitutes a GMO and what does not, how biosafety is ensured in other industries for GMOs, what requirements might need to be met to deploy synthetic biology solutions in the environment, and what technical enhancements to biological safety might be possible.

I1. Explosives, Perchlorate

Platforms Monday | Posters (*) Monday Evening
Chairs: Kevin Morris (ERM) and
Christopher Jackson Ritchie (Ramboll)

Bioelectrochemical Treatment of Perchlorate in Groundwater: Laboratory-Scale Testing to Inform Potential Field Applications. *A.J. Hanson, S. De Long, J. Blotevogel, U. Patel, C. Ritchie, S. Warner, and L. Redfern.*
Andrea J. Hanson (Colorado State University/USA)

***Biological Reduction of Perchlorate and Chlorate with a Slow-Release Substrate in Soils with High Concentration of Sulfate and Varying Characteristics.** *Y. Saedi, R. Britto, D. Grady, and J. Batista.*
Jacimaria Batista (University of Nevada, Las Vegas/USA)

***Biotic and Abiotic Reduction of Perchlorate and Co-Contaminants Using Zero-Valent Iron.** *J.M. Gonzales, J.R. Batista, U. Patel, and C. Rich.*
Jacimaria Batista (University of Nevada, Las Vegas/USA)

***Combined Role of Granular Formulations of *Kinneretia asachharophila* and Organic Amendments in Bioremediation of RDX-Contaminated Soils.** *M.A. Khan, S. Yadav, A. Sharma, and S. Sharma.*
Mohd Aamir Khan (Indian Institute of Technology Delhi/India)

***Containment and Remediation of Perchlorate and Chlorinated Volatile Organic Compounds in Complex Aquifer Systems: Bermite Facility, Santa Clarita, California.** *H. Amini.*
Hassan Amini (GSI Environmental, Inc./USA)

Degradation of Insensitive Munitions Constituents in the Environment: Predicting the Products and Their Properties Using In Silico Methods. *T.L. Torralba-Sanchez, E.J. Bylaska, and P.G. Tratnyek.*
Tifany Torralba-Sanchez (Mutch Associates, LLC/USA)

***Ex Situ Remedial Innovation for Abatement of White Phosphorus-Impacted Soils.** *A. Kenwell, C. Shores, and B. Hodge.*
Amy Kenwell (Geosyntec Consultants/USA)

***Factors Controlling Autotrophic Bioremediation of Perchlorate Using In Situ Hydrogen Generation: Results from Multiple Bench-Scale Tests.** *U. Patel and C.J. Ritchie.*
Christopher Jackson Ritchie (Ramboll/USA)

***High-Resolution Site Characterization (HRSC) for Design of Treatment System Remedial Augmentation.** *S.T. Downey, R. Mayer, Z. Parham, S. Smith, and P. Coleman.*
Steven Downey (APTIM/USA)

***Improving Sustainable Munitions Wastewater Treatment with Ion Exchange.** *D. Tran, J. Weidhaas, and R. Goel.*
Dana Tran (University of Utah/USA)

In Situ and Ex Situ Biocell to Treat Perchlorate and Nitroaromatic Explosives in Soil and Groundwater. *K.A. Morris and J. Mcginty.*
Kevin Morris (ERM/USA)

Modeling the Reduction Rates of Munitions Constituents in the Subsurface. *K.P. Hickey, D.M. Di Toro, P.C. Chiu, and R.F. Carbonaro.*
Kevin P. Hickey (University of Delaware/USA)

***Overcoming Challenging Site Conditions to Remediate High Perchlorate Concentrations in Groundwater Using In Situ Bioremediation.** *W.A. Foss, P. Srivastav, and R.E. Mayer.*
William Foss (APTIM/USA)

***Predicting Abiotic Reduction Rates of Munitions Compounds in Soils.** *J. Murillo-Gelvez, P.A. Cárdenas, J.C. Rincón, D.M. Di Toro, P.C. Chiu, and R.F. Carbonaro.*
Jimmy Murillo Gelvez (University of Delaware/USA)

***Removal of IMX-101 Constituents from Process Wastewater by Fenton Oxidation and Hydrothermal Treatment.** *D.B. Gent, S.L. Larson, and B. Smolinski.*
David B. Gent (U.S. Army Corps of Engineers Engineer Research & Development Center/USA)

***Removal of Munitions Compounds from Aqueous Solutions via Chitin- and Chitosan-Based Materials.** *L.A. Gurtowski, C.S. Griggs, and M.K. Shukla.*
Luke Gurtowski (U.S. Army Engineer Research and Development Center/USA)

***Response Surface Modeling for Reverse Osmosis Remediation of Wastewater Containing Energetic Compounds.** *S.J. Cavanaugh and J. Weidhaas.*
Stephen Cavanaugh (University of Utah/USA)

***Serving Potable Water from an "Extremely Impaired" Groundwater Superfund Source.** *D. Roff, D. Cebra, J. Duffey, H. Holbrook, E. Lang, and K. Javendal.*
Douglas F. Roff (AECOM/USA)

Treatment of Munitions Constituents Manufacturing Wastes Using a Membrane Bioreactor System. *P.B. Hatzinger, P. Hedman, M. Fuller, C. Schaefer, T. Webster, and K.-H. Chu.*
Paul Hatzinger (APTIM/USA)

I2. Advances in 1,4-Dioxane Biological Treatment Technologies

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Francisco Barajas-Rodriguez (AECOM) and Bonani Langan (Wood)

***Aerobic Cometabolism of Chlorinated Solvents and 1,4-Dioxane in Continuous Flow Columns Packed with Gellan-Gum Hydrogels Co-Encapsulated with ATCC Strain 21198 and TBOS or T2BOS as a Slow Release Compounds.** *M. Azizian, L. Semprini, and M. Hyman.*
Mohammad Azizian (Oregon State University/USA)

Bioaugmented Phytoremediation to Degrade 1,4-Dioxane and Co-Contaminants. *R.A. Simmer, T.E. Mattes, J.L. Schnoor, J. Mathieu, and P.J.J. Alvarez.*
Reid Simmer (University of Iowa/USA)

***Biodegradation of 1,4-Dioxane by Psychrophilic Propanotrophs**. *J. Antunes and M. Li.*
Jose Antunes (New Jersey Institute of Technology/USA)

***Bioremediation Options for 1,4-Dioxane.** *S. Dworatzek, J. Webb, B. Petty, and C. Zhou.*
Sandra Dworatzek (SiREM/Canada)

***Cometabolism of 1,4-Dioxane and Chlorinated Hydrocarbon Mixtures Induced by Multiple Primary Substrates: Laboratory and Modeling Studies.** *H.R. Rolston, L. Semprini, M.R. Hyman, D. Lippincott, P.B. Hatzinger, and A.S. Danko.*
Hannah Rolston (Oregon State University/USA)

***Construction and Characterization of a Bacterial Consortium for Biodegradation of 1,4-Dioxane.** *K. Motomura, Y. Hemmi, K. Enomoto, and N. Okutsu.*
Kei Motomura (Kurita Water Industries/Japan)

***EPA Modified Corrective Measures: Re-Aligning Strategy to 1,4-Dioxane.** *S. Knox and D. Young.*
Sheri Knox (Wood/USA)

Establishing the Prevalence and Relative Rates of 1,4-Dioxane Natural Attenuation to Improve Remedy Evaluations. *D.T. Adamson, J. Wilson, D. Freedman, A.A. Ramos-Garcia, C. Lebron, and A. Danko.*
David T. Adamson (GSI Environmental Inc./USA)

Evaluation of Natural Attenuation of 1,4-Dioxane in Groundwater Using a ^{14}C Assay. *D.L. Freedman, A.A. Ramos Garcia, D.T. Adamson, J.T. Wilson, C. Lebrón, and A.S. Danko.*
David Freedman (Clemson University/USA)

Field Demonstration of In Situ Bioremediation of 1,4-Dioxane: A Push-Pull Testing Investigation. *Y. Li, D.T. Adamson, J. Mathieu, A.S. Danko, and C.S. Sorensen.*
Yue Li (GSI Environmental Inc./USA)

***First Full-Scale Implementation of Propane Biosparge System for In Situ Remediation of 1,4-Dioxane.** *C. Bell, J. Wong, and K. Gerber.*
Caitlin Bell (Arcadis/USA)

Full-Scale In Situ Propane and Oxygen Biosparging for Cometabolic Bioremediation of 1,4-Dioxane. *C. Bell, A. Lorenz, and D. Favero.*
Caitlin Bell (Arcadis/USA)

***Identification of the Phylotypes Involved in cis-Dichloroethene and 1,4-Dioxane Biodegradation in Soil Microcosms.** *H. Dang and A.M. Cupples.*
Alison Cupples (Michigan State University/USA)

***Laboratory and Field-Scale Evaluation of Multiple Bioremediation Technologies for 1,4-Dioxane.** *F.J. Krembs, G.E. Mathes, J. Pruis, K. McDonald, M.G. Sweetenham, and M.R. Olson.*
Fritz Krembs (Trihydro Corporation/USA)

***RPI's CAT 100 Successfully Treats 1,4-Dioxane and CVOCs.** *S. Noland.*
Scott Noland (Remediation Products, Inc./USA)

***Sequential Anaerobic and Aerobic Bioaugmentation for Commingled Groundwater Contamination of Trichloroethene and 1,4-Dioxane.** *F. Li, D. Deng, L. Zeng, S. Abrams, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

***Synchronous Biodegradation of 1,4-Dioxane and Trichloroethene by Mycobacterium sp. DT1.** *D. Deng, J. Antunes, and M. Li.*
Jose Antunes (New Jersey Institute of Technology/USA)

Treatability and Optimization Studies for 1,4-Dioxane and CVOC-Impacted Groundwater Using BioGAC Column Systems. *N.W. Johnson, J. Ngo, P. Ramos, I. Kwok, Y. Miao, S. Mahendra, Y. Liu, E.E. Mack, C. Walecka-Hutchison, J. Popovic, and A. Danko.*
Shaily Mahendra (University of California, Los Angeles/USA)

An Update: Aerobic Fixed Film Biological Treatment Process for 1,4-Dioxane at the Lowry Landfill Superfund Site. *L. Cordone, D.R. Griffiths, C. Carlson, and A. Biniwale.*
Les Cordone (Parsons/USA)

Untangling the Robust Catalytic Versatility of Soluble Di-Iron Monooxygenases in Initiating the Biotransformation of Legacy and Emerging Groundwater Pollutants. *D. Deng, D. Pham, F. Li, J. Antunes, and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

I3. 1,4-Dioxane Remediation Challenges

Platforms Tuesday | Posters (*) Monday Evening
Chairs: Tesema Chekol (Battelle) and David Lippincott (APTIM)

Addition of 1,4-Dioxane Removal System to Municipal Water Treatment Plant: Pilot to Operation. *K. Wolohan, J. Macejkovic, and A. Ling.*
Katie Wolohan (Barr Engineering Co./USA)

***Design-Build Expedites the Remediation of a 1,4-Dioxane Groundwater Plume through Source Removal.** *P. Randazzo, K. Dyson, and B. Quann.*
Peter Randazzo (Brown and Caldwell/USA)

***Higher Screening Levels for 1,4-Dioxane: New Research May Mean Less Cleanup.** *N. Weinberg, M. Lafranconi, D. Nelson, and C. Walecka-Hutchinson.*
Nadine Weinberg (ERM/USA)

In Situ Biostimulation and Bioaugmentation of Chlorinated Solvents and 1,4-Dioxane. *A. Polasko-Todd, L. LaPat-Polasko, and S. Mahendra.*
Laurie LaPat-Polasko (Matrix New World Engineering/USA)

In Situ Ozone and Hydrogen Peroxide Remediation of 1,4-Dioxane in the Coastal Plain Region of North Carolina. *C. Krouse, D. Briley, and J. Wilke.*
Caleb Krouse (AECOM/USA)

***In Situ Remediation of a 1,4-Dioxane Plume in a Heterogeneous Aquifer, Lessons Learned: Full-Scale Remediation with Activated Sodium Persulfate.** *T. Louviere and P. Hsieh.*
Trevor Wade Louviere (Dalton, Olmsted & Fuglevand, Inc./USA)

The Innovative Case for Monitored Natural Attenuation as a Remedy for 1,4-Dioxane in a Complicated Geologic Regime. *L.L. Kammer, M.R. Kanarek, J.J. Soukup, C.L. Sprague, and M.D. Summerlin.*
Lisa Kammer (Weston Solutions, Inc./USA)

***Investigation and Remediation Strategy for a Fast-Moving 1,4-Dioxane Plume at a Military Site.** *S. Gopinath, T. Eilber, and G. Geckeler.*
Sree Gopinath (Bodhi Group/USA)

***Lessons Leaned for Remediation of 1,4-Dioxane at Chlorinated Solvent Sites Using In Situ Thermal Remediation.** *G. Mackey, A. Villanueva, J. Winkler, M. Appel, D. Nelson, A. Salvador, and J. Baldock.*
Graham Mackey (ERM/USA)

***Multi-Tool Characterization, Delineation and Capture of a Detached, Commingled, 1,4-Dioxane and Chlorinated Ethenes Plume in Coastal Plain Deposits.** *C. Meyn, J. Marolda, and S. MacMillin.*
Charles Meyn (Brown and Caldwell/USA)

***Selecting the Most Viable Oxidant to Treat 1,4-Dioxane in Groundwater.** *K. Ramanand, R. Ruhmke, K.D. Dyson, and J. Seracuse.*
Karnam Ramanand (Brown and Caldwell, Inc./USA)

***Treating 1,4-Dioxane in Commingled Plumes with ISCO.** *B.A. Smith and B. Desjardins.*
Brant Smith (Evonik Active Oxygens/USA)

I4. Microplastics, Pharmaceuticals, and Other Emerging Contaminants

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Alison Cupples (Michigan State University) and John Simon (Gnarus Advisors LLC)

***Assessment of Treatment Technologies for Removing Microplastics from Water: Current Perspectives and Future Directions.** *Y. Kunukcu.*
Yasemin Kunukcu (TRC Companies/USA)

***Bench-Scale Biodegradation of 1,2,3-Trichloropropane from a Dilute Aquifer Using Dehalogenimonas-Containing Bioaugmentation Culture.** *M. Pompliano and S. Dworatzek.*
Michael Pompliano (Matrix Design Group/USA)

***Design and Lessons Learned from 1,2,3-Trichloropropane Groundwater Remediation with Granular Activated Carbon.** *C. Martinson, A. Riffel, M. Sweetenham, W. Clayton, and J. Bartholomew.*
Allison Riffel (Trihydro Corporation/USA)

***Detection and Genotyping of Rotavirus Present in Samples of Wastewater and Superficial Water of the City of Sao Paulo.** *A.P. Queiroz and D. Mehnert.*
Ana Paula Queiroz (Waterloo Brasil/Brazil)

***Discovery of a Novel Sulfolane-Degrading Bacterium through Lab- and Field-Scale Studies.** *T.A. Key, A. Thavendrarasa, L. Eastcott, P. Dennis, X. Druar, M. Vachon, J. Webb, S. Dworatzek, J. Harder, S. Hains, and A. Madison.*
Trent Key (ExxonMobil Environmental and Property Solutions Company/USA)

***Effect of Micro- and Nano-Plastics on the Microbial Reductive Dechlorination Process.** *F. Kara Murdoch, Y. Sun, F. Loeffler, and K.H. Kucharzyk.*
Fadime Kara Murdoch (Battelle/USA)

Emerging Contaminants: Anticipating Developments. *D. Nelson, K. Sellers, and N. Weinberg.*
Kevin Morris (ERM/USA)

***Enhanced Solar Light-Driven Photocatalytic PPCP Degradation by Chlorine Activation for Drinking Water Treatment.** *C. Lung and I.M.C. Lo.*
Cheuk Wai Lung (The Hong Kong University of Science and Technology/Hong Kong)

FDOM as a Screening Technique for Fluorescent Pharmaceuticals in a Contaminant Plume. *M.M. Broholm, L. Vinther, C.H.H. Hansen, H. Draborg, U. McKnight, A.-R. Schittich, P.L. Bjerg, C. Stedmon, U. Wünch, L. Dissing, and J.K. Pedersen.*
Mette Broholm (Technical University of Denmark/Denmark)

***How Clean is Clean for Plastic Pellet Remediation?** *S.S. Patil, K. Maroo, J. Powell, S. Dunn, D. Gerber, J. Burdick, and J. Henson.*
Sonal Patil (Arcadis U.S., Inc./USA)

In Situ Reduction of 1,2,3-Trichloropropane in Groundwater: Advancements and Case Studies. *M. Asher, S. Varadhan, E. Suchomel, L. Kane, and S. Dworatzek.*
Melissa Asher (Geosyntec Consultants/USA)

***Microplastics as Hubs Enriching Antibiotic-Resistant Bacteria and Pathogens in Municipal Activated Sludge.** *D. Pham and M. Li.*
Mengyan Li (New Jersey Institute of Technology/USA)

***Microplastics: California and Beyond—A Survey of State Approaches to Microplastic Research and Regulation.** *R. Henke, S. Edmonds, R. Maxwell, and J. Rohrer.*
Rachel Henke (Roux/USA)

