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Journal of the American Society of Mining and Reclamation

The Journal of the American Society of Mining and Reclamation **(JASMR)** promotes the exchange of basic and applied solutions for the reclamation, restoration, and revitalization of landscapes impacted by the extraction of natural resources—including, but not limited to coal, minerals, gas, and oil. Contributions reporting original research, case studies, field demonstrations, or policy dealing with some aspect of ecosystem reclamation are accepted from all disciplines for consideration by the editorial board.

Contributions to JASMR

The Journal of the American Society of Mining and Reclamation publishes contributions under the headings Research Papers, Case Studies, Demonstrations, Policy Papers and Review articles. All papers are peer reviewed. Manuscripts may be volunteered, invited, or coordinated as a symposium.

Research Papers: Emphasis is given to the understanding of underlying processes rather than to monitoring. Applying these principals to specific, replicated laboratory, glasshouse, and field problems dealing with reclamation are encouraged. These reports are grouped into the following ASMR defined groups: ecology, forestry and wildlife, geotechnical engineering, land use planning and design, international tailings reclamation, soils and overburden, and water management.

Case Studies: Papers in this category report on reclamation activities over spatial or temporal scales. Monitoring of the response of ecosystem components (water, soil, and vegetation) to innovative practices are the basis for these case study reports.

Demonstration Studies: Papers in this category report on reclamation activities that do not necessarily include projects where significant amounts of data are collected. These may consist of largely photographic evidence of before and after some reclamation technique is applied. These may be observations that practicing reclamationists have observed that have changed how they continued to enhance the process of returning disturbed landscapes to a more desirable condition.

Policy or Review Papers: Submission of papers dealing with regulatory and procedural issues are welcome. These papers emphasize changing approaches to the science and technology of landscape revitalization. We strive to have them reviewed within 6 weeks.

Other: Letters to the Editor are accepted, and Book Reviews may be invited by the Editor-in Chief.

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List of Abstracts

Abstracts of papers that were to have been presented in Duluth

The abstracts listed are only those in which the authors were not opposed to including them in this issue of JASMR. An email was sent to all corresponding authors and I allowed two weeks to respond. Those who did not respond I assumed that they were not opposed. This does not preclude these authors in presenting the same materials (abstracts) in future meetings of ASRS, such as 2021 in Boise ID. Some editing has been done to make these abstracts consistent with past publications. The footnote #1 was changed to indicate that the proposed papers were never presented due to the coronavirus and the cancelation of the meeting in Duluth MN.

BUTTE MONTANA WEST SIDE SOILS OPERABLE UNIT REMEDIAL INVESTIGATION SAMPLING USING ELECTRONIC FIELD TOOLS[1]

N.R. Anton*, C. Love, C. Kelley, M. Goldberg, Z. Adams, and N. Greene[2]

Abstract: The West Side Soils Operable Unit of the Silver Bow Creek/Butte Area Superfund Site in Butte, Montana consists of abandoned silver and manganese mines in the Independence mining district to the west and northwest of the City of Butte. The mine area consists of 70 large abandoned mines and over 350 mine claim exploration sites over a 6,500-acre area. In the 1880s silver mining boom, the Independence district produced from 15 to 30 tons of silver ore per day, with later resurgence in the 1940's for manganese used in steel manufacturing for World War II, leaving a legacy of widespread mine waste contamination. CDM Smith conducted remedial investigation sampling in 2019, including approximately 3,800 surface soil samples at mine areas and adjacent soils, 200 subsurface soil samples within mine dumps using a direct-push rig, 90 surface water samples, and 40 sediment samples. Soil samples were analyzed for field paste pH and lithology, with a fraction for field-portable x-ray fluorescence (XRF) and laboratory metals, leaching potential, and acid base accounting. All sample locations and field data were collected using iPads pre-loaded with customized ESRI™ Survey123 and Collector applications. All GPS data were collected with a Trimble R1 receiver linked to the Collector application on the iPad to obtain sub-meter accuracy sample locations linked with the media-specific Survey123 forms. The Collector application provided in-field maps of the mine claims, mine features, aerial imagery, hydrology, roads, and georeferenced mine workings and geology. Field GPS data and survey forms were stored in an ArcGIS Online environment with immediate access by office staff. The electronic field tools allowed for rapid data collection, real-time viewing of data to improve efficiency and decision making and provided a site characterization extent that would not have been possible with traditional paper forms. The overall design and operation of the field tool technology is presented, along with data processing, application challenges, quality control checking, editing, and lessons-learned. These types of electronic data collection tools are become more common in various industries, although this talk emphasizes that adequate pre-planning and management are needed to meet project goals and ensure quality. [3]

Additional Key Words: Abandoned mine, sampling, GPS, iPAD, XRF, ArcGIS applications.

