

study to evaluate various passive and semi-passive methods for treatment of the Danny T Mine adit water. The bench-scale study for the Tiger Mine was focused on potential in situ-based treatments that could be deployed inside the underground mine workings area. A representative mine discharge water (Tiger mine adit "I-AD004, the "Firehose" adit) was collected in bulk and analyzed at the treatability laboratory in batch container tests with various reagents. The report summarizes each of these studies, including their objectives, experimental and sampling procedures, results, conclusions, and recommendations. <https://senspub.epa.gov/work/08/181/2788.pdf>

SELENIUM, URANIUM, AND NITRATE: TREATMENT OF TROUBLESOME CONTAMINANTS IN MINING WASTEWATERS - EBR CASE STUDIES

Opara, A., J. Adams, J. Fudyma, and J. Bowden.
Journal of American Society of Mining and Reclamation 7(2):19-34(2018)

This study presents three bench- and onsite pilot-scale case studies using electro-biochemical reactor (EBR) technology for Se, U, and NO₃⁻ bio-reduction and removal from mining wastewaters. The studies used different mining waters and each were contaminated with varying concentrations of Se, U, and NO₃⁻. The EBR technology treated the waters to 3⁻N. <https://www.asmf.us/Portals/0/Documents/Journal/Volume-7-Issue-2/Opara-117.pdf>

Research

A PERMEABLE REACTIVE BARRIER (PRB) FOR THE REMOVAL AND IMMOBILIZATION OF SELENIUM IN SEEP WATER AND SHALLOW GROUNDWATER AT A PHOSPHATE MINE IN SOUTHERN IDAHO: RESULTS OF BENCH SCALE TESTING

Walker, W.J., D. Tooke, M. Wright, J. Hamilton, C. Schreiber, and J. Peterson.
Journal American Society of Mining and Reclamation 7(3):20-44(2018)

This bench study tested whether a permeable reactive barrier (PRB) could treat Se-contaminated groundwater and seep water from a phosphate mine in Idaho. The study consisted of: (1) a test to determine the chemistry of the site-water and the components of the proposed PRB, (2) batch leaching studies, and (3) vertical column studies testing the PRB media. The groundwater Se was reduced from 1 mg/L to < 0.02 mg/L in the first 3 hours of column contact time, well below the 0.05 mg/L water quality goal. Aside from Se reduction, no significant deleterious changes to water quality were observed when compared to primary water quality standards. <https://www.asmf.us/Portals/0/Documents/Journal/Volume-7-Issue-3/Walker-WA.pdf>

REMEDICATION OF ACID MINE DRAINAGE-IMPACTED WATER BY VETIVER GRASS (*CHRYSOPOGON ZIZANIODES*): A MULTISCALE LONG-TERM STUDY

Kiskila, J. D., D. Sarker, S. Paria, S.V. Saha, and R. Datta.
Ecological Engineering 129:97-108(2019)

The study developed a cost-efficient and sustainable floating treatment wetland system using vetiver grass (*Chrysopogon zizanioides*). Year-long large- and small-scale hydroponic experiments were used to determine the effectiveness of vetiver for treating acid mine drainage-impacted waters from the Tab-Simco mine site in southern Illinois. For the large-scale mesocosm study, vetiver rafts were suspended in 100-gal containers. Water quality was monitored every 28 days and at the end of the experiment (364 days); plant health was monitored by measuring changes in biomass and recording visual changes in root and shoot coloration and morphology. There was higher net removal of Fe (81%) and Pb (81%) with lower removal of Ni (38%), Zn (35%), SO₄²⁻ (28%), Mn (27%), Cr (21%), Al (11%) and Cu (8.0%). Toxicity characteristic leaching procedure showed that vetiver biomass was not hazardous waste as a result of metal accumulation. From the small-scale experiment, there was near complete removal of SO₄²⁻ (91%) and metals (90-100%) with the exception of Pb (15%) and Cu (0.0%).