***Pentachlorophenol, Polychlorinated Dibenzo-p-Dioxin, and Polychlorinated Dibenzofuran Concentrations in Soil Surrounding Treated Utility Poles.** *A. Lutey and J. Sampson.*
Amber Lutey (Integral Consulting, Inc./USA)

Still Haven't Found What You're Looking For? Integrated Interdisciplinary Analyses May Be the Solution. *S.T. Glassmeyer, M.A. Mills, A.L. Batt, E.K. Medlock Kakaley, Q. Teng, E.T. Furlong, and D.W. Kolpin.*
Susan Glassmeyer (U.S. EPA/USA)

***Transport and Fate of "New" Pesticide/Biocide Metabolite in Groundwater (Denmark).** *M. Frederiksen, M. Christophersen, N. Tuxen, L. Clausen, P.L. Tüchsen, G.A.S. Janniche, C.N. Albers, and P.L. Bjerg.*
Majken Frederiksen (Ramboll/Denmark)

I5. Technical Impracticability: Challenges and Considerations for Evaluation of Fractured Rock Sites

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Michael Gefell (Anchor QEA, LLC) and Bernard Kueper (Queen's University)

Adaptive Management for Characterization and Remediation of DNAPL in Fractured Crystalline Bedrock. *E.C. Ashley, R.A. Wymore, and N.J. Castonguay.*
Ernest Ashley (CDM Smith, Inc./USA)

***Assessment of Impact with Xylenes in the Crystalline Aquifer at an Industrial Site in Sao Paulo, Brazil, Using Geophysics and Mathematical Modeling.** *D. Saunite, L.T. Kimura, and N.D. Brandsch.*
Danilo Saunite (EBP Brasil/Brazil)

***Characterizing Chlorinated Ethene Sources and Transport in a Complex Fractured Rock Aquifer Impacting Twin Cities Area Municipal Supply.** *D.A. Scheer.*
David Scheer (Minnesota Pollution Control Agency/USA)

Deep Enough: Limitations on Vertical Delineation in Fractured Bedrock Aquifers. *M.K. Cobb, T.H. Darby, and W. Plasket.*
Michael Cobb (Arcadis/USA)

***DNAPL in Shallow Fractured Rock: Geotechnical Studies for Environmental Management Strategy.** *C. Shibata, J. Teixeira, K. Farris, D. Szuch, R. Royer, M. Sousa, M. Alarsa, G. Nishikawa, F. Oliveira, and R. Passos.*
Kathryn Farris (Arcadis/USA)

***Evaluating Feasible Methods to Remediate 1,4-Dioxane and Uranium in Fractured Rock at the Nuclear Metals, Inc. Superfund Site.** *B. Thompson, N. Hunt, A. Hoffmann, D. Adilman, C. Elder, D. Chlebica, and M. Kelley.*
Bruce Thompson (de maximis, inc./USA)

Evaluation of High-Resolution Methods for VOC Contaminant and Flux Distributions in Igneous Rock. *L. Davidsson, S. Chapman, B. Parker, P. Pehme, C. Maldaner, and E. Bergstedt.*
Lars Davidsson (WSP/Sweden)

***Heat and Treat Bedrock: Can ERH be Effective in Sandstone?** *G. Heron, M. Nanista, E. Crownover, A. Morgan, E. Marnette, and J. Pustjens.*
Gorm Heron (TRS Group, Inc./USA)

***Multiphase Hydrogeological Characterization of a Fractured Bedrock Aquifer to Optimize Amendment Injection.** *T. Tomaselli, J. Button, and J.N. Dougherty.*
Travis Tomaselli (CDM Smith/USA)

Multiple, Short-Term, Cross-Hole Aquifer Tests to Three-Dimensionally Map Hydraulic Conductivity in Metamorphic Rocks. *R.D. Mutch, K.J. Rader, C.J. Fanelli, and E. Meeks.*
Robert Mutch (Mutch Associates, LLC/USA)

***Site Characterization for Remediation in Fractured Rock Settings.** *K.S. Novakowski.*
Kent Novakowski (Queen's University/Canada)

***Understanding Radius of Influence of Bedrock Fractures.** *W. Slack.*
William Slack (FRx, Inc./USA)

***Understanding the Hydrogeological Conceptual Model to Define Remediation Approach: Bedrock Mapping in a Site with Hydrocarbon and Chlorinated Compounds Contamination.** *S. Aluani, F. Tomiatti, R. Moura, G. Siqueira, and N. Moura.*
Sidney Aluani (SGW Services/Brazil)

I6. Depositional Environments and Stratigraphic Considerations for Remediation

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Shaun Cwick (Weston Solutions, Inc.) and Mike Shultz (Burns & McDonnell)

Application of Environmental Sequence Stratigraphy (ESS) Using High-Resolution Site Characterization (HRSC) Tools. *L.J. Mastera and R.J. Fiacco.*
Larry Mastera (ERM/USA)

Application of Geology-Focused Approach in the Implication at a Site with Complex Geology and Site Logistics. *K. Carr, S. Price, A. Rees, and J. Sadque.*
Katharine Carr (AECOM/USA)

***Applied Environmental Sequence Stratigraphy.** *B.D. Smith.*
Brian D. Smith (Trihydro Corp./USA)

Bringing it All Back Home: The Depositional Systems Approach to Remediation Geology and the Current Status of Stratigraphic Practice. *C. Plank, R. Cramer, M.R. Shultz, and J. Gillespie.*
Colin Plank (Burns & McDonnell/USA)

***Case Study on Amendment Delivery Methodology for Permeable Reactive Barrier (PRB) Installation in a Challenging Lithology at Shaw AFB, Sumter, South Carolina.** *G. Simpson, D. Christensen, J. Chytil, S. Palakur, and D. Pizarro.*
Gary Simpson (AST Environmental, Inc./USA)

***Correlation of Water-Bearing Fracture Zones with Stratigraphic Horizons in Sedimentary Rock.** *J.M. Marolda, R.L. O'Neill, and S. Stucker.*
James Marolda (Brown and Caldwell/USA)

Optimizing the Level of Detail in Stratigraphic Interpretations. *J.P. Brandenburg and M.D. Einarson.*
J.P. Brandenburg (Haley & Aldrich, Inc./USA)

***Predicting the Feasibility of Groundwater Remediation Strategies from Depositional Systems Analysis.** *M.R. Shultz, C.P. Plank, and R. Cramer.*
Mike Shultz (Burns & McDonnell/USA)

***Role of Sequence Stratigraphy in Remediation Geology: An Example from the Puchack Well Field Superfund Site, New Jersey**. *J. Sadeque and J. Rice.*
Junaid Sadeque (AECOM/USA)

***Using Facies Models and Depositional Systems to Understand and Predict Continuity of Aquitards.** *C. Plank, R. Cramer, and M.R. Shultz.*
Colin Plank (Burns & McDonnell/USA)

***Using Sequence Stratigraphy to Inform RI Activities at a Superfund Site Located within a Complex Fluvial Setting.** *R.C. Samuels, L.J. Alexander, M. Kieling, and D. Flores.*
Ryan Samuels (AECOM/USA)

I7. Process-Based Conceptual Site Models (CSMs) for Informing Remediation

Platforms Wednesday | Posters (*) Wednesday Evening
Chairs: Michael Bower (The Boeing Company) and Robert J. Stuetzle (The Dow Chemical Company)

Conceptual Site Model for a Complex Mixed-Composition NAPL Site in Fractured Sedimentary Rock under Hydraulic Control. *J.J. Frederick, P.R. Trudell, and K. Goldstein.*
Paul Trudell (WSP/USA)

Expedited High-Resolution Characterization and Mass Discharge Evaluation of Dissolved Metals Emanating from a Former Vanadium Extraction Facility, Soda Springs, Idaho. *N. Tucci, M. Einarson, C. Payne, J. Chu, L. Peterson, and T. Lewis.*
Murray Einarson (Haley & Aldrich, Inc./USA)

Identifying Natural and Anthropogenic Groundwater Discharge Areas in a Fractured Rock System and Use of Mass Flux to Support Remedy Selection. *R. O'Neill, J. Marolda, and S. Stucker.*
Robert O'Neill (Brown and Caldwell/USA)

***Improving the CSM for a Large Commingled Contaminant Plume in Fractured Granitic Bedrock to Develop Remedial Alternatives.** *K. Brasaemle, Y. Andren, N. Goers, and C. Nathe.*
Karla Brasaemle (TechLaw, Inc./USA)

***Leveraging PRISM® to Assess Contaminant Migration Pathways at a Complex Geologic Site, Washington, DC.** *R.C. Samuels, J. Sadeque, K. VanGelder, and D.G. Collins.*
Ryan Samuels (AECOM/USA)

***A "Multiple Lines of Evidence Approach" for High-Resolution 3-D Geological Modelling/Risk Assessment of a Former Landfill Site in Denmark.** *K.E.S. Klint.*
Knud Erik Klint (Geo/Denmark)

***Streamlining Lifecycles with High-Resolution Site Characterization (HRSC) and Three-Dimensional Conceptual Site Models.** *J. Orris and J. Ruf.*
Joshua Orris (Antea Group/USA)

***Successful CSM Development at Bedrock Chlorinated Solvent Site with Historic Mines and Channels.** *T. Halihan, J. Ewert, S.W. McDonald, and K. Spears.*
Todd Halihan (Oklahoma State University/USA)

Use of a Conceptual Site Model to Enhance DNAPL Recovery from Low-Permeability Glacial Soils. *M.L. Schmidt and A. Heitger.*
Martin Schmidt (EHS Support/USA)

***Using a Semi-Analytical Method to Simulate Matrix Diffusion in Random Discrete Fracture Networks.** *K.T. Pham and R.W. Falta.*
Kien T. Pham (Clemson University/USA)

Panel Discussion—Thursday, Track I

Remediation Geology, Remediation Hydrogeology, and Process-Based CSMs to Support Complex Site Remediation

Moderators

Rick Cramer (Burns & McDonnell)
Robert Stuetzle (Dow Chemical)

Panelists

Frederick Day-Lewis (PNNL)
Sophia Lee (NAVFAC EXWC)
Herb Levine (U.S. EPA, Region IX)
Jim Strunk (Dow Chemical)
John Wilson (Scissortail Environmental Solutions, LLC)

This panel will explore the relationship between geology, hydrogeology, process-based conceptual site models (CSMs), and remediation with a focus on strategic management of complex contaminated sites. Remediation geology is a recently developed workflow that emphasizes the development of a technically sound geologic model to create a more accurate three-dimensional subsurface permeability framework to better understand controls on contaminant migration. Remediation hydrogeology builds on the remediation geology workflow by hydrologically calibrating the robust geologic frameworks using high-resolution hydrologic datasets (e.g., hydraulic head, groundwater velocity, contaminant, and hydrogeochemistry profiles). These hydrologically-calibrated geologic frameworks enhance the assignment of groundwater flow and contaminant transport parameters throughout the three-dimensional volumes of interest, allowing for robust representation of advective and diffusive transport and interactions influencing contaminant behavior, i.e., development of Process-Based CSMs.

Some topics for discussion include:

- What geology-related issues impede remediation?

- Have you hydraulically (and hydrochemically) calibrated your geology or geologically (K, mineralogy, etc.) calibrated your groundwater hydrology?
- Matching the remedy to the geology and hydrogeology architecture (3-D spatial geometry)
- How do you match the scope and level of effort to the problem?
- For highly complex aquifer analysis, what is the role of high-resolution data sets?
- How does hydrogeology inform the geologic model, and vice versa?
- Do you know what processes are most strongly influencing (or are desired changes to) site conditions?
- What is the definition of a Process-Based CSM?

I8. Advances in the Application of Geologic Interpretation to Remediation

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Rick Cramer (Burns & McDonnell) and J. Mark Stapleton (Noblis)

Accelerated Remedial Approaches Using Environmental Sequence Stratigraphy. *J.M. Stapleton, J. Gillespie, K. Glover, R. Cramer, and C.P. Plank.*
J. Mark Stapleton (Noblis/USA)

***Application of Sequence Stratigraphy in Developing Remediation Strategy in LNAPL-Impacted Sites.** *J. Sadeque, R. Samuels, K. Carr, and J. Garcia-Rincon.*
Junaid Sadeque (AECOM/USA)

Applications of Environmental Sequence Stratigraphy (ESS) Decision Making and Field Work Planning. *T. Andrews, S. Kline, and W. Nolan.*
Trevre Andrews (Jacobs/USA)

***Connecting the Dots: Advanced Geologic and Geochemical Analysis Key to Identifying an Upgradient Source of Gasoline Impacting an Industrial Site in Southern California.** *M. Einarson, C. Payne, D. Bernier, and P. Fontaine.*
Murray Einarson (Haley & Aldrich, Inc./USA)

***Correlating the Permeability of Specific Fracture Sets to Regional Tectonic Stresses: A Case Study from Sao Paulo, Brazil.** *C.W. Payne, M.D. Einarson, and M. Singer.*
Charles Payne (Haley & Aldrich, Inc./USA)

***A Guide to Performing Remediation Applying Remediation Geology: Two Case Studies.** *S. Pittenger, P.M. Dombrowski, S. du Pont, and T.L. Blazicek.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

***Improved Remedial Approaches at Complex Sites Using Health Risk Assessments Informed by Sequence Stratigraphy and Groundwater Modeling.** *K. Patel-Coleman, G. Kenoyer, and M. Shultz.*
Kanan Patel-Coleman (Burns & McDonnell Engineering Company, Inc./USA)

Leveraging Geologic Controls to Focus Your Remedial Strategy. *T.H. Darby, R. Stuetzle, J.F. Strunk, Jr., M. Petersen, and C. Bertz.*
Thomas H. Darby (Arcadis/USA)

***Use of a Conceptual Site Model to Evaluate Contaminant Migration Pathways in Complex Igneous and Metamorphic Rock Terrains.** *M.L. Schmidt, J. Breza, and J. Hershberger.*
Martin Schmidt (EHS Support/USA)

Using Sequence Stratigraphy to Inform a PFAS RI: Cannon AFB, New Mexico. *R.C. Samuels and J. Gillespie.*
Ryan Samuels (AECOM/USA)

I9. Remediation Approaches in Fractured Rock and Karst Aquifers

Platforms Thursday | Posters (*) Wednesday Evening
Chairs: Michael Lamar (CDM Smith, Inc.) and Raymond Lees (Langan)

***BiRD Overcomes Rising Source Concentrations and Back Diffusion: Exceptional In Situ Contaminant Plume Treatment Performance.** *J. Studer and N. Glenn.*
James Studer (InfraSUR, LLC/USA)

***Case Study of Karst Site in Kentucky: Bedrock Remediation of PCE (10-Year Review).** *D. Guilfoil and K. Thompson.*
Duane Guilfoil (AST Environmental, Inc./USA)

Cutting Off the Hand that Feeds the Plume: Remediation of a Fractured Rock Aquifer. *W. Plasket, M. Cobb, A. Horneman, and S. Potter.*
Whitney Plasket (Arcadis U.S., Inc./USA)

Developing an Appropriate Conceptual Site Model for Near- and Long-Term Contaminant Remedy Decisions in a Faulted Karst Setting. *C. Maxwell, A. Riemer, T. Halihan, and K. Evans.*
Christopher R. Maxwell (Stantec Consulting Services, Inc./USA)

***Discovery of Submerged Springs: A Step Forward to Effectively Remediate and Manage Contaminated Groundwater in a Karst Aquifer.** *H. Rafiee, W. Zhou, J. Zoeckler, and C. Jettie.*
Christina Jettie (Hana Engineers & Consultants, LLC/USA)

***Extended Zone of Influence and Enhanced Mass Removal Achieved in Fractured Bedrock with Air Sparging.** *M. Berman, H. Hays, and J. Dishon.*
Michael Berman (SRS/USA)

***Field Performance of Novel Amendments to Support the Biodegradation of TCE in a High Sulfate Fractured Bedrock Environment.** *M.R. Harkness, P. Hare, P. Freyer, and L. Scheuing.*
Mark Harkness (Ramboll/USA)

***Finding the Flux: Risk-Based Closure Strategies of Complex Fractured Rock Sites.** *A. Horneman, M. Klemmer, W. Parry, and R.J. Stuetzle.*
Allan Horneman (Arcadis/USA)

***The First Implementation of a Combined ERH and MPE Remedy at a Fractured Bedrock Site in Scotland, UK.** *A. Morgan and G. Wealthall.*
Andrew Morgan (Geosyntec Consultants/United Kingdom)

GWQS Achieved in Fractured Bedrock at a TCE Release Site in New Jersey. *B. Brab.*
Bill Brab (AST Environmental/USA)

***In Situ Remediation of a Fractured Metamorphic Bedrock Aquifer Impacted with TCE and 1,1,1-TCA through ERD Techniques: Pilot-Scale Results.** *M. Chaturgan and D. Smith.*
Mindy Chaturgan (EWMA/USA)

Investigation and Remediation of a Chlorinated Solvent Release: A Case Study. *S. Manley.*
Stuart Manley (GHD/USA)

Naturally and Biologically-Mediated Abiotic Transformation of TCE in Low-Permeability Formations. *D.L. Freedman, H. Wang, R. Yu, L. Slater, S. Falzone, M. Glamoclija, and R. Iery.*
David Freedman (Clemson University/USA)

***Optimizing Remediation in Bedrock: Lessons from Successful Remediation at Two Sites following Past Failures.** *P.M. Dombrowski, P. Kakarla, M. Temple, C. Weeden, D. Bytautas, and J. Catanzarita.*
Paul M. Dombrowski (ISOTEC Remediation Technologies/USA)

Remediation of Chlorinated Solvent Plume in Fractured Bedrock via Pneumatically-Enhanced Injections of Zero-Valent Iron and Carbon Substrate. *H. Rodack, P. Downham, and P. Armstrong.*
Haley Rodack (Roux Associates, Inc./USA)

***Remediation of Persistent Arsenic in Groundwater Using Groundwater Circulation Wells as an Effective Source Removal Approach in a Fractured Rock Aquifer.** *M. Petrangeli Papini, P. Ciampi, G. Rehner, E.J. Alesi, E. Bartsch, M. Pellegrini, S. Olivieri, F. Bonfanti, and G. Liali.*
Marco Petrangeli Papini (University of Rome “La Sapienza”/Italy)

***Site Closure Ramifications of Karstic Terrain Hydrogeology.** *D.T. Heidlauf, B. Kennington, S. Popelar, A. DeDolph, and S. Tarmann.*
David Heidlauf (Ramboll/USA)

Strategy to Transition a Dilute TCE Plume at a Bedrock Site from Active In Situ Biotreatment Mode to Monitored Natural Attenuation. *K. Ramanand, C. Milone, and P. Randazzo.*
Karnam Ramanand (Brown and Caldwell, Inc./USA)

***A Synergistic Approach to Fractured Bedrock Remediation Using Combined Remediation Strategies and Delivery Methods.** *B.S. Langan and J. Bennett.*
Bonani Langan (Wood/USA)

Technical and Regulatory Approaches for Cleanup of Contaminated Groundwater at Test Area North at the INL. *P.K. Johansen, M. Roddy, and N. Badrov.*
Pete Johansen (Idaho DEQ/USA)

***Thermal Conductive Heating for Remediation of Bedrock: State of the Art.** *S. Griepke, J. LaChance, and N. Ploug.*
Steffen Griepke (TerraTherm Inc./USA)

SHORT COURSES

Short Course Schedule

The link to register for a Short Course can be found on the **Short Courses** page on the Conference website.

