Technology Innovation News Survey

Entries for February 16-29, 2024

Market/Commercialization Information

F -- ASTM PHASE III ENVIRONMENTAL REMEDIATION FOR CHINL (COMBINE)

U.S. Department of the Interior, Bureau of Indian Affairs, Navajo Region, Gallup, NM
Contract Opportunities on SAM.gov 140A0924Q0029, 2024

This is an Indian Small Business Economic Enterprise set-aside under NAICS code 541620. The Bureau of Indian Affairs (BIA), Navajo Regional Office, Branch of Environmental Management (BEM), is seeking a licensed environmental contractor to conduct the American Society for Testing and Materials (ASTM) Phase III Environmental Remediation for the Central Navajo Agency, Chinle Land Transfer Project. The project encompasses six vacant properties located along BIA Navajo Route 7 (Main Street) in Chinle, Apache County, Arizona. The BIA BEM estimates a total of 84.276 acres to be remediated and returned to the Navajo Nation. Work includes the removal of asbestos, lead-based painted materials, hazardous/universal wastes, solid waste, and regulated materials following federal, state, and/or local regulations. The Period of Performance for ASTM Phase III Environmental Remediation is 120 days from the receipt of the Notice to Proceed. Contractors must attend the BIA scheduled site visit site prior to bidding on the project. The award will be made on a Best Value Basis to the contractor whose quotation conforms to the requirements, is most advantageous to the Government, and is fair and reasonable. The last day for questions will be on April 5, 2024, at 2:00 PM MDT. Offers are due by 2:00 PM MDTY on April 12, 2024.
https://sam.gov/opp/ea14bd0a838c4e1fbc36912224939056/view

F -- R10 UPPER COLUMBIA RIVER SAMPLING AND REMOVAL TECH (SOL)

U.S. Environmental Protection Agency, Region 7 Contracting Office, Lenexa, KS
Contract Opportunities on SAM.gov 68HE0724R0014, 2024

This is a total small business set-aside under NAICS code 562910. EPA Region 7 requires a contractor to support the Upper Columbia River Sampling and Removal project. Support will focus on upland contaminated properties and lakes/wetlands affected by heavy metals contamination. The objective of this contract is to reduce the human health risk of exposure to lead and arsenic by removing contaminated soils from the assigned properties within the greater Northport Area and to provide necessary sampling support at the Upper Columbia River Site as needed. Work includes: 1) an additional round of soil sampling at properties that have not been previously sampled; 2) completion of a removal assessment and prioritization of properties for cleanup using data obtained during the current and previous sampling events; and 3) time-critical removal actions (TCRA) at the properties identified for cleanup. Work also requires sampling of contaminated upland lakes/wetlands identified by EPA. Offers are due by 1:00 PM CDT on April 23, 2024. https://sam.gov/opp/317d6cc1890a4600802688b36cdb8ef5/view

F -- FY24 MULTIPLE AWARD ENVIRONMENTAL SERVICES (MAES) MULTIPLE AWARD TASK ORDER CONTRACT (MATOC) (SOL)

U.S. Army Corps of Engineers (USACE), North Atlantic Division, Baltimore, MD
Contract Opportunities on SAM.gov W912DR24R0003, 2024

This is a full and open competition under NAICS code 562910. USACE requires Environmental Services in support of the USACE Baltimore District within its assigned mission areas of the North Atlantic Division, with incidental the contiguous U.S., Alaska, Hawaii, and Puerto Rico. The contracts may be for a wide range of environmental services and will be firm-fixed-price. The work may also require actions to characterize and/or remediate radioactive material or military munitions and explosive of concern or munitions constituents as well as to perform environmental sustainability services. A wide variety of potential projects could be expected in this contract, including: Investigation and Field Studies/Activities; Reviews; and Operation, Maintenance and Optimization. The Contractor may be required to provide a wide variety of engineering services to support remediation/response actions. The extent of the engineering services will be described in detail in each individual task order and may include structural, mechanical, electrical, architectural, geotechnical, geological, civil, environmental, ordnance, cost engineering, and other engineering support. The successful Contractor shall perform all necessary planning, fieldwork, and prepare all engineering documents identified in the Task Order. The contract will have a base ordering period of five years from the date of award with two 2-year optional ordering periods, which will be effective (if exercised) once the ordering period for Year 5 has concluded. The optional ordering period may be exercised at any time during the base ordering period of the contract. Offers are due by 12:00 PM EDT on April 12, 2024.
https://sam.gov/opp/b4da4223468347738e746ed063ffe3a1/view