PERFORMANCE OF A SULFIDOGENIC BIOREACTOR INOCULATED WITH INDIGENOUS ACIDIC COMMUNITIES FOR TREATING AN EXTREMELY ACIDIC MINE WATER

Gonzales, D., Y. Liu, D.V. Gomez, G. Southam, S. Hedrich, P. Galleguillos, C. Colipai, et al.
Minerals Engineering 131:370-375(2019)

This study tested the performance of a low pH sulfidogenic bioreactor inoculated with an indigenous microbial community to treat mine-impacted water. The inoculum was obtained from anaerobic sediments collected from an acidic river located in northern Chile. The sulfidogenic bioreactor system (2.3 L) was operated as a continuous flow mode unit for 99 days at 30°C with and without synthetic water based on the chemical composition of the acidic river. The bioreactor pH was set to 4.5 initially and was increased in stages to pH 6.0 during the experiment. Results show that zinc concentrations in liquors draining the bioreactor were below the detection level in most of the samples analyzed. Increasing the glycerol concentration increased the removal of iron (70%), but generated acetic acid (from 1 to 5 mM). Microbial populations changed with varying operation parameters, and a known acetogenic sulfidogen (*Desulfoproposinus acididurans*) became more dominant over time.

APPLICATION OF RESPONSE SURFACE METHODOLOGY AND DESIRABILITY FUNCTION IN THE OPTIMIZATION OF ADSORPTIVE REMEDIATION OF ARSENIC FROM ACID MINE DRAINAGE USING MAGNETIC NANOCOMPOSITE EQUILIBRIUM STUDIES AND APPLICATION TO REAL SAMPLES

Gugushe, A.S., A. Nombolo, and P.N. Nomngongo.
Molecules 24:1792(2019)

This study tested the effectiveness of magnetic multi-walled carbon nanotube/zeolite nanocomposites to adsorb and remove arsenic ions in simulated and real acid mine drainage samples. Adsorption studies demonstrated that the nanoadsorbent can remove arsenic in simulated samples within 35 min. After separation from the solution, the nanoadsorbent was washed in a 0.05 mol/L HCL solution for regeneration, and was reusable for at least 10 cycles of adsorption-desorption with no significant decrease in the adsorption capacity. The nanoadsorbent was also used for the arsenic removal from acid mine drainage. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6539554/pdf/molecules-24-11792.pdf>

A REVIEW ON TREATMENT OF ACID MINE DRAINAGE WITH WASTE MATERIALS: A NOVEL APPROACH

Saha, S. and A. Sinha.
Global NEST Journal 20(3):512-528(2018)

The present study reviewed different aspects of treating acid mine drainage (AMD) with active treatment and waste materials and factors associated with the treatment process. The results from the investigation showed that fly ash, metallurgical slag, and cement kiln dust raise the pH of acidic solution more, in comparison to zero-valent iron and organic waste, due to their richness in lime content. Metal removal from AMD varied, due to the composition of AMD and the characteristics of waste materials. https://journal.gnest.org/sites/default/files/Submissions/gnest_07610/gnest_07610_published.pdf

General News

PROGRESSES IN RESTORATION OF POST-MINING LANDSCAPE IN AFRICA

Festini, E.S., M. Tigabu, M.N. Chilishige, S. Syampungani, and P.C. Oden.
Journal of Forestry Research 20(2):381-396(2019)

This review documents the state-of-knowledge and identifies gaps in the restoration of the post-mining landscape in Africa through literature review. Findings included substantial progress in identifying species suitable for phytoremediation, a lack of studies to evaluate the feasibility of organic amendments to promote autochthonous colonization of mine wastelands or growth of planted species, and successful cases of large-scale post-mining restoration practices for limestone quarries in Kenya, sand mining tailings in South Africa, and gold mine wastelands in Ghana. *This article is Open Access at* <https://link.springer.com/article/10.1007/s11676-018-0621-x>