ITRC Courses. U.S. state and federal government employees qualify to attend ITRC courses at no cost.

Please contact Devin Seckar (dseckar@ecos.org) to verify your eligibility and obtain the waiver promotion code.

Sunday, May 22, 8:00 a.m.–5:00 p.m. (all-day)

- Applied Sequence Stratigraphic Concepts for Predictive Conceptual Site Models: A Hands-On Training Session (page 86)
- Data Analytics and Statistics in Quantitative Chemical Analysis: Chemometric Workflow for Forensics Investigations (page 87)
- ITRC PFAS Training: Managing PFAS Contamination at Your Site (page 87)
- Technical Writing for Environmental Professionals (page 88)

Sunday, May 22, 8:00 a.m.–12:00 noon (half-day)

- Assessing and Addressing Potential Preferential Pathways for Vapor Intrusion (page 88)
- Borehole Geophysics and Hydrogeologic Characterization for Multilevel Well Design and Construction (page 88)
- Utilizing CSIA to Assess Source and Fate of Contaminants, and the Performance of Remediation Treatments (page 89)
- Optimizing Injection Strategies and In Situ Remediation Performance (page 89)
- Hydrogeochemistry Made Easy for Applied Site Investigation and Remediation (page 90)

Sunday, May 22, 1:00–5:00 p.m. (half-day)

- Improving Remedial Outcomes: Rethinking the Predictive Modeling Paradigm (page 90)
- In Situ Remediation of Contaminant Mass in Low-Permeability Materials (page 90)
- Introduction to Groundwater Remediation Geochemistry (page 91)
- ITRC and the Emerging Contaminant 1,4-Dioxane (page 91)
- Leapfrog Works—Implicit 3-D Geologic Modelling (Session 1): Getting Started with Leapfrog Works (page 92)

Tuesday, May 24, 2:00–6:00 p.m. (half-day)

- Leapfrog Works—Implicit 3-D Geologic Modelling (Session 2): Modelling Your Chlorinated Solvent Plume with the Contaminants Extension (page 92)
- Unmanned Aerial Vehicles for Site Assessment and Characterization (page 92)
- Practical High-Pressure Injection: Preparation, Tools, Design, Distribution, and Evaluation Illustrated by Case Studies (page 93)
- The ITRC Guidance: Implementing Advanced Site Characterization Tools (page 93)
- Disposal of PFAS and Other Liquid Chemical Wastes by Underground Injection (page 94)
- ITRC: Risk Communication Toolkit Training (page 94)
- Discovering Biodegradation of Emerging Contaminants for Site Management via Bioremediation (page 95)

Sunday, May 22
8:00 a.m.–5:00 p.m.

Applied Sequence Stratigraphic Concepts for Predictive Conceptual Site Models: A Hands-On Training Session

Instructors: Junaid Sadeque and Ryan Samuels (AECOM)

Objective: This course will provide hands-on training on using sequence stratigraphy to develop more accurate and predictive conceptual site models (CSMs) by understanding the subsurface geology. The course is suitable for both experienced and new professionals in the environmental industry. The potential audience includes environmental professionals and students engaged in site investigation and remediation projects.

Overview: Sequence stratigraphy is a powerful predictive tool for determining heterogeneity of sediments and connectivity of flowpaths in the subsurface. As a result, this technology has arguably revolutionized stratigraphic analyses in the petroleum sector since the 1970s. However, despite a similar need for predicting subsurface geology, the environmental world is yet to embrace sequence stratigraphy as a mainstream approach of geological investigations. This gap can be reduced by teaching the application of sequence stratigraphy specific to developing predictive CSMs. Besides lectures on the basic concepts, the student will receive ample opportunity to review actual case studies and try out the techniques of sequence stratigraphy using real data from the environmental industry in an interactive, workshop environment. While primarily geology-focused, this course is designed to walk the participants through the fundamental principles and gradually lead them to more advanced concepts, so that the uninitiated in stratigraphy can also follow. At the end of the day, the participant will leave with a deeper appreciation of how sequence stratigraphy can be properly implemented into investigation and remediation projects.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–5:00 p.m.

Data Analytics and Statistics in Quantitative Chemical Analysis: Chemometric Workflow for Forensics Investigations

Instructor: Mike Dereviankin (Chemistry Matters, Inc.)

Objective: The course will target intermediate data scientists interpreting complex quantitative chemical data sets. This course will also provide unique approaches to using modern programming languages and workflows to organize the workflow of their data analytics. Possible attendees include students, researchers, industry scientists, and data science consultants.

Overview: The rapid advancement and increased ability to resolve chemical components has superseded the common procedures for forensic data analysis. Chemometrics is a discipline blended in data science that aims to efficiently extract information from the expanding inventory of measurable chemicals. A methodological workflow rooted in big predictive analytics will be presented for statistically modelling changes in complex collected chemical data for applications in forensics consulting. After completion of this course, attendees will have gained familiarity with concepts involving data pre-processing, statistical correlation, and multivariant statistical analysis. Case studies will be presented for the application of modern data science techniques and creating supporting visuals.

Laptops are ***required*** for this course.

Sunday, May 22
8:00 a.m.–5:00 p.m.

ITRC PFAS Training: Managing PFAS Contamination at Your Site

Instructors: Dora Chiang (Wood), Jason Conder (Geosyntec Consultants), William DiGuiseppi (Jacobs), Sandra Goodrow (New Jersey Department of Environmental Protection), Kristi Herzer (Vermont Department of Environmental Conservation), Charles Neslund (Eurofins Lancaster Laboratories Environment Testing, LLC), Patricia Reyes (Interstate Technology and Regulatory Council [ITRC]), KateEmma Schlosser (State of New Hampshire), and Shalene Thomas (Wood)

Objective: Per- and polyfluoroalkyl substances (PFAS) are an emerging group of contaminants that present unique issues with site characterization, sampling and analysis, fate and transport, and remedial approaches. Regulators, site managers, facility owners, consultants, and technology developers will gain state-of-the-art knowledge on PFAS and will be able to make better decisions on managing PFAS-impacted sites.

Overview: Since 2017, the Interstate Technology and Regulatory Council (ITRC) PFAS team (the team) developed and completed 11 fact sheets, 10 PFAS training module videos, and four roundtable webinars that transfer the knowledge on PFAS naming conventions and physical/chemical properties; sources and uses; regulatory trends; site characterization, sampling and lab methods; fate and transport; human and ecological risk assessment; treatment technologies; aqueous film-forming foam (AFFF); risk communication and stakeholder perspectives. The team also completed the Technical and Regulatory Guidance Document on PFAS (https://pfas-1.itrcweb.org). The latest Guidance Document revision will be completed by the date of this 8-hour ITRC classroom training. The robust >600 member PFAS team recognizes the complexity of the topic and the importance of communicating the current science and practice for PFAS. This 8-hour ITRC classroom training led by PFAS experts from state agencies and consulting practice will review and provide updates on the occurrence, transport, risk assessment and mitigation of PFAS in the environment.

This training class supports participants to:

- Gain essential knowledge of PFAS sources and uses
- Recognize the unique aspects of PFAS sampling, analysis, and data accuracy
- Develop an understanding of PFAS fate and transport and issues surrounding surface water quality
- Establish knowledge of PFAS uptake and bioaccumulation associated with ecological and human receptors, and their potential toxic effects based on today's state of the science
- Improve understanding of Site characterization, PFAS fate and transport in soil and groundwater
- Gain knowledge on PFAS treatment technologies ranging from commercially available, limited field demonstrated to developing approaches, using separation, destruction, and combined technologies to remove PFAS from soil and groundwater. Design considerations and performance evaluation will be presented for some demonstrated technologies
- Understand best practices for managing AFFF and potential considerations for transition to fluorine-free and/or PFAS-free alternatives.

The training will include information from case studies and incorporate interactive learning experiences for reinforcing these course learning objectives.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–5:00 p.m.

Technical Writing for Environmental Professionals

Instructor: Benjamin Alter (GZA GeoEnvironmental, Inc.)

Objective: This course will impress upon the attendees the importance of clear written communication and provide tools and practical advice with which they can improve their technical work product. The potential audience includes all environmental professionals, even those at senior levels, who prepare and review technical work products as well as academicians who write research papers.

Overview: This course will provide context to the environmental professional who writes and reviews technical work products. It is designed to provide theoretical structure as well as practical advice to the attendee. The topics covered flow logically from the overall goals and structure of the technical document, to the goals and structure of the paragraph, down to the individual sentence. Emphasis will be placed on engaging the attendees with questions and practical examples. The pace will be lively and light-handed. A passionate writer and seasoned instructor, Mr. Alter is the author of Environmental Consulting Fundamentals (2nd edition, 2019), a widely-used textbook. He has taught technical writing in company settings and continuing education settings. He was an adjunct professor for over a decade at the City University of New York (CUNY).

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–12:00 p.m.

Assessing and Addressing Potential Preferential Pathways for Vapor Intrusion

Instructors: Lila Beckley and Thomas McHugh (GSI Environmental, Inc.), Kelly Pennell (University of Kentucky), Gina M. Plantz and Richard Rago (Haley & Aldrich, Inc.)

Objective: This technical course provides comprehensive instruction on preferential pathway vapor transport considerations, with the objective that attendees will become familiar with lines of evidence for appropriately screening vapor intrusion sites with potential preferential pathways, application of sampling and analytical methods, and techniques for corrective mitigation. The course will also include a summary of a decade of case studies.

Overview: Vapor intrusion (VI) is defined as the migration of vapor-forming chemicals from sources in soil and groundwater into the indoor air of occupied buildings. In varying levels of detail, over two decades of regulatory vapor intrusion guidance documents generally describe a conceptual model of VI that includes vapor-phase partitioning, diffusive transport from saturated and unsaturated vapor sources in the vadose zone, and advective and convective transport into buildings. More recently updates include an emphasis for the investigator to also evaluate the potential for preferential pathways in VI assessments. However, there is a lack of information detailing a conceptual model of vapor transport via this pathway and correspondingly little or no guidance on how to assess preferential pathways. Accordingly, preferential pathway assessments are not currently being investigated in a consistent manner, if conducted at all. Studies have shown that the contemporary conceptual model for VI does not exactly apply when preferential pathways are present. This technical course provides comprehensive instruction on preferential pathway vapor transport considerations, with the objective that attendees will become familiar with lines of evidence for appropriately screening VI sites with potential preferential pathways. A preferential pathway conceptual site model will be described, including commonly identified preferential pathway contaminant entry points, vapor transport within preferential pathways, and vapor transport from preferential pathways into buildings. Also covered are an application of sampling and analytical methods and techniques for corrective mitigation.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–12:00 p.m.

Borehole Geophysics and Hydrogeologic Characterization for Multilevel Well Design and Construction

Instructors: John Dougherty (CDM Smith Inc.) and Robert Garfield (Hager-Richter Geoscience, Inc.)

Objective: The objectives of this course are to familiarize students with 1) the different types of multilevel monitoring well systems, 2) borehole geophysical methods that are most useful for hydrogeologic characterization of overburden and fractured bedrock, 3) other methods for hydrogeologic characterization of fractured bedrock, and 4) the design of multilevel wells using borehole geophysical logs and other hydrogeologic data.

Overview: The course will review the various types of multilevel groundwater sampling systems available on the market and their application in overburden and fractured bedrock. The capabilities, advantages, and limitations of the systems will be discussed. The course will review borehole geophysical methods used to characterize overburden and fractured bedrock and demonstrate how this information is compiled, analyzed, and used to select and design a multilevel well. The guidance from the USGS and the Interstate Technology Regulatory Council (ITRC) Characterization and Remediation in Fractured Rock Team on borehole geophysical methods will be reviewed. Borehole geophysical methods reviewed will include caliper, natural gamma, electromagnetic (EM) induction, electrical resistivity, fluid temperate and fluid conductivity, optical televiewer (OTV), acoustic televiewer (ATV), flow meter logging (heat pulse, spinner, EM), and nuclear magnetic resonance (NMR). The process of analyzing these logs in the field and office to guide flow meter logging, other testing, and to select and design the multilevel systems will be presented. The course will also review other methods used to characterize open boreholes in fractured bedrock including packer testing, FLUTe FACT, FLUTe transmissivity profiles, NAPL liners, and various groundwater sampling methods. The benefits of lining open boreholes with a blank FLUTe liner will be discussed. An example and exercise of how information from these many characterization methods can be compiled and integrated will be presented and the integrated borehole log will be analyzed and used to design a multilevel well. Lastly, the course will review and evaluate the construction process for various multilevel well systems and include a discussion on subcontract specifications for the multi-level system installation as well as the borehole geophysical logging and other testing services.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–12:00 p.m.

Utilizing CSIA to Assess Source and Fate of Contaminants, and the Performance of Remediation Treatments

Instructors: David Alden (Tersus Environmental, LLC), Daniel Bouchard (Contam-i-sotopes), and Orfan Shouakar-Stash (Isotope Tracer Technologies, Inc.)

Objective: This course aims to present the latest advancement in the applications of compound-specific isotopes analysis (CSIA) and environmental isotopes as forensic tools to discern the origin of specific contaminants and characterizing and assessing the fate of different contaminants released in the environment. The potential audience includes environmental professionals, engineers, regulators, and community stakeholders engaged in the management and remediation of contaminated sites.

Overview: Isotopes, including CSIA, are considered a powerful tool in delineating commingled contaminant plumes, detecting better understanding, and quantifying biotic and abiotic transformation of various contaminants (e.g., chlorinated solvents, hydrocarbons, etc.). The course will cover the theory and background of isotopes, followed by an extended presentation of several field case studies, with a special focus on the latest advancements in combining CSIA with other traditional isotope analysis and classical site characterization approach. This short course is designed to show the latest advancement in CSIA and the potential applications of stable isotopes in general and in more specific terms in investigating natural attenuation and active remediation of various contaminants. CSIA has been successfully used in determining the source of contaminations, understanding the fate of contaminants in the groundwater, and evaluating the effectiveness of remediation actions, including the performance assessment for a broad range of biological (natural and enhanced), chemical (e.g., in situ chemical oxidation [ISCO] and permeable reactive barriers [PRB] and physical (e.g., thermal treatment and pump and treat) remediation strategies. In the last decade, CSIA has been extensively applied to many contaminated sites, and the outcome proved to be highly successful in providing information unrevealed by conventional concentration analysis. Most previous studies heavily relied on 13C-CSIA, whereas most recent investigations have been employing additional isotopes (37Cl-CSIA and 2H-CSIA). The recent interest in the two-dimensional isotope approach (13C and 37Cl) or, in some cases three-dimensional isotope approach (13C, 37Cl, and 2H) is driven by advancements in the analytical methodologies, laboratory pieces of evidence, and also field applications that demonstrated the added value of the application of multiple CSIA in distinguishing different sources of contamination as well as better understand the fate of the contaminants in the subsurface. The course will also shed light on the use of CSIA in vapor intrusion.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–12:00 p.m.