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2. Nick R. Anton (* presenter), PE, Catherine Love, GISP, Connor Kelley, Michelle Goldberg, CDM Smith, Helena, MT 59601; Zack Adams, CDM Smith, Fairfax, VA 22030; and Nikia Greene, USEPA, Helena, MT 59601.
3. Work reported here was conducted near 46° 1' 5.15" N, 112° 34' 55.18" W.

REDEVELOPING ABANDONED QUARRIES FOR COMMUNITY PARKS – CENTRAL MINNESOTA[1]

J.D. Asp* and J.M. Halter[2]

Abstract: Central Minnesota is known for its quantity and quality granite. Multiple granite companies have operated in the St. Cloud – Cold Spring area for decades. Abandoned granite quarries are present throughout the area and are becoming community amenities verses waste areas. The City of St. Cloud restored a 680-acre area into Quarry Park and Nature Preserve with hiking, biking, fishing, swimming, and rock-climbing opportunities for the public. This included making the area safe for recreation, while removing usage deterrents for people to access the abandoned quarry. Nearby, the City of Waite Park used the 20-acre land donated by the local quarry owner and created a 4 – 5,000 seat open air community amphitheater. This paper provides a look at regional quarrying efforts that are beautified for long-term community reuse.
Additional Key Words: Development, reclamation, repurposing, community amenity, safety.

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2. Joel D. Asp (* presenter), Senior Scientist, and Jon M. Halter, P.E. (MN), Short Elliott Hendrickson Inc.

EVALUATING THE INFLUENCE OF THE FORESTRY RECLAMATION APPROACH ON HYDROLOGY ON APPALACHIAN COAL MINES[1]

C.D. Barton*, T.N. Williamson, C.T. Agouridis, K.M. Yeager, W.E. Bond, and M. Gerlitz [2]

Abstract: Many surface coal mines in Appalachia have been reclaimed as grasslands instead of the forest land type that existed prior to mining, leading to changes in watershed hydrology. Canopy interception is expected to be lower in reclaimed grassland sites and soils tend to be compacted. This can result in increased overland flow and potentially increased sedimentation to streams. Reclamation using the forestry reclamation approach (FRA) should provide a canopy that functions similar to a natural forest and provide soil that better promotes infiltration. A multi-faceted project was undertaken to examine the influence of FRA on hydrology with the following objectives: 1) compare canopy interception and soil saturated hydraulic conductivity (Ksat) across a variety of reclamation strategies; 2) use a sediment record to evaluate the effectiveness of differing reclamation techniques for minimizing erosion; and 3) model annual evapotranspiration at the watershed scale under differing reclamation strategies. Rainfall-interception rates varied with tree type and age, with 10- and 20-year old FRA coniferous stands passing less than 50% of total rainfall to the ground, respectively. The lowest interception rate occurred with 10-year old FRA deciduous plots that had not achieved canopy closure. Whereas, interception rates for the 20-year old FRA deciduous trees that had achieved canopy closure were equivalent to those for a non-mined mature 100-year forest stand. Radionuclide data indicated that sediment loads increased due to mining, but significant reductions were observed through the entire reclamation period. In recent years, when FRA canopy closure was achieved, the lowest sediment deposition rates of the record were observed. Ksat measurements showed that reclaimed grasslands had the lowest total porosity and a relatively high field capacity, which resulted in a soil profile with minimal space for new infiltration during precipitation events. Ksat on FRA soils were higher at the 0 to 20-cm depth than the 20 to 40-cm depth, which suggests that water can infiltrate but slows as it moves into the deeper soil profile. Because of the lower porosity and Ksat with depth, models for each of the non-FRA mine reclamation strategies resulted in a more water-limited environment for plant growth and flashier streamflow.

Additional Key Words: Canopy Interception, Evapotranspiration, Saturated Hydraulic Conductivity, Sediment Dating.

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2. Christopher D. Barton (*presenter), Professor, Forestry and Natural Resources, University of Kentucky, Lexington, KY, 40546; Tanja N. Williamson, Research Hydrologist-Pedologist, USGS OH-KY-IN Water Science Center; Carmen T. Agouridis, Associate Dean, and Morgan Gerlitz, M.S. Student, Biosystems and Agricultural Engineering, University of Kentucky; Kevin M. Yeager, Associate Professor, and William E. Bond, M.S. Student, Earth and Environmental Sciences, University of Kentucky.

