Technology Innovation News Survey

Entries for November 1-15, 2022

Market/Commercialization Information

FY23 GUIDELINES FOR BROWNFIELDS TRAINING, RESEARCH, AND TECHNICAL ASSISTANCE GRANT

Environmental Protection Agency, Funding Opportunity EPA-I-OLEM-OBLR-22-12, 2022

EPA's Office of Brownfields and Land Revitalization is soliciting applications for funding to eligible entities to provide training, research, and technical assistance to facilitate the inventory of brownfield sites, site assessments, remediation of brownfield sites, community involvement, or site preparation. Grants awarded under this solicitation will help communities, organizations, government agencies, nonprofits, and individuals tackle the challenge of cleaning up and revitalizing brownfield properties. EPA anticipates awarding approximately one grant in each of the five topic areas below:

- Nation-wide technical assistance for Brownfields Revolving Loan Fund (RLF) grant recipients (RLF TA)
- Nation-wide technical assistance to nonprofits seeking to reuse brownfields sites (Nonprofits TA)
- Nation-wide technical assistance to local government leaders on developing and/or operating brownfields programs within their jurisdictions (Local Government TA)
- Research, technical assistance, and related outreach on minimizing displacement resulting from brownfields assessment, cleanup and reuse (Anti-displacement research)
- Research, technical assistance, and related outreach on land banking approaches for brownfields revitalization (Land banks research)

The total estimated funding available under this competitive opportunity is $4,000,000, subject to the availability of funds, quality of applications, and other applicable considerations. EPA anticipates awarding five cooperative agreements. The maximum value of each grant will be based on the particular project but will not exceed $1,000,000 over a five-year project period each for topics 1, 2, and 3 and will not exceed $500,000 over a four-year project period for topics 4, and 5 under this competitive opportunity. Cooperative agreements awarded will be funded with Infrastructure Investment and Jobs Act (or the "Bipartisan Infrastructure Law") funds. The closing date and time for receipt of applications is February 14, 2023, 11:59 p.m. ET. https://www.grants.gov/web/grants/view-opportunity.html?oppId=344534

COLUMBIA RIVER BASIN RESTORATION FUNDING ASSISTANCE PROGRAM - TOXIC REDUCTION LEAD

Environmental Protection Agency Region 10, Funding Opportunity EPA-I-R10-OW-CRBRP-2023-02, 2022

EPA Region 10 is issuing a Request for Applications (RFA) from eligible entities to improve water quality in the Columbia River Basin through specific actions to reduce toxics, and/or increase public education and outreach. The Columbia River Basin Restoration Program (CRBRP) will assist tribal, state, and local governments; nongovernmental entities, and others as they implement the Columbia River Basin Toxics Reduction Action Plan and the Lower Columbia River Estuary Plan - Comprehensive Conservation and Management Plan and conduct activities to support EPA national goals for the Columbia River Basin. Eligible activities must address at least one of the following categories: eliminating or reducing pollution; cleaning up contaminated sites; improving water quality; reducing runoff; protecting habitat; or promoting citizen engagement or knowledge. Priority for funding will be given to applications which are consistent with federal fiscal year 2023 (FY2023) funding priorities as described in the RFA. EPA will be hosting the same informational webinar on two different dates. Potential applicants are encouraged to participate in one of these information sessions to learn more about the Columbia River Basin Restoration program and the grant application process. Pre-registration is not required. Webinar links and dial-in information will be posted at https://www.epa.gov/columbiariver/columbia-river-basin-restoration-funding-assistance-program.

- Thursday, January 19, 2023, 1:00 - 2:30 p.m. (Pacific)
- Thursday, February 23, 2023, 1:00 - 2:30 p.m. (Pacific)

Applications must be submitted by Monday March 13, 2023, at 11:59 p.m. ET. Late applications will not be considered for funding. https://www.grants.gov/web/grants/view-opportunity.html?oppId=344820

FUSRAP/HTRW VERIFICATION & LABORATORY SERVICES (PRESOL)

U.S. Army Corps of Engineers (USACE), Mississippi Valley Division, St, Louis, MO
Contract Opportunities on SAM.gov, Solicitation W912P923R0009, 2022