Optimizing Injection Strategies and In Situ Remediation Performance

Instructors: Richard J. Desrosiers (GZA GeoEnvironmental, Inc.), Tamzen Macbeth (CDM Smith), Elizabeth Rhine (Bhate), and David Scheer (Minnesota Pollution Control Agency)

Objective: This course will present the Interstate Technology and Regulatory Council (ITRC) Optimizing Injection Strategies and In Situ Remediation Performance Technical Regulatory Guidance document as a 4-hour short course. The training will guide remediation practitioners through the design and implementation of successful in situ remedies, how to quickly identify and diagnose poor performance, and the optimization of under-performing remedies. The audience includes state and federal regulators, environmental professionals, and stakeholders.

Overview: In situ chemical and biological treatment technologies are effective when amendments are successfully emplaced in contact with the contaminant mass. The leading causes of ineffective remedy performance are failure to adequately characterize the site, failure to account for contaminant mass storage in low permeability zones, and failure to effectively distribute amendments in low permeability materials. The focus of this short course is on remedial design characterization and the application of in situ technologies where biological and/or chemical amendments are distributed in the subsurface to treat targeted contaminant mass in porous media and fractured rock. Emphasis is given to understanding: 1. geologic and hydrogeochemical data needs (i.e., remedial design characterization); 2. spatial distribution of contaminant mass storage in low permeability material; 3. developing emplacement strategies to improve amendment distribution; 4. iterative and adaptive refinement of amendment selection, dose, and delivery; 5. performance metrics necessary for successful in situ remediation programs; 6. recognizing when to transition to monitored natural attenuation or an alternate remedy, which may require additional treatability or pilot testing; and 7. regulatory perspectives and community considerations. The course instructors will illustrate design and optimization approaches with case studies, and will review commonly encountered field and design issues and resolutions.

Laptops are ***not required*** for this course.

Sunday, May 22
8:00 a.m.–12:00 p.m.

Hydrogeochemistry Made Easy for Applied Site Investigation and Remediation

Instructor: George (Bud) Ivey (Ivey International, Inc.)

Objective: The course will present an easy to comprehend, visually driven model for understanding the technical aspects of hydrogeological contaminant chemical behavior as this pertains to conceptual site models, site investigation of vapor intrusion, soil and groundwater investigation, and improving in situ and ex situ site remediation strategies.

Overview: The course will introduce attendees to a new and easy to use set of hydrogeological and chemical principles to better understand and predict vapor, soil and groundwater contaminant behavior on sites. This is achieved through a visually driven and interactive hands-on presentation format in which attendees learn: water is not H_2O but a cluster, an easy rule to predict the solubility of all contaminants, the simple cause of contaminant sorption (i.e., absorption and adsorption), that soil textures and forest density models have much in common to understand contaminant movement (transmissivity) in soil, bedrock and groundwater hydrogeological settings, and how these understandings can aid practitioners to complete better site investigations and remediation action plans. Even attendees with limited chemistry, microbiology, geology and/or hydrogeology experience will learn a new set of applied principles to easily predict the behavior of contaminants in soil, sediment, bedrock, and groundwater regimes, including water solubility, sorption potential, and how to potentially improve physical, biological and chemical availability for in situ or ex situ remediation strategies. The course will challenge conventional understandings (models) of what water and organic contaminants are, and provide three simple tools to predict their behavior in soil, bedrock and groundwater environments. In doing so, this simplifies many of the highly technical contaminant hydrogeology principles by allowing attendees a better understanding of why some contaminants dissolve in water while others do not, and why some absorb or adsorb to soil while others do not, why some more quickly than others, and why some contaminants express limited "availability" for remediation, while others do not. Attendees will leave the workshop with an applied ability to predict contaminant behavior as it affects environmental site investigation and remediation.

Laptops are ***not required*** for this course.

Sunday, May 22
1:00–5:00 p.m.

Improving Remedial Outcomes: Rethinking the Predictive Modeling Paradigm

Instructors: Prashanth Khambhammettu, Marc Killingstad, and Michael Kladias (Arcadis)

Objective: The objective of this course is to discuss the leading causes of uncertainty that hinder the success of predictive numerical models at contaminated sites and present an overview of the tools at our disposal for quantifying and mitigating uncertainty and deriving better outcomes for clients and stakeholders. The primary audience will be environmental professionals but the course will also be of interest to regulators and stakeholders who are vested in cleanup efforts of contaminated sites.

Overview: Numerical models are often used to predict the long-term impact of remedial designs at contaminated sites. Traditionally, a numerical model is developed based on a conceptual site model and calibrated against historical measurements. This calibrated model is considered as a "single truth" and is used to predict the future impact of the proposed remedy. However, this approach fails to acknowledge the underlying uncertainty and often leads to increased life-cycle costs and surprises for clients and stakeholders. This course will present a pragmatic framework that is based on acknowledging and addressing uncertainty, and dynamically adapting remedial designs, to derive better outcomes for clients and stakeholders. Uncertainty will be described in the context of remedial modeling and some of the leading causes of uncertainty that hinder remedial success will be identified and ranked. Some of the latest methods and tools to quantify numerical model uncertainty will be presented. Finally, how high-resolution characterization and dynamic/adaptive design techniques could be used to optimize remedial designs and improve remedial outcomes will be explained.

Laptops are ***not required*** for this course.

Sunday, May 22
1:00–5:00 p.m.

In Situ Remediation of Contaminant Mass in Low-Permeability Materials

Instructors: David B. Gent (U.S. Army Corps of Engineers, Engineer Research & Development Center), Steffen Griepke (TerraTherm Inc.), William Slack (FRx, Inc.), Eric J. Tollefsrud (Geosyntec Consultants, Inc.), and James Wang (Geosyntec Consultants)

Objective: The course will provide information specifically related to remediation in low-permeability materials (e.g., clay and fractured rock), including modeling and conceptual site model (CSM) development for remedial design, as well as remediation technologies suitable for such challenging materials. The potential audience includes environmental site/program managers, regulators, and remediation practitioners.

Overview: Topics related to challenges and benefits of remediating contaminant sources in low-permeability materials, including development of CSMs supporting remedial design, as well as processes and applications of several in situ remediation technologies particularly suitable for these challenging materials will be covered. The life-cycle of a CSM demands iterative improvement of understanding as the project proceeds, based on systematic procedures. Data gap assessment and uncertainty analysis are the structural elements in the life-cycle of a CSM, and proper management of these CSM elements is particularly challenging and critical for sites with low-permeability zones. Some pitfalls in evolution of the CSM life-cycle will be examined and examples of CSMs that have been developed to meet the design, implementation and performance assessment of increasingly sophisticated remedial technologies will be presented. The CSM discussions will have particular focus on fractured bedrock as a low-permeability medium. Various environmental fracturing technologies have been demonstrated to effectively facilitate in situ remediation of low-permeability materials. The mechanisms, techniques, and applications of environmental fracturing, including the current spectrum of proppant materials, fracture emplacement methodologies, and remedial applications will be discussed. An in-depth explanation of several thermal technologies, including thermal conductive heating (TCH), steam-enhanced extraction (SEE), and electrical resistance heating (ERH), that are often considered as effective alternatives for low-permeability materials and bedrock will be provided. Remedial design approaches and tools, as well as guidelines for evaluating strengths and weaknesses of each technology with considerations of challenging site conditions will be considered. Electrokinetic (EK) transport of remediation amendments in the subsurface relies on ion migration and electroosmosis, which are electrochemical mechanisms relatively independent of soil's hydraulic conductivity. Therefore, EK transport can achieve effective distribution of select amendments in low-permeability and heterogeneous subsurface formations. The fundamentals of EK technology, its engineering implementation, and example projects will be presented.

Laptops are ***not required*** for this course.

Sunday, May 22
1:00–5:00 p.m.

Introduction to Groundwater Remediation Geochemistry

Instructor: Bill Deutsch (Geochemistry Services LLC)

Objective: This course will enable attendees to better understand 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.

Laptops are ***not required*** for this course.

Sunday, May 22
1:00–5:00 p.m.

ITRC and the Emerging Contaminant 1,4-Dioxane

Instructors: David T. Adamson (GSI Environmental Inc.), William DiGuiseppi (Jacobs), Gladys Liehr (Florida Department of Health), and Patricia Reyes (Interstate Technology and Regulatory Council [ITRC])

Objective: The 1,4-dioxane (1,4DX) training/workshop will provide a summarized overview about ITRC, as well as an overview of each deliverable the 1,4DX team has investigated including history and use of 1,4-dioxane, fate and transport, remediation technologies, risk assessment and toxicology, sampling and analysis, and regulatory framework. The summarized but in-depth information is much needed by, but not limited to, state and federal personnel in regulatory programs tasked with characterizing and remediating state, underground storage tank (UST) owners, and for individuals putting together programs that are developing strategies to address this set of emerging contaminants. It is expected consultants can use the products as well as stakeholders and the regulated community.

Overview: Characterization of sites contaminated by 1,4-dioxane (1,4DX) poses challenges on several fronts. First, 1,4DX is not detected using standard volatile organic compound analytical methods and therefore most solvent site owners are unaware of the high likelihood of impacts from this compound. Second, there are no field screening methods (e.g., photoionization detector) that are appropriate for assessing the level of contamination at a site without fixed laboratory analysis. This leads to slow progress in investigation because of analytical turnaround times. Third, laboratory analytical methods are plagued by the difficulty in separating the DX from the water samples due to its miscibility and low Henry's Law coefficient. As a result, method detection limits are often too high to meet the low standards, especially the subpart per billion standards being promulgated in some states. Fourth, 1,4DX's miscibility and low sorption to organic matter in soils leads to very high mobility. Plumes as long as 7 miles have been documented. This poses challenges for sites late in their lifecycle where outer wells have been abandoned and may need to be re-drilled to understand the nature and extent of 1,4DX, which can easily be present above standards at greater distances than the host chlorinated solvent from which it was released. The compound is not treated well by traditional groundwater treatment commonly (and cost effectively) applied at chlorinated solvent sites, such as carbon adsorption, air stripping, zero-valent iron chemical reduction, and anaerobic bio-stimulation. Therefore, at contaminated sites where 1,4DX is newly discovered, existing remedies will need to be supplemented or replaced and, at newly discovered sites, the selection of treatment technologies will be driven by the presence of 1,4DX.

Laptops are ***not required*** for this course.

Sunday, May 22
1:00–5:00 p.m.

Leapfrog Works—Implicit 3-D Geologic Modelling (Session 1): Getting Started with Leapfrog Works

This session intended for new and beginning users.

Instructor: Sean D. Buchanan (Seequent)

Objective: Learn the fundamental concepts and tools necessary to get you going in Leapfrog Works, including data import and visualization, 3-D geological modelling, producing cross-section deliverables and generating output files to be utilized in an array of software platforms. The second portion of the course will be focused on applying the Leapfrog Works Contaminants Extension to domain and model a chlorinated solvent plume using two kriging estimators (Ordinary and Simple Kriging). You can choose to join the first session, second session, or join both sessions.

Overview: Leapfrog Works is a dynamic 3-D subsurface modelling solution that turns complex data into clear, easy-to-interpret models. Leapfrog Works helps you visualize and understand the geology to communicate and make decisions on all your civil engineering and environmental projects. This first session will navigate the program interface, import, and validate an array of data types, build a geological model utilizing borehole data, and generate cross-sections and shareable modelling movies.

A laptop and mouse are ***required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

Leapfrog Works—Implicit 3-D Geologic Modelling (Session 2): Modelling Your Chlorinated Solvent Plume with the Contaminants Extension

This session intended for new and advanced users.

Instructor: Sean D. Buchanan (Seequent)

Objective: Learn the fundamental concepts and tools necessary to get you going in Leapfrog Works, including data import and visualization, 3-D geological modelling, producing cross-section deliverables and generating output files to be utilized in an array of software platforms. The second portion of the course will be focused on applying the Leapfrog Works Contaminants Extension to domain and model a chlorinated solvent plume using two kriging estimators (Ordinary and Simple Kriging). You can choose to join the first session, second session, or join both sessions.

Overview: Characterizing contaminated land and groundwater is now accessible, rigorous, and auditable with Seequent's Contaminant Extension for Leapfrog Works. By combining 3-D dynamic geological models with best practice geostatistical methods in an easy-to-learn, interactive 3-D modelling environment, you can reliably define plumes and report on contaminated sites. The Contaminants Extension provides intuitive and robust geostatistical tools to create transparent and defensible contaminant mass and location estimates in saturated and unsaturated zones. Attendees to this session will domain, model, and report on a chlorinated solvents plume utilizing geostatistical tools to establish the variograms that will be used to inform the Ordinary and Simple Kriging estimators. These estimators will then be evaluated onto a block model to calculate contaminant mass and volumes at different concentration thresholds. Calculations and filters will be applied within our block model and the Leapfrog Works Block Interrogation tool will be utilized to view samples used to inform each specific block in the model. Finally, some of the reporting functionality within the Contaminant Extension will be explored.

A laptop and mouse are ***required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

Unmanned Aerial Vehicles for Site Assessment and Characterization

Instructor: William Stiteler (Arcadis)

Objective: This course will familiarize the student with environmental and risk assessment applications of unmanned aerial vehicles (UAVs,) and will provide an overview of the regulations governing their commercial use.

Overview: The use of UAVs has expanded dramatically in recent years. This course will introduce remediation, assessment, and site characterization applications of this tool. Topics will include the analysis of imagery from various types of sensors, including multispectral and thermal cameras, as well as photogrammetric measurements, magnetometer analysis, and the use of UAVs for sampling the physical environment (water, vapor, etc.). The regulatory landscape governing the commercial use of UAVs will also be covered, as well as the range of available platforms and UAV tools. The course is intended for students with limited background in the use of UAVs, who wish to begin using them, or who want to learn about considerations when hiring a contractor for UAV work. If time and conditions permit, students will have the opportunity to fly a small UAV.

Laptops are ***required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

Practical High-Pressure Injection: Preparation, Tools, Design, Distribution, and Evaluation Illustrated by Case Studies

Instructors: Scott Noland (Remediation Products, Inc.), Ryan Oesterreich (Arcadis), Deborah Schnell (GeoSierra Environmental, Inc.), and Ed Winner (Remedial Products, Inc.)

Objective: Course participation will help attendees such as managers, regulators, and consultants make informed decisions when they plan, direct, and evaluate high-pressure injections. The course will discuss tool selection, injection techniques, and the proper applications of the same under various site conditions and with multiple amendment types, and it will describe and illustrate the same using case studies.

Overview: In situ remediation by injections of amendments has blossomed into a common practice over the last 25 years. Unfortunately, advancements in technology, techniques, and equipment, as well as knowledge of what works versus what does not work have not been effectively communicated to remediation professionals. Many misconceptions exist regarding pumps, injection tooling, flow rate, injection point grid spacing, injection pressure, how injectate moves in the subsurface, how to monitor and evaluate amendment distribution during and after injections are completed, and, finally, what quality assurance/quality control measures can be implemented and performed in the field to ensure the best outcome. This course will provide a needed, in-depth understanding of high-pressure injection, primarily in the overburden, but also in the bedrock. The course is designed to enable participants to evaluate injection work plans and to specify equipment and injection techniques best suited to a particular remediation effort. It will assist field personnel in detecting and diagnosing problems and in critically evaluating and implementing measures to overcome them. Finally, the course will address post-injection evaluation of amendment distribution and appropriate laboratory testing to monitor performance. Topics will be systematically discussed in detail during the class and illustrated using case studies. The didactic approach will be partially problem-based. A core, significant concept will be presented after which a problem from a case study will be presented. The participants will then be encouraged to solve the problem, identify the error, or oversight, to which the core concept is relevant. The purpose is to ensure that the participants recall and remember lessons many years after the course is completed.

Laptops are ***not required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

The ITRC Guidance: Implementing Advanced Site Characterization Tools

Instructors: James Finegan (Kleinfelder), Maile Gee (California Regional Water Quality Control Board), Lizanne Simmons (Kleinfelder), and Ed Winner (Remedial Products, Inc.)

Objective: This course will encourage the use of advanced site characterization tools (ASCTs) in the areas of direct sensing, surface geophysics, borehole geophysics, and remote sensing and to improve the participant's ability to appropriately select and apply ASCTs. Within this objective is the introduction to the ITRC's ASCT document, website, and training videos.