F -- $35M SDVOSB RAPID RESPONSE SATOC (SOL)

U.S. Army Corps of Engineers (USACE), Omaha District, Omaha, NE
Contract Opportunities on SAM.gov W9128F24R0058_Solicitation, 2024

This is a service-disabled veteran-owned small business set-aside under NAICS code 562910. The USACE Omaha District, seeks a contractor to perform Rapid Response/Immediate Response/Emergency Response, Environmental Remediation Services and Other Mission Related Support Services in support of the USACE and its customers in the Continental U.S., including Alaska and Hawaii, and outlying areas within South Atlantic Division Areas of Responsibilities. The majority of the task orders that will be issued under this contract will provide services related to requirements of RCRA, CERCLA, the EPA Emerging Contaminate Program; the National Oil and Hazardous Substances Pollution Contingency Plan, Military Munitions Response Program, the Clean Water Act, the Clean Air Act, National Environmental Policy Act, National Historic Preservation Act, Endangered Species Act and other related Federal Programs in addition to State/Local specific regulations/requirements dealing with hazardous waste management/disposal, radioactive waste/mixed waste management/disposal, and with Underground Storage Tanks (USTs), and other fuels related issues. Actions may address both regulated and non-regulated toxic substances and emerging contaminants. Incidental construction (for example, excavation/removal of contaminated soil, off-site disposal of contaminated soil, installation of treatment systems, etc.) will also be included in this contract; however, construction activities will be incidental to the remediation effort. This SATOC will have a base ordering period of three (3)

years with a four (4) year optional ordering period, or until the $35M contract capacity is expended, whichever occurs first. The Federal Acquisition Regulations (FAR) Clause 52.217-8, "Option to Extend Service" will be incorporated into the contract and may be exercised at the discretion of the Government. The contract awarded will include both cost reimbursement and firm-fixed-price task orders, for response actions and remediation of various hazardous waste sites. Offers are due by 2:00 PM CDT on April 13, 2024.
https://sam.gov/opp/5c4e0153dbaa4274b12e1ac0b33aae71/view

Cleanup News

SUSTAINABLE TREATMENT SYSTEM CAPS OFF CLEANUP AT ELIZABETH MINE SUPERFUND SITE

EPA website, Published March 19, 2024

Elizabeth Mine left ~80 acres of exposed waste rock and tailing after closure. These waste piles discharged contamination into local water bodies, affecting aquatic life in the West Branch of the Ompompanoosuc River. EPA added Elizabeth Mine to the NPL in 2001, identifying abandoned, highly toxic waste sites and prioritizing them for long-term cleanup from hazardous contamination. In 2001, EPA began implementing cleanup at Elizabeth Mine, including planned, time-critical action measures to stabilize and reinforce a local dam near the site was on the verge of collapse, including providing stand-by pumps to increase extra drainage capacity when snow melted. A major component of the cleanup was the Rotating Cylinder Treatment System (RCTS™), chosen due to its smaller footprint and lesser amounts of lime (calcium oxide) required to treat the high concentration of iron discharging from the tailing impoundment as compared to conventional lime treatment systems. By 2018, the iron concentration in the waste discharging from the tailing impoundment had been sufficiently decreased, allowing EPA to look for a more sustainable treatment method. EPA worked closely with the Vermont Department of Environmental Conservation and site consultants to develop an innovative passive treatment system that uses limestone beds, open settling ponds, vertical flow pond, and treatment wetlands to clean the water without any electrical power. The system has a level of redundancy that allows various components to be off-line and still achieve cleanup objectives. Data collected through June 2023 has shown that the passive treatment system effectively removes iron from the leachate to meet the state's water quality criterion.
https://www.epa.gov/sciencematters/sustainable-treatment-system-caps-cleanup-elizabeth-mine-superfund-site

THE RIDGEWAY TMF COVER SYSTEM AFTER 20 YEARS OF ATMOSPHERIC FORCING, WHAT WE KNEW THEN AND NOW

Meiers, G., Z. Kenyon, P. Butsavage, and M. Pernito. | Proceedings of the 16th International Conference on Mine Closure, 2-5 October, Reno, NV, 2023

