Technology Innovation News Survey

Entries for April 1-30, 2017

Market/Commercialization Information

RCRA ENFORCEMENT AND PERMITTING ASSISTANCE (REPA) 6, ZONE 2

U.S. Environmental Protection Agency, Office of Acquisition Management, Washington, DC.
Federal Business Opportunities, FBO-5682, Solicitation SOL-HQ-17-00006, 2017

EPA's Office of Acquisition Management plans to issue a competitive total small business set-aside solicitation to provide technical support services to EPA Zone 2 (EPA Regions 4, 5, and 6). The Government intends to award two multiple-award fixed-rate IDIQ contracts from the future solicitation. The contracts will support EPA activities and EPA-coordinated activities that further RCRA goals and programs or related Agency initiatives. Four distinct yet interrelated programs exist under RCRA: (1) Subtitle D of RCRA promotes and encourages the environmentally sound management of solid waste. It includes minimum federal technical standards and guidelines for state solid waste plans. (2) Subtitle C establishes a management system that regulates hazardous waste from the time it is generated until its ultimate disposal. (3) Subtitle I regulates petroleum products and hazardous substances (as defined under Superfund) that are stored in underground tanks. It establishes performance standards for new tanks and requires leak detection, prevention, and corrective action at underground tank sites. (4) Subtitle J regulates medical waste generation, treatment, destruction, and disposal. The anticipated ordering period includes one 24-month base period and one 36-month option period. The NAICS code for this acquisition is 541620 (Environmental Consulting Services). Release of the solicitation is anticipated on or about August 15, 2017, with award anticipated around March 1, 2018. Monitor FedConnect at https://www.fedconnect.net/FedConnect/?doc=SOL-HQ-17-00006&agency=EPA for the synopsis, amendments, and other information related to this procurement [Note: It might be necessary to copy/paste the URL into your browser for direct access].

BEAL MTN. MINE BARREN POND LEACH FIELDBEAL MTN. MINE BARREN POND LEACH FIELD

U.S. Forest Service, R-1 Western Montana Acquisition Zone, Missoula, MT.
Federal Business Opportunities, FBO-5626, Solicitation AG-0343-S-17-0031, 2017

The Northern Region of the Forest Service requires contractor services for reclamation work at Beal Mountain Mine, a former open-pit gold mine located approximately 16 miles west southwest of Butte, Montana, on the Butte-Jefferson Ranger District of the Beaverhead-Deerlodge National Forest. This work requires handling mine waste, which may contain metals and chemicals that are listed as hazardous substances under CERCLA. The contractor and all subcontractors shall provide written documentation that all onsite personnel engaged in the work have received the OSHA 40-hour HAZWOPER training required under 29 CFR 1910.120. The magnitude of this project is estimated to be between $250,000 and $500,000. Offers must be received by 2:00 PM MT on July 18, 2017
https://www.fbo.gov/spg/USDA/FS/03R6/AG-0343-S-17-0031/listing.html

LABORATORY GEOLOGIC LOGGING SERVICES

U.S. Department of Energy, CH2M Hill Plateau Remediation Company, Richland, WA.
Federal Business Opportunities, FBO-5685, Solicitation 20170614TB, 2017

CH2M Hill Plateau Remediation Company (CHPRC) plans to perform extensive characterization of soils beneath waste sites associated with the 200-BC-1 (27 waste sites) and the 200-WA-1 (163 waste sites) OUs on the Central Plateau at the Hanford Site, WA, to determine the nature and extent of vadose zone contamination. CHPRC seeks to identify potential vendors with expertise in geologic logging (describing lithology in cores), core photography, identification of intervals of possible radiologic and chemical contamination through the use of hand-held field screening instruments, taking core samples for laboratory analysis, shipping samples in compliance with DOT and International Air Transport Association regulations to laboratories designated by CHPRC, and report preparation. Potential vendors must be able to supply a facility (either off or on the Hanford Site) in which the geologic logging, photography, sampling, and core storage https://www.fbo.gov/notices/2e784ca9b141e2f5c5a1800463b48464

GOODFELLOW AFB LONG-TERM MONITORING

Department of the Air Force, Goodfellow Air Force Base, San Angelo, Texas.
Federal Business Opportunities, FBO-5684, Solicitation FA8903-17-R-0052, 2017

The 772 ESS/PKS seeks a contractor to conduct long-term monitoring and well installation for Site ST004 at Goodfellow Air Force Base, Texas. This requirement is being issued as a 100% small business set-aside under NAICS code 562910. A Remedial Action Plan currently being developed will include establishment of a plume management zone (PMZ) for TPH and BTEX and deed recordation of the PMZ. All activities will be executed at Site ST004 (Fuel Storage Area) at Goodfellow AFB during a 12-month period of performance. A single firm-fixed-price contract is anticipated. Proposals are due by 2:00 PM CT on July 18, 2017.
https://www.fbo.gov/notices/f26aee8d74b07bca840d68ea71c41817

PEER REVIEW PANEL FOR RAINIER MESA/SHOSHONE MOUNTAIN

U.S. Department of Energy, Navarro Research and Engineering Inc., North Las Vegas, NV.
Federal Business Opportunities, FBO-5684, Solicitations NEPS-1508, 1509, 1510, & 1511, 2017

Qualified individuals are invited to submit a proposal to participate on an expert Peer Review Panel tasked with reviewing the groundwater flow and transport model and associated documentation developed for the Rainier Mesa/Shoshone Mountain (RM/SM) Corrective Action Unit (CAU) 99 of the Underground Test Area (UGTA) Activity, Nevada National Security Site. The panel is to determine whether the model, results, interpretations, and documentation are consistent with the requirements of the FFACO Alternative Modeling Strategy and Decision Process for closure of the CAU. The panel will consist of four individuals (including one chairperson) with expertise in the following subject areas: **RFP NEPS-1508:** Modeling of radionuclide transport by groundwater.
https://www.fbo.gov/spg/DOE/SNJV/NNSANV/NEPS-1508/listing.html

RFP NEPS-1509: Hydrogeology of the arid western United States.
https://www.fbo.gov/spg/DOE/SNJV/NNSANV/NEPS-1509/listing.html
RFP NEPS-1510: Risk-based regulatory closure of contaminated groundwater sites.
https://www.fbo.gov/spg/DOE/SNJV/NNSANV/NEPS-1510/listing.html
RFP NEPS-1511: Environmental regulation, risk-based decision-making, and environmental regulation enforcement (preferably experienced as an environmental cleanup regulator).
https://www.fbo.gov/spg/DOE/SNJV/NNSANV/NEPS-1511/listing.html
Proposals to participate are due via email by 4:00 PM PT on July 10, 2017.

Cleanup News

INDIVIDUAL WASTE DISCHARGE REQUIREMENTS FOR IN SITU REMEDIATION OF GROUNDWATER IMPACTED BY CHLORINATED VOLATILE ORGANIC COMPOUNDS ASSOCIATED WITH THE FORMER RAYTHEON FACILITY, NEWPORT BEACH

State of California, Santa Ana Regional Water Quality Control Board, 23 pp, 2016

Medical offices for the Newport Healthcare Center were developed on the former Raytheon Newport Beach site, where electronic aircraft components were manufactured. Raytheon currently is conducting in situ injections of chemical amendments to remediate chlorinated VOCs (mainly PCE and TCE) and petroleum fuel hydrocarbons still present in the groundwater. Enhanced in situ bioremediation (EISB) was selected as the groundwater cleanup method for the site based on the findings that underlying groundwater conditions promote natural degradation of the contaminants. EISB was successfully performed at the site during pilot testing and as part of limited interim groundwater cleanup activities from 2005 to 2007. Full-scale EISB implementation was performed March-August 2009, and a second round of EISB injections of a more limited scale took place in November 2011. Based on the results of ongoing performance monitoring, Raytheon's consultant proposed additional EISB injections at four on-site locations. Under Order R8-2016-0061, the following chemical amendments will be injected into the subsurface: anoxic water treated with zero-valent iron; *Dehalococcoides* microbial culture KB-1™; and Newman Zone® emulsified food-grade vegetable oil (emulsified soybean oil, lactate, water, and food-grade additives, emulsifiers, and preservatives).
http://www.waterboards.ca.gov/santaana/board_info/agendas/2016/12_16/Item_7.pdf