PASSIVE TREATMENT OF ACID-MINE DRAINAGE

Zipper, C., J. Skousen, and C. Jage.
Virginia Cooperative Extension, Publication 460-133, 14 pp, 2018

This publication presents guidance to design passive treatment systems for acid mine drainage. The mechanisms governing these systems' treatment effectiveness and performance are clearly described. <https://atechworksheets.lib.umd.edu/bitstream/handle/10013/24257/CSES-216.pdf?sequence=1>

ECOSYSTEM GOODS AND SERVICES CASE STUDIES AND MODELS SUPPORT COMMUNITY DECISION MAKING USING THE ENVIROATLAS AND ECO-HEALTH RELATIONSHIP BROWSER

Bolgenin, D.W., T.R. Angradi, J. Bousquin, T.J. Canfield, T.H. DeWitt, R.S. Fulford, et al.
EPA 600-R-18-167, 109 pp, 2018

Case studies, data tools, and models are presented to illuminate multiple lines of inquiry focused on improving the public's use of ecosystem goods and services (EGS) concepts for addressing environmental, social, and economic problems. The report summarizes current strategies for using EGS case studies and models to support community decision-making while highlighting the broad use of the EnviroAtlas and Eco-Health Relationship Browser. https://nepis.epa.gov/Exec/Query/Query.cfm?_id=910007001

HOW THE COMMUNITY VALUE OF ECOSYSTEM GOODS AND SERVICES EMPOWERS COMMUNITIES TO IMPACT THE OUTCOMES OF REMEDIATION RESTORATION AND REVITALIZATION PROJECTS

Williams, K.C., D.W. Bolgenin, T.R. Angradi, J. Carlson, R. Clarke, et al.
EPA 600-R-17-292, 61 pp, 2018

This report summarizes a systematic and comprehensive investigation of Remediation to Restoration to Revitalization (R2R2R) in the Great Lakes region. R2R2R is a place-based practice that requires ongoing communication amongst federal and state agencies, local governments, and citizens. Data from the Great Lakes Area of Concern collaboration were analyzed to identify factors that shaped decisions, participation, and the inclusion of stakeholder and public values. Two frameworks were then created that can be used to facilitate interpretation and transparency. One framework can be applied to decision contexts to discuss who/what/how decision outcomes. The second framework can be used to interpret distinct values and factors that inform or constrain decisions across boundaries of experience or responsibility. The frameworks are designed to improve transparency and facilitate conversations about decisions and ecosystem services. https://nepis.epa.gov/Exec/Query/Query.cfm?_id=910007018

PRACTICAL STRATEGIES FOR ASSESSING FINAL ECOSYSTEM GOODS AND SERVICES IN COMMUNITY DECISION MAKING: FY 17 OUTPUT SHC 2.61

U.S. EPA, Office of Research and Development, Gulf Breeze, FL.
EPA 600-R-18-183, 41 pp, 2018

Research outputs from the Community-Based Final Ecosystem Goods and Services Project in the Sustainable and Healthy Communities National Research Program are presented. The report summarizes how community-based studies have previously utilized ecosystem services to inform aspects of their decision-making, identify best practices that might transfer to other communities, and identify gaps in those practices. https://nepis.epa.gov/Exec/Query/Query.cfm?_id=910007014

ECOSYSTEM GOODS AND SERVICES PRODUCTION AND BENEFIT FUNCTIONS CASE STUDIES REPORT: FY 16 OUTPUT SHC 2.61

U.S. EPA, Office of Research and Development, Gulf Breeze, FL.
EPA 600-R-18-189, 32 pp, 2018

Research and development conducted under the Sustainable and Healthy Communities Research Program is intended to inform and empower decision-makers to weigh and integrate human health, socio-economic, environmental, and ecological factors to foster sustainability in the built and natural environments. This report describes EPA's research to incorporate the sustainability of final ecosystem goods and services production and benefits into community-scale decision making at study sites around the United States. https://nepis.epa.gov/Exec/Query/Query.cfm?_id=910007014