Overview: The course will cover four types of tools: direct-sensing tools, downhole-geophysical tools, surface-geophysical tools, and remote-sensing tools. Specific information for the appropriate application of the tools as well as the technical limitations of each tool will be discussed. Direct-sensing tools measure a parameter of interest through direct contact or precise, discrete sampling. Several of these tools are advanced into the subsurface to obtain logs of lithology or the permeability of soils or unconsolidated formations. Some tools provide logs about the presence and level of volatile organic compounds while others are used to provide information about the presence of non-aqueous phase liquids. Tools can also be combined to provide sensors for both contaminant detection and lithologic identification in one device. The course will present multiple such tools and outline their best use. Borehole and surface geophysics tools measurement contrasts in the physical properties of different materials (through active or passive detection methods), differences that are then used to infer or estimate parameters of interest. For example, contrasts observed in gamma radiation can be used to infer changes in lithology while changes in temperature in a borehole can be used to infer groundwater flow direction and velocity. Surface geophysical methods are non-intrusive and used to evaluate the subsurface over large areas. For example, electrical resistivity can be used to identify the location and contour of the bedrock surface through the overlying soil. The course will illustrate the values of these tools and offer application advice. The rising availability of inexpensive, small drones has opened new opportunities for particular types of remote sensing and has spurred the development of new technologies applicable to site characterization activities. The course will outline available technologies for such drones and their operating parameters.

Laptops are ***not required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

Disposal of PFAS and Other Liquid Chemical Wastes by Underground Injection

Instructors: Murray Einarson (Haley & Aldrich, Inc.), Frank Marine (Texas Molecular), Susan L. McKenzie (SMcKenzie Consulting, LLC), Rich Walther (Haley & Aldrich, Inc.), and Aaron C. Weegar (Weegar-Eide & Associates)

Objective: This course will provide attendees with an understanding of United States Environmental Protection Agency (USEPA)'s Underground Injection Control (UIC) program, with particular emphasis on poly- and perfluoroalkyl substances (PFAS) and other liquid chemical wastes. Attendees will gain specific knowledge of the feasibility and costs of disposal of liquid chemical wastes, including, but not limited to, wastes containing PFAS, and will learn the pros and cons of liquid waste disposal via underground injection compared to other waste disposal options. Engineers, site managers, consultants, scientists, and regulators will benefit from this material.

Overview: Disposal of liquid wastes by underground injection has been practiced for decades in the United States and is permitted under USEPA's UIC program. There are six classes of UIC wells, including Class I wells that inject hazardous and non-hazardous wastes thousands of feet into hydraulically-isolated geologic formations. In 2020, USEPA published a guidance document that identified UIC as a viable option for disposal of liquid wastes containing PFAS. This short course will provide attendees with an overview of USEPA's UIC program, including the types of liquid wastes that can be disposed of via underground injection, and the permitting and compliance requirements for Class I UIC facilities. Particular focus will be on the practical aspects of liquid waste disposal, including the current geographic availability of UIC facilities that accept PFAS and other chemical wastes, waste characterization requirements, transportation and disposal costs, and long-term liability of liquid waste generators.

Laptops are ***not required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

ITRC: Risk Communication Toolkit Training

Instructors: Melissa Harclerode (CDM Smith, Inc.), Lisa McIntosh (Woodard & Curran), Kerry Pflugh (New Jersey Department of Environmental Protection), and Shalene Thomas (Wood)

Objective: The purpose of this short course is to help practitioners develop, refine, and implement successful risk communication plans and outreach activities applicable across a diverse body of contemporary environmental issues. Regulators, site managers, facility owners, consultants, technology developers, and other stakeholders will all benefit from the short course instruction.

Overview: In 2018, the Interstate Technology and Regulatory Council (ITRC) assembled a multi-technical initiative team to collaboratively develop a risk communication toolkit for environmental issues and concerns. The ITRC Risk Communications Toolkit includes a brief overview of risk communication, walks through the steps in developing a communication plan, presents an overview of risk communication concepts, applies these principles in case studies, and includes various tools to facilitate risk communication plan development. The training will begin with a brief overview of risk communication basics and challenges, discuss the role of risk perception, and present the risk communication planning process and toolkit resources. The second portion of the course is formatted as a breakout session for participants to walk through each component of a risk communication plan based on a mock case study. Group breakout sessions will be conducted for attendees to gain experience in key techniques to develop specific, measurable, achievable, relevant, and time-bound (SMART) goals, formulate key messages, and select communication and engagement methods. Attendees will leave the class with an advanced understanding of the risk communication planning process and ultimately be better prepared to perform risk communication and public outreach.

Laptops are ***not required*** for this course.

Tuesday, May 24
2:00–6:00 p.m.

Discovering Biodegradation of Emerging Contaminants for Site Management via Bioremediation

Instructors: Dora Chiang (Wood), Trent Key (ExxonMobil Environmental and Property Solutions Company), Mengyan Li (New Jersey Institute of Technology), Andrew Madison (Golder Associates, Inc.), and Jinxia Liu (McGill University)

Objective: The training will introduce the background of emerging contaminants, the different types of biological processes that have been elucidated and the framework to collect lines of evidence to verify biodegradation of emerging contaminants. PFAS biotransformation potential based on laboratory and field investigations will be introduced. Regulators, site managers, problem owners, consultants, and technology developers will gain state of the art knowledge on biodegradation of emerging contaminants and make better decisions on selection of investigation tools and treatment technologies.

Overview: Biodegradation has been researched, studied and engineered as a natural remedy with low energy intensity and potentially low cost to manage contaminated sites. Advancing biodegradation of contaminants to an engineering solution begins with discovering a microbial community, microorganism, and/or functional gene that metabolically or co-metabolically degrades and/or transforms a contaminant. The biological system is further enriched, characterized, and tested to be a feasible engineering solution. Biological systems capable of degrading or transforming contaminants previously thought to be non-biodegradable have been repeatedly discovered and described due to microbial adaptivity to gain energy and carbon sources. The training will begin with introducing the background of emerging contaminants, the need of understanding their attenuation mechanisms in the environment, different types of biological processes that have been elucidated on contaminant biodegradation to answer common questions such as "is biodegradation occurring?", "how can biodegradation be enhanced through bioremediation?", and "how can bioremediation be monitored or optimized?"

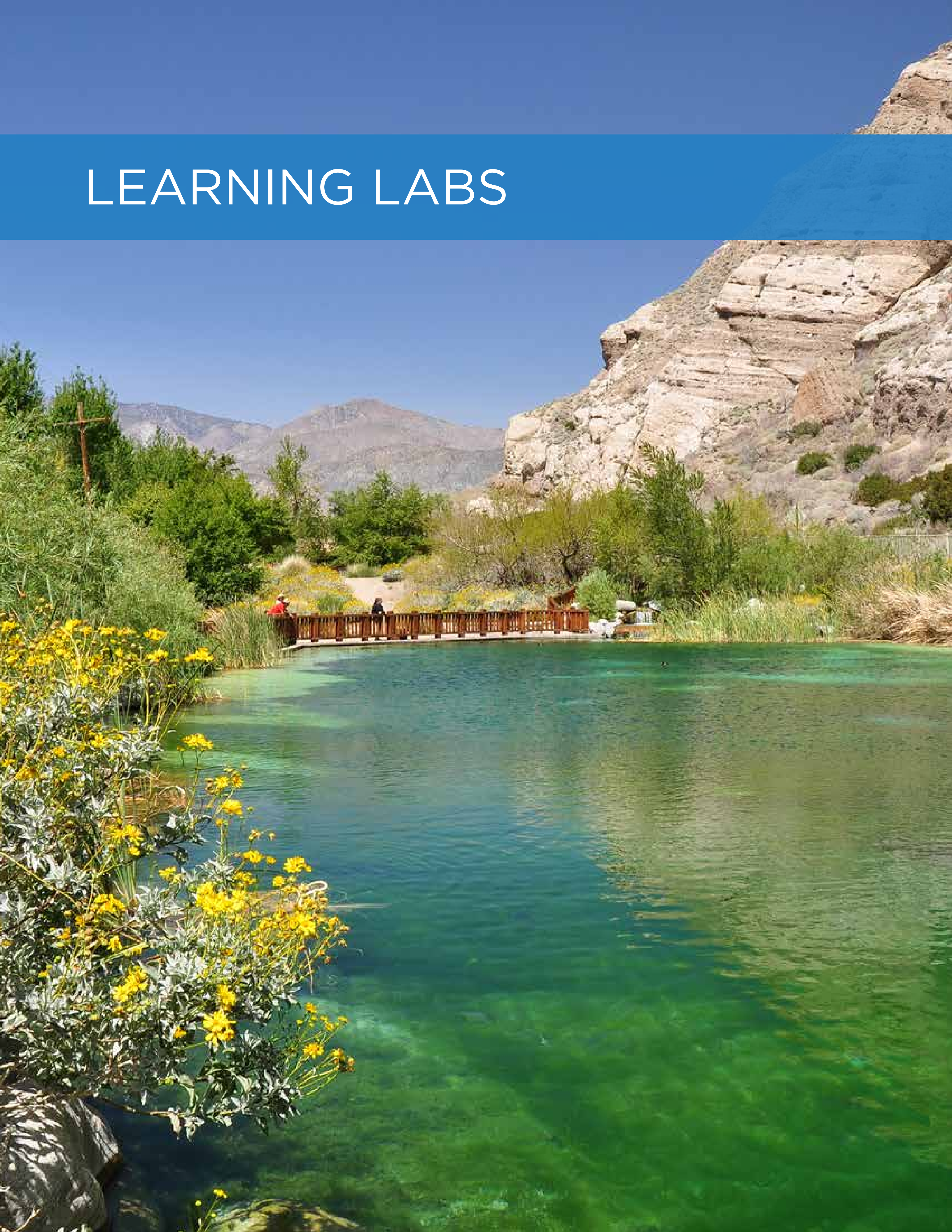
To transfer the techniques and technologies to answer these questions, this course is designed and will be broken into four primary sections for the following learning objectives:

- To gain essential knowledge on biological process, molecular biological tools (MBTs) used to measure biological processes, and risk-based approaches utilizing this information.
- To develop understanding on the discovery of 1,4-dioxane biodegradation, a contaminant previously thought to be non-biodegradable, as well as the biodegradation potential of other historic and current emerging contaminants.
- To learn about a bioremediation framework established to standardize application and implementation, lessons learned, and the case studies to assess, design, and monitor biodegradation of regulated and emerging contaminants.
- To learn about PFAS precursors detected in the environment and their biotransformation potential.

Case studies will be presented that demonstrate how each of these elements can be investigated and applied in real world scenarios. The training will also incorporate interactive learning experience for reinforcing these course learning objectives.

Laptops are ***not required*** for this course.

LEARNING LABS



Learning Lab Schedule

The Learning Lab, located in the Exhibit Hall, will consist of hands-on demonstrations highlighting specific technologies, tools, and software. A schedule of the planned demonstrations as of February 18, 2022, can be seen below.

Monday, May 23

- **12:10–12:35 p.m.**—Unique Web-Based Design Assistant Improves Design and Injection Control for Remediating Hydrocarbon Sites with Microscale Carbon Technology (page 97)
- **1:00–1:25 p.m.**—Surface-Active Foam Fractionation Benchtop Apparatus: PFAS Treatability/Feasibility Demonstration (page 98)
- **1:50–2:15 p.m.**—Documenting In Situ Reactive Mineral Formation Using the Min-Trap™: A New Monitoring Well-Based Sampling Tool (page 98)
- **2:40–3:05 p.m.**—Groundwater Profiling with the GWP 1.75 (page 98)

Tuesday, May 24

- **8:50–9:15 a.m.**—The Optical Image Profiler (OIP) for Detection and Assessment of Fluorescent NAPLs by Direct Push Methods (page 99)
- **9:40–10:05 a.m.**—Groundwater Flux Measurements: Introduction to the Utility of Passive Flux Devices and Improvements to Available Methods Data Collection (page 99)
- **10:30–10:55 a.m.**—Selecting Sustainable Remediation Options Using the SURE Toolbox for Contaminated Land Management: Hands-on Training (page 100)
- **11:20–11:45 a.m.**—Navigating Vapor Intrusion and California Development: How to Sample Utilizing Three-Way Manifold and Reusable Shroud to Minimize Cost/Time/Helium Use (page 100)
- **12:10–12:35 p.m.**—3-D Visualization and Analysis Software Demonstration (page 100)
- **1:00–1:25 p.m.**—UV-Transparent Wells for Non-Destructive Monitoring of LNAPL Distribution in the Ground Using HRSC Optical Techniques (page 101)

Wednesday, May 25

- **8:00–8:25 a.m.**—Successful Sub-Slab Vapor Data Collection, Best Practices (page 101)
- **8:50–9:15 a.m.**—PFAS Rapid Data Analysis and Insight Dashboard (page 102)
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Thursday, May 26

- **8:00–8:25 a.m.**—Web Application-Based Digital Conceptual Site Models: The Future of Dynamic, Life Cycle CSMs (page 104)
- **8:50–9:15 a.m.**—HET-TRANS: A New Practical Software Tool for Examining Plume Remediation and Back-Diffusion at Sites with Highly Heterogeneous Subsurface Geology (page 105)
- **9:40–10:05 a.m.**—Furthering Hydraulic Characterization by Visual Mapping of Injection Data (page 105)
- **11:20–11:45 a.m.**—In Situ Remediation Optimization Calculators and Technology Matrix: Manifolding, Radius of Influence, Dosing, and Chlorinated Solvent and Petroleum Technology (page 106)
- **12:10–12:35 p.m.**—Automated Remote Continuous Vapor Intrusion Monitoring and Response: Streamlining Deployment Logistics (page 106)

Monday, May 23
12:10–12:35 p.m.

Unique Web-Based Design Assistant Improves Design and Injection Control for Remediating Hydrocarbon Sites with Microscale Carbon Technology

Instructor: Todd Herrington (REGENESIS)

Objective: Remediation of hydrocarbon plumes with a microscale carbon can be made simple using guided and uncomplicated on-line software supported by a library of application and guidance resources.

Description: The use of activated carbon-based injectates has grown in popularity in large part due to the desire for rapid contaminant reduction, and the ability to couple sorption with in-place biodegradation. A new paradigm in remediation will be presented where an easily deliverable in situ, microscale-activated carbon remedial fluid is coupled with an on-line design assistant to allow environmental consultants to both perform their own design and do their own product injections with the resources needed for correct application. This Learning Lab will focus on how the web-based design assistant (www.petrofix.com/design) guides practitioners through source grid injections, excavation applications, tank basin flood treatments, and permeable interception barrier estimates. The on-line interface directs users through a simple decision process that allows multiple projects to be generated, stored, and edited based on the needs of the project. Inherent in the design software are "design rails" that help practitioners navigate through their sites and adhere to design best practices, such as injection volumes to ensure product overlap, that result in effective treatments. Major areas to be covered will be the on-line software for rapid remedial estimates and training resources provided to help ensure successful injections. Every design generated by the design assistant can generate a one-page output summary that can be downloaded and shared. This output page is a valuable summary to include in workplans, drilling estimates, and especially for the regulatory approval process. The on-line interface and output summaries allow for both the consulting and regulatory community to explore designs and evaluate cleanup approaches with this technology.

Monday, May 23
1:00–1:25 p.m.

Surface-Active Foam Fractionation Benchtop Apparatus: PFAS Treatability/Feasibility Demonstration

Instructors: David Burns and Peter Murphy (OPEC Systems P/L)

Objective: A bunded bench-scale Surface-Active Foam Fractionation (SAFF) apparatus (3-ft tall, 3-ft long 1-ft wide, 1:50 scale model) will be demonstrated to the audience to provide a visual/verbal explanation of multistage SAFF featuring clear acrylic columns and clear connector tubing. The semi-automated apparatus will be filled with potable water (approximately 8 gallons) plus two to three drops of household kitchen detergent to simulate PFAS separation/concentration into a foam for passive removal in the primary fractionator and rapid vacuum removal of foam in the secondary fractionator. The intended audience consists of remediation engineers, site managers and regulators not familiar with the process of foam fractionation.

Description: SAFF is a new intensified water treatment process to rapidly remove PFAS from impacted waters (e.g., groundwater, surface water, trade waste, landfill leachate) applicable to both ex situ and in situ applications. A 1:50 bench-scale semi-automated SAFF apparatus will be demonstrated to the Learning Lab audience to explain PFAS separation/concentration using nothing more than rising air bubbles (i.e., air/water interfacial surfaces) for uptake of amphiphilic molecules including summary of treatment results from two full-scale water treatment field trials underway since May 2019 for the Australian Department of Defence (Army Aviation Centre Oakey [AACO]) and a Swedish landfill leachate site (Telge). The 1:50 bench-scale SAFF apparatus is used for treatability/feasibility testing to model site-chemistry remediation objectives. The audience will be shown rising air bubbles swarming the primary/secondary fractionation columns and crowding into the passive and rapid vacuum hoods for removal. This vision will assist the audience in understanding the treatment results (via ribbon graph), PFAS waste concentration/enrichment factor (CF or EF) obtained from the AACO and Telge sites.

Monday, May 23
1:50–2:15 p.m.

Documenting In Situ Reactive Mineral Formation Using the Min-Trap™: A New Monitoring Well-Based Sampling Tool

Instructor: Kate Clark (Microbial Insights, Inc.)

Objective: Participants will gain a practical understanding of how and when to use an innovative new tool called the Min-Trap™ to assess in situ reactive mineral formation. The presentation will introduce the technology, explain how Min-Traps™ can be adapted for different applications, provide practical guidance on deployment and sampling techniques, summarize available analytical methods, and showcase data from field applications.