When the solicitation is released, it will be competed as a full and open competition under NAICS code 562910. The Government intends to issue a solicitation for a Single Award Task Order Contract for the continued support of Hazardous, Toxic and Radioactive Waste verification, laboratory and environmental services managed by the St. Louis District of USACE. This contract will primarily provide for interdisciplinary support of the Formerly Utilized Sites Remedial Action Program (FUSRAP). The work at the FUSRAP St. Louis Sites falls under the CERCLA and is performed in accordance with the Multi-Agency Radiation Survey and Site Investigation Manual. The St. Louis FUSRAP sites contain low-level radiological and chemically contaminated material. Geographic proximity includes: FUSRAP sites managed by the St. Louis District located in the metropolitan St. Louis area and the Iowa Army Ammunition Plant in Burlington, Iowa; as well as other geographical regions within the boundaries of the Mississippi Valley Division or other sites assigned to the St. Louis District. Sites range from heavily industrialized areas to open fields. The Government may, at its discretion and with concurrence of the Contractor, request the Contractor to perform work in other geographical regions in or out of the St. Louis District's boundaries. The work anticipated under this contract is primarily for, but not limited to, low-level radioactive contaminated material investigation, extent of contamination surveys, environmental assessments, on-site laboratory analysis, radiological and health physics technical support, removal action verification, and environmental monitoring. Operating the on-site radiological laboratory, the Contractor must achieve and maintain accreditation through successful completion of the American Association for Laboratory Accreditation evaluation process. Also, the Contractor must conduct performance evaluation testing as directed by the USACE Hazardous, Toxic and Radioactive Waste Center of Expertise and the DoD Environmental Laboratory Accreditation Program and Mixed Analyte Performance Evaluation Program. Other services requested will include laboratory and field data analysis and management, administrative recordkeeping and document management, geographic information services, computer-aided design and drafting, technical/regulatory integration, community involvement, and project controls necessary for the execution of the St. Louis District FUSRAP. The contract will be awarded using the best value tradeoff process. Required small business participation will be over 35 percent. The contract will be a cost-reimbursable Cost Plus Fixed-Fee (CPFF) contract with a one-year period of performance. https://sam.gov/opp/c16e543c765a4c908c7275b1b736eba4/view

Cleanup News

USING PROTOTYPES TO ENABLE DEVELOPMENT OF COMMERCIALLY VIABLE FIELD SCALE CONTAMINATED SITE REMEDIATION PROCESSES

Guerin, T.F. I Chemosphere 288(Part 2):132481(2022)

Soil structure was damaged from solvents and localized heating after a large fire which potentially limited bioremediation of an industrial site. Lab prototypes, including a bioflushing reactor, were developed and tested to treat contamination. After successful lab testing (96% phenol removal), the bioflushing prototype was applied in the field. Using a small-scale 2000 L bioreactor, the field prototype removed 95% phenol, and the trial was then scaled to commercial cleanup. After 600 days of treatment, intensive soil grid sampling revealed hotspots of remaining solvents as well as heterogeneity in the subsurface, but overall concentrations decreased below the initial assessment. The process decreased initial soil phenol concentrations of ~500 mg/kg (pre-treatment area average) to 75 mg/kg across the most contaminated areas. Phenol toxicity increased with depth and is linked to increasing oxygen deficit. The prototyping process enabled site clean-up and scaling for bioremediation.

NATURAL SOURCE ZONE DEPLETION (NSZD) INSIGHTS FROM OVER 15 YEARS OF RESEARCH AND MEASUREMENTS: A MULTI-SITE STUDY

Kulkarni, P.R., K.L. Walker, C. J. Newell, K.K. Askarani, Y. Li, and T.E. McHugh.
Water Research 225:119170(2022)