The Rio Tinto, Kennecott Ridgeway Mining Company tailings management facility (TMF) was reclaimed with a dry cover system and is a unique case study spanning over 20 years of closure performance. The TMF contains ~60 million tonnes of potentially acid-generating tailings (PAG). After mining operations ceased, the TMF was reclaimed with a hydraulically-placed saprolite clay water store-and-release cover system. A key performance objective of the cover system is maintaining high saturation in the cover and tailings, thereby limiting oxygen ingress and providing geochemical stability to the potentially acid-generating tailings. Vegetation on the cover is primarily Bermuda grasses, millet, and sericea lespedeza. The vegetation was originally mowed to maintain the grassland but was discontinued later, allowing woody brush species to colonize the landform. Vegetation management was implemented in 2022 to return the cover to the original grassland vegetation. The cover system design was supported by numerical simulations of water balance to evaluate performance under varying climatic conditions. A field response numerical simulation model was developed to gain further insight into the predicted performance of the cover system. A cover system assessment program was implemented to obtain multiple lines of evidence to support the performance of the cover system following 22 years of atmospheric forcing, including an in situ sampling and characterization program to assess vegetation characteristics and geotechnical and geochemical properties of the tailings and cover material. The oxygen ingress rate through the cover system was estimated to be 1-5 mol/m ^{2}/yr, suggesting that vegetation management could reduce the oxygen ingress rate. The degree of saturation in the tailings and cover material ranged from 68%-100%, supporting the estimated oxygen ingress. https://papers.acg.uwa.edu.au/d/2315_032_Meiers/032_Meiers.pdf

TRACE METAL AND PHOSPHORUS LOADING FROM GROUNDWATER SEEPAGE INTO SOUTH FORK COEUR D'ALENE RIVER AFTER REMEDIATION AT THE BUNKER HILL SUPERFUND SITE, NORTHERN IDAHO, 2022

U.S. Geological Survey Scientific Investigations Report 2023-5125, 38 pp, 2023

The USGS completed a post-remediation seepage study to quantify zinc, cadmium, and phosphorus loading from groundwater to the South Fork Coeur d'Alene River in the same reach as a pre-remediation study at the Bunker Hill Superfund site in northern Idaho. Previous studies, including a pre-remediation seepage study, identified groundwater seepage beneath the Central Impoundment Area (CIA) as a major contributor to trace-metal and nutrient loads in the South Fork Coeur d'Alene River. A major remediation project led by EPA aimed to reduce groundwater loading to the river via a groundwater collection system (GWCS) at the CIA. Discharge measurements and water-quality samples were collected during base-flow conditions in the South Fork Coeur d'Alene River between Kellogg and Smelterville and in surface-water inputs to the reach. Results show reduced groundwater loads of dissolved zinc, cadmium, and total phosphorus entering the South Fork Coeur d'Alene River. The largest groundwater loading reductions to the South Fork occurred in the middle section of the reach adjacent to the CIA, where the GWCS was expected to have the biggest impact. In the South Fork middle section, loads from groundwater of dissolved zinc decreased from 85 ± 9.3 kg/d to 11.6 ± 19.2 kg/d (86% reduction), dissolved cadmium decreased from 0.59 ± 0.10 kg/d to 0.11 ± 0.06 kg/d (81% reduction), and total phosphorus decreased from 6.5 ± 0.45 kg/d to 0.79 ± 0.97 kg/d (88% reduction). In addition to reduced groundwater loading, lower concentrations of dissolved zinc, dissolved cadmium, and total phosphorus were observed at the site farthest downstream from the GWCS. Ambient water-quality-criteria ratios decreased at all river monitoring sites, although zinc and cadmium concentrations still exceeded the site-specific criteria designated to protect aquatic life. The reduction in trace metals and phosphorus in South Fork Coeur d'Alene River also has implications for water quality downstream in the main stem Coeur d'Alene River and Coeur d'Alene Lake.
https://pubs.usgs.gov/sir/2023/5125/sir20235125.pdf

Demonstrations / Feasibility Studies

LIME SLURRY TREATMENT OF SOILS DEVELOPING ON ABANDONED COAL MINE SPOIL: LINKING CONTAMINANT TRANSPORT FROM THE MICROMETER TO PEDON-SCALE

Wood, D.L., K.A. Cole, E.M. Herndon, and D.M. Singer.
Applied Geochemistry 151:105617(2023)