Description: In situ remediation strategies for chlorinated solvents are increasingly being designed to harness the reducing power stored in reactive minerals to facilitate abiotic contaminant transformation. In addition, many in situ treatment approaches for metal contaminants rely on the sequestration of the target contaminant within a precipitated mineral phase. However, cost-effective tools to evaluate and document these treatment processes in field applications are currently limited. While the analytical techniques to characterize reactive minerals are well developed, collection of samples to evaluate in situ mineral formation means costly drilling is required. A simple and cost-effective approach for the collection of samples to directly confirm the formation of these reactive minerals in situ without the need for drilling is needed. A novel approach to monitoring the formation of reactive minerals has been developed that provides direct evidence of reactive mineral formation within an aquifer matrix without the need for drilling. The Mineral Trap (or Min-Trap™) is a passive sampling device that is deployed within a conventional monitoring well. Porous medium contained within the Min-Trap™ provides a carrier substrate upon which target minerals can form passively. Analysis of the solid-phase media within the Min-Trap™ through chemical, microscopic, or spectroscopic means gives direct evidence of the formation of target minerals in situ while avoiding the challenges associated with traditional drilling-based sampling techniques. This low cost, monitoring well-based approach is a significant addition to the monitoring toolbox, with which practitioners can document reactive mineral formation in situ and obtain conclusive data to evaluate degradation capacity, support remedy optimization, and/or facilitate natural attenuation evaluations.

Monday, May 23
2:40–3:05 p.m.

Groundwater Profiling with the GWP 1.75

Instructors: Janet Castle (Eagle Synergistic), Thomas Christy (Geoprobe Systems, Inc.), Wesley McCall, (Geoprobe Systems)

Objective: This Learning Lab will introduce participants to the new GWP 1.75 direct push groundwater profiler. This tool was designed to obtain groundwater samples from multiple depths in a single push. Attendees will learn when to use a profiling tool and when to use a discrete interval sampler. Participants will also learn time requirements for proper purging and sampling using a profiling tool. The mechanics of assembling a profiler for field use will be demonstrated. Participants will also be taught how to display and interpret data logs made during use of the GWP 1.75 groundwater profiler.

Description: This groundwater profiling tool is designed with multiple screened sample ports over a 4 inch (100 mm) vertical interval. Clean water is injected through the sample ports at a rate of approximately 500 mL/min as the probe is advanced into unconsolidated formations using direct push methods. As the tool is driven to depth the injection flow rate and pressure are monitored and used to create a log with depth that is indicative of soil permeability. This log of injection pressure and flow rate is used to define zones where groundwater can be effectively purged and sampled using the profiling tool. At a selected sampling depth, advancement of the profiler is halted, purge water flow is shut off, and an actuator is used to activate a downhole reciprocating pump. Purging of the sampler proceeds until water quality parameters indicate that all purge water has been removed from the sampler and formation, at which point samples of the formation water may be obtained. Flow rates to the GWP 1.75 profiler are controlled by local formation permeability. Flow rates exceeding 250 mL/min can be achieved in sand and gravel formations at depths of 100 ft (30 m). This Learning Lab will teach site investigation techniques used to understand formation permeability and how to select the appropriate groundwater sampler. Examples will be shown of formations appropriate to profiler deployment and soils where the use of discrete interval samplers is indicated. Example logs from field use of this tool will also be presented, including volatile organic compound concentration data.

Tuesday, May 24
8:50–9:15 a.m.

The Optical Image Profiler (OIP) for Detection and Assessment of Fluorescent NAPLs by Direct Push Methods

Instructors: Thomas Christy, Ben Jaster, and Dan Pipp (Geoprobe Systems)

Objective: Operation of the OIP probe and system will be conducted during the lab with data and images of fluorescent products/wastes presented onscreen. The user-friendly log viewing software will be demonstrated to share real-world OIP log results and interpretation.

Description: The OIP is a direct push logging tool developed by Geoprobe Systems® that enables the operator to detect fluorescent nonaqueous phase liquids (NAPLs) in soils and many unconsolidated formations. There is a sapphire window on the side of the probe and an ultraviolet (275 nm) light emitting diode (UV LED) inside the probe illuminates the formation through the window. The OIP-UV system is used for the detection of common petroleum fuels (e.g., gasoline, diesel). A CMOS camera mounted behind the window captures images of fluorescence at 30 frames per second. The images are displayed onscreen in real time as the probe is advanced at 2 cm/sec into the formation. One image of fluorescence is saved to file every 0.05 ft (~15 mm) of log depth. The software analyzes each image to determine the area of fluorescence detected. A log of the area of fluorescence is plotted versus depth. The probe also contains a visible light (VIS) LED. The operator may halt probe advancement at any time to sequentially capture still images of UV-induced fluorescence and a visible light image for formation texture and color. The OIHPT is equipped with an electrical conductivity array and a hydraulic profiling tool (HPT) sensor to define lithology and assess potential migration pathways. Additionally, an OIP-Green probe uses a green (520 nm) wavelength laser diode to induce fluorescence of coal tars, creosote and some heavy fuels. The log viewing software allows the investigator to plot the graphical logs versus depth and also to view all of the images captured while logging. The viewing software will be used to review and evaluate OIP and OIHPT logs obtained from selected field sites. No laptop computer is required for attendees.

Tuesday, May 24
9:40–10:05 a.m.

Groundwater Flux Measurements: Introduction to the Utility of Passive Flux Devices and Improvements to Available Methods Data Collection

Instructors: Paul Erickson and Craig Sandefur (REGENESIS)

Objective: The objective of this Learning Lab is to reinforce the importance of accounting for contaminant flux when planning for in situ remediation, and to introduce a newly developed commercial method to collect passive flux data.

Description: For in situ remediation projects, a clear understanding of the vertical heterogeneities in contaminant and groundwater flux is vital to remedial success. Under or overestimation of the contamination extent can lead to excessive project costs due to reapplication needs or overdosing of remedial amendments. One effective method of collecting these data are passive flux devices, which are placed in existing monitoring wells for a period of time and then retrieved to simultaneously collect contaminant and groundwater flux measurements at discrete vertical intervals. The goal of this Learning Lab is to broadly inform on how important the concepts of groundwater flux and specific contaminant discharge are to efficient, effective remediation and to familiarize attendees with a newly available flux measurement device. Examples will be presented of how aquifer heterogeneity often creates discrete vertical zones of greater or lesser importance to contaminant transport, and therefore remediation design. The location of these zones can be identified and accounted for by using, in part, data collected by passive flux devices. A new sampling device developed by REGENESIS, known as a FluxTracer, will also be demonstrated. Attendees will be introduced to the devices and go through the deployment and retrieval process on a project site. The actual devices will be shown to better illustrate what simple steps a user will need to prepare for when collecting data using this method.

Tuesday, May 24
10:30–10:55 a.m.

Selecting Sustainable Remediation Options Using the SURE Toolbox for Contaminated Land Management: Hands-on Training

Instructors: J. Mark Nielsen and Christine Redfern (Ramboll)

Objective: This session will demonstrate the use of a new on-line decision analysis tool for evaluating the sustainability and potential resiliency of remediation approaches to manage contaminated sites. This hands-on instruction will provide participants an opportunity to learn how to complete a sustainability assessment of a contaminated site for potential remedial options based on various sustainability indicator parameters, and where necessary, engage in virtual (i.e., due to potential continuing COVID restrictions) stakeholder dialogue. The demonstration is appropriate for regulators, project managers, scientists, engineers, and field personnel.

Description: Ramboll has developed a dialogue tool that provides an on-line comparative assessment of remedial options for contaminated sites. Embodied with information and approaches from various international guidance documents, including Sustainable Remediation ISO Standard 18504, Sustainable Remediation Forum-UK (SuRF-UK) guidance and ITRC's Green and Sustainable Remediation guidance, Ramboll's Sustainable Remediation Evaluation (SURE) Tool, the dialogue tool is intended to facilitate a discussion among site owners, regulators, remediation practitioners, and/or public stakeholders to compare and contrast remedial options for a site using sustainability evaluation criteria. While risk management remains the overarching objective for any site, being able to quantitatively appraise, then describe the resulting evaluation of remediation sustainability (and resiliency) in a straight-forward, transparent, and concise report is a new development that SURE has been developed to achieve. Ramboll's SURE tool utilizes a variety of weighting indicators to screen remediation approaches based on an integration of appraiser/consultant experience with remedy technical specifications and site characterization details. This Learning Lab will include the following facets: an introduction to sustainable and resilient remediation approaches; summary of sustainability metrics and weighting indicators used to assess site and remedy information; overview and instruction on the use of the SURE tool; site practice examples using the SURE tool; and discussion on participant results and open forum on the objectives of sustainable remediation and potential future uses of SURE.

Tuesday, May 24
11:20–11:45 a.m.

Navigating Vapor Intrusion and California Development: How to Sample Utilizing Three-Way Manifold and Reusable Shroud to Minimize Cost/Time/Helium Use

Instructor: Will Rice (Enthalpy Analytical)

Objective: This Learning Lab will teach anyone experienced or new on soil vapor sampling with helium as a leak tracer in an optimal fashion. Participants will leave with a deeper understanding of not only how but why certain requirements are needed and how to better pre-empt these.

Description: The goal of this session is to engage and educate those responsible for site characterization for the purpose of property transaction and use. Laboratory analytical and field sampling practices rely on each other being sound in their approach. In order to achieve this coordination and communication between labs, consultants, regulators and developers are warranted. Most notable this impacts approach to attenuation factor, a key component of characterization and achievable goals. Attendees will get a clear explanation and examples of how sites with potential risk of inhalation of contaminated air, water vapors, or soil particles have been handled and how to develop realistic data goals for risk mitigation, then achieve them through the technology demonstrated.

Tuesday, May 24
12:10–12:35 p.m.

3-D Visualization and Analysis Software Demonstration

Instructor: Thomas Cook (CDM Smith, Inc.)

Objective: This Learning Lab will demonstrate the latest features of the Leapfrog Works 3-D visualization and analysis (3DVA) software used to support the investigation, evaluation, and remediation of contaminated soil, groundwater, and sediment.

Description: Through the innovative use of 3DVA software, complex contaminated soil and groundwater remediation challenges can be resolved faster and more efficiently than ever before. By incorporating all of the available site data into a 3DVA model, the project team is able to better understand the distribution of contamination in the subsurface, evaluate the nature and extent of contamination, and more efficiently perform other activities such as remedial investigations, contaminant transport evaluations, feasibility studies and remedial design. The latest 3DVA software enables the entire project team to explore the 3-D model on their own by using either the free model viewing desktop software or a web browser. The desktop software and web browser provide access to the full 3-D (and sometimes 4-D) datasets for project geologists, engineers, risk assessors, and decision makers to evaluate the contaminant distribution and possible remediation options. In addition to internal use, the 3DVA software provides powerful presentation visuals for sharing site results and project team conclusions with the client, regulators, and the public. The 3DVA software can also be used by the remediation engineers to make better remedial design decisions and then present the designs to project stakeholders to facilitate consensus on site cleanup decisions. This Learning Lab will demonstrate some of the latest features of the 3DVA software tools using real-world site examples with an emphasis on demonstrating how the use of the 3DVA software enabled the project team to resolve complex contaminant challenges by effectively incorporating all available site data including lithology, analytical results, historic reports and cross sections, and borehole and surface geophysics into a comprehensive 3-D conceptual site model.

Tuesday, May 24
1:00–1:25 p.m.

UV-Transparent Wells for Non-Destructive Monitoring of LNAPL Distribution in the Ground Using HRSC Optical Techniques

Instructor: Julio Zimbron (E-Flux)

Objective: High-resolution site characterization (HRSC) tools provide detailed mapping of contaminant distributions in the ground, and detailed context information about formation features that are often heterogeneous in nature. These features have made HRSC tools very useful in building the light, nonaqueous phase liquid (LNAPL) conceptual site model. This presentation will describe a non-destructive technique to survey boring logs using optical HRSC methods, enabling such surveys at critical decision points during the site lifetime.

Description: Ultraviolet (UV)-based surveying methods, such as laser-induced fluorescence (LIF), have proven very useful in characterizing detailed contaminant distributions in the ground. Such data density is very useful in understanding LNAPL mobility, risk, and the needs of remedies at LNAPL-contaminated sites. However, these tools are normally only available on a one-time basis due to the destructive nature of these surveys. Bored locations are normally plugged or turned into traditional monitoring wells, making the availability of such HRSC tools limited. E-Flux has developed a simple technique to transform a bored location surveyed into a monitoring port that can be repeatedly surveyed using HRSC UV-based techniques. This presentation will demonstrate the use of such locations, and how these surveys can shed light into the factors that affect LNAPL redistribution in the ground upon groundwater level and contaminant mass loading changes. It will also show how these factors translate into free LNAPL thickness at a traditional monitoring well.

Wednesday, May 25
8:00–8:25 a.m.

Successful Sub-Slab Vapor Data Collection, Best Practices

Instructors: Laurie Chilcote (Vapor Pin Enterprises, Inc.) and Craig Cox (Cox-Colvin & Associates, Inc.)

Objective: The Vapor Pin® technology provides a secure platform for consultants to quickly and accurately collect essential sub-slab data (soil gas screening data, soil gas samples for laboratory analysis, and sub-slab pressure readings) used in source characterization studies, vapor intrusion assessments, vapor (VOC and radon) mitigation system design and evaluation. The Vapor Pin® Insert is being specified in drawings and projects across the US and is used to facilitate the collection of soil gas samples and pressure measurements beneath engineered vapor intrusion barriers (e.g., Geo-Seal®), or vapor mitigation coatings (e.g., Retro-Coat™)

Description: The Vapor Pin® is a small sub-slab vapor port that is installed in minutes using commonly available hand tools (hammer drill, drill bits, and dead blow hammer). Once installed, the Vapor Pin® can be securely covered, making it suitable for multiple sampling events, or simply used to gather data during a single event. After the sampling is complete, the Vapor Pin® can be retrieved for reuse. The fact that Vapor Pin® is installed in a rapid, yet minimally intrusive manner, allows practitioners to cost-effectively gather high resolution active soil gas data sets. This increased site coverage provides a better understanding of the spatial variability beneath sites. When used with screening tools, such as multi-gas meters or photoionization detectors, areas of interest such as hot spots and preferential pathways can be quickly identified and targeted for analytical sampling. They are also used for continuous monitoring of differential pressure and vapor concentration. A major advantage the Vapor Pin® over other sub-slab vapor ports is that a leak-proof seal between the port and the concrete is formed immediately by the silicon sleeve that covers its outer edge. Recent enhancements to the Vapor Pin® allow it to connect to a variety of sampling devices through a barb fitting, Swagelok® compression fitting, or quick connect valve. As a result, the Vapor Pin® can quickly and reliably connect to a wide variety of vapor screening instruments, evacuated canisters, bottle vacs, absorbent tubes, manometers, portable gas chromatographs/ mass spectrometers, and other sensors. In addition, a variety of attachments have been developed to allow for the collection of soil gas samples at greater depths and to isolate VOC-impacted slabs. The Vapor Pin® Insert is being specified in drawings and projects across the US and is used to facilitate the collection of soil gas samples and pressure measurements beneath engineered vapor intrusion barriers (e.g., Geo-Seal®), or vapor mitigation coatings (e.g., Retro-Coat™) The Vapor Pin®, first introduced to the market in 2011, has become the world-wide standard tool for sub-slab investigations with tens of thousands in use in North America, South America, Australia, Europe, Africa, and Asia.

Wednesday, May 25
8:50–9:15 a.m.

PFAS Rapid Data Analysis and Insight Dashboard

Instructors: Katie Elich and Jeffrey Hale (Woodard & Curran)

Objective: The Learning Lab will present practical, creative, and insightful data analysis methods for the evaluation of per- and polyfluoroalkyl substances (PFAS) data using an innovative data dashboard platform that provides rapid analysis and insight into PFAS data, including source type, source location, concentration distribution, concentrations relative to criteria, and migration characteristics.

Description: It is well established that there are many PFAS, each with its own physical and chemical properties, and that these compounds are widespread in the environment, deriving from many industrial sources and consumer products. This has triggered the proliferation of groundwater sampling for PFAS and the accumulation of PFAS data, often without foresight of intended use or application. Many PFAS data are insufficiently analyzed, tabulated without evaluation, or remain archived in various databases. The number of PFAS and their unique properties result in opportunities for insightful data analysis using practical and creative data analysis methods. However, application of these techniques can be tedious, time-consuming, inefficient, and inconsistent using an ad-hoc approach. Rapid and insightful analysis of these data is necessary for them to be meaningful and to realize the full value of their collection. This Learning Lab will demonstrate practical, creative, and insightful data analysis methods using an innovative data dashboard platform that provides rapid analysis and insight into PFAS data. Graphical output will illustrate source type, source location, concentration distribution, comparison to criteria, and migration characteristics. Participants will enjoy an interactive session, using their laptops to access an externally hosted version of the dashboard tool with example dataset and case study on which to experiment. The real-time, interactive nature of the PFAS data dashboard tool is ideal for desktop evaluation, and as a graphics and visualization tool for dynamic meetings with stakeholders.