Site-average natural source zone depletion (NSZD) rates from 40 petroleum LNAPL source zone sites from researchers, project reports, and scientific papers to compile data on general site location; LNAPL fuel type; measurement method, number of locations, and number of measurements per location; and calculated site-average NSZD rate in L/ha/yr per site and the associated measurement method. The resulting dataset showed site-average NSZD rates that ranged from 650 to 152,000 L/ha/yr (70 to 16,250 gal/acre/yr), with a median value of 9,540 L/ha/yr (1,020 gal/acre/yr). The median site-average NSZD rate by type of fuel spill did not show a statistically significant difference between fuel types. When comparing the different NSZD measurement methods applied to the same sites, the site-average NSZD rates differed by a factor of up to 4.8 (i.e., ratio of faster rate to slower rate), with a median difference of 2.1. No clear bias was observed between NSZD rate measurement methods. At four sites with NSZD rate calculations by season, NSZD rates were typically higher during summer and fall compared to winter and spring. For these sites, Q_{10} values (a measure of the increase in NSZD rate associated with a 10°C increase in temperature) ranged from 0.8-15.1, with a median of 2.2. Results suggest that increasing mean annual soil temperature at a site using engineered methods could potentially increase the biodegradation rate (e.g., an increase of 10°C could double the NSZD rate). For five sites with site-average NSZD rates for multiple years, average NSZD rates varied by 1.1 to 4.9 times across years. Evaluating the NSZD rates suggests that measurable NSZD occurs across a broad range of LNAPL sites. Although NSZD rates vary across sites, fuel type is not the primary factor explaining observed differences in rates.

IN SITU PASSIVE SAMPLING TO MONITOR LONG TERM CAP EFFECTIVENESS AT A TIDALLY INFLUENCED SHORELINE

Smith, A.V., X. Shen, U. Garza-Rubalcava. W. Gardiner, and D. Reible.
Toxics 10(3):106(2022)

Polydimethylsiloxane solid-phase microextraction passive samplers were used to evaluate the long-term performance of a sand/gravel cap placed in 2005 in a tidally influenced shoreline in Puget Sound to reduce PAH transport into overlying surface water. Sampling in 2010 and 2018 measured porewater concentrations of < 1 ng/L total PAHs in the cap layer. d-PAH performance reference compounds were used to evaluate the extent of equilibration of the contaminants onto the samplers and to estimate net upwelling velocities through a mass transfer model. The upwelling velocities were then used to predict the long-term migration of selected PAHs through the cap. Results show that the cap is expected to continue to effectively limit contaminant exposure at the cap-water interface. *This article is* ***Open Access*** *at* https://www.mdpi.com/2305-6304/10/3/106/htm.

Demonstrations / Feasibility Studies

TRACKING NSZD MASS REMOVAL RATES OVER DECADES: SITE-WIDE AND LOCAL SCALE ASSESSMENT OF MASS REMOVAL AT A LEGACY PETROLEUM SITE

Davis, G.B., J.L. Rayner, M.J. Donn, C.D. Johnston, R. Lukatelich, A. King, T.P. Bastow,
and E. Bekele. I Journal of Contaminant Hydrology 248:104007(2022)

Site-specific gasoline and diesel NSZD rates are reported from sites undergoing NSZD over 21-26 years. NSZD rates were estimated in 1994, 2006 and 2020 for diesel and in 1999, 2009 and 2020 for gasoline using depth profiles of soil gases (oxygen, carbon dioxide, methane and volatiles) above LNAPL. Each date also had soil-core mass estimates, which were used with NSZD rates to estimate the longevity for LNAPL presence. Site-wide coring (in 1992, 2002 and 2007) estimated LNAPL mass reductions of 12,000 t. For diesel NSZD, the ratio of NSZD rates for 2006 (16,000-49,000 L/ha/y) to those in 2020 (2600-14,000 L/ha/y) was ~3-6. By 2020, the 1994 diesel NSZD rates would have predicted the entire removal of measured mass (16-42 kg/m^2). For gasoline, NSZD rates in 1999 were extremely high (50,000-270,000 L/ha/y) but 9-27 times lower (5800-10,000 L/ha/y) a decade later. The gasoline NSZD rates in 1999 predicted near complete mass removal in 2-12 years, but 10-11 kg/m^2 was measured 10 and 21 years later, which is 26% of the initial mass in 1999. The outcomes substantiate the need to understand NSZD rate changes over the lifetime of LNAPL-impacted sites.