The efficacy of using lime slurries to neutralize acidity and encourage the (co)precipitation of metal(loids) with Fe(III)-(oxy)hydroxides, and potentially other metal-oxides and/or Ca-bearing phases was evaluated through parallel field application and lab-based flow-through column experiments at the Huff Run sub-watershed 25 in Tuscarawas County, Ohio. The site was chosen partly due to its classification as one of the most highly AMD-impacted sub-watersheds in the region. Lysimeters were installed at 25 and 75 cm depths at two locations with historical spoil to monitor porewater composition on two sides at the base of each pile. Half of each slope received seven lime slurry treatments. A suite of aqueous and solid phase geochemical and mineralogical approaches was used to determine how the composition, texture, morphology, and spatial distribution of mineral coatings differ in pre- and post-lime treated soils and how this impacts the distribution and transport of trace metal(loid)s. Porewater pH and electrical conductivity in all lysimeters decreased throughout the field season, but there was no obvious response to lime treatment at either site or any depth. Treatment and depth were significant factors affecting Ca, K, Ni, SO_4^{2-}, and DOC concentrations at the first site, while only treatment effects were significant for dissolved Al and Cu ($p < 0.05$). No trends in metal concentration were observed over time for all soil, although DOC and SO_4^{2-} decreased over the field season. Pedon-scale changes in metal porewater concentrations in response to treatment were linked to micrometer-scale changes in mineral surface coatings; higher concentrations of Ca, Fe, Mn, and Zn were observed in the coatings and no changes were observed in Fe redox speciation, whereas total S decreased likely due to oxidation of S in coal fragments. Column experiments exhibited a much greater response in effluent composition with respect to lime treatment. The untreated columns had ~1 order of magnitude more H^+ leached throughout the experiment ($p < 0.001$), resulting in greater Ca, Al, Cu, and DIC leached and less Mn, Zn, and SO_4^{2-}. Soil treated with the lime slurry in the column experiments exhibited larger and thicker secondary Fe-coatings, including the addition of Fe-sulfates. Despite clear trends in the lab-based column experiment where the lime-to-soil ratio was higher, the effects were either muted or undetected in the field pilot project, suggesting that a higher application rate of lime in the field is needed to achieve a similar effect.

APPLICATION OF A NOVEL AMENDMENT FOR THE REMEDIATION OF MERCURY MINE SITES WITH HYDROLOGIC CONTROLS

McCord, S., G. Reller, J. Miller, and K. Pingree. Hydrology 10(7):155(2023)

The MercLok™ mercury (Hg) treatment technology was applied to Hg-contaminated calcines at two abandoned Hg mine sites in northern California. The objective was to evaluate its efficacy in rendering such contaminated materials less hazardous, thereby reducing remediation project costs. The first application (Site 1) consisted of two calcines amended with MercLok in isolated reactor buckets under two hydrologic remediation approaches ("repository cap" and "-reactive barrier") while exposed to ambient environmental conditions. Non-amended and amended calcines and their leachates were analyzed for Hg content and related conditions over five months, demonstrating a >95% reduction in leachable Hg. The second application (Site 2) involved full-scale site remediation by applying both approaches and additional hydrologic controls to minimize run-on, erosion, and runoff. Confirmation sampling and subsequent observations indicate that the amendments and hydrologic controls effectively stabilized the site and minimized Hg releases. These application projects demonstrate the efficacy of MercLok as a component of hydrologic controls for treating Hg-contaminated material to achieve long-term mine site remediation objectives. *This article is* ***Open Access*** *at* https://www.mdpi.com/2306-5338/10/7/155

BENEFICIAL USE OF DREDGED SEDIMENTS AS A RESOURCE FOR MINE RECLAMATION: A CASE STUDY OF LAKE DIANCHI'S MANAGEMENT IN CHINA

Dong, Y., F. Xu, X. Liang, J. Huang, J. Yan, H. Wang, and Y. Hou.
Waste Management 167:81-91(2023)