Wednesday, May 25
9:40–10:05 a.m.

Supercritical Water Oxidation: Successfully Destroying Per- and Polyfluoroalkyl Substances (PFAS) in the Environment

Instructors: Stephen Rosansky and Julia Stowe (Battelle)

Objective: This Learning Lab will describe principals of supercritical water oxidation (SCWO) and how it is used to mineralize PFAS into innocuous products including carbon dioxide, water, and inert salts.

Description: PFAS are an emerging class of recalcitrant contaminants that present unique remediation challenges. They are a group of more than 5,000 compounds that have diverse physical and chemical properties, affecting their fate and transport in the environment and the efficacy of technologies to uniformly treat them. Furthermore, they are chemically, biologically, and thermally stable due to the strong carbon-fluorine bond that is common to these compounds, making conventional technologies used to treat other recalcitrant compounds ineffective. Because of the known health effects of several of these compounds and suspected toxicity of others, there is a growing demand to remediate them. Realizing the need to eliminate PFAS without producing harmful byproducts, Battelle has developed a technology utilizing SCWO, referred to as the PFAS Annihilator™. SCWO leverages the unique properties of supercritical water to rapidly oxidize PFAS. Battelle has developed a bench-scale system and a mobile system capable of treating about 50 gallons per day (gpd) of feed through the reactor and is fabricating a larger mobile system capable of treating about 350 gpd. These systems employ a tubular reactor where oxidation takes place, heat exchangers to recover heat, and salt separators to remove salts that precipitate out of solution above the supercritical point of the feed to prevent clogging. Tests have demonstrated that a five-log reduction of PFAS in impacted media can be achieved, with a residence time of less than 10 seconds. The reaction is not adversely impacted by organic co-contaminants and SCWO does not appear to preferentially treat a particular PFAS. An overview of SCWO and select data demonstrating destruction of PFAS in a variety of impacted media including investigation derived waste, aqueous film-forming foam, landfill leachate, and granular activated carbon regenerant will be presented. A mobile system will be present on site so that attendees can obtain a first-hand understanding of the process and equipment used to destroy this unique and recalcitrant group of compounds.

Wednesday, May 25
10:30–10:55 a.m.

The Application of Indicators and Tracers for Vapor Intrusion Sampling Strategies with a Scale Building

Instructor: Benjamin F. Thomson (Jacobs)

Objective: Monitoring low-cost indicators and tracers (I&T), such as differential temperature, differential pressure, and radon, has been suggested as a way to improve the representativeness of vapor intrusion (VI) sampling data by targeting sampling times on the basis of the I&T information. This Learning Lab will illustrate how I&T devices can be installed and provide a better understanding of VI concepts using a miniature building (scale model). This Learning Lab will be a useful demonstration for engineers, site managers, and regulators.

Description: The scale building is anticipated to have a realistic envelop and will serve to illustrate concepts driving VI. Innocuous materials will be used to help visualize airflow. The Learning Lab will show how to install devices such as: low-cost temperature data loggers; differential pressure data loggers/

micromanometers; and consumer-grade radon detectors. As further illustration for these concepts, PowerPoint slides and/or a poster will provide examples for data processing, including sampling time selection (including automated options), selection for sampling of rooms/structures most vulnerable to VI, and mitigation system effectiveness verification. After some introductory remarks, the audience will be able to view the inside of a miniature building and the space below it (through plexiglass), as vapor flow is generated and drawn up into the building by advection through a preferential pathway (a simulated crack in the building foundation). An ordinary floor fan will be used to simulate wind effects and a small heater used to demonstrate stack effect. A computer screen and other sensors will be used to illustrate how differential temperature and differential pressure data are acquired in real time to track forces driving vapor flow.

Wednesday, May 25
11:20–11:45 a.m.

SOCRATES: A Web-Based Application for Environmental Data Analytics

Instructor: Christian Johnson (Pacific Northwest National Laboratory)

Objective: This Learning Lab will provide a hands-on demonstration of the web-based SOCRATES software for data-driven analytics for environmental restoration sites. Using Hanford data as an example, attendees will learn how web-based tools can be used to evaluate water level data, plume dynamics, remediation systems, monitoring systems, and remotely sensed data. Environmental professionals and site managers will benefit from this Learning Lab that demonstrates the ease of access to analytics relevant to site decision-making.

Description: Environmental restoration efforts often involve collection of multiple types of data and can comprise a large quantity of data. Web-based tools offer an improved approach to working with data and rapidly obtaining results. Advantages of web-based tools include wide availability of the application (via a web browser), access to up-to-the-date data, availability of standard analytical methods to ensure consistent application regardless of the analyst doing the work, built-in functionality/logic to make setting up the analysis quick and easy, and ability to provide transparent access to clients/stakeholders. The Suite of Comprehensive Rapid Analysis Tools for Environmental Sites (SOCRATES) is a web application providing data-driven analytics that help make sense of site environmental data. SOCRATES includes a suite of modules for analyzing groundwater levels and flow direction, contaminant concentrations, water quality parameters, plume dynamics, remediation systems, and remote sensing data interpretation. This Learning Lab will allow users to work with SOCRATES, using the U.S. Department of Energy's Hanford site as the example data set, to illustrate how web-based tools can facilitate data analysis to answer key questions and support remedial decisions.

Wednesday, May 25
12:10–12:35 a.m.

Electrical Geophysical Monitoring and Characterization of Contaminant Storage and Release in Low Permeability Zones

Instructors: Ramona Iery (U.S. Navy), Lee Slater (Rutgers University), Fred Day Lewis (PNNL), and Neil Terry (USGS)

Objective: Simultaneous monitoring of electrical resistivity and fluid-specific conductance during an ionic tracer test provides a new approach to quantifying hydrogeological parameters that control solute exchange between mobile and immobile zones. The objective of this Learning Lab is to (1) briefly explain the basic theory of a dual-domain porous medium, (2) showcase laboratory and field applications of electrical monitoring to estimate dual domain parameters, and (3) demonstrate the analysis of a typical dataset using a software tool.

Description: Models of dual-domain mass transfer (DDMT) are used to describe anomalous transport behavior (e.g., contaminant rebound after the stop of pumping) as observed in active remediation efforts and often attributed to the process of back diffusion. New technologies are needed to better quantify DDMT at contaminated field sites in order to understand the long-term fate of contaminants in low-permeability zones. Electrical geophysical measurements, when combined with pore fluid specific conductance measurements during an ionic tracer injection (or flush) experiment, can be used to quantify DDMT parameters. This Learning Lab will briefly cover the theory of electrical geophysical inference of DDMT parameters from a tracer test. Example applications of the approach from SERDP- and ESTCP-funded research will be demonstrated. Applications will include laboratory measurements on rock cores obtained from chlorinated solvent-contaminated fractured rock sites and in situ measurements from a borehole using the Mobile Immobile Porosity Exchange Tool (MI-PET) developed and demonstrated under ER201732. A video describing a typical MI-PET deployment, highlighting system components (packer-electrode assembly, fluid injection and sampling ports) will be shown. Software tools developed to interpret typical datasets from an electrical geophysical tracer test will be demonstrated. These tools will be used to explain how the relationship between bulk electrical conductivity of the porous medium and fluid-specific conductance recorded over time can be analyzed to infer immobile porosity fraction and exchange rate coefficients via analytical and semi-analytical techniques. Broader applications of the methodology, including the characterization of river- and lake-bed properties controlling groundwater-surface water exchange, will be briefly discussed.

Wednesday, May 25
1:50–2:40 p.m.

Using Augmented Reality for Geological and Groundwater Modelling

Instructors: Sean D. Buchanan, Bart Jordan (Seequent), and Konrad William Quast (Wood)

Objective: Displaying the results of modelling, whether it is geological, hydrogeological or another form of modelling, has always been a challenge specifically when coupled with 'real-time' data collection. With the computing power available today and the advent of highly sophisticated software, 3-D and 4-D model results can be highly informative and non-technical decision makers can benefit from the viewing of the model results. This Learning Lab will demonstrate the use of augmented reality using HoloLens™ glasses for the viewing of models.

Description: A holographic hydrogeologic model using augmented reality combined with specific visualization software can be used to illustrate to the client, regulators, stakeholders, and the public, underground hydrogeologic features and the extent of potential groundwater impacts as perceived today and into the future (model predictions). As a first step for geologists and hydrologists into the augmented reality world, Wood Resilient Environments with Seequent will be presenting a groundwater geologic model in 3-dimensions (3-D). While not presented during this demonstration, additional functionality is also possible with current technological advancements. One such advancement is the incorporation of 'real-time' data collection that can be integrated into 3-D and 4-D models. Data from the field can now be directly updated in an existing 3-D model, and the user can visualize changes as the data are being collected and input into Leapfrog Works™, a dynamic subsurface geologic modelling software. This is made possible by Seequent's collaborative cloud-based solution Central. For this demonstration, the audience will be able to view a 3-D holographic groundwater geologic model on a large screen via Miracast™ that the presenter is seeing in the HoloLens 2™ unit. A select number of conference participants will be invited to use HoloLens 2™ glasses to view the groundwater model in augmented reality in a follow up session. Participants will be able to visualize the geology and hydrogeology of the site, fault blocks, and interpolated plume of PFAS contaminants in 3-D.

Wednesday, May 25
3:05–3:30 p.m.

In Situ Bioreactor: A Unique Remediation Tool Delivering Sustained Biostimulation

Instructor: Kate Clark (Microbial Insights, Inc.)

Objective: The in situ bioreactor (ISBR) is an innovative remediation tool that uses Bio-Sep® bead technology to provide sustained biostimulation in impacted wells. A demonstration of the ISBR in a simulated monitoring well will highlight the tool's design and function, and the presentation will also showcase data from successful field applications.

Description: ISBRs provide targeted bioremediation by stimulating high concentrations of indigenous contaminant-degrading microorganisms. ISBRs are designed to fit within a 2-inch monitoring well and can be customized to address a variety of remedial challenges. The ISBRs are filled with Bio-Sep® beads, which provide a matrix of powdered activated carbon (PAC) and Nomex® that can be rapidly colonized by the active portion of a microbial community. The PAC adsorbs contaminants and nutrients present in the aquifer and serves to collect indigenous degraders for treatment purposes. Additionally, amendments can be delivered into the unit via topside equipment. At sites with potentially inhibitory contaminant concentrations, contaminant adsorption onto PAC can serve to lower bulk concentrations in the vicinity of the ISBR and overcome the inhibition. On the other hand, at locations where contaminant concentrations are too low to sustain an active population of degraders, the PAC concentrates contaminants, subsequently enhancing biodegradative activity. Furthermore, groundwater flow through the bioreactor allows for microorganisms from within the bioreactor to migrate into the formation beyond the wellbore area to further promote biodegradation in the aquifer. "Bioaugmenting" the plume with these native microorganisms avoids concerns about the survivability of injecting laboratory-grown cultures in the field. This feature can also be beneficial at sites with contaminants that are not currently addressed by commercial cultures. ISBRs are well-documented to induce positive shifts in microbial growth and corresponding decreases in compounds of concern. This presentation will include case studies from chlorinated solvent and petroleum hydrocarbon sites where ISBRs were used to enhance biodegradation and rapidly reduce contaminant concentrations.

Thursday, May 26
8:00–8:20 a.m.

Web Application-Based Digital Conceptual Site Models: The Future of Dynamic, Life Cycle CSMs

Instructors: Rick Cramer, John Hesemann, and Colin Plank (Burns & McDonnell)

Objective: This Learning Lab will introduce participants to a new technological approach to developing, maintaining, and utilizing dynamic digital conceptual site models. The demonstrated approach facilitates the integration of existing and newly acquired geologic, hydrologic, and analytical data. Participants will gain hands-on experience with a web application-based conceptual site model (CSM) and use it to make decisions in several site management and work planning scenarios.

Description: Web application-based digital CSMs will revolutionize CSM delivery, utility, and lifespan within the groundwater remediation industry. This new approach to CSMs provides access to traditional CSM work products (potentiometric and iso-concentration maps, analytical and potentiometric time and depth series, lithological logs, geologic cross-sections, and source and receptor relationships) in a software environment consisting of dynamically scalable visualizations (maps, cross sections, 3-D models), tailored database query tools connected to the visualizations and live infographic charts, and linked static project files and images. These elements, presented in a "dashboard" format, allow for intuitive data interrogation and exploration within the context of the project team's existing CSM work products. Additionally, when linked to field geographic information system (GIS) software, the CSM becomes an integral part of the project execution and workflow, facilitating a more effective real-time decision-making process. Because a web application-based digital CSM requires only the use of a web browser, minimal training is necessary for use. Web-application platforms provide an effective means of transferring institutional knowledge at a complex site between consultants and/or generations of project staff and managers. This approach to CSM delivery results in a CSM that is no longer treated as a static "File Cabinet" CSM; rather, the CSM is a dynamic "living" data model accessible to all project disciplines and readily available for project management, technical working group discussion, and transparent and effective communication with project stakeholders. This Learning Lab will demonstrate the use of this recently developed technology at several project locations, provide an overview of the best practices for database management and data acquisition necessary for effective development, and provide an opportunity for hands-on use of the tool in some decision-making scenarios.

Thursday, May 26
8:50–9:15 a.m.

HET-TRANS: A New Practical Software Tool for Examining Plume Remediation and Back-Diffusion at Sites with Highly Heterogeneous Subsurface Geology

Instructor: Daniel Burnell (Tetra Tech, Inc.)

Objective: This presentation will provide a clear demonstration of a new, easy-to-use Windows software tool, and how it can be applied to better understand contaminant plume behavior including: (1) transient changes in plume spatial distribution; (2) distinct patterns within the slowly decreasing concentration data over time in monitoring wells; and (3) plume spatial zones where back-diffusion is likely to cause tailing and a long cleanup timeframe. This tool will be useful for environmental scientists, site managers, and regulators to not only improve conceptual understanding but also predictions of the cleanup time as a result of heterogeneous advection and back-diffusion at sites with different degrees of subsurface geologic heterogeneity.

Description: The HET-TRANS software is a new practical contaminant fate and transport modeling tool that can be applied to more accurately simulate contaminants in groundwater at sites with both mild and strong subsurface heterogeneity. Given the well-known limitations of models that use the standard advection-dispersion equation (ADE), this software uses an extended ADE model that can simulate advection, retardation, dispersion, back-diffusion, and degradation of contaminants in highly heterogeneous mobile and immobile zones. This software will be useful to help environmental scientists, site managers, and regulators to quickly assess a site and estimate the cleanup timeframe of contaminants including PFOA in groundwater. Written in Python, this software has a simple graphical user interface (GUI) that is easy to use, and the code can be quickly ported to Windows, Apple, and Linux operating system platforms. The user-friendly GUI enables quick input of parameters on a single sheet, including choosing the appropriate model, running the model, and plotting the results. For one-dimensional (1-D) model simulations, both plume centerline versus distance and concentration versus time plots are provided. For three-dimensional (3-D) model simulations, contour-flood plots are provided. For a particular project, both a summary file of input and calculated parameters and graphic plots are saved in user-name files. The HET-TRAN models allows the user to simulate a spill, continuous source, depleting source, or a finite-duration release as a result of source zone remediation. This tool can help managers to assess when and where back-diffusion may cause plume tailing. Given its ability to simulate both advection and back-diffusion in highly heterogeneous subsurface environments, this modeling tool helps environmental professionals to also better understand how: (1) plume mass can persist near source areas even when nonaqueous phase liquid is not present; (2) long concentration versus time tails occur in monitoring wells; and (3) better interpret breakthrough curve data including changes in slopes as a result of heterogeneous advection, back-diffusion, and degradation reactions.

Thursday, May 26
9:40–10:05 a.m.

Furthering Hydraulic Characterization by Visual Mapping of Injection Data

Instructor: Andrew Kavanagh (REGENESIS)

Objective: Among remediation practitioners it is a known truth: there is not sufficient understanding of the hydrology before implementing a remediation project. However, there is a largely unexplored yet abundant data mine collected during in situ remediation projects that can greatly enhance the understanding of hydraulic conditions. When used properly in conjunction with an adaptive remediation approach, a successful remedy and more rapid site closure can be assured.

Description: One of the most common methods employed for the injection of remediation fluids is pumping through drilling rods advanced by a direct push rig. When done correctly, flow rates, pressure responses and applied volumes are recorded for a given vertical interval as fluids are injected. Through the relationship between an applied pumping (i.e., flow) rate and the formation pressure response, a relative permeability can be derived for a given volume or unit of treatment. These permeability units can then be plotted, and visual enhancement applied to create a cross-sectional image of the subsurface hydrological architecture. When viewed in real-time during injection, these images are a useful aid in properly directing remedial fluids to the target contaminant flux zones. Once completed, they can often greatly enhance the hydraulic understanding at a project site due to the density of data that is often collected during injection. A case study will be presented to demonstrate how this approach was used to overcome a challenging heterogeneous environment during installation of a permeable reactive barrier utilizing a liquid activated carbon substrate to cut off migration of chlorinated solvents from an industrial facility into a residential area.

Thursday, May 26
11:20–11:45 a.m.