MICROBIAL RECOVERY IN SOILS TREATED BY EX-SITU THERMAL DESORPTION AND MIXING AFTER CRUDE OIL SPILL IN WESTERN NORTH DAKOTA[1]

Zachary J. Bartsch*, Thomas M. DeSutter, and Caley K. Gasch[2]

Abstract: Arbuscular mycorrhizal fungi (AMF) can help vascular plants acquire extra micronutrients by invading root cells with arbuscules and vesicles, and although most plants take advantage of this symbiotic relationship, AMF may provide additional benefits for revegetation of remediated soils that contain limited nutrient or water availability. In 2013, an oil spill in semi-arid western North Dakota on agricultural land prompted a large-scale remediation project using ex-situ thermal desorption (TD). Plots were constructed in 2015 with native, uncontaminated topsoil (A), TD treated subsoil (TDU), untreated subsoil (SP), and composted manure (m) to create the following treatments: A, A+m, TDU, TDU+A, TDU+m, TDU+A+m, SP, SP+A, SP+m, SP+A+m where soil ratios were 1:1 by volume and manure was applied at 40 Mg/ha to the 0-15 cm depth. In 2019 grain sorghum was planted, and at the 2nd leaf stage soil and root samples were taken for quantification of phospholipid-derived fatty acid (PLFA) for microbial abundance in the soil, and for infection of roots by AMF. These root infection and PLFA data will be analyzed using single factor analysis of variance tests with a least significant difference test planned for any significance findings. Results from this study will increase our knowledge of how TD treated soils, and soils having little to no organic matter, may be populated with microbiological species as a result of cropping sequence and natural conditions.

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2. Zachary J. Bartsch (*presenter), Thomas M. DeSutter, and Caley K. Gasch, Department of Soil Science, North Dakota State University, Fargo, North Dakota, USA.

SULFATE-REDUCING BIOREACTORS FOR TREATMENT OF HIGH-ACIDITY AMD: UPDATE OF THE PERFORMANCE OF THE TAB-SIMCO PASSIVE TREATMENT SYSTEM[1]

P.T. Behum,* L. Lefticariu, and K. Pankey[2]

Abstract: A major shortfall of a typical passive remediation technologies is the inability of providing long-term (>10 year) treatment of acid mine drainage (AMD) with a high metal content, in particular, a high aluminum content (Al >20 mg/L). AMD sites with these characteristics are typically treated passively using sulfate-reducing bioreactors. Sulfate- reducing bioreactors provide a suitable environment where organic carbon is oxidized to bicarbonate (HCO_3), and sulfate (SO_4^{2-}) is reduced to hydrogen sulfide H2S(aq). Bicarbonate is available to react with H^+, decreasing the acidity in the system; dissolution of limestone included in the bioreactor supplements to the bicarbonate alkalinity. H2S readily dissolves in water and combines with metals (Me), such as Fe, Ni, and Zn, to form sulfide mineral precipitates (MeS). This paper updates previous research on the treatment performance and geochemistry of one bioreactor-based demonstration system, the Tab-Simco Passive Treatment System in Carbondale, Illinois, USA. The untreated AMD (101 L/min) is poor quality with a median pH = 2.94, D. Fe = 486 mg/L, D. Al = 122 mg/L and 3,270 mg/L of SO4. The Tab-Simco treatment system was constructed in 2007 as one of the first full-scale bioreactor employed for the treatment of acidic coal mine drainage in the US; the treatment media was replaced in 2013. Throughout the life of the system, the median discharge water quality has been pH = 6.11, D. Fe = 8.2 mg/L, Al = 0.2 mg/L, and SO4 = 1,688 mg/L. On average, 96% of the acidity is removed or sequestered as monosulfides, and 48.4% of sulfate is reduced. This amounts to a removal of 27 tons/yr. of iron, 7.2 tons/yr. of aluminum, and 46 tons/yr. of sulfur. Geochemical trends will also be presented as a guide toward system longevity.[3]

Additional Key Words: Low-pH iron oxidation, adsorption, aerobic wetland, oxidation pond.