A study incorporated a field planting experiment with a life cycle assessment to confirm the practical effectiveness of sediment disposal via mine reclamation and its environmental and economic superiority over alternative scenarios. The sediment offered plentiful organic matter and nitrogen for mine substrate, stimulating plant growth and increasing photosynthetic carbon fixation density, enhancing plant root absorption, and improving the effect of soil immobilization on heavy metals. A 2:1 ratio of mine substrate to sediment is recommended to significantly promote ryegrass yield while reducing groundwater pollution and soil contaminant accumulation. Due to the significant reduction in electricity and fuel, mine reclamation had minimal environmental impacts on global warming (2.63×10^2 kg CO_2 eq./kg DS), fossil depletion (6.81×10^{-3} kg oil eq./DS), human toxicity (2.29×10^{-5} kg 1,4-DB eq/kg DS), photochemical oxidant formation (7.62×10^{-5} kg NOx eq./kg DS), and terrestrial acidification (6.69×10^{-5} kg SO_2 eq./kg DS). Mine reclamation also had a lower cost (CNY 0.260/kg DS) than cement production (CNY 0.965/kg DS) and unfired brick production (CNY 0.268/kg DS). The use of freshwater for irrigation and electricity for dehydration were key factors in mine reclamation. Through this comprehensive evaluation, the disposal of dredged sediment for mine reclamation was verified to be both environmentally and economically feasible. *See introduction at* https://www.sciencedirect.com/science/article/abs/pii/S0956053X23003513

Research

DIANTHUS SYLVESTRIS SUBSP. SYLVESTRIS AS A PROMISING CANDIDATE FOR PHYTOSTABILIZATION OF COPPER-CONTAMINATED POST-MINING SITES IN ALPINE ECOSYSTEMS

Poscic, F., F. Ginaldi, C. Ferfuia, I. Paskovic and A. Babst-Kostecka.
Nordic Journal of Botany 2:e04199(2024)

A study explored the potential of *Dianthus sylvestris* subsp. *sylvestris* to remediate post-mining sites contaminated with copper (Cu) at high altitudes, which is a challenging task for most management strategies. More than 1,300 mg Cu/kg in shoots were found in plants collected at the Monte Avanza legacy mine site, however, it was unclear whether the presence of copper was due to hyperaccumulation or foliar contamination. Field samples were washed with two different protocols to address the gap followed by a controlled Cu-tolerance test. Very high Cu concentrations exceeding the Cu hyperaccumulation threshold of 300 mg/kg were found in samples washed with water. Results for the plants cleaned with EDTA suggested a Cu exclusion strategy. Under controlled conditions, the plant showed Cu hypertolerance but did not hyperaccumulate Cu. *D. sylvestris* presents a Cu exclusion strategy rather than

hyperaccumulation potential, making it a suitable candidate for Cu phytostabilization at high-altitude legacy mine sites.

RESEARCH BRIEF 351: USING EARTH MATERIALS TO REMOVE METALS NEAR ABANDONED MINES

National Institute of Environmental Health Sciences, Superfund Research Program, March 2024

SRP-funded researchers developed a new cost-efficient strategy that uses limestone and a naturally occurring mineral to clean up water contaminated with arsenic and uranium. Because these metals often co-occur in the environment, the team aimed to develop an approach to remove both contaminants simultaneously. Hydroxyapatite was incorporated to address limitations associated with limestone, a mineral that immobilizes uranium and arsenic. The team mixed solutions containing uranium and arsenic with either limestone or a combination of limestone, phosphate, and calcium. Then, experiments were conducted at low, neutral, and high pH levels. At initially low pH levels, adding limestone increased pH to neutral, removing 90% of uranium and 100% of arsenic, but could not remove uranium and arsenic. At both low and neutral pH levels, incorporating calcium and phosphorus removed 90% of uranium but failed at removing arsenic. A second batch of experiments was conducted with limestone and higher calcium and phosphate concentrations, which increased the pH of the solution and encouraged hydroxyapatite formation, resulting in nearly complete arsenic and uranium removal. X-ray analysis confirmed that hydroxyapatite had formed and bound to most of the arsenic and uranium. However, uranium removal efficiency decreased when pH increased beyond 9.0. Findings suggest that adding calcium and phosphorous to limestone at a pH between 8.0 and 9.0 can form hydroxyapatite and enhance arsenic and uranium removal from water. Based on results, a low-cost remediation strategy could be developed to help American Indian communities affected by contamination from abandoned mining sites.
https://tools.niehs.nih.gov/srp/researchbriefs/view.cfm?Brief_ID=351

EVALUATION OF SOIL HEAVY METALS POLLUTION AND THE PHYTOREMEDIATION POTENTIAL OF COPPER-NICKEL MINE TAILINGS PONDS

Shi, J., W. Qian, Z. Jin ,Z. Zhou, X. Wang, and X. Yang.
PLoS ONE 18(3):e0277159(2023)