2017 STRATEGIC PLAN: KIRTLAND AIR FORCE BASE FUEL LEAK

New Mexico Environment Department, 40 pp, 2017

Multiple measures have been implemented in the source area to remove the mass of fuel contamination at Kirtland AFB. Almost 5,000 tons of soil contaminated with fuel constituents was removed through three separate excavation events between 2000 and 2014. Four years of bioslurping significantly reduced the amount of residual LNAPL. Soil vapor extraction initiated in 2003 vacuumed ~570,000 gal of fuel from soil in the source area and also facilitated biodegradation of an additional 200,000 gal of fuel. In 2015, an interim measure of groundwater pump and treat began operation to address the plume of dissolved-phase ethylene dibromide (EDB). The groundwater P&T system was designed to stop migration of EDB towards drinking water wells; extract and treat EDB-contaminated groundwater; and collapse the plume back toward the Kirtland AFB boundary. Several pilot tests are planned for 2017: (1) aerobic and anaerobic in situ biodegradation of groundwater contamination, and (2) bioventing for removal of source area soil contamination. https://www.env.nm.gov/wp-content/uploads/2016/06/KAFB2017StrategicPlan_Version3.0_FINAL.pdf

IN-SITE THERMAL REMEDIATION AT COMPLEX DNAPL CANADIAN RAIL YARD SITE

Coughlin, J., L. Thomas, P. Kornelsen, and J. LaChance.
RAILTEC 2016 Conference Proceedings, University of Illinois at Urbana-Champaign. Abstract, 2016

In situ thermal remediation (ISTR) was implemented at a Canadian rail yard to address a DNAPL source zone located mainly under an active facility. A dissolved-level groundwater plume extended 3 kilometers off site. The plume lies within a complex braided stream lithology and flows under several residential neighborhoods. Remedial technologies implemented on site have included in situ chemical oxidation (ISCO) for the source zone and a groundwater pump, treat, and reinjection system at the property boundary for control of the off-site plume. The ISCO applications had some success in reducing dissolved-phase concentrations within the source zone but less success in addressing DNAPL. Pump and treat commenced in 2005, followed by system expansion in 2015, and contaminant concentrations in off-site groundwater have declined during its operation. A combined ISTR approach using the electro-thermal dynamic stripping process (ETDSP™) and steam-enhanced extraction was conducted in the source zone to remove the remaining DNAPL beginning in March 2016.

AIRPORT KWIK STOP

Washington Department of Ecology Toxics Cleanup Website, 2017

The Airport Kwik Stop site was formerly a convenience store that sold gasoline and diesel. The site includes the former Airport Kwik Stop, the former Cabin Grill, and vacant properties north, south, and east of the Cabin Grill. The Airport Kwik Stop building is now the Airport General Store and no longer sells fuel. The Cabin Grill is a private residence. Soil and groundwater samples taken in 2010 and 2011 showed petroleum-related contaminants that affected drinking water wells in the vicinity. In 2012, the Washington Department of Ecology installed soil vapor extraction and air sparging systems to address petroleum hydrocarbons and BTEX contamination and has added to these systems since their initial construction. Ecology proposes to expand the treatment approach by injecting bioremediation amendments into groundwater as described in a 2017 work plan posted for public review and comment.
https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=4203

IN-SITU THERMAL REMEDIATION CONSTRUCTION COMPLETION REPORT: SOLVENTS RECOVERY SERVICE OF NEW ENGLAND (SRSNE) SITE

SRSNE Site Group. U.S. EPA, Region 1, 29 pp + appendices A-I, 2017

A multi-phase cleanup is underway at the SRSNE Site, located on ~14 acres of land along the Quinnipiac River in Southington, Connecticut. In situ thermal remediation completed in 2015 removed >99% of the targeted waste oils and solvents (PCE, TCE, TCA, etc.) in soils beneath the site. See Appendix F: *In-Situ Thermal Remediation Demonstration of Attainment of Interim NAPL Cleanup Levels and Recommendations* for details. Following site preparation between 2010 and 2013, treatment was carried out between 2013 and 2015 via a network of 607 heating probes and 551 vapor recovery wells. The next and expected final step of the remedy construction involves

consolidating remaining contaminated soils and isolating them beneath a permanent, waterproof cap. The area's rails-to-trails network will be expanded as part of the cap construction. *This report, its appendices, and other technical documents are available at* http://www.srsnesite.com/docs/.

Demonstrations / Feasibility Studies

DESIGNING, ASSESSING, AND DEMONSTRATING SUSTAINABLE BIOAUGMENTATION FOR TREATMENT OF DNAPL SOURCES IN FRACTURED BEDROCK: ESTCP COST AND PERFORMANCE REPORT

ESTCP Project ER-201210, 100 pp, 2017

A small portion of a (presumably) much larger PCE source area was targeted at Edwards Air Force Base, Calif., and the DNAPL mass and distribution were quantified in two separate depth intervals with discrete fractures. Geophysical testing showed that DNAPL was present, that the well capacities within the source area were sufficient to distribute the amendments in conductive fractures, and that there was hydraulic connectivity in both zones in the two wells used for the field test. During biological treatment (SDC-9 culture), enhanced dissolution of the DNAPL sources was observed in both the shallow and deep fractures intervals. In the shallow fracture zone, the measured DNAPL mass removal was ~100%, whereas it was only 45% over the same period in the deep zone. The difference in DNAPL mass removal between the two zones was attributed to the DNAPL architecture, as the flow field in the deep zone was more complex, and a greater extent of the DNAPL was present in mass transfer controlled zones. Rebound testing showed no increase in the sum of chlorinated ethenes and ethane in the shallow zone 10 months after active treatment, but the concentrations did rebound significantly in the deep zone, likely owing to residual DNAPL mass.
https://www.estcp.com/content/download/44772/419088/file/ER-201210%20Cost%20&%20Performance%20Report.pdf

REQUEST TO TERMINATE WASTE DISCHARGE REQUIREMENTS PERMIT FOR ENHANCED IN SITU BIOREMEDIATION PILOT TESTS FOR VOCS

State of California, Los Angeles Regional Water Quality Control Board, 63 pp, 2016

Enhanced in situ bioremediation (EISB) pilot test injection activities using emulsified vegetable oil and sodium lactate were conducted intermittently between January 2011 and November 2014 to address VOCs in the groundwater of the Plant 1, Building 1-1 Area of the Former Northrop Grumman East Complex, Hawthorne, Calif. Pilot results showed that complete dechlorination of dissolved-phase TCE was achieved in all wells influenced by and located within the EISB pilot test area. Bioaugmentation with KB-1™ culture was instrumental in overcoming cis-1,2-DCE stall and achieving complete dechlorination. A biorecirculation system effectively distributed the amendments and KB-1 both down- and cross-gradient to stimulate microbially facilitated processes. Elevated TOC concentrations and robust *Dehalococcoides* populations were sustained more than 15 months after operation of the biorecirculation system ceased. Termination of the Waste Discharge Requirements Order for the site was requested in June 2016. The *Bioremediation Pilot Study Summary Report* begins on **page 7** of the PDF file at
http://geotracker.waterboards.ca.gov/esi/uploads/geo_report/9539254963/WDR100000377.PDF
Additional documentation of the cleanup of this site is available at
http://geotracker.waterboards.ca.gov/profile_report?global_id=WDR100000377.

ASSESSING THE EFFICACY OVER TIME OF THE ADDITION OF INDUSTRIAL BY-PRODUCTS TO REMEDIATE CONTAMINATED SOILS AT A PILOT-PLANT SCALE

Gonzalez-Nunez, R, A. Rigol, and M. Vidal.
Environmental Monitoring and Assessment 189(4):Article 155(2017)

The effect of the addition of industrial by-products (gypsum and calcite) on the leaching of As and metals (Cu, Zn, Ni, Pb and Cd) in a soil contaminated by pyritic minerals was monitored over a period of 6 months at a two-pit pilot plant. Unamended contaminated soil was placed in one pit, while a mixture of the contaminated soil (80% w/w), gypsum (10% w/w), and calcite (10% w/w) was placed in the other pit. Soil samples and leachates of the two pits were collected at different times, and the leaching pattern of major and trace elements in the soil samples was assessed with the pHstat leaching test. Addition of the by-products led to an increase in initial soil pH from around 2.0 to 7.5, and the concentration of trace elements in soil extracts obtained from the pHstat leaching test decreased to values lower than the hazardous waste threshold for soil management. Trace element concentration in the pilot-plant leachates decreased over time in the control soil, probably due to the formation of more insoluble secondary minerals containing sulfur, but decreased to a greater extent in the amended soil. The remediated soil pH remained constant over the 6-month period, and X-ray diffraction analyses confirmed that the phases did not vary over time.