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2. Paul T. Behum, PhD. (* presenter), Sr. Hydrologist, Office of Surface Mining, Alton, IL 62025, Liliana Lefticariu, PhD, Professor, Department of Geology, Southern Illinois University, Carbondale, IL 62901; and Krystal Pankey, Environmental Protection Specialist III, Office of Mines and Minerals, Benton, IL 62812.
3. Work reported here was conducted near 37° 41’ 49” N; 89° 09’ 44” W.

EFFECTS OF CROPPING SEQUENCES, TILLAGE, AND MANURE APPLICATION ON CROP YIELDS IN A PIPELINE RECLAMATION SETTING IN WESTERN NORTH DAKOTA [1]

Nicholas Birkhimer*, Thomas DeSutter, Jerry Bergman, Kevin Horsager, Kyle Dragseth, Meridith Ramsey, and Cameron Wahlstrom[2]

Abstract: The expansion of infrastructure needed to extract and transport oil and natural gas in the Bakken and Three Forks oil reserves in the northern Great Plains is potentially impacting agricultural land. This study aims to determine the effects of five four-year crop rotations and two perennial cropping sequences sub-treated with three tillage methods and manure application on crop yields in roadway and pipeline disturbance areas compared to an undisturbed control area (long-term no-till). This study was initiated at the Williston (North Dakota) Research Extension Center when a 91 cm diameter water pipeline was installed in 2015. The seven cropping sequences tested were four years of durum (wheat), a durum-cover crop rotation, a cover crop-durum rotation, a durum-pea-barley-safflower rotation, a pea-barley-safflower-durum rotation, perennial alfalfa, and perennial grasses. Each cropping sequence was initially planted as no-till on the roadway, pipeline, and undisturbed control plots. In 2017, annual cropping sequence plots were subdivided into three plots. These plots were either left as no-till, ripped, or ripped and applied with manure. All perennial plots were left as no-till. In 2019 all plots were planted with durum to assess reclamation success. Crops were harvested when they reached maturity each year and yields were processed and compared using paired t-tests. Further analysis will be made, and results will be presented at the conference. The impact of this research will be a greater understanding of how landowners and reclamation specialists can improve the productivity of their soils after major disturbances.

Additional Key Words: pipeline, reclamation, crop rotation, tillage.

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2. Nicholas Birkhimer (* presenter), Thomas DeSutter, and Kevin Horsage, Department of Soil Science, NDSU, Fargo, ND; Jerry Bergman, Kyle Dragseth, Meridith Ramsey, and Cameron Wahlstrom, NDSU Williston Research Extension Center, Williston, ND.

INNOVATIVE TECHNOLOGIES TO IMPROVE RECLAMATION MONITORING [1]

C. Bowles*, M. Rawitch, D. Mumm [2]

Abstract: Coal mining reclamation in the western United States faces some unique challenges due to the harsh environment and often rugged landscapes. Mining companies in the last ten years have begun to use new reclamation approaches including geomorphic reclamation methods, global positioning systems (GPSs), and new design software to improve landform stability. These new reclamation approaches are more effective at utilizing precipitation to harvest moisture by mimicking natural landforms. Until recently, the final and most intricate aspect of reclamation, revegetation, has been relatively stagnant in terms of technological advancement. Improvements in the fields of remote sensing, data science, and web-based GIS, allow for the implementation of new workflows facilitating an unprecedented level of understanding in mine reclamation. During this presentation, we will discuss the collection of imagery data using remotely piloted aircraft systems (RPAS or drones) at the La Plata Mine in northwestern New Mexico. We will review innovative methodologies (e.g., machine learning) that can be used to monitor reclamation. These methodologies will show how value is created from drone data by automating advanced imagery analyses, including methodologies for change detection over time, landform stability monitoring, and vegetation monitoring. This new holistic approach to reclamation monitoring brings the opportunity for better understanding of the reclamation progress and could lead to a more efficient and sustainable path to closure.[3]

Additional Key Words: RPAS, drones, GIS, holistic, closure.

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2. Christopher Bowles (*presenter), Founder of Galago Powered by Ramboll, Arlington, VA 22203; Mike Rawitch, Founder of Galago Powered by Ramboll, Overland Park, KS 66210; Dan Mumm, Environmental Engineer, Waterflow, NM 87421.
3. Work reported here was conducted near 36° 59’ 12” N; 108° 08’ 56” W.