ASSESSMENT OF REED GRASSES (PHRAGMITES AUSTRALIS) PERFORMANCE IN PFAS REMOVAL FROM WATER: A PHYTOREMEDIATION PILOT PLANT STUDY

Ferrario, C., C. Peruzzi, A. Cislaghi, S. Polesello, S. Valsecchi, R. Lava, F. Zanon, G. Santovito, A. Barausse, and M. Bonato. I Water 14:946(2022)

A phytoremediation pilot plant was supplied by a contaminated well with surface and groundwaters significantly impacted by PFAA discharges from a fluorochemical factory in Lonigo, Italy. The investigation detected PFBA, PFOA, PFBS, and PFOS inside the inlet and outlet waters of the phytoremediation pilot plant and in reed grasses grown in its main tank. Results demonstrate that the pilot plant reduced up to 50% of considered PFAAs in mass flow without an evident dependence on the physico-chemical characteristics of the contaminants. PFAAs were found in the exposed reed grasses at concentrations up to 13 ng/g ww. A positive correlation between PFAA concentration in plants and exposure time was also observed. The article highlights the potential efficiency of phytodepuration in PFAS removal and recommends improving the knowledge about its application in constructed wetlands as a highly sustainable choice in wastewater remediation.https://www.mdpi.com/2073-4441/14/6/946/pdf

PFASSIVE™: AN EQUILIBRIUM PASSIVE SAMPLER FOR PFAS IN SEDIMENT PORE WATER AND SURFACE WATER!

Pautler, B.G., 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. Mitzel.
RemTec & Emerging Contaminants Summit, 4-6 October, Westminster, CO, abstract only, 2022

The presentation highlights targeted and non-targeted results from in situ field testing of a novel passive sampler, PFASsive, and compares results with those obtained from traditional grab sampling. *See SiremLab webinar presentation on PFAssive:* https://vimeo.com/706996860

EVALUATION OF DENDROREMEDIATION POTENTIAL OF TEN QUERCUS SPP. FOR HEAVY METALS CONTAMINATED SOIL: A THREE-YEAR FIELD TRIAL

Li, X. J. Xiao, M.M.A. Salam, and G. Chen.
Science of The Total Environment 851(Part 1):158232(2022)

Ten *Quercus* species were examined throughout a 3-year field trial (2018-2020) to assess their ability to dendroremediate Cd- and Zn-contaminated soil. Nine *Quercus* species (all but *Quercus velutina* Lam.) demonstrated good survival ability without any stress in the 3-year growth period. In 2020, *Quercus texana* Buckley and *Quercus fabri* Hance plants produced the greatest biomass (2100 and 1880 g/plant) among the nine *Quercus* s spp. *Quercus texana* accumulated the highest total Cd (39.3 mg/plant) in 2020, 8.5 times higher than that in 2018, followed by *Quercus pagoda* Raf. (8.85 mg/plant) and *Q. fabri* (8.07 mg/plant) plants, respectively. Cd accumulation increased by 7.4 times for *Q. pagoda* and 22 times for *Q. fabri* compared to 2018. The results from 2020 indicated that *Q. fabri* had the highest Zn accumulation (205 mg/plant), followed by *Quercus nigra* L. (149 mg/plant) and *Q. texana* (140 mg/plant), respectively. Values increased 14, 6.4, and 6.2 times compared to 2018. Using the comprehensive bioaccumulation index, *Q. texana* and *Q. fabri* had the best potential to remediate Cd- and Zn-polluted soil, with values of 0.82 and 0.60, respectively.