FLEXIBLE REACTIVE BERM (FRBERM) FOR REMOVAL OF HEAVY METALS FROM RUNOFF WATER

Larson, S., W.A. Martin, J.J. Romano, J. Sylva, and M. Dortch.
ESTCP Project ER-201213, 81 pp, 2016

Small arms firing ranges (SAFRs) are sometimes constructed next to wetland areas, which represents a potential point of regulatory interest as the wetlands are at risk from heavy metal contamination in the firing range runoff water. The runoff water treatment presented in this report is based on the proven use of a geotextile fabric woven into a tubular filter sock and filled with sand. This demonstration used a proprietary commercial mixture of Time Release Amendment Phosphate System™ (TRAPPS™) (Slater UK Ltd), an apatite formulation with relatively insoluble minerals (phosphate, Fe, Mn, Mg) tailored to stabilize specific contaminants of concern (i.e., Pb, Sb). A mathematical model provided design information and predicted filter performance for surface runoff water on the field demonstration site, the Kinder Range at Fort Leavenworth, Kansas. The demonstration objectives were to validate (1) application of the reactive filter barrier technology at field scale for heavy metals removal and (2) the sediment transport model developed by ERDC-EL for removal or containment of metal-contaminated sediment in runoff water. Installation cost of the flexible reactive barriers was less than $1,000. Cost will vary, depending on the metal-adsorption amendment used. Under appropriate sediment loading conditions, maintenance over a 30-yr time span will be ~$5,000, which brings the total cost for treatment of a SAFR to ~$6,000. Based on ecotoxicity levels for Pb in sediment, the cost avoidance provided by reactive filter barriers would be $142K for the North Kinder Range.
https://www.estcp.com/content/download/45020/421000/file/ER-201213%20Final%20Report.pdf *See also the* ***ESTCP Cost and Performance report*** *at*
https://www.estcp.com/content/download/45021/421010/file/ER-201213%20Cost%20&%20Performance%20Report.pdf.

FIELD DEMONSTRATION AND VALIDATION OF TREECS™ AND CTS FOR THE RISK ASSESSMENT OF CONTAMINANTS ON DEPARTMENT OF DEFENSE (DOD) RANGES

Johnson, B.E., M.S. Dortch, and E.J.Weber.
ESTCP Project Number ER-201435, 177 pp, 2017

The Training Range Environmental Evaluation and Characterization System (TREECS™) was developed to forecast the fate of and risk from munitions constituents, e.g., high explosives and metals, within and transported from firing/training ranges to surface water and groundwater. The Chemical Transformation Simulator (CTS) was developed by U.S. EPA to provide physicochemical properties of complex organic chemicals, information TREECS uses to predict the environmental fate of munitions constituents. This study validated the capability of TREECS and CTS to predict RDX concentrations in receiving waters downgradient of training/firing ranges for three installations: Demolition Area 2 of Massachusetts Military Reservation, MA; Artillery Impact Area of the U.S. Military Academy, West Point, NY; and Zulu Impact Area of Marine Corps Base Camp Pendleton, CA. Results demonstrated the utility of these modeling systems for forecasting the fate of emerging high explosives associated with new insensitive munitions and for evaluating best management practices for reducing downgradient receiving water concentrations.
https://www.estcp.com/content/download/45018/420980/file/ER-201435%20Final%20Report.pdf

FIELD REMEDIATION TRIALS FOR SULFOLANE IMPACTED SOIL AND GROUNDWATER: AERATION, NUTRIENT AMENDMENTS AND/OR PEROXIDE?

Lennox, B. and E. Pringle.
Remtech 2016: Remediation Technologies Symposium, 27 slides, 2016

Sulfolane is an organosulfur compound that is highly soluble in water, with a reported solubility of 1,000 g/L. In its pure form, sulfolane is a clear, colorless liquid that is heavier than water. The compound is a persistent contaminant in groundwater and is presumed not to break down easily in low oxygen/low nutrient environments. A trial sulfolane remediation program was conducted using aeration, H_2O_2, and nutrient amendment at an upstream oil and gas site in southern Alberta. The most successful approaches used aeration and/or nutrient amendments to reduce sulfolane concentrations in both soil and groundwater, while H_2O_2 treatments were less successful. Ex situ soil remediation trials included aeration and nutrient amendment or an ALLU bucket and peroxide application. The ALLU bucket approach was considered to be the most effective trial and coincidently was the most economical approach when sulfolane in soil was remediated from an average concentration of ~3 mg/kg to below detection limits and Tier 1 guidelines within 45 days of treatment. Other aeration or nutrient amendment soil remedial trials using an ex situ treatment system were successful at reducing sulfolane concentrations by 97%. Groundwater remediation approaches included sparging, peroxide addition, and water recirculation. The most effective approach was the use of a trash pump to circulate and aerate water within a test cell, which reduced sulfolane concentrations by 94% after just over seven hours of treatment.
Slides: http://www.esaa.org/wp-content/uploads/2016/10/16-Lennox.pdf
Longer abstract: http://www.esaa.org/wp-content/uploads/2016/09/RemTech2016Abstracts-26.pdf

Research

RECENT ADVANCES IN VAPOR INTRUSION SITE INVESTIGATIONS

McHugh, T., P. Loll, and B. Eklund.
Journal of Environmental Management [Publication online 22 Feb 2017 prior to print]

Research efforts and field investigations have improved scientific understanding of vapor intrusion processes, including the role of preferential pathways and natural barriers to vapor intrusion. This review addresses recent developments in the regulatory framework and conceptual model for vapor intrusion, and discusses innovative investigation methods. *This paper is **Open Access** at* http://www.sciencedirect.com/science/article/pii/S0301479717301196.

IN SITU MOBILIZATION OF ARSENIC IN GROUNDWATER: AN INNOVATIVE REMEDIATION APPROACH?

Maier, M.V., M. Isenbeck-Schroeter, L.B. Klose, S.M. Ritter, and C. Scholz.
Procedia Earth and Planetary Science 17:452-455(2017)

Processes of arsenic release into groundwater were studied to evaluate an inefficient pump-and-treat system at a contaminated site in Germany. Groundwater and aquifer material sampling indicated elevated As mobility and a differentiated spatial distribution of As(V) and As(III). An artificial increase of As mobilization in addition to ongoing pump and treat was considered as a remediation option for the contaminated site. Typically, As mobility increases under iron-reducing conditions, yet water ingredients, such as phosphate, can trigger As mobility. The affinity of phosphate to sorb onto mineral phases leads to a competitive surface-complexation of phosphate and As. In column tests, As release from contaminated aquifer material was significantly enhanced by phosphate addition. Under oxic and anoxic redox conditions, geochemical processes led to elevated release of mobile As fractions up to a total of 50-60% and almost 100%, respectively, in a period of 90 days. Phosphate amendment is currently being investigated on the site at field scale. *This paper is **Open Access** at*
http://www.sciencedirect.com/science/article/pii/S1878522016301485.

ANOXIC NITRATE REDUCTION COUPLED WITH IRON OXIDATION AND ATTENUATION OF DISSOLVED ARSENIC AND PHOSPHATE IN A SAND AND GRAVEL AQUIFER

Smith, R.L., D.B. Kent, D.A. Repert, and J.K. Boehlke.
Geochimica et Cosmochimica Acta 196:102-120(2017)

Scientists conducted an in situ field study in a wastewater-contaminated aquifer on Cape Cod to investigate nitrate as a potential electron acceptor for Fe(II) oxidation in groundwater and the implications for redox-sensitive groundwater contaminants. Long-term (15 yr) geochemical monitoring within the contaminant plume indicated interacting zones with variable nitrate-, Fe(II)-, phosphate-, As(V)-, and As(III)-containing groundwater. Nitrate and phosphate were derived predominantly from wastewater disposal, whereas Fe(II), As(III), and As(V) were mobilized from the aquifer sediments. Multiple natural-gradient, anoxic tracer tests comprised injections of nitrate and bromide into nitrate-free, Fe(II)-containing groundwater. The aquifer sediments yielded Fe(II)-oxidizing, nitrate-reducing microbial enrichment cultures. Field and culture results suggest that nitrogen oxide reduction and Fe(II) oxidation in the aquifer are a

complex interaction of coupled biotic and abiotic reactions. Overall results demonstrate that anoxic nitrate-dependent iron oxidation can occur in groundwater; that it could control iron speciation; and that the process can affect the mobility of other chemical species (e.g., phosphate and arsenic) not directly involved in the oxidation-reduction reaction. *See additional information at* https://toxics.usgs.gov/highlights/2017-02-23-nitrate_arsenic_immobilization.html.