A study aimed to understand the characteristics of heavy metal pollution around a copper-nickel mine tailings pond and screen local plant species potentially suitable for phytoremediation. Results showed that Cd, Cu, Ni, and Cr in the soil around the tailings pond were at a heavy pollution level, Mn and Pb pollution was moderate, and Zn and As pollution was light. Positive matrix factorization (PMF) model results showed that the contributions made by industrial pollution to Cu and Ni were 62.5% and 66.5%, respectively; atmospheric sedimentation and agricultural pollution contributions to Cr and Cd were 44.6% and 42.8%, respectively; the traffic pollution contribution to Pb was 41.2%; and the contributions made by natural pollution sources to Mn, Zn, and As were 54.5%, 47.9%, and 40.0% respectively. The maximum accumulation values for Cu (53.77 mg/kg), Ni (102.67 mg/kg), Cr (91.10 mg/kg), Cd (1.16 mg/kg), and As (7.23 mg/kg) in 10 plants exceeded the normal content of heavy metals in plants. *Ammophila breviligulata* Fernald had the highest comprehensive extraction coefficient (0.81) and comprehensive stability coefficient (0.83). Results indicate that the heavy metal pollution in the soil around the copper-nickel mine tailings pond may affect the normal growth of plants. *Ammophila breviligulata* Fernald has a strong comprehensive remediation capacity and can be a remediation plant species for multiple metal compound pollution sites.
https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0277159&type=printable

COMPARISON OF SYNTHETIC RHAMNOLIPIDS AS CHEMICAL PRECIPITANTS FOR PB, LA, AND MG

McCawley, I.A., R.M. Maier, and D.E. Hogan
Journal of Hazardous Materials 447:130801(2023)

Research examined a novel approach to recovering metals from natural and contaminated aqueous systems based on rhamnolipid-facilitated chemical precipitation. Metal complex from solution, mixing only, and mixing followed by filtration or centrifugation were assessed to remove rhamnolipids. Recent advances in synthetically producing rhamnolipid surfactants allowed for the investigation of various rhamnolipid structures. Rhamnolipids with differing lengths and numbers of hydrophobic tails were assessed to remove Pb, La, and Mg from single metal solutions. Removal increased with increased rhamnolipid hydrophobicity and with adding an active removal step (filtration or centrifugation). Filtration removed ≤96% of all metals, while centrifugation removed ≤97% for Pb and La and 60% for Mg. Future studies in mixed-metal and real-world solutions will be needed to confirm the viability of these techniques in complex systems.

UNVEILING A TECHNOSOL-BASED REMEDIATION APPROACH FOR ENHANCING PLANT GROWTH IN AN IRON-RICH ACIDIC MINE SOIL FROM THE RIO TINTO MARS ANALOG SITE

Fernandez-Caliani, J.C., S. Fernandez-Landero, M.I. Giraldez, P.J. Hidalgo, and E. Morales.
Science of The Total Environment 922:171217(2024)

The potential of Technosols, made from non-hazardous industrial wastes, was tested as a sustainable solution for highly acidic iron-rich soils at the Rio Tinto mining site in Spain. The mine soils exhibit extreme acidity (pH_{H2O} = 2.1-3.0), low nutrient availability (non-acid cation saturation Brassica juncea under greenhouse conditions. Technosols were tailored by adding varying weight % of waste amendments (10%, 25%, and 50%) into the mine Technosol. The waste amendments comprised a blend of organic waste (water clarification sludge [WCS]) and inorganic wastes (white steel slag [WSS] and furnace iron slag [FIS]). The formulations included: (T0) exclusively mine Technosol (control), (T1) 60% WCS+40% WSS, (T2) 60% WCS+40% FIS and (T3) 50% WCS+16.66% WSS+33.33 % FIS. The analyses covered leachate quality, soil pore water chemistry, and plant response (germination and survival rates, plant height, and leaf number). Results revealed a significant reduction in leachable contaminant concentrations, with Pb (26.16 mg/kg), Zn (4.94 mg/kg), and Cu (2.29 mg/kg) dropping to negligible levels and shifting towards less toxic species. These changes improved soil conditions, promoting seed germination and seedling growth. Technosol T1 showed promise in overcoming mine soil limitations, enhancing plant adaptation, buffering against acidification, and stabilizing contaminants through precipitation and adsorption mechanisms. The study stresses the importance of tailoring waste amendments to specific soil conditions and highlights the broader implications of the Technosol approach, such as waste valorization, soil stabilization, and insights for *Brassica juncea* growth in extreme environments, including Martian soil simulants.