COST SAVING CLOSURE* OF FLY ASH IMPOUNDMENTS[1]

Al Briggs*, Ron Froh, and Jay Clayton[2]

Abstract: An alternative safe, sustainable, and cost-effective closure approach has been developed to close an estimated five hundred fly ash impoundments across the United States (US Patent 10,058,904 B2). The traditional closure approach for fly ash impoundments involves dewatering and/or establishing a suitable sloped subgrade through import and placement of fill and/or significant regrading of the fly ash. The final cover consisting of lower permeability soil and/or a geomembrane overlain by a protective soil cover is then placed to accomplish closure. The traditional closure approach is challenging considering the low strength and high compressibility of the fly ash, required specialized heavy construction equipment, the time required for construction, and capital needs compared to closure construction over more stable materials. In this presentation an alternative closure approach which overcomes these challenges is presented. The patented closure approach can offer a 40% to 50% cost reduction and consists of a geomembrane deployed over the existing grades of the impoundment, placement of a protective soil cover/ballast layer, seasonal retention of water to form shallow pond(s), and development of an ecologically improved habitat. The approach may include the construction of gently sloped interim berms to form isolated cells producing man-made wetlands, utilizing the original grades of the impoundment. The equivalency of this closure approach to traditional closure methods with regards to reducing the flux of liquid through the existing ash is demonstrated. Existing site conditions are utilized to assist in the closure of the impoundment. An Ohio EPA PTI was recently granted for a project along the Muskingum River, and this approval will be discussed.

Additional Key Words: fly ash, closure, sustainable habitat.

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2. Al Briggs (* presenter), KEY Environmental, Inc., 200 Third Ave, Carnegie, PA 15106; Ron Froh, and Jay Clayton, Commercial Liability Partners, LLC., 217014 New College Avenue, Suite A, Grover, MO 63040.

USING UNMANNED AERIAL VEHICLES TO MONITOR EROSION CONTROL MEASURES ON A RECLAIMED CENTRAL UTAH COAL MINE[1]

Christopher Brown*, R. Douglas Ramsey, Thomas Thompson[2]

Abstract: The Utah Division of Oil Gas and Mining (UDOGM) has been utilizing a specific deep gouging erosion control method referred to as "pocking," which they consider to be an effective reclamation technique that promotes plant growth and restricts surface erosion to the reclamation site. The objective of this study is to quantify the effectiveness of pocking using Unmanned Aerial Systems (also referred to as drones) and provide a methodology and GIS tool to efficiently and economically monitor pocked site condition over time. To do this we are evaluating surface erosion of a pocked landscape at the recently reclaimed Cottonwood/Wilberg mine site in Emery County, Utah using digital surface models (DSMs) derived from drone imagery. Using structure from motion processing, we generated multitemporal DSMs of the study site and compare the differences of DSMs over time to measure erosion and infilling of individual pocks. To validate drone derived DSMs, we are using annual terrestrial LiDAR scans, sediment gauges, and ground based measurements of erosional infilling for individual pocks. Vegetation growing within the pocks is inventoried using a Micasense RedEdge-M multi-spectral camera, to determine how vegetation is distributed throughout the pocks. These data will be compared to a second, and geographically adjacent and topographically similar reclaimed site (Des Bee Dove coal mine) located a mile east of the Cottonwood/Wilberg site. The Des Bee Dove site was reclaimed in 2004 using the same pocking technique. With the data we have collected, we have begun to measure erosional rates at the Cottonwood/Wilberg site and will project what this site will look like based on the current condition of the Des Bee Dove site. In partnership with the UDOGM we will publish the drone evaluation methods, along with a GIS tool, for public and private land managers to use to evaluate future reclamation sites that use this pocking, and potentially other reclamation techniques.

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2. Christopher Brown (* Presenter), MS Student; R. Douglas Ramsey, Student, Utah State University, Logan, Utah; Thomas Thompson, Utah Division of Oil Gas and Mining, Salt Lake City, Utah.

PLANNING, REMOVAL, AND RELOCATION OF THE HIBBING MINE FOR MINE PROGRESSION[1]

M.J. Bolf* and A. Lucia [2]

Abstract: The rich history of Minnesota's Mesabi Iron Range is told and retold through varied sources. But, for visitors to the Hibbing Taconite and Hull Rust Mahoning Mine View facility, a bird's-eye view of the vast historic and present mining operations is worth a thousand words. When Hibbing Taconite Company announced ongoing progression of taconite mining, the existing mine view overlook would be affected. Iron Range community, agency, and mining stakeholders determined ways to relocate this community park and visitor center for its thousands of visitors each year. A primary goal was for this audience to gain knowledge of the rich mining history and vast geologic reserves of Northeast Minnesota in context of the region's heritage. This is the "nuts and bolts" story of community leaders, industry, infrastructure engineers, and architectural visionaries collaborating to recreate the Mine View in Hibbing, Minnesota for generations to come.