DESIGNING A PERMEABLE REACTIVE BARRIER FOR THE REMEDIATION OF COPPER CONTAMINATED GROUNDWATER

Walkons, Christopher, Master's thesis, Michigan Technological University, 36 pp, 2016

This project entailed the design of a sorption based pilot-scale permeable reactive barrier (PRB) to remove copper from the groundwater in northern Michigan's Keweenaw Peninsula, an area severely affected by the deposition of Cu-laden mine tailings. The specific site selected for the pilot PRB is a riparian area of stamp sand deposits adjacent to Huron Creek. The reactive material for the barrier is the residual of coagulants used in drinking water treatment operations. Kinetic and column experiments were conducted to understand the significance of chemical and physical mass transfer limitations, and a leaching test showed that the concentrations of hazardous elements leached from the water treatment residuals do not exceed specified limits. Permeameter tests performed with various mixtures of the water treatment residuals and an inert support material (pea gravel) were conducted to determine the optimum mix for matching the hydraulic conductivity of the field site. Additional work at the site determined groundwater flow direction, pore-water velocity, and contaminant concentration for designing the PRB dimensions and placement. http://digitalcommons.mtu.edu/etdr/249/

ADVANTAGES AND CHALLENGES OF TWEEN 80 SURFACTANT-ENHANCED TECHNOLOGIES FOR THE REMEDIATION OF SOILS CONTAMINATED WITH HYDROPHOBIC ORGANIC COMPOUNDS

Cheng, M., G. Zeng, D. Huang, C. Yang, C. Lai, C. Zhang, and Y. Liu.
Chemical Engineering Journal 314:98-113(2017)

Among surfactants employed to enhance remediation efficiency, Tween 80 has gained interest due to its low cost, low polarity, low toxicity, and high solubilization capacity. This paper provides an overview of Tween 80-enhanced removal of hydrophobic organic compounds by soil washing, soil flushing, electrokinetics, and other treatments. http://ee.hnu.cn/eeold/php/news/pic/yunfeirandompic_1484142533.pdf

PHYTOFORENSICS TOOLS: THE DEGRADATION AND DETECTION OF CHLORINATED SOLVENTS IN INTEGRATED SYSTEMS

Goodwin, Tommy J. Jr., Master's thesis, Missouri University of Science and Technology, 129 pp, 2016

Bioremediation, permeable reactive barriers, and phytoremediation were integrated in different combinations to evaluate the remediation potential. Zero-valent iron (ZVI) and bioaugmentation with a *Dehalococcoides* sp. (dhc) culture were applied separately and in combination for degradation of dissolved-phase PCE. *Salix pentandra* were planted in reactors and concurrently served as monitoring tools. Characteristics studied between reactor combinations included plant health, contaminant degradation rates, and water uptake. By creating an area of lower water potential, trees direct groundwater flow through the reactive zone and potentially take up the contaminated groundwater. ZVI and dhc achieved up to 92.0% and 99.3% reduction of PCE, respectively, and ZVI and dhc together achieved a PCE concentration reduction of 99.7%. DCE was found in all reactors that contained dhc but in no reactors without dhc. Plant sampling (phytoforensics) revealed degradation profiles and offered a low-impact, low-cost approach to monitoring PCE degradation processes in the subsurface. http://scholarsmine.mst.edu/masters_theses/7503

RESTORATION OF MANUFACTURED GAS PLANT SITE SOIL THROUGH COMBINED ULTRASOUND-ASSISTED SOIL WASHING AND BIOAUGMENTATION

Chen, F., M. Tan, J. Ma, G. Li, and J. Qu.
Chemosphere 146:289-299(2016)

An effective ex situ soil remediation technology was developed to remove PAHs and heavy metals from a contaminated site. Ultrasonication (20 kHz, 45 min) combined with methyl-beta-cyclodextrin (75 g/L) and S,S-ethylenediaminedisuccinic acid (25 g/L) were efficient in extracting mixed pollutants from the soil. After two successive washing cycles, the removal efficiency of PAHs and heavy metals was ~84.5% and 81.3%, respectively. The high removal of metals reduced soil microtoxicity significantly, which enabled PAHs biodegradation. Inoculation of PAHs-degrading bacterial strains with nutrients removed 86.8% of residual PAHs in 16 weeks, with significant increase in PAH degrader population and soil enzyme activity. After treatment, residual levels of individual PAHs and heavy metals met Chinese soil quality standards for residential use. The combined cleanup strategy proved to be effective and environmentally friendly for remediation of mixed contaminants.

PASSIVE SOLAR DISTILLATION OF ACID ROCK DRAINAGE

Shreve, S., L. Galuska, A. Stoller, A. Raney, A. Caceres, C. Chambers, C. Graham, and D. Hazlett.
Univ. of Arkansas, Fayetteville, Chemical Engineering Undergraduate Honors Thesis 103, 40 pp, 2017

Arkansas Razorback Distillers (A.R.D.) designed a passive solar distillation system for treating acid rock drainage (ARD) from abandoned mines that reduces both metal sulfate contaminants and acidity. Using the Freeport McMoRan Inc. Copper Queen legacy mine in Bisbee, Arizona, for a base case scenario, A.R.D's design is close to that of a traditional solar still with the exception that water vapor is not reclaimed; pure water passively evaporates to the atmosphere at 5 gal/min. In the full-scale design, sunlight enters through a double-pane polycarbonate roof 6 mm thick, heating the water and vaporizing it. The water vapor/air mixture is forced from the still via a thermosiphon, which maintains a low relative humidity within the still to increase the driving force for greater evaporation rates. Rather than removing the salt brine continuously, the salts precipitate and collect at the bottom of the solar still for batch removal at long intervals (e.g., 20 yr). Multiple small solar stills will be installed in parallel, each still 102 ft long, 22 ft wide, and 10.5 ft high. Each still is estimated to cost $40,000. Twenty-seven stills are required to achieve evaporation of 5 gal/min; hence, the total capital cost for a 20-yr system is $1,100,000 (~$18/ft^2). This report provides a detailed explanation of the location, technology, process summary, economic analysis, experimental results, regulations, safety considerations, and scalability for a solar distillation system in Bisbee. http://scholarworks.uark.edu/cheguht/103

MICROBIAL REPOPULATION FOLLOWING IN SITU STAR REMEDIATION

Overbeeke, Gavin, Master's Thesis, University of Western Ontario, 169 pp, 2017

In situ STAR (Self-sustaining Treatment for Active Remediation) is an emerging remediation technology that uses smoldering combustion to destroy NAPL contamination in the subsurface. Drying and sterilization of the treatment zones occurs as STAR smoldering slowly travels through contaminated soils (~0.5 to 5 m/day) and subjects them to high temperatures (400-1000°C). Warming of unsmoldered soils around the treatment zone affects the microbial communities within them. To quantify microbial repopulation following STAR treatment and observe heating effects on microorganisms living in surrounding soils, soil cores were taken at regular intervals following STAR treatment a former creosol manufacturing facility in New Jersey, allowing time for groundwater to re-infiltrate and for microbial populations potentially to reestablish. Rapid bacterial repopulation was observed over a 2-month period to ~107 gene copies/g of soil in the treated zone, with variable impacts within untreated soils. In general, long-term microbial abundance was largely dependent on the amount of organic matter present in the soil following STAR. A bench-top column study demonstrated that addition of lactate and sulfate increased the carrying capacity of the STAR-treated soil and shifted the microbial community to promote sulfate-reducing bacteria. Overall, the work illustrates that microbial populations in STAR-treated soil do recover via groundwater infiltration, but robust communities take time to establish.
http://ir.lib.uwo.ca/etd/4404/

STARx TECHNOLOGY FOR WASTE OIL SLUDGE TREATMENT INVESTIGATED WITH NUMERICAL MODELLING

Solinger, Rebecca L., Master's thesis, University of Western Ontario. 176 pp, 2016