REMEDIATION OF ACID MINE DRAINAGE IN THE HAIZHOU OPEN-PIT MINE THROUGH

COAL-GANGUE-LOADED SRB EXPERIMENTS
Dong, Y., Z. Gao, J. Di, D. Wang, Z. Yang, X. Guo, Y. Li, X. Zhu, and G. Wang.
Sustainability 15(12):9375(2023)

Coal gangue (CG) combined with sulfate-reducing bacteria (SRB) was employed to address acid mine drainage (AMD) characterized by high concentrations of Fe^{2+}, Mn^{2+}, and SO_4^{2-} at the Haizhou open-pit mine. The effects of coal-gangue dosage, SRB inoculation concentration, and temperature on AMD treatment with CG-loaded SRB were determined through single-factor and response surface methodology (RSM) experiments. The removal mechanisms of SO_4^{2-}, Fe^{2+}, and Mn^{2+} were revealed by considering the principles of adsorption isotherms, adsorption kinetics, and reduction kinetics. The overall effectiveness of the four types of coal-gangue-loaded SRB in repairing AMD was as follows: 3# CG-loaded SRB > 2# CG-loaded SRB > 1# CG-loaded SRB > 4# CG-loaded SRB. The optimum conditions for repairing AMD with CG-loaded SRB were a coal-gangue dosage of 52 g, SRB inoculation concentration of 11.7%, and temperature of 33.4°C. The order of factors affecting SO_4^{2-} and Fe^{2+} removal from AMD by CG-loaded SRB was SRB inoculation concentration>temperature>coal-gangue dosage. For Mn^{2+}, the order of influence was temperature>SRB inoculation concentration>coal-gangue dosage. In repairing Fe^{2+} with CG-loaded SRB, the biological activity metabolism of SRB played a leading role, while the adsorption isotherm of Mn^{2+} followed the Freundlich model. The adsorption kinetics of CG-loaded SRB for Fe^{2+} and Mn^{2+} in AMD conformed to Lagergren's second-order kinetic model, while the reduction kinetics of SO_4^{2-} conformed to a first-order reaction model. *This article is* ***Open Access*** *at* https://www.mdpi.com/2071-1050/15/12/9375.

General News

NATURAL ATTENUATION IN THE VADOSE ZONE: NATURE'S GIFT TO MINE CLOSURE
R. Bowell. | Proceedings of the 16th International Conference on Mine Closure, 2-5 October, Reno, NV, 2023

This review summarizes natural attenuation methods that occur with the weathering and erosion of mine wastes and the interaction of leachates in the vadose zone. These processes can effectively reduce the concentrations and mobility of contaminants, leading to their eventual removal or degradation. Some key natural attenuation processes in the vadose zone include biodegradation, volatilization, oxidation-reduction reactions, hydrolysis, photolysis, and dilution.The effectiveness of natural attenuation in the vadose zone depends on several factors, including the nature of the chemicals, the redox and pH potential of the environment, soil properties, groundwater flow rates, and site-specific conditions, such as the availability of oxygen, nutrients, and suitable microbial. Natural attenuation is an important aspect of the long-term management of chemical loading in the environment. While it has limitations, combined with other methods, such processes are effective in mine closure and should be considered in the planning and assessment of long-term geochemistry at post-closure facilities. https://papers.acg.uwa.edu.au/d/2315_000_Bowell/000_Bowell.pdf

UTILIZATION OF BIOCHAR FOR REMEDIATION OF HEAVY METALS IN AQUEOUS ENVIRONMENTS: A REVIEW AND BIBLIOMETRIC ANALYSIS
Phiri, Z., N.T. Moja, T.T.I. Nkambule, and L.-A. de Kock. Heliyon 10(4):e25785(2024)