Additional Key Words: reclamation, repurpose, stockpile, geotechnical engineering, landscape architecture.

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2. Matthew J. Bolf (* presenter), Sr. Civil Engineer | Principal, Short Elliott Hendrickson Inc., Duluth, MN 55802; Andrew Lucia, Principal Architect, LUCITO, Minneapolis, MN 55402.

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VARIATION IN FLUVIAL GEOMORPHIC DESIGN INPUT VALUES, ITS EFFECT ON DESIGN PERFORMANCE, AND EMERGING TECHNIQUES FOR INPUT VALUE MEASUREMENT[1]

N. Bugosh*, J.F.M. Duque, and I. Zapico[2]

Abstract: Fluvial geomorphic reclamation has been shown to produce functional reclamation landforms that have sediment yields comparable to adjacent undisturbed land when designed using appropriate input values. The GeoFluv™ method is a specific, patented method for fluvial geomorphic design that has been used on projects having a variety of climates, earth materials, and vegetation assemblages. The GeoFluv method requires the user to input specific values measured on stable reference areas near the project. There can be remarkable consistency in these input values from site to site on the global scale, yet local variations in some parameters as great as six hundred percent at sites as close as 80 km have been reported. Designers must understand that using the appropriate input values is necessary to obtain the proper hydrologic function of constructed fluvial geomorphic reclamation. The use of inappropriate values could result in problems ranging from erosion that would require repairs to catastrophic failure. Designers may experience difficulty getting input value measurements because of weather conditions limiting site access, thick vegetation that inhibits ground travel and measurement, landowner restrictions, or difficulty in finding stable, undisturbed reference areas in highly developed regions. As new remote-sensing tools become available there is interest in the potential for using them to obtain or supplement on-site measurements. This paper presents and discusses the variation observed in some of these input parameters from sites located on several continents, reviews some methods used to measure input values, and shows some effects of using inappropriate values in the design or altering the values during construction on actual projects.

Additional Key Words: GeoFluv, remote sensing.

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2. Nicholas Bugosh (*presenter), GeoFluv, Menlo Park, California 94025, and Jose F. M. Duque, professor, Geoscience Institute, IGEO (CSIC, UCM), 28040 Madrid, Spain and Geodynamics Department, Complutense University, 28040 Madrid, Spain, and Ignacio Zapico, PhD candidate, Geoscience Institute, IGEO (CSIC, UCM), 28040 Madrid, Spain and Geodynamics Department, Complutense University, 28040 Madrid, Spain.

PENNSYLVANIA'S ABANDONED MINE LAND (AML) EMERGENCY PROGRAM[1]

Eric E. Cavazza* and John J. Stefanko[2]

Abstract: The Pennsylvania Department of Environmental Protection's Bureau of Abandoned Mine Reclamation (BAMR) implements an Abandoned Mine Land (AML) Emergency Program to address suddenly occurring, high-priority, abandoned mine land (AML) problems that occur throughout Pennsylvania's coal fields. BAMR maintains two field offices; one in eastern Pennsylvania (Anthracite Region) in Wilkes-Barre and one in western Pennsylvania (Bituminous Region) in Ebensburg. Both field offices maintain in-house construction crews with significant equipment available to respond and address many small AML Emergencies (hazards) such as pothole subsidences and mine drainage breakouts. For larger AML Emergencies such as subsidence events causing structural damage to homes, businesses, and roads; mine fires; coal refuse fires; landslides; or other large-scale or complex AML problems, projects are completed by outside contractors. The contractors are hired through solicitation of bids or proposals with very short timeframes between bid issue and bid opening. Since October of 2010, BAMR has addressed over 700 AML Emergencies which equates to approximately 80 AML Emergency projects each calendar year. Due to the increased precipitation over the Commonwealth the last several years, that number has increased to an average of 86 AML Emergency projects over the last five (5) years (2015–2019) with a record number of 127 addressed in calendar year 2018. The average cost to address those AML Emergency projects over that five-year period was $4.66 million per year. This presentation will provide some background on Pennsylvania's AML Emergency Program; some summary statistics including the annual number of projects completed and costs; and also highlight through both photos and videos some typical projects recently completed by the program.