In Situ Remediation Optimization Calculators and Technology Matrix: Manifolding, Radius of Influence, Dosing, and Chlorinated Solvent and Petroleum Technology

Instructor: Eliot Cooper (Cascade Remediation Services)

Objective: This Learning Lab will demonstrate four in situ remediation design tools that Cascade has developed to help our customers optimize remediation performance. The tools are based on hundreds of sites across the country and represent best practices and lessons learned to optimize future projects. Acess to the tools will be provided to those in the Learning Lab and each will be described in enough detail so that they can be used by the attendees. Participants will need to provide their own laptops to participate in the training.

Description: The Learning Lab will provide hands-on training on how to use the following Cascade Calculators and Technology Matrix.

1. The Manifold Calculator will help calculate a Return on Manifolding Investment (ROMI) for direct push and injection through wells.
2. The Radius of influence (ROI) calculator will calculate a ROI based on injection volumes and seepage velocity for target intervals both for injection or fracturing of liquids and solids to ensure a sound basis for contact and residence time.
3. The Dosing calculator will help provide a sound basis for number of injection events, specification of injectable intervals, and application of confidence factors.
4. The Chlorinated Solvent Matrix defines thermal, chemical, and characterization technology best practices considering phase (source, transition and plume) versus contaminant mass (DNAPL, PPM < DNAPL solubility and < PPM), and lithology (clay, heterogeneous, sand). This matrix can also be updated by firms that have done enough projects to develop a specific one for their projects to help train their staff and provide references to clients.

Thursday, May 26
12:10–12:35 a.m.

Automated Remote Continuous Vapor Intrusion Monitoring and Response: Streamlining Deployment Logistics

Instructor: Mark Kram (Groundswell Technologies, Inc.)

Objective: Participants will learn how to deploy VaporSafe® continuous automated vapor concentration and pressure monitoring to rapidly identify and confirm indoor sources of trichloroethene (TCE) and other volatile organic compounds (VOCs), determine whether vapor intrusion is occurring, identify vapor entry locations and preferential pathways, and prevent acute toxic exposures via automated response. Participants (site managers and regulators) will become familiar with field logistical requirements, learn how to set up system components, access and navigate the web dashboard, set automated response criteria and interpret observations.

Description: The continuous automated monitoring system is comprised of a customized laboratory-grade analytical instrument equipped with various detectors for rapidly measuring TCE, tetrachloroethene (PCE), vinyl chloride and other VOC concentrations indoors, in subsurface vapors, and outdoors at levels sufficient to meet regulatory requirements. Other features include multiplexing to allow for continuous monitoring from up to 16 locations as far as 300 m from the analyzer, evaluation of spatial and temporal concentration dynamics, measurement of pressure differential and climatic data, and efficient remote data management of the hundreds of data points collected each day via Cloud-based automated data-processing, visualization, alerting, and response. The approach incorporates automated calibration runs and delivery of status reports. Data patterns generated result in the ability for site managers to quickly move to the next phase in the vapor intrusion risk management process (e.g., identify/exploit correlations with natural and anthropogenic controlling factors, determine reasonable maximum exposure concentration and risk, obtain site closure, design and confirm surgical mitigation approaches, and rapidly assess large neighborhoods, etc.). The approach is also ideal for remediation performance monitoring (e.g., preventing fugitive VOC and methane emissions during thermal and amendment applications) and for triggering actions when treatment components are depleted or require adjustment. Continuous automated monitoring and response represents a comprehensive and cost-effective risk characterization and prevention option for consultants, RPs and the regulatory community.

CONFERENCE SPONSORS

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AECOM is a world leader in developing innovative environmental solutions with cutting-edge expertise in remediation technologies. AECOM has been a key participant in technical consortia, discussing innovative remedial solutions for contaminated sediment and regulatory strategies for emerging contaminants like 1,4-dioxane and per- and polyfluoroalkyl substances. We solve complex site challenges using an effective endpoint strategy, addressing a broad range of contaminants and working with diverse stakeholders. AECOM remediation teams critically assess the nature and extent of contamination, risks to receptors and safe exposure levels; utilize leading-edge biological, chemical and physical technologies to reduce project costs; and prepare and implement effective remedial designs. Stop by our booth to hear about our DE-FLUOROTM PFAS destruction technology! A Fortune 200 firm, AECOM had revenue of approximately $13.2 billion during fiscal year 2020. Visit us at **aecom.com**

At **Allonnia** we believe that waste is a failure of imagination. We're bringing advanced biology and progressive engineering to develop breakthrough technologies that solve the world's toughest waste remediation challenges and enable a closed loop economy. Allonnia was founded on the belief that the answer to our waste and pollution challenges lies in nature. In nature, nothing is wasted, and we believe this principle can—and must—be applied to industry as well. Visit us at **allonnia.com**

Arcadis is the world's leading company delivering sustainable design, engineering and consultancy solutions for natural and built assets. We are more than 27,000 people, in over 70 countries, dedicated to improving quality of life. With sustainability at the heart of everything we do, our focus is on maximizing our impact aimed at improving quality of life. The solutions we develop address important societal challenges around resilience, places and mobility. Leveraging data and technology, we have the capabilities and services to meet client demands driven by global trends such as urbanization, climate change, digitalization, evolving stakeholder expectations and potential unforeseeable events. Visit us at **arcadis.com**

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Directional Technologies specializes in the design and installation of horizontal remediation wells for challenging site conditions. For 29 years and counting, Directional Technologies has been a leader in the environmental remediation industry with multiple innovations and breakthroughs. We take an engineering-first approach to helping you design superior solutions for your clients, enabled by our team of in-house engineers and highly professional crews. Our clients include property owners, regulators, and environmental consultants, who often hire us because they are frustrated with the limitations of traditional vertical wells, have complex site conditions that require specialized expertise and techniques, or are simply looking for a true partner that will get the job done right. Solutions designed and installed by Directional Technologies have provided a path to completion for many projects previously considered unfeasible. Innovative horizontal well solutions often lead to a quicker site closure, therefore lowering the overall cost of the remediation project. Directional Technologies is not your typical directional driller; we are engineers and geologists working with you to solve your client's problems. We work to understand your project objectives and constraints and utilize our engineering expertise and proprietary software to develop site-specific designs that have proven to provide superior performance. Our experience installing over 1,000 horizontal remediation wells provides us with an excellent resource to ensure that your project is successful. We have had the privilege of working with creative and smart consultants from remediation firms across the country and internationally. Directional Technologies is the leader in horizontal remediation wells and the only company that can provide design, installation, state-of-the-art custom designed horizontal well screen, horizontal well modeling, and site-specific remediation solutions. Visit us at **directionaltech.com**

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EPOC Enviro (EPOC) is a division of Australian environmental engineering company OPEC Systems. EPOC is one of very few technology providers to design and construct a commercial scale PFAS Wastewater Treatment Plant. The WTP, located at Army Aviation Centre Oakey in Queensland, Australia, can process up to 250,000 litres per day of PFAS-contaminated water to below drinking water guidelines. For nearly 30 years OPEC Systems has been designing, supplying, installing and maintaining intelligent environmental engineering solutions for industry and government. At the core of OPEC's PFAS treatment capabilities is OPEC's patented foam fractionation technology, Surface Active Foam Fractionation® (SAFF®). SAFF is a physical separation process that harnesses the power of pure air to effectively remove PFAS from contaminated waters. It is the most elegant, sustainable and cost-effective remediation process on the market. Treatment of priority PFAS compounds (PFOS,PFOA, PFHxS, and other =C6 chemistries) are rapidly removed from water to below drinking water criteria without the need for adsorbent media. With tens of millions of gallons of PFAS contaminated water successfully treated to date, SAFF is the proven lead technology for any PFAS remediation treatment train. SAFF can also be used as a sole treatment. Visit us at **epocenviro.com**

FRx provides specialty injection and delivery services in support of soil, bedrock, and groundwater remediation. The company founders conceived and developed many reliable techniques and technologies while serving as principal investigators for several research and development projects sponsored by the USEPA in the 1980's and 1990's. FRx was founded in 1994, and continued development and deployment of efficient, innovative and cost effective injection technologies has been a primary focus ever since. Particular focus is placed on injection methodologies that allow targeted emplacement of solid phase remedial substrates for well productivity stimulation, ISCO, ISCR and/or enhanced bioremediation purposes. FRx has contributed to the successful remediation of sites in the majority of the states, as well as across the remainder of the North American continent, Europe and South America. Visit us at **frx-inc.com**

ISOTEC Remediation Technologies is the premier source for in-situ remediation solutions in the environmental industry. For over 26 years, ISOTEC has development and implemented proven site solutions for groundwater and soil remediation, including: ISCO (in-situ chemical oxidation), ISCR (in-situ chemical reduction), EISB (enhanced in-situ bioremediation), activated carbon-based amendments, metals treatment and combined remedies. ISOTEC's national field offices provide remediation design characterization, direct-push injection, drilling and soil mixing services from the design phase through project completion. Visit us at **isotec-inc.com**

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mi microbialinsights

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Program at a Glance

MONDAY, May 23	TUESDAY, May 24	WEDNESDAY, May 25	THURSDAY, May 26
7:00 a.m.–7:00 p.m. Registration, Exhibits, Poster Group 1 Display 7:00–8:00 a.m. Continental Breakfast 8:30-10:00 a.m. Plenary Session 10:30 a.m.–12:00 p.m. General Lunch 2:30–3:00 p.m. Afternoon Beverage Break	7:00 a.m.–1:50 p.m. Registration, Exhibits, Poster Group 1 Display 7:00–8:00 a.m. Continental Breakfast 10:00–11:00 a.m. Morning Beverage Break	7:00 a.m.–7:00 p.m. Registration, Exhibits, Poster Group 2 Display 7:00–8:00 a.m. Continental Breakfast 9:30–10:00 a.m. Morning Beverage Break 11:30 a.m.–1:00 p.m. General Lunch 2:30–3:00 p.m. Afternoon Beverage Break	7:00 a.m.–1:00 p.m. Registration, Exhibits, Poster Group 2 Display 7:00–8:00 a.m. Continental Breakfast 9:30-10:00 a.m. Morning Beverage Break 11:30 a.m.–1:00 p.m. General Lunch 2:30–3:00 p.m. Afternoon Beverage Break
12:10–4:20 p.m. Platform Sessions & Learning Lab Demonstrations	**8:00 a.m.–1:50 p.m. Platform Sessions & Learning Lab Demonstrations**	**8:00 a.m.–4:20 p.m. Platform Sessions & Learning Lab Demonstrations**	**8:00 a.m.–4:20 p.m. Platform Sessions** **8:00 a.m.–1:00 p.m. Learning Lab Demonstrations**
A1. Emerging Remediation Technologies	A2. Abiotic and In Situ Biogeochemical Processes: Applications and Lessons Learned A3. ZVI: 25 Years of Groundwater Remediation Applications	**Panel:** Thermal Remediation Technology Updates: Eight Experts Discuss Four Years of Innovations in 100 Minutes A4. Combined Remedies and Treatment Trains	A5. Permeable Reactive Barriers: Best Practices and Lessons Learned A6. Thermally Enhanced In Situ Degradation Processes at Sub-Boiling Temperatures A7. Horizontal Wells: Applications and Lessons Learned in Site Characterization and Remediation A8. Electron Donors: Innovations for Biodegradation
B1. In Situ Technologies: Lessons Learned	B2. Thermal Conductive Heating: Best Practices and Lessons Learned B3. Thermal Conductive Heating: Case Studies	B4. In Situ Chemical Oxidation: Optimized Design Approaches and Lessons Learned B5. Injectable Activated Carbon Amendments: Lessons Learned and Best Practices B6. Innovations in ZVI Amendment Formulations and Applications	B7. nnovative and Optimized Amendment Delivery and Monitoring Methods B8. Monitored Natural Attenuation: Innovative Monitoring Approaches/Lines of Evidence and Lessons Learned B9. Advanced and Synthetic Biological Treatment Applications B10. Electrical Resistance Heating: Best Practices and Lessons Learned
C1. Remedial Design/Optimization: Applications of Mass Flux and Mass Discharge	C2. Remedy Implementation: Assessing Performance and Costs C3. In Situ Activated Carbon-Based Amendments: Assessing Effectiveness and Performance C4. Compound-Specific Isotope Analysis: Case Studies in Evaluating Remedy Performance	C5. Site Closure: Models Used to Estimate Cleanup Timeframes C6. Data Analytics: Use of Advanced Decision Analysis Tools, Including AI and Machine Learning for Improved Analysis, Optimization and Decision Making C7. Optimizing Remedial Systems	C8. Setting Cleanup Goal End Points: When Are We Done? C9. GSR Best Practices and Nature-Based Remediation Case Studies C10. Climate Resilience and Site Remediation C11. Aligning Remediation Goals with Environmental, Social, and Governance (ESG) Considerations
D1. Large, Dilute and Commingled Plume Case Studies **Panel:** Investigating and Remediating a Major Chlorinated Solvent DNAPL Site	D2. Landfill Assessment and Remediation D3. Adaptive Site Management: Lessons Learned for Site Characterization and Remedy Implementation	D4. Evaluating Surface Water/ Groundwater Interactions: Innovative Monitoring Approaches and Modeling Applications D5. DNAPL Source Zone Remediation: Lessons Learned D6. Low-Permeability Zone Challenges, Permeability Enhancements, and Case Studies	D7. Precipitation and Stabilization of Metals D8. Mining and Uranium Site Restoration D9. Managing Chromium-Contaminated Sites

MONDAY, May 23	TUESDAY, May 24	WEDNESDAY, May 25	THURSDAY, May 26
E1. Advances in the Analysis of Non-Target Per- and Polyfluorinated Alkyl Substances (PFAS) E2. PFAS and Bugs: The Search Continues	E3. Ex Situ PFAS Treatment: Soils/Solids and Other Waste Streams **Panel:** Should We Develop PFAS Ambient Levels: Why and How?	E4. PFAS Human Health and Ecological Risk Assessment and Toxicity E5. Managing PFAS at Publically-Owned Treatment Works (POTWs) E6. Ex Situ PFAS Water Treatment Technologies	E7. PFAS Site Characterization E8. In Situ PFAS Treatment Approaches
F1. PFAS Fate and Transport Properties	F2. PFAS Conceptual Site Model Approaches F3. PFAS Program Management in a Rapidly Changing Regulatory Environment F4. PFAS Source and Forensic Considerations	F5. PFAS: Groundwater Treatment Case Studies F6. Ex Situ PFAS Destruction Technologies F7. Advances in Vapor Intrusion Investigations	F8. Vapor Intrusion Mitigation and Effectiveness F9. Vapor Intrusion Risk Assessment and Site Management
G1. Expedite Site Closure: Innovative Strategies and Approaches G2. Practice of Risk Communication and Stakeholder Engagement	**Panel:** Monitored Natural Source Zone Depletion G3. Heavy Hydrocarbons: Characterization and Remediation G4. Natural Source Zone Depletion	G5. In Situ Remediation of Petroleum Hydrocarbons G6. LNAPL Recovery/Remediation Technology Transitions G7. LNAPL Sites: Understanding and Managing Risks	G8. Environmental Forensics: Site Characterization and Source Determinations G9. Remote Sensing, Drones, and Other Unmanned Systems for Remote Monitoring and Site Assessments G10. Using Omic Approaches and Advanced Molecular Tools to Optimize Site Remediation G11. International Remedy Applications: Regulatory and Logistical Challenges of Remediation Abroad
H1. Improvements in Site Data Collection, Data Management, and Data Visualization	H2. Conceptual Site Models: Improvements in Development and Application	H3. Advanced Geophysics and Remote/Direct Sensing Tools and Techniques H4. Advanced Sampling and Analysis Tools and Techniques	H5. Groundwater Modeling: Advancements and Applications H5. Groundwater Modeling: Advancements and Applications H6. MIP/HPT/LIF/UVOST–Realtime HRSC Tools and Techniques H7. HRSC Suites of Tools to Improve CSMs
Panel: How Can Genetically-Modified Organisms Safely Solve Environmental Challenges? I1. Explosives, Perchlorate	I2. Advances in 1,4-Dioxane Biological Treatment Technologies I3. 1,4-Dioxane Remediation Challenges	I4. Microplastics, Pharmaceuticals, and Other Emerging Contaminants I5. Technical Impracticability: Challenges and Considerations for Evaluation of Fractured Rock Sites I6. Depositional Environments and Stratigraphic Considerations for Remediation I7. Process-Based Conceptual Site Models (CSMs) for Informing Remediation	**Panel:** Remediation Geology, Remediation Hydrogeology, and Process-Based CSMs to Support Complex Site Remediation I8. Advances in the Application of Geologic Interpretation to Remediation I9. Remediation Approaches in Fractured Rock and Karst Aquifers
4:00–6:30 p.m. Poster Group 1 Presentations and Refreshments See page 15 for presentations in Poster Group 1.	2:00–6:00 p.m. Short Courses 3:00–5:00 p.m. Film Screening with Craig Leeson	4:30–6:30 p.m. Poster Group 2 Presentations and Refreshments See page 16 for presentations in Poster Group 2.	4:30 p.m. Closing Reception

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