Self-sustaining Treatment for Active Remediation (STAR) is being further developed as an ex situ treatment system (STARx) for industrial wastes mixed with sand. This study used a 2-D (vertical cross-section) numerical model to systematically explore the sensitivity of STARx hotpad performance to system design, operational parameters, and environmental factors. The phenomenological model that was used uniquely combines a multiphase flow code and a front expansion routine. The model was first calibrated and validated against ~2 m width hotpad experiments. Pilot-scale simulations then investigated the sensitivity of system performance to injected airflow rate, organic liquid concentration, hotpad configuration, system dimensions, heterogeneity of intrinsic permeability, and heterogeneity of organic liquid concentration. The expected performance of two field-scale configurations (~10 m width) was also explored. Hotpad performance is predicted to be most sensitive to injected air flux, with higher air fluxes achieving higher rates of organic liquid destruction and treating larger fractions of the initial mass. The uniformity of the advancing smoldering front was predicted to be highly dependent on the effective permeability ratio between untreated and treated materials, and increased heterogeneity is predicted to degrade remedial performance.
http://ir.lib.uwo.ca/etd/4153/

EVALUATION OF ELECTRON DONORS FOR PERCHLORATE AND NITRATE BIODEGRADATION IN CONTAMINATED GROUNDWATER APPLICATIONS

Sarria Cortes, Mayra Alejandra, Master's thesis, University of Nevada, Las Vegas. 125 pp, 2016

The efficacy of four electron donors—two emulsified soybean oils (EOS-100 and EOS-Pro), glycerol, and a compost/mulch extract—were evaluated for biological reduction of nitrate and perchlorate using batch microcosm testing. Tests were conducted in two different matrices: (1) vadose zone soil mixed with surface water from Lake Mead and (2) saturated soil mixed with groundwater. Samples were analyzed to evaluate nitrate and perchlorate removal kinetics, the effects of phosphate addition, and the effects of varying soil:water ratios. EOS-100 and glycerol achieved similar overall reduction of nitrate and perchlorate in the vadose zone soil application, although EOS-100 exhibited faster kinetics. In saturated soil, EOS-Pro was superior to EOS-100. Evaluation of soil:water ratios showed that the most significant variable limiting nitrate and perchlorate reduction was the availability of electron donor rather than water volume. Phosphate addition indirectly improved perchlorate reduction by increasing the rate of nitrate biodegradation, particularly for samples with a mass-based nitrogen:phosphorus ratio higher than 0.22:1.
http://digitalscholarship.unlv.edu/thesesdissertations/2901

EX SITU BIOREMEDIATION OF CHLOROPHENOL CONTAMINATED SOIL: COMPARISON OF SLURRY AND SOLID-PHASE BIOREACTORS WITH THE TWO-STEP POLYMER EXTRACTION-BIOREGENERATION PROCESS

Angelucci, D.M. and M.C. Tomei.
Chemical Technology and Biotechnology 91(6):1577-1584(2016)

A soil highly contaminated by a mixture of 4-chlorophenol (4CP) and pentachlorophenol (PCP) (~4 g/kg each), was treated in different bioremediation systems. Removal efficiencies achieved with polymer extraction were >70% for a contact time of 24 h; the contaminated polymer then was regenerated in a 2-phase partitioning bioreactor (~100 and 85% efficiencies for 4CP and PCP, respectively). Efficiencies in the range of 70-80% were achieved for soil decontamination, with almost complete mineralization of the two compounds in reaction times suitable for application (

MICROWAVE HEATING-MEDIATED REMEDIATION OF HYDROCARBON-POLLUTED SOILS: THEORETICAL BACKGROUND AND TECHNO-ECONOMIC CONSIDERATIONS

Falciglia, P.P. and F.G.A. Vagliasindi.
Enhancing Cleanup of Environmental Pollutants, Volume 2: Non-Biological Approaches. Springer International Publishing, Print ISBN: 978-3-319-55422-8, 2017

Microwaves (MW) are a part of the electromagnetic spectrum, occurring in the frequency range of 300 MHz-300 GHz. Compared to other remediation methods, the advantages of MW heating include simplicity, safety, flexibility, and cost-effectiveness as it offers the potential for significant reduction in treatment times, risk of contamination, and costs. In conventional thermal systems, the energy is transferred through conduction, convection, and radiation, whereas MW heating supplies energy directly to soil by molecular interaction with the generated electromagnetic field. The soil components are heated individually and instantaneously, overcoming limits imposed by material heat transfer properties. Reviews of the literature show that MW remediation has the potential to remove polar and semipolar organic pollutants from soil. This chapter discusses the theoretical background of the MW heating process and related techno-economic features for ex situ full-scale applications in remediation of hydrocarbon contaminants.

LINDANE BIOREMEDIATION CAPABILITY OF BACTERIA ASSOCIATED WITH THE DEMOSPONGE *HYMENIACIDON PERLEVIS*

Stabili, L., G. Pizzolante, A. Morgante, M.C. Nonnis, C. Longo, A.M. Aresta, C. Zambonin. G. Corriero, and P. Alifano.
Marine Drugs 15:108(2017)

The role of bacteria associated with the sponge *Hymeniacidon perlevis* was assessed for lindane degradation. Seven isolates showed a remarkable capacity to utilize lindane as a sole carbon source, leading to a percentage of residual lindane ranging from 3% to 13% after 12 days of incubation with the pesticide. The lindane metabolite 1,3-6-pentachloro-cyclohexene was observed upon lindane degradation. The bacteria identified as capable of lindane degradation were assigned to *Mameliella phaeodactyli*, *Pseudovibrio ascidiaceicola*, *Oceanicaulis stylophorae*, *Ruegeria atlantica*, and to three new uncharacterized species. The results obtained are a prelude to the development of future strategies for the in situ bioremediation of lindane. *This paper is* ***Open Access*** *at* http://www.mdpi.com/1660-3397/15/4/108.

THE CONCEPTION OF AN EXPERIMENTAL MODEL FOR EX SITU BIOREMEDIATION OF SOILS CONTAMINATED WITH PETROLEUM HYDROCARBONS

Sur, I.M., V. Micle, M.N. Boros, and G.C. Rogozan.
AES Bioflux 9(1):72-76(2017)

This paper describes how to design an experimental model that can be used in the optimization of a biopile for ex situ bioremediation of hydrocarbon-contaminated soils. The proposed model includes several biopile cells that are reduced in size. Lab experiments were made using the model at constant parameters (pH, temperature, nutrients ratio) and variable parameters (duration and intensity of soil aeration, humidity, amount of microorganisms). Optimal parameters of ex situ bioremediation can be established based on the experimental results.
http://www.aes.bioflux.com.ro/docs/2017.72-76.pdf

REMEDIATION APPROACHES FOR POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) CONTAMINATED SOILS: TECHNOLOGICAL CONSTRAINTS, EMERGING TRENDS AND FUTURE DIRECTIONS

Kuppusamy, S., P. Thavamani, K. Venkateswarlu, Y.B. Lee, R. Naidu, and M. Megharaj.
Chemosphere 168:944-968(2017)

Established remedial options available for treating PAH-contaminated soils are incineration, thermal conduction, solvent extraction/soil washing, chemical oxidation, bioaugmentation, biostimulation, phytoremediation, composting/biopiles, and bioreactors. Integrating physico-chemical and biological technologies is also widely practiced for better cleanup of PAH-contaminated soils. Electrokinetic remediation, vermiremediation, and biocatalyst-assisted remediation are still at a developmental stage. The objective of this review is to provide a critical overview that focuses only on the treatment options available for field soils. The authors also propose the development of novel multifunctional green and sustainable systems—a mixed cell culture system, biosurfactant flushing, transgenic approaches, and nanoremediation—to overcome the existing technological limitations in tackling PAHs of high molecular weight.

EVALUATION OF IN SITU REMEDIATION METHODS IN SOILS CONTAMINATED WITH ORGANIC POLLUTANTS

Simpanen, Suvi, PhD dissertation, University of Helsinki, Lahti, Finland. 42 pp, 2016

Different in situ remediation methods were evaluated in lab-, pilot-, and field-scale studies to compare their effectiveness in treating organics-contaminated soils, with a focus on oil hydrocarbons, PAHs, and chlorinated aromatic hydrocarbons (chlorophenols). The soils used in the study were mainly obtained from a former gas station, wood treatment areas, and a pilot-scale real fuel spill. The following remediation methods were studied: (1) **Forest soil addition:** Organic forest soil applied atop chlorophenol-contaminated mineral soil significantly increased chlorophenol degradation under optimal conditions and under field conditions. (2) **Biostimulation:** Improving soil nutrient ratios via nitrogen amendment was the most important factor for increasing contaminant biodegradation. Biostimulation of freshly oil-contaminated soil caused changes in soil microbial community, decreased oil leakage through the soil, and was suitable to use in groundwater areas. (3) **Surfactant (methyl-beta-cyclodextrin) addition:** After biostimulation reduced the amount of low molecular weight PAHs in the soil, surfactant proved useful for solubilizing and enhancing the biodegradation of 4-5 ringed PAHs. (4) **Chemical oxidation with H_2O_2:** Oxidation was not effective for fresh oil-contaminated soil, although it increased oil migration through the soil. (5) **Electrokinetic remediation:** An electric field introduced into dense and wet soil caused soil dewatering, after which soil vapor extraction was effective for VOCs removal. https://helda.helsinki.fi/handle/10138/168815