This study provides a comprehensive overview of biochar-based heavy metal remediation in aquatic environments and highlights knowledge gaps and future research directions. The Population, Intervention, Comparison, and Outcome (PICO) approach was applied to explore using biochar to remove heavy metals from aqueous media. Data were merged from Scopus and the Web of Science Core Collection databases to acquire a comprehensive perspective of the subject. PRISMA guidelines were applied to establish search parameters, identify the appropriate articles, and collect the bibliographic information from the publications between 2010 and 2022. The bibliometric analysis showed that biochar-based heavy metal remediation is a research field with increasing scholarly attention. The removal of Cr(VI), Pb(II), Cd(II), and Cu(II) was the most studied among the heavy metals. Five main clusters were identified that centered on adsorption, water treatment, adsorption models, analytical techniques, and hydrothermal carbonization by performing keyword co-occurrence analysis. Trending topics include biochar reusability, modification, acid mine drainage (AMD), wastewater treatment, and hydrochar.
https://www.cell.com/action/showPdf?pii=S2405-8440%2824%2901816-4

A REVIEW OF PASSIVE ACID MINE DRAINAGE TREATMENT BY PRB AND LPB: FROM DESIGN, TESTING, TO CONSTRUCTION
Wang, Y., C. Wang, R. Feng, Y. Li, Z. Zhang, and S. Guo.
Environmental Research 251(Part 1):118545(2024)

This article comprehensively evaluates permeable reactive barrier systems utilized to remediate acid mine drainage. The concept of low permeability barriers, derived from site-contaminated groundwater management, is also introduced. Strategies for selecting materials, the physicochemical aspects influencing long-term efficacy, the intricacies of design and construction, and the challenges and prospects inherent in barrier technology are described.

ANAEROBIC BIOREACTOR TECHNOLOGY (ABT) FOR THE TREATMENT OF ACID MINE DRAINAGE (AMD)
Bhavya, K., S. Begum, and A.G. Rao. Biotechnological Innovations in the Mineral-Metal Industry. ISBN 978-3-031-43624-6, ISBN 978-3-031-43627-7, Chapter 10:161-178(2024)

Chapter 10 critically reviews the available aerobic and anaerobic bioreactor technologies, emphasizing anaerobic bioreactors to treat AMD. In the remediation of AMD, the anaerobic process is a biological remediation that neutralizes acidity and precipitates metal contaminants by natural microbial consortia, preferably sulfate-reducing bacteria (SRB). As the AMD is associated with low organic matter, an external factor carbon source is required to complete the remediation process. Anaerobic bioreactors, such as membrane bioreactors, continuous stirred tank reactors, bioelectrochemical systems, and up-flow sludge blanket reactors, are suitable bioreactor processes for the treatment of AMD wherein the syntrophic activity of both SRBs and other fermentative and few methane forming bacteria takes place. Through the application of SRBs, these anaerobic reactors are paving the way in treating AMD due to their efficacy and cost-effectiveness. However, the addition of external organic substances is required during the treatment of AMD with SRB, which could play a pivotal role in determining the cost of the technology. Comparing the passive and active SRB-based alternatives, their substrate choice, the recent advances in the anaerobic treatment of AMD, and future perspectives as an alternative to conventional techniques are discussed.

LESSONS LEARNED FROM 20+ YEARS POST-CLOSURE CARE OF BHP'S LEGACY MINE SITES IN NORTH AMERICA

Ayers, B.K. | Proceedings of the 16th International Conference on Mine Closure, 2-5 October, Reno, NV, 2023

This paper uses hindsight from experiences within BHP's Legacy Assets to present numerous lessons learned to achieve optimized closure outcomes and objectives for mine sites. Key lessons learned include:

- Relinquishment is a great aspiration for closed mine sites, but sites should be developed, operated, and closed if long-term care and maintenance become a reality.
- Closure-related decisions should be based on risks, not solely on regulatory compliance. It is acknowledged that most jurisdictions are moving to a risk-based as opposed to a prescriptive approach for final site closure. In some jurisdictions, however, mine closure regulations are not stringent enough to force owners into a risk-based approach supported by robust science and thorough technical assessments to select an optimized closure strategy.
- Selecting an optimized mine closure strategy should be based on the undiscounted value of estimated closure and post-closure costs. If closure strategies are selected based on the present value of these costs, the industry tends to favor strategies that offer the least number of opportunities to build social value while leaving the site/owner exposed to higher closure risk due to issues such as changing societal and regulatory demands, climate change, and emerging chemical species of concern.

https://papers.acg.uwa.edu.au/d/2315_008_Ayres/008_Ayres.pdf

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