Additional Key Words: Mine Subsidence.

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2. Eric E. Cavazza, P.E. (*presenter), Director, Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, Harrisburg, PA 17106 and John J. Stefanko, Deputy Secretary, Pennsylvania Department of Environmental Protection, Office of Active and Abandoned Mining Operations, Harrisburg, PA 17106.

MONITORING AND ANALYSIS OF THE CHANGE AND REUSE OF ABANDONED MINE LAND IN MENTOUGOU DISTRICT, BEIJING[1]

L.L. Cheng*, Y. Zhang[2]

Abstract: Mentougou District was the main mineral resource production area of Beijing. In order to protect ecological environment, this district was set as part of the 'ecological conservation and development zone of Beijing' since 2004. Most mines were closed, which led to a large number of abandoned mine land. It is practically significant to reuse the abandoned mine land to expand the space for other industries. In order to find out whether the reuse directions of abandoned mine land conforms to the trend and requirements of industrial transformation, this paper monitored the spatial and temporal change of abandoned mine land in Mentougou District from 2006 to 2018 based on remote sensing images and field research and analyzed the reuse directions and the influencing factors. The results showed that from 2006 to 2018, the area of abandoned mine land in this district decreased generally, and the area of reused abandoned mine land reached a peak during 2010 to 2014; the reuse directions of abandoned mine land were mainly forestland and high-tech industrial land, and the main influencing factors were natural environment, population growth, economic development and policy. It was found that the reuse of abandoned mine land in this district had positive effect on the industrial transformation and matched the functional orientation of 'ecological conservation and development zone of Beijing.'

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2. Linlin Cheng (* presenter), Professor, Surveying and Land Use Department, China University of Mining and Technology (Beijing), Beijing, China, 100083; and Ye Zhang, Graduate Student, China University of Mining and Technology (Beijing), Beijing, China, 100083.

SERVICING THE COUNTRIES, MINE MAP NEEDS[1]

S.C. Chisholm[2]

Abstract: The United States has a long history of mining for coal and hard rock recourses. For most of that time, the locations and workings of the mines were not recorded. This created a lot of problems due to the lack of information available including mine disasters that took the lives of thousands of miners. The National Mine Map Repository (NMMR) was signed into law in 1969 to maintain and archive every closed and abandoned mine map within the United States. The NMMR acquires maps through public outreach efforts directed at state and federal agencies as well as mining companies, engineering and consulting firms, surveying companies, universities, and private citizens. Through its expert analysis of mine maps and related information, the NMMR assists both the public and private sectors by providing necessary mine data for economic evaluation, risk assessment, industrial and commercial development, highway construction, and preservation of public health, safety and welfare. The NMMR strives to increase public use and accessibility of its unique information by transforming its archive into digital georeferenced media. Though the NMMR still keeps its copies of mine maps on microfilm, film cameras have been replaced by state-of-the-art digital scanners. Once the images have been captured digitally, the NMMR collects pertinent mine map information such as the location of the mines, mine names, company names, commodity, and available geological information. This information is accessible and searchable through multiple public web platforms including the NMMR public web map and the Mine Map Index. This presentation will focus on a map project from start to finish, showcasing the entire archive process and how that information is requested and disseminated to the public.[3]

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2. Sean J. Chisholm, Mine Map Program Specialist, National Mine Map Repository, 3 Parkway Center Dr, Pittsburgh, PA 15220.
3. Work reported here was conducted near 40.425359, -80.038254.

A STUDY OF COAL MINE OVERBURDEN SUPPORT IN WESTERN KENTUCKY[1]

Clyde DeRossett[2]

Abstract: This paper examines statistics of a data set of mine subsidence investigated sites in Western Kentucky collected over more than a 20-year period. It includes sites that were both affected by mine subsidence and sites that overlie mine workings but could not be identified as being impacted by mine subsidence. Analyses were done to see how well extraction rate, pillar shape and pillar strength calculations did in the prediction of successful overburden protection for the data set. National Institute for Occupational Safety and Health (NIOSH) research into mine pillar strength and other studies of coal mine pillar behavior is examined. How the pillar geometry affects both the pillar strength and pillar foundation is reviewed. A comparison of modern research to the data set is made. Suggestions of how this information could be used along with publicly available site-specific information for cursory evaluation of overburden support or subsidence damage potential is discussed.