EVALUATION OF THE SUITABILITY OF THE WATERLOO MEMBRANE SAMPLER FOR SAMPLE PRECONCENTRATION BEFORE COMPOUND-SPECIFIC ISOTOPE ANALYSIS

Goli, O., T. Gorecki, H.T. Mugammar, M. Marchesi, and R. Aravena.
Environmental Technology & Innovation 7:141-151(2017)

The objective of this research was to evaluate the applicability of the Waterloo Membrane Sampler (WMS) for compound-specific isotope analysis (CSIA), with intended applications in the unsaturated zone and in vapor intrusion studies. Tests were performed to evaluate isotope effects associated with sorption and desorption of the analytes under active and passive sampling conditions. The experiments used a standard gas mixture containing three model analytes—hexane, benzene, and TCE. Lowest detectable concentrations were 0.65mg/m^3 hexane, 0.88mg/m^3 benzene, and 4.38 mg/m^3 TCE. The developed method was applied in a field study of results obtained for benzene and toluene that confirmed good data reproducibility. Results indicate that CSIA coupled with WMS has the potential to become a valuable tool in unsaturated zone studies and environmental forensics. *See additional information in O. Goli's thesis at* https://uwspace.uwaterloo.ca/handle/10012/7295?show=full.

NATURALLY OCCURRING DECHLORINATION REACTIONS IN ROCK MATRICES: IMPACTS ON TCE FATE AND FLUX

Schaefer, C.E.
Environmental Technology & Innovation 6:115-122(2016)

Chlorinated solvents in rock matrices can serve as a long-term contaminant source in fractured rock aquifers, sustaining groundwater plumes for extended periods of time. The intensity and longevity of the groundwater plume will be affected by the diffusional flux between the rock matrix and adjacent conductive fractures, as well as the fate of contaminants residing within the rock matrix itself. To assess the impacts of slow, naturally occurring abiotic dechlorination reactions on TCE fate and transport in rock matrices, 1-D numerical simulations were performed based on experimental data from intact rock cores. Simulations showed that a TCE dechlorination rate constant of 1x10^{-8}/s can have a substantial impact on TCE uptake and release from the rock matrix. In addition, varying the simulated matrix porosity indicated that the impacts of matrix reactions are exacerbated in low-porosity matrices. Overall results showed

that contaminant removal from rock matrices can be dominated by abiotic reaction, and that the back-diffusion timeframes for sustaining bedrock plumes above regulatory levels might be limited to a few decades if abiotic reactions are occurring within the rock matrix. *See additional information in the report from SERDP project ER-1685 at* https://www.estcp.com/content/download/37362/356277/file/ER-1685-FR.pdf.

PRACTICAL ASSESSMENT AND OPTIMIZATION OF REDOX-BASED GROUNDWATER REMEDIATION TECHNOLOGIES

Tratnyek, P.G. and R.L. Johnson. SERDP Project ER-2308, 114 pp, 2017

Many approaches to remediation of contaminated groundwater rely on contaminant degradation processes that are, directly or indirectly, based on redox reactions. Predicting and optimizing such processes requires reliable methods for characterizing in situ redox conditions, but the existing methods (usually direct ORP measurement with a Pt electrode) are inadequate. This project took a chemical probe reaction approach, which involved adding chemical reactivity or redox probes (CRPs) that react with the medium, and monitoring the resulting change in speciation of the CRP either by measuring the color change or using a Pt electrode. Variations on this method can be used to characterize thermodynamic, kinetics, and capacity aspects of the redox conditions in a sample. CRPs could be used at field sites in push-pull tests, or for ex situ characterization of preserved samples.
https://www.estcp.com/content/download/42251/403055/file/ER-2308%20Final%20Report.pdf

THREE-DIMENSIONAL ARTIFICIAL TRANSPIRATION FOR EFFICIENT SOLAR WASTE WATER TREATMENT

Li, X., R. Lin, G. Ni, N. Xu, X. Hu, B. Zhu, G. Lv, J. Li, S. Zhu, and J. Zhu.
National Science Review [publication online prior to print] 2017

Achieving optimum solar steam efficiency requires simultaneous minimization of radiation, convection, and conduction losses without compromising light absorption. Inspired by the natural transpiration process in plants, scientists at Nanjing University, China, have developed a concept of artificial transpiration with a graphene oxide-based 3D hollow cone structure that minimizes all three components of heat loss and angular dependence of light absorption. This innovation enables over 85% solar steam efficiency under one sun without external optical or thermal management. The artificial transpiration device can provide a complementary path for wastewater treatment by producing water purified to WHO drinking water standards directly from wastewater contaminated with metal ions. *The paper and a separate file of supplemental material are temporarily* ***Open Access*** *(click on PDF) at* https://academic.oup.com/nsr/article-lookup/doi/10.1093/nsr/nwx051.

AN ELECTRIC FIX FOR REMOVING LONG-LASTING CHEMICALS IN GROUNDWATER

Blotevogel, J.
Colorado State University: The Conversation, 12 Apr 2017

Studies have shown that a method called electrochemical oxidation can remove per- and polyfluorinated substances (PFASs) from wastewater. It works by passing a direct electrical current between electrodes (conductive metal plates). When the voltage is high enough, PFAS molecules give up an electron to the positive electrode, starting a chain reaction that turns PFASs into carbon dioxide and fluoride. At field scale, the goal would be to remove PFASs that have spilled and soaked into the earth, contaminating groundwater supplies. Past research at a former munitions storage site in Pueblo, Colorado, demonstrated that it was possible to treat groundwater contaminated with explosives by passing it through an electrolytic barrier. To do this, scientists sank mesh electrodes that looked like window screens into a trench. Contaminated groundwater moved naturally through these mesh electrodes, where an electrical current broke down the pollutants. This process required ~5 to 15 volts of electricity—roughly the amount supplied by a car battery. Current research at Colorado State University aims to apply the electrolytic barrier technology to treatment of PFAS-contaminated water and also to couple electrochemical oxidation with biological degradation by using a live fungus to help break down PFASs.
https://theconversation.com/an-electric-fix-for-removing-long-lasting-chemicals-in-groundwater-69610

ELUCIDATING THE FATE OF A MIXED TOLUENE, DHM, METHANOL, AND I-PROPANOL PLUME DURING IN SITU BIOREMEDIATION

Verardo, E., O. Atteia, and H. Prommer.
Journal of Contaminant Hydrology 201:6-18(2017)

A subsurface model was developed to analyze the performance of an actively operating field-scale enhanced bioremediation scheme at a study site affected by a plume of mixed toluene, dihydromyrcenol, methanol, and i-propanol. High-resolution, time-series data were used to constrain the model development and calibration. Resulting analysis shows that the observed failure of the treatment system is linked to an inefficient oxygen injection pattern. Simulations also suggest that additional contaminant spills have occurred, resulting in a significant increase in contaminant fluxes that remain untreated.

LONG-TERM ERT MONITORING OF BIOGEOCHEMICAL CHANGES OF AN AGED HYDROCARBON CONTAMINATION

Caterina, D., A.F. Orozco, and F. Nguyen.
Journal of Contaminant Hydrology 201:19-29(2017)

This paper present electrical resistivity tomography imaging results for data collected over a period of 2 years on a diesel-contaminated site undergoing bioremediation. Low electrical resistivity anomalies were observed in areas associated with the highest contaminant concentrations, likely from contaminant transformations due to microbial activity and accompanying release of metabolic products. Large seasonal variations of the bulk electrical resistivity in the contaminated areas corresponded to temperature and groundwater level fluctuations; however, the amplitude of bulk electrical resistivity variations largely exceeds the amplitude expected based on existing petrophysical models. The study results suggest that variations in electrical properties are controlled mainly by microbial activity, which in turn depends on soil temperature and hydrogeological conditions.