SUMMARY REPORT FAIRBANKS INTERNATIONAL AIRPORT PLUMESTOP® PILOT STUDY FAIRBANKS, ALASKA

Shannon & Wilson for Fairbanks International Airport (FAI), 482 pp, 2021

A pilot study was designed to target PFOS, PFOA, PFHpA, PFHxS and PFNA using PlumeStop® colloidal activated carbon (CAC). Design Verification Testing (DVT) was conducted before injection, including detailed soil logging and grain-size analysis, groundwater sampling for target and non-target analytes, using PFMs to measure contaminant flux, and injection testing to characterize remedial conditions in the test area. Regional groundwater velocity and gradient data were used to design models to estimate application volumes, CAC quantity, and anticipated treatment longevity. A total of ~8,470 gallons of PlumeStop were injected at 20 injection points. Initial baseline groundwater sampling showed PFOS and PFOA concentrations over seven times the Lifetime Health Advisory level. PFHxS and PFHpA were detected at 530 ng/L and 24 ng/L, respectively. PFNA was not detected in baseline samples. Two months after PlumeStop injection, groundwater samples had an estimated detection of PFOS below the reporting limit. Other PFAS analytes were not detected. As of December 2020, PFOS, PFOA, PFHpA, PFHxS and PFNA were not detected in the post-injection samples. Out of eight other PFAS analytes detected in the baseline samples, three analytes had detectable results twenty months after PlumeStop injection, including PFBA, PFBS and PFPeA. These analytes contain fewer carbons in their chemical structure (short-chain) and are displaced from the CAC sites by larger-chain PFAS analytes. The pilot study indicates that PlumeStop is less effective at long-term treatment of short-chain PFAS. However, the pilot study was not designed to target these analytes. https://dot.alaska.gov/airportwater/docs/Fairbanks%20International%20Airport/2021.12%20FAI%20PlumeStop%20Pilot%20Study%20Report%20for%20Public.pdf.
To see all site documents, click on Fairbanks International Airport from the list of dropdowns: https://dot.alaska.gov/airportwater/.

Research

AN INVESTIGATION OF THERMAL AIR DEGRADATION AND PYROLYSIS OF PER- AND POLYFLUOROALKYL SUBSTANCES AND AQUEOUS FILM-FORMING FOAMS IN SOIL

Alinezhad, A., P.C. Sasi, P. Zhang, B. Yao, A. Kubatova, S.A. Golovko, M.Y. Golovko, and F. Xiao. I ACS ES&T Engineering 2(2):198-209(2022)

A study was conducted to delineate factors that impact the fate of PFAS in soil during thermal treatment and influence the selection and operation of thermal technologies for remediating PFAS-contaminated sites. Thermal decomposition of PFAS in soil was rapid at 400-500°C, regardless of whether the soil was contaminated by a single PFAS compound or a PFAS mixture in aqueous film-forming foams. Substantial degradation (>99%) of PFAS in soil, including PFOA, PFOS, short-chain homologs, cationic and zwitterionic precursors, and PFOA and PFOS alternatives, occurred in 30 min at 500°C in both a sealed reactor in air and a horizontal reactor under a continuous flow of N_2. The effect of the initial PFAS level in soil (0.001-10 μmol/g) and soil texture was insignificant, provided a sufficiently high temperature was applied. Kaolinite dramatically decreased the apparent yield of F from PFAS heated at >300°C, likely due to the chemisorption of F radicals on kaolinite. This phenomenon was not observed when kaolinite and NaF were thermally treated. Various nonpolar thermal degradation products of PFOA and PFOS were reported for the first time. The profile of fluorinated volatiles, particularly perfluoroalkenes, was similar between these two chemicals. The results support a radical-mediated degradation pathway of PFAS.
See presentation from Northeast Conference on The Science of PFAS:
https://wbwa.com/wems/wbwa_backend/get_event_s3_file_api?event_id=sopc_2020038&file_url=https://d1keuthy5s86c8.cloudfront.net/static/ems/upload/files/bifab_Alinezhad_3_Ali_Alinezhad.pdf&eventkey=ad5b9325b33ddf90075c415919b94

IMMOBILISATION OF METALS FROM BOTTOM SEDIMENTS USING TWO ADDITIVES AND THERMAL TREATMENT

Koniarz, T., A. Baran, M. Tarnawski, and M. Jewiarz.
Science of The Total Environment 851(Part 2):158157(2022)

A study used two additives to immobilize metals (Cd, Zn, Pb and Cr) and evaluated the effect of three combustion temperatures on metal content and bottom sediment properties. The mixtures were prepared using contaminated bottom sediment, cellulosic waste and biomass ash. The bottom sediment samples were subjected to a thermal process in a second experiment at 500, 800 and 950°C. Adding cellulosic waste and biomass ash to acidic, metal-contaminated bottom

sediments significantly improved the properties of the resulting mixtures, including an increase in pH, sorption capacity, and macronutrient content and a decrease in the content and mobility of metals. The thermal process effectively reduced the ecotoxicity of the sediments, the total element content and their leachability, and thus mobility, with increasing process temperature. Results revealed that converted contaminated bottom sediments can be effectively managed, provided that further studies on their technical application are carried out.