PERFORMANCE OF PASSIVE SYSTEMS FOR MINE DRAINAGE TREATMENT AT LOW TEMPERATURE AND HIGH SALINITY: A REVIEW

Ali, H.E.B., C.M. Neculita, J.W. Molson, A. Maqsood, G.J. Zagury.
Minerals Engineering 134:325-344(2019)

This paper reviews the principal parameters and processes that influence the quality of mine drainage (MD) and the performance of passive treatment of MD in cold climates. Major factors that affect treatment performance of passive systems are highlighted, such as low temperature, contamination level, and salinity. This review also discusses the effect of MD contamination level on passive biochemical reactor (PBR) efficiency. The effect of high salinity is discussed, with its potential to increase or decrease metal and sulfate removal depending on the major ions present. Reactive transport models used to predict long-term MD treatment efficiency are also considered. Further studies are needed to evaluate the simultaneous combined effect of these parameters on the performance of PBRs. <https://www.sciencedirect.com/science/article/pii/S0890/18>

A CRITICAL REVIEW ON REMEDIATION, REUSE, AND RESOURCE RECOVERY FROM ACID MINE DRAINAGE

Naidu, G., S. Ryu, R. Thiruvenkatchari, Y. Choi, S. Jeong, and S. Vigneswaran.
Environmental Pollution 247:1110-1124(2019)

This review underscores characteristics and implication of acid mine drainage (AMD), remediation approaches in mining sites, alternative treatment technologies for water reuse, and resource recovery. The role of membrane processes and alternative treatment technologies to produce water for reuse from AMD is highlighted. This review provides insights in establishing reuse and resource recovery as the holistic approach towards sustainable AMD treatment. Finally, integrated technologies that deserve in-depth future exploration are highlighted.

ACID MINE DRAINAGE FORMATION, CONTROL, AND TREATMENT: APPROACHES AND STRATEGIES

Skousen, J.G., P.F. Ziemkiewicz, and L.M. McDonald.
The Extractive Industries and Society 6(1):241-249(2019)

This article discusses the process of acid mine drainage (AMD) formation and use of preventive and control measures and describes treatment methods for existing AMD discharges. *This article is Open Access at* <https://reader.elsevier.com/reader/sd/pii/S2214790X18302156?token=A38E69A279BCE3A394268E53D33E4461A550E20837336021185727373D0AD06712ED8C68A6E76C6FC13A886437321E>

A SYSTEMATIC MAPPING STUDY ON THE DEVELOPMENT OF PERMEABLE REACTIVE BARRIER FOR ACID MINE DRAINAGE TREATMENT

Tigue, A.A., R.A. Malenab, and M.A. Promentilla.
MATEC Web of Conferences 268:06019(2019)

This paper identifies what has been studied and what the biggest challenges and limitations are on the use of permeable reactive barrier for acid mine drainage treatment. The reactive media used in permeable reactive barriers are organized into five categories: iron-based, organic-based, inorganic minerals-based, industrial waste-based, and combined media. The majority of research used combined media as the reactive substrate. The future direction is toward the use of combined media as a reactive material for acid mine drainage treatment. https://www.matec-conferences.org/articles/mateconf/pdf/2019/17/mateconf_iscs18_06019.pdf

A REVIEW OF RECENT STRATEGIES FOR ACID MINE DRAINAGE PREVENTION AND MINE TAILINGS RECYCLING

Park, I., C.B. Tabellin, S. Jeon, X. Li, K. Seno., M.Ito, and N. Hiroyoshi.
Chemosphere 219:588-606(2019)

This paper reviews two alternative strategies-prevention techniques and mine waste recycling-for the management of acid mine drainage (AMD) and mine tailings. In this review, recent advances in AMD prevention techniques like oxygen barriers, utilization of bactericides, co-disposal and blending, and passivation of sulfide minerals are discussed. In addition, the paper introduces the recycling of mine tailings as construction and geopolymer materials to reduce the amounts of wastes for disposal.

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

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