TCE LONGEVITY IN THE VADOSE ZONE AND LOADING TO THE GROUNDWATER: THE CASE OF EPISODIC NAPL RELEASES FROM NEAR-SURFACE SOURCE

Dafny, E.
Environmental Technology & Innovation 7:128-140(2017)

Using numerical simulations, TCE longevity in the vadose zone and the loading to groundwater following episodic NAPL releases from a near-surface source were quantified in a study of episodic leaks from a metal plating factory sewer system and leak migration through a sandy unsaturated zone to the water table. The numerical investigation was carried out using the T2VOC code of the TOUGH family and the PetraSim2016 graphical user interface (GUI). The effects of land-cover conditions (i.e., connection to atmosphere and interception of rain) and vadose zone depth on TCE distribution, partitioning, and fate were demonstrated in 3D, multiphase, multi-component simulations. In all simulations, the NAPL plume spread only to a distance of several meters below the source. A general trend of increased $TCE^{(aq)}$ loads to the groundwater appeared during the disposal period, followed by a substantial and immediate drop at its termination and a long-term gradual decrease in loads thereafter. Each simulated case showed somewhat different characteristics of the time-dependent load function. Over a period of five decades, only a small fraction (0.08-3%) of the migrating TCE reached the 5-30 m depth water table; covered (roofed) soils and thicker vadose zones had the lowest loads.

NEWLY IDENTIFIED MICROBIAL PROCESS COULD REDUCE TOXIC METHYLMERCURY LEVELS

Oak Ridge National Laboratory News, 31 May 2017

A team from DOE's Oak Ridge National Laboratory has discovered a new way to remove toxic methylmercury from water using certain methanotrophs—bacteria that feed off methane gas and can either take up or break down methylmercury. Methane and methylmercury are both formed in similar anoxic (oxygen-deficient) environments. In collaboration with methanotroph experts from the University of Michigan and Iowa State University, the researchers used mass spectrometry to examine the behavior of different methanotrophs for methylmercury uptake and decomposition. They found that several species, including *Methlyosinus trichosporium* OB3b, showed the ability to both take up and break down methylmercury. Project findings were published in *Science Advances* 3:e1700041(2017).
https://www.ornl.gov/news/newly-identified-microbial-process-could-reduce-toxic-methylmercury-levels

TREATMENT OF SOIL-WASHING EFFLUENTS POLLUTED WITH HERBICIDE OXYFLUORFEN BY COMBINED BIOSORPTION-ELECTROLYSIS

Chair, K., A. Bedoui, N. Bensalah, C. Saez, F.J. Fernandez-Morales, S. Cotillas, P. Canizares, and M.A. Rodrigo.
Industrial & Engineering Chemistry Research 56(8):1903-1910(2017)

After soil washing with sodium dodecyl sulfate (SDS) efficiently removed the herbicide oxyfluorfen from a test soil, the effluent was treated with a combination of biosorption and electrolysis. In the biosorption process, the maximum adsorption capacity of fresh activated sludge from a municipal wastewater treatment plant was found to be 18 mg of oxyfluorfen per gram of biomass. Effluents of the biosorption process then underwent anodic oxidation, photoelectrolysis, and sonoelectrolysis at high and low frequency. The four technologies were able to mineralize the effluent completely, although important differences arose during the treatment that depended on the application of ultrasound or UV irradiation and on the release of sulfate from SDS oxidation; intermediates were removed faster because of the activation of sulfate radicals. The system removed oxyfluorfen and its oxidation intermediates faster than it removed SDS, such that when the contaminants were fully depleted, large concentrations of SDS remained in the treated solution, thus opening the possibility of reusing the soil washing fluid.

GLOWING BACTERIA COULD DETECT BURIED LANDMINES

The Hebrew University of Jerusalem, Apr 2017

Researchers from the Hebrew University of Jerusalem reported [*Nature Biotechnology* 35(4):308-310(2017)] the development of a novel, functional system combining lasers and bacteria to remotely map the location of buried landmines and unexploded ordnance. The system is based on the observation that all landmines leak minute quantities of vapors from the explosives, which accumulate in the soil above them and serve as markers for their presence. The researchers molecularly engineered live bacteria that emit a fluorescent signal upon contact with the vapors. The bacteria were encapsulated in small polymeric beads and scattered across the surface of a test field in which real antipersonnel landmines were buried. Using a laser-based scanning system, the test field was remotely scanned and the location of the buried landmines was determined in the first demonstration of a functional standoff landmine detection system. For engineered biosensors to become reliably useful in a landmine detection system, several challenges need to be overcome, such as enhancing the sensitivity and stability of the sensor bacteria, improving scanning speeds to cover large areas, and making the scanning apparatus more compact for use aboard a light unmanned aircraft or drone. http://new.huji.ac.il/en/article/34416

NEW ENVIRONMENTAL TECHNOLOGY UPTAKE AND BIAS TOWARD THE STATUS QUO: THE CASE OF PHYTOREMEDIATION

Montpetit, E. and E. Lachapelle. Environmental Technology & Innovation 7:102-109(2017)

Under certain conditions, phytoremediation is a cost-effective tool for remediating sites with organic contaminants and trace elements; however, awareness and use of this technology by practitioners lags significantly behind that of conventional technologies, reflecting a status quo bias and preference for conventional excavation. Drawing on data from a survey of soil decontamination practitioners, this study sheds new light on why, despite its promise, phytoremediation remains under-used. This review highlights the challenge of transferring scientific knowledge from the laboratory to practitioners working to mitigate serious environmental problems.

SOIL FLUSHING AND SIMULTANEOUS DEGRADATION OF ORGANIC POLLUTANTS IN SOILS BY ELECTROKINETIC-FENTON TREATMENT

Popescu, M., E. Rosales, C. Sandu, J. Meijide, M. Pazos, G. Lazar, and M.A. Sanroman.
Process Safety and Environmental Protection 108:99-107(2017)

In a study that combined electrokinetic technology and Fenton's process to remediate soil affected by petroleum hydrocarbons, experiments using kaolinite spiked by Rhodamine B were performed to determine the influence of variables such as H_2O_2 dosage, Fe soil concentration, and porosity. The use of the colored sample enabled easy monitoring of the oxidation reactions across the soil bed. The highest color removal rate was reached at a solution of ~10% H_2O_2, and little influence of Fe soil concentration was detected at the range of concentrations used in these experiments. In all cases, citric acid was added in the anolyte and catholyte solutions to solubilize the iron as Fe-citrate complex. Application of the electrokinetic-Fenton process achieved a TPH removal efficiency of 54.4% after 15 days of

treatment and 58.2% after 27 days, with a homogeneous removal of contaminants.

LOW-COST MONITORING DEVICE USES LIGHT TO QUICKLY DETECT OIL SPILLS

Science Daily, 6 Mar 2017

Monitoring for oil spills currently relies on technically complex and expensive instruments placed in aircraft or satellites to detect oil spills across large areas. Researchers from the Universidade de Vigo, Spain [*Applied Optics* 56(8):2150-2156(2017)], have developed a new device that is designed to float on water for remotely monitor a small area susceptible to pollution or tracking the evolution of contamination at a specific location. Initially, the low-cost device is capable of distinguishing from five types of oil, thus enabling a more specific response to counteract a spill. When crude or refined oil absorbs UV light, it emits a unique fluorescence spectrum, which the monitoring device uses as a "fingerprint" to identify the type of oil by comparing the measured fluorescence with information in a database. The new device is made with an inexpensive and simple setup of four photodiode detectors with different colors of cellophane film filters. This setup allows the researchers to record four signals, each consisting of different regions of the fluorescence spectrum. The device includes a commercial radio module to send data and receive configuration commands and a low-cost microcontroller similar to the ones used to operate drones, and it uses inexpensive UV LEDs as light sources. The researchers plan to construct a solar-powered prototype that could be placed in a buoy and left in place for months. To expand the oil identification database, they also are recording fluorescence fingerprints for types of oil not included in the initial study. https://www.sciencedaily.com/releases/2017/03/170306110341.htm

STREAMING POTENTIAL MODELING IN FRACTURED ROCK: INSIGHTS INTO THE IDENTIFICATION OF HYDRAULICALLY ACTIVE FRACTURES

Roubinet, D., N. Linde, D. Jougnot, and J. Irving.
Geophysical Research Letters 43(10):4937-4944(2016)

A highly efficient 2D discrete-dual-porosity approach is presented for solving fluid flow and associated self-potential (SP) geophysical method problems in fractured rock. The approach is specifically designed for complex fracture networks that cannot be investigated using standard numerical methods. SP signals associated with pumping conditions for several examples were simulated to show that (i) accounting for matrix fluid flow is essential for accurate SP modeling and (ii) the sensitivity of SP to hydraulically active fractures is intimately linked with fracture-matrix fluid interactions, which suggests that fractures associated with strong SP amplitudes are likely to be hydraulically conductive, attracting fluid flow from the surrounding matrix. *The manuscript version of this paper is available at* https://arxiv.org/pdf/1605.07841.