GRANULAR ACTIVATED CARBON ADSORPTION OF PERFLUOROALKYL ACIDS FROM GROUND AND SURFACE WATER
Kempisty, D.M., E. Arevalo, A.M. Spinelli, V. Edeback, E.R.V. Dickenson, C. Husted, C.P. Higgins, R.S. Summers, and D.R.U. Knappe.
AWWA Water Science 4(1):e1269(2022)

PFAA adsorption by granular activated carbon (GAC) was evaluated in bench-, pilot- and full-scale studies to determine the effects of PFAA characteristics and background organic matter on carbon use rates. Rapid small-scale column tests (RSSCTs) were conducted according to the proportional diffusivity (PD) design to assess their suitability to predict full- or pilot-scale GAC performance. PFAA removal from groundwater (GW) and coagulated surface water (SW) was studied using two sub-bituminous coal-based GACs. Batch tests using pulverized GAC showed that the GACs performed similarly in GW, but GAC with a larger mesopore volume was more effective for PFAA removal from SW. In column tests, carbon use rates decreased with increasing PFAA chain length and were lower for GW (total organic carbon [TOC] = 0.7 mg/L) than for SW (TOC = 2.0-2.7 mg/L). The volume of SW that could be treated to 10% or 50% PFAA breakthrough was ~50-60% of the volume of GW that could be treated when comparing pilot-scale data for SW with full-scale data for GW. Consistent differences in PFAA adsorption capacity were not observed for empty bed contact times of 13 and 26 min in full-scale adsorbers treating GW. On average, the PD-RSSCT simulating PFAA removal from GW consistently overpredicted full-scale adsorption capacity by ~70%. Using a carbon use rate of <25 mg GAC/L water treated as a criterion for the feasibility of GAC treatment, full- and pilot-scale GAC adsorber data suggest that GAC is a viable treatment option (carbon use rate <25 mg GAC/L water treated) for PFCAs with six or more carbon atoms in SW and five or more carbon atoms in GW. For perfluoroalkyl sulfonic acids, GAC treatment is viable for compounds containing four or more carbons based on results obtained for SW and GW. https://awwa.onlinelibrary.wiley.com/doi/epdf/10.1002/aws2.1269

ASSESSING AND MITIGATING BIAS IN PFAS CONCENTRATIONS DURING GROUNDWATER AND SURFACE WATER SAMPLING
Hawley, E.L., R. Deeb, D. Bogdan, B. DiGuiseppi, A. Struse, H. Rectenwald, C. Schaefer,
T. Schwichtenberg, and J. Field. l 2022 Emerging Contaminants in the Environment Conference (ECEC22), 27-28 April, virtual, 15 minutes, 2022

Findings are summarized from an ongoing SERDP project, including science-based guidelines for practical field sampling equipment and procedures, sample shipping and storage, and research frontiers to improve techniques for surface water PFAS sampling (i.e., surface microlayer sampling methods to assess PFAS stratification and enrichment at the air/water interface and variability in field measurements using different common PFAS sampling methods).
Video: https://www.youtube.com/watch?v=lTeLIdqXFg8&list=PLBCBPVHKoeNcA014ZZLcGA4xiLjzZKMA7&index=12
Slides: https://www.ideals.illinois.edu/items/123491
More information: https://serdp-estcp.org/projects/details/2790bf90-57b4-4258-8a0a-71e00e80291c

WATER FLUX PROFILING IN FRACTURED ROCK BOREHOLES WITH AN IN-WELL POINT VELOCITY PROBE (IWPVP)
Heyer, B.R., T.C. Osorno, B.A.Carrera, C.M.W. Mok, and J.F. Devlina.
Journal of Hydrology 613(Part A):128383(2022)