ACCELERATION OF GROUNDWATER REMEDIATION BY DEEP SWEEPS AND VORTEX EJECTIONS INDUCED BY RAPIDLY PULSED PUMPING

Kahler, D.M. and Z.J. Kabala.
Water Resources Research 52(5):3930-3940(2016)

Mixing between well-connected pores (whose volume is flushed as water flows through the aquifer) and poorly connected pores (whose volume does not exchange readily when water flows through the aquifer) is a limiting factor in groundwater remediation. Under steady flow, contaminants trapped in the poorly connected pores are transferred only by molecular diffusion. This slow mixing process between pore types is a bottleneck to remediation. A novel rapidly pulsed pumping method is presented that increases mixing between these pore types. In rapidly pulsed pumping during pump and treat, the increase in flow causes a deep sweep, which pushes the flow into poorly connected pores and sweeps out sequestered contaminants. The decrease in flow causes a vortex ejection, which causes the vortex within the poorly connected pore to emerge with contaminant. This technique can decrease the time and cost needed to remediate contaminated aquifers. Because rapidly pulsed pumping enhances mixing between well-connected and poorly connected pores, it can be applied to other remediation schemes, such as in situ methods. *See details in D.M. Kahler's dissertation at* https://dukespace.lib.duke.edu/dspace/handle/10161/3915?show=full

SEQUESTRATION OF CATECHOL AND PENTACHLOROPHENOL BY MECHANOCHEMICALLY TREATED KAOLINITE

Ancona, V., P. Di Leo, and M.D.R. Pizzigallo.
Clays and Clay Minerals 64(5):(2016)

In an investigation of the efficiency of the mineral kaolinite in promoting the sequestration of catechol (CAT) and pentachlorophenol (PCP) by mechanochemical treatment, well-crystallized kaolinite (KGa-1b) was milled for prolonged times with different amounts of organic molecules to obtain two different clay:organic compound ratios. Extended grinding and a higher clay mineral:organic compound ratio were more effective in promoting removal than simple contact. After 1 h of treatment, PCP and CAT removal was 32% and 20%, respectively. A 7-day undisturbed incubation of the milled mixtures increased CAT removal up to 40%. The interaction mechanism between kaolinite and each organic compound after treatment was inferred by integrating information from spectroscopic, diffractometric, and chromatographic analyses, which suggested a strong interaction between CAT and KGa-1b.

PERFORMANCE OF POLYMER-ENHANCED BENTONITE-SAND MIXTURE FOR COVERING ARSENIC-RICH GOLD MINE TAILINGS FOR UP TO 4 YEARS

Hosney, M.S. and R.K. Rowe.
Canadian Geotechnical Journal 54(4):588-599(2017)

Experiments were conducted over a 4-year period on a polymer-enhanced bentonite-sand mixture (PEBSM) used as cover for gold mine tailings. In an investigation of the effect on PEBSM hydraulic conductivity (k) of subgrade porewater chemistry, subgrade water content, and confining stress, results showed that the reduction in the mole fraction of bound Na^+ (ESP) and corresponding increase in k of PEBSM with time was highly dependent on the ionic strength of the subgrade porewater. A foundation layer 0.15 m thick between tailings and PEBSM layer significantly lowered the reduction in ESP and increase in k with time as did a reduction in the subgrade water content. The PEBSM layer acted as a good barrier to upward migration of arsenic from tailings toward cover soil above the PEBSM layer. *See the manuscript version of this paper at* https://tspace.library.utoronto.ca/bitstream/1807/76049/1/cgj-2016-0375.pdf.

AN ANALYTICAL APPROACH TO ASSESS QUALITY CONTROL SAMPLE SIZES OF CEMENT-BASED SOLIDIFICATION/STABILIZATION

Liza, R., G.A. Fenton, C.B. Lake, and D.V. Griffiths.
Canadian Geotechnical Journal 54(3):419-427(2017)

This paper presents an analytical approach to selecting the sample size required to achieve acceptable quality control in a cement-based solidification/stabilization construction cell program intended for the treatment or containment of contaminated soils. An example illustrates how the proposed approach can be used in practice to assess the required sample size for the quality control program of cement-based S/S construction cells. *For additional information, see the manuscript version of this paper at* https://dalspace.library.dal.ca/handle/10222/72621 *or R. Liza's dissertation at* https://dalspace.library.dal.ca/bitstream/handle/10222/55971/Liza-Rukhsana-PhD-CIVL-November-2014.pdf.

General News

AN ASSESSMENT OF MINE LEGACIES AND HOW TO PREVENT THEM: A CASE STUDY FROM LATIN AMERICA

Pacheco Cueva, V.
Springer, New York. ISBN: 978-3-319-53976-8, 2017

This book presents a case study of a small abandoned mine in Latin America by assessing some of the most damaging legacies of the San Sebastian mine in eastern El Salvador, comparing the country's mine closure legislation against world best practice standards, and providing strategies for awareness, prevention, and remediation. The most damaging legacy to the environment is that of acid mine drainage contamination of the local river, felt well beyond the mining district. *View the table of contents and chapter abstracts at* http://www.springer.com/us/book/9783319539751#otherversion=9783319539768.

INSURE: INNOVATIVE SUSTAINABLE REMEDIATION

INSURE is a four year Interreg Central Baltic project running from September 2015 until August 2019. The project is a cooperative effort between seven partners from Sweden, Finland, and Latvia. INSURE's goal is to make the remediation of contaminated sites more frequent and sustainable. Six pilot areas will be investigated during the project and tested for the performance of remediation alternatives. This effort encompasses three major work packages:

- Sustainable remediation.
- Strategic management methods.
- Technical tools for visualization of contaminated sites.

Several newsletters that describe project activities are available on the INSURE website at http://www.insureproject.se/en/.

APPLYING BIOAUGMENTATION TO TREAT DNAPL SOURCES IN FRACTURED ROCK

Schaefer, C., G. Lavorgna, M. Annable, and E. White.
ESTCP Project ER-201210, 38 pp, 2017

This document aims to provide practical guidance and insight into the application of bioaugmentation to treat DNAPL sources in fractured rock with a focus on treatment of residual (i.e., non-mobile) DNAPL sources. Recommendations are based largely on insights attained through a field demonstration performed in fractured granite at Site 37 at Edwards Air Force Base in the vicinity of Building 8595, adjacent to the location of a reported surface release of PCE. The following sections of this document provide: 1) recommended approaches for source area identification and characterization, 2) guidance on amendment delivery and operation, 3) a recommended monitoring approach, 4) a strategy for assessing performance data (including rebound), and 5) a discussion of secondary groundwater impacts and biofouling.
https://www.estcp.com/content/download/44773/419098/file/ER-201210%20Guidance%20Document.pdf

VAPOR INTRUSION GUIDANCE FOR CONTAMINATED SITES

Alaska Department of Environmental Conservation (DEC), 105 pp, 2017

The Alaska DEC has finalized its 2009 draft vapor intrusion guidance for evaluating and controlling vapors migrating from the subsurface into an occupied structure. This guide presents a strategy—a series of steps—for consistently assessing the potential for risk from vapor intrusion.
http://dec.alaska.gov/spar/csp/guidance_forms/docs/January-2017-VI-Guidance-with-App-FINAL.pdf

PETROLEUM HYDROCARBONS IN GROUNDWATER: GUIDANCE ON ASSESSING PETROLEUM HYDROCARBONS USING EXISTING HYDROGEOLOGICAL RISK ASSESSMENT METHODOLOGIES

CL:AIRE (Contaminated Land: Applications in Real Environments), London. ISBN 978-1-905046-31-7, 44 pp, 2017

This guide was developed to present an effective, reliable, and consistent approach to petroleum hydrocarbon assessment within hydrogeological risk assessments. Advice is provided on how to (1) evaluate the risk from hydrocarbon mixtures; (2) consider the available analytical techniques; (3) estimate the implications of NAPL for dissolved-phase groundwater risk assessments; and (4) promote a lines-of-evidence approach to evaluate the importance of biodegradation and other natural attenuation processes. http://www.claire.co.uk/phg

The Technology Innovation News Survey welcomes your comments and suggestions, as well as information about errors for correction. Please contact Michael Adam of the U.S. EPA Office of Superfund Remediation and Technology

Innovation at adam.michael@epa.gov or (703) 603-9915 with any comments, suggestions, or corrections.

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