Flow in a fractured rock aquifer beneath the Edwards Air Force Base was characterized by depth profiling two wells using In-Well Point Velocity Probes (IWPVPs). The probes were optimized for use in fractured rock wells and to meet several challenges, including sampling depths up to 38 m, high background site-water salinity, and variable well construction (screened vs open borehole and well diameters of 7.62 cm and 15.8 cm). Internal fluxes ranged from 3 to 53 m/d. The channeled internal design of the probe inherently provides information about general flow directions and allows further interpretation of specific flow directions within ±15°, which was generally consistent with the expected regional flow direction. Notably, a significant shift in the flow system (up to 180° shift in the flow direction) was observed following a rain event. The IWPVP identified highly transmissive zones in the fractured rock, independently confirmed by passive flux meters and oxidation-reduction potential sensors. Transmissivity profiles determined during the deployment of a Flexible Liner Underground Technologies™ liner also showed similarities in the depths of potentially high flow rates, particularly in the shallow portion of the well (<20 m). With additional information on fracture apertures provided by an acoustic televiewer, the internal fluxes were converted to water fluxes in the observed fractures, indicating seepage velocities in the rock aquifer between 3.7 m/d and 22.4 m/d.

A NEW ANALYTICAL MODEL FOR TRANSPORT OF MULTIPLE CONTAMINANTS CONSIDERING REMEDIATION OF BOTH NAPL SOURCE AND DOWNGRADIENT CONTAMINANT PLUME IN GROUNDWATER
Su, H., K.-W. Zheng, Z.-Y. Liao, C.-P. Liang, S.-W. Wang, and J.-S. Chen.
Advances in Water Resources 167:104290(2022)

A new analytical model is presented to remediate NAPL sources and downgradient contaminant plumes in groundwater at sites contaminated with chlorinated solvents and their degradation products with different retardation factors. The model also considers both NAPL source and plume remediation simultaneously. A plume reactive transport model is coupled with a source model that accounts for depletion of mass by dissolution or first-order decay reactions, corresponding with source mass removal or destruction. The source model is accounted for by relating source mass to the flux-averaged source discharge concentration through a power function. The model considers 1-D advection, 3-D dispersion, first-order decay reactions and ingrowth, and linear isothermal equilibrium sorption. The proposed analytical solution was derived through successive application of the Laplace transform in time and the double finite Fourier cosine transform regarding y and z. The correctness of the analytical model and its auxiliary FORTRAN computer program code showed excellent agreements between the simulated plume concentrations of all contaminants obtained from the derived analytical model and a semi-analytical model. Applying the proposed analytical solutions illustrates that using identical retardation factors for all contaminants may underestimate or overestimate contaminant mobility when the retardation factors of the individual contaminants differ greatly from the identical retardation factor value adopted in all contaminants. Experiments on six scenarios corresponding to six remedial treatments found that the enhanced source decay and partial removal of source mass are the main controlling factors in reducing contaminant concentrations, whereas plume decay effectively reduced PCE concentrations.

General News

ENVIRONMENTAL SEQUENCE STRATIGRAPHY (ESS)
Naval Facilities Engineering Systems Command, 4 pp, 2022

This fact sheet summarizes the overall ESS methodology, benefits of ESS to site restoration, and provides two case studies demonstrating the application of ESS techniques at Navy sites. ESS characterization was applied to the Joint Base Anacostia-Boling site to develop a high-resolution stratigraphic framework. ESS enhanced the existing 3-D conceptual site model (CSM) and refined mass discharge estimates. ESS was also implemented at the Naval Base Kitsap Keyport Operable Unit 1 site to better delineate the regional aquitard contact, aid in fate and transport modeling, and refine the CSM. ESS results can be used as a guide to optimize additional data collection and remedial design planning, and improve the cost-efficiency of the overall project. https://exwc.navfac.navy.mil/Portals/88/Documents/EXWC/Restoration/er_pdfs/e/Final_ESS_FactSheet_9_26_22.pdf?ver=NQ_p1MoIIwmxomv8CtJVaw%3d%3d

COST COMPARISON OF SOIL VAPOR EXTRACTION AND SUBSLAB DEPRESSURIZATION FOR VAPOR INTRUSION MITIGATION
Lutes, C., L. Stewart, R. Truesdale, J. De Loera, J.H. Zimmerman, and B. Schumacher.
Groundwater Monitoring & Remediation 42(4):43-53(2022)

Capital, operation, and treatment costs of soil vapor extraction (SVE) were compared to sub-slab depressurization (SSD) systems using data collected during a multi-year demonstration project conducted at eight buildings in an urban setting. The capital cost of the SVE system was substantially less than the estimated total capital cost of individual SSD systems. However, SVE costs were higher, especially in the early operating years during the mass removal and treatment phases. As a result, the cumulative SVE system cost rose above the SSD systems in the sixth year of operation. A significant portion of SSD's operations and maintenance cost advantage comes from the assumption that off-gas treatment is unnecessary. Alternative cases show SVE costs are likely lower when numerous small buildings requiring independent SSD systems overlie the SVE zone of influence. Conversely, SSD systems are less costly for cases with few small buildings overlying the SVE zone of influence. An additional benefit of SVE is continued mass removal. In a situation where an existing SVE can be repurposed for VI protection from residual VOC mass, the SVE cumulative costs over 30 years can remain lower than the cost of installing and operating SSD systems in multiple buildings.

PYLENM: A MACHINE LEARNING FRAMEWORK FOR LONG-TERM GROUNDWATER CONTAMINATION MONITORING STRATEGIES
Meray, A.O., S. Sturla, M.R. Siddiquee, R. Serata, S. Uhlemann, H. Gonzalez-Raymat, M. Denham, H. Upadhyay, L.E. Lagos, C. Eddy-Dilek, and H.M. Wainwright.
Environmental Science & Technology 56(9):5973-5983(2022)

A comprehensive machine learning (ML) framework known as the Python package PyLEnM (Python for Long-term Environmental Monitoring) was developed to monitor long-term groundwater contamination. PyLEnM aims to establish the seamless data-to-machine learning pipeline with various utility functions, such as quality assurance and quality control, coincident/co-located data identification, the automated ingestion and processing of publicly available spatial data layers, and novel data summarization/visualization. The key ML innovations include (1) time series/multianalyte clustering to find the well groups with similar groundwater dynamics and to inform spatial interpolation and well optimization; (2) the automated model selection and parameter tuning, comparing multiple regression models for spatial interpolation; (3) the proxy-based spatial interpolation method by including spatial data layers or in situ measurable variables as predictors for contaminant concentrations and groundwater levels; and (4) the new well optimization algorithm to identify the most effective subset of wells for maintaining the spatial interpolation ability for long-term monitoring. The methodology was demonstrated using the monitoring data at the Savannah River Site F-Area.*Access PyLEnM at* https://pypi.org/project/pylenm/

ENHANCED ATTENUATION (EA) TO MANAGE PFAS PLUMES IN GROUNDWATER
Newell, C.J., H. Javed, Y. Li, N.W. Johnson, S.D. Richardson, J.A. Connor, and D.T. Adamson.
Remediation 32(4):239-257(2022)

This paper proposes eight EA approaches for PFAS in groundwater, including technologies currently being implemented at PFAS sites, conventional remediation technology applications to PFAS sites, and novel, innovative approaches to enhance PFAS retention. These EA approaches leverage PFAS properties to (1) facilitate sorption to conventional and novel sorbents; (2) concentrate PFAS at air/water interface via gas sparging; and/or (3) encourage retention via tidal pumping and PFAS salting out processes. For each proposed EA approach, the paper describes the methodology or concept and discusses the key processes, potential applications, anticipated increases in PFAS retention compared to natural systems, potential challenges, alternate designs, and current likelihood of large-scale adoption. https://onlinelibrary.wiley.com/doi/epdf/10.1002/rem.21731

THERMAL REMEDIATION OF VOCS, SVOCS AND PFAS
Kluger, M. l OGWA Virtual Workshop on Hydrocarbon Site Management, 13 January, abstract only, 2022

Presentation covers technology fundamentals and provides insights on where to apply electrical resistance heating, thermal conduction heating (TCH), and steam-enhanced extraction. It also discusses a novel approach of applying TCH to volatilize PFAS.
See presentation from LIAP Geologists webinar https://www.youtube.com/watch?v=gpGzZlAyb88