Additional Key Words: Mine Subsidence, Coal Pillar Strength

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2. Clyde DeRossett, Consultant PE, PG, MSc email: clyded@Bellsouth.net

THE CURRENT SITUATION AND RECLAMATION PLANNING OF COAL MINING SUBSIDENCE LAND IN SHANDONG, CHINA[1]

Dongzhu Yuan*and Zhenqi Hu[2]

Abstract: Coal is the basic energy and important raw material in Shandong Province of China. While coal resources development has made important contributions to economic and social development, it has also caused serious impact on ecological environment, forming a large-scale surface subsidence. This paper revealed the current situation of coal mining subsidence land in Shandong Province, especially the quantity and spatial distribution, and predicted the future subsidence from 2020 to 2030 by using of probability integral method. The impact of subsidence due to underground coal mining was also discussed. Based on the analysis of damage characteristics of subsided land and its distribution in Shandong Province, the zoning of subsidence classification was summarized as five subsidence zones. In accordance with the requirements of green development strategy and ecological civilization construction, combined with the actual situation of subsidence and requirements of regional development, this paper puts forward the ideas and principles of subsidence land reclamation planning. Four types of land use were chosen as reclamation direction. Based on subsidence zoning, the five major reclamation zones are divided, and the reclamation goals and tasks for the five major zones are presented. The reclamation goals and tasks for different cities with different planning periods were also made in this plan so that provincial government could push and judge the reclamation effectiveness. This paper provides technical support for promoting the reclamation of coal mining subsidence in Shandong Province by rationally arranging the reclamation planning layout and tasks.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Dongzhu Yuan (* presenter), PhD Student, and Zhenqi Hu, Professor, University of Mining and Technology, Beijing, Beijing 100083.
3. Work reported here was conducted near 39°59'47" N; 116°20'42" W.

TEXAS NATIVE SEEDS: A REGIONALLY BASED SEED DEVELOPMENT PROGRAM TO ENABLE STATE LEVEL GRASSLAND RESTORATION[1]

A.D. Falk*, F.S. Smith, and K.A. Pawelek[2]

Abstract: Texas Native Seeds is a Texas-wide collaborative research and native plant development project modeled after the South Texas Natives Project. South Texas Natives was developed due to failures in native grassland restoration seeding across South Texas. Many of the past failures were caused by a lack of locally adapted native plant material, which historically originated from as far as Kansas. In the first 10 years of work, South Texas Natives and its collaborators made 15 regionally adapted native germplasm releases. These releases are based on years of research and constructed by mechanically blending seed produced in isolation from multiple regional parent populations. The key to South Texas Natives long-term success was that the project worked hand in hand with commercial seed dealers resulting in the commercial availability of the seed releases. Discovery of and production activities in the Eagle Ford Shale prompted major seed demand for restoration on thousands of acres in South Texas. The use and success of material developed by the project particularly in this arena has led to larger statewide demand from which the Texas Native Seeds Program was born. Currently Texas Native Seeds has 6 project regions and has released 35 regional germplasm. Through our work these germplasms have been seeded on over 400 miles of oil and gas pipeline rights-of-way in the last 2 years, as well as many acres of mining and energy production restoration activities. Even with these successes, Texas Native Seeds faces several challenges to meet the native seed demands across Texas. First is assisting commercial seedsmen estimate demand. Since native seed is a perishable commodity, we must work closely with commercial seed dealers to estimate quantities to meet year-to-year needs, yet not have growers overproduce which could lead to losses during storage. Another challenge is working with multiple commercial seedsmen, and ensuring opportunities for production by all, while ensuring adequate supply, quality, and consumer concerns are address. Texas Natives Seeds has provided a model on how to develop successful restoration material and make it available at a statewide level, however, the need for additional research and refinement still exists3.

Additional Key Words: Commercial Production.

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2. Anthony D Falk (* presenter), Assistant Director South Texas Natives; Keith A. Pawelek Associate Director; and Forrest S. Smith, Dan L. Duncan Endowed Director, Texas Native Seeds, Kingsville, TX 78363.
3. Work reported here was based at 27˚31’36” N; 97˚52’54” W.

FIRST-YEAR RESULTS OF HELICOPTER LIMING OF SOILS IN THE MONONGAHELA NATIONAL FOREST [1]

J. Fowler*, J. Skousen, S. Connolly, S. Mellor, A. Nottingham[2]

Abstract: Forest soils in the Appalachian region have become more acidic due to acid deposition, uptake of base cations (Ca, K, Mg, and Na) by vegetation, and release of organic acids through decomposition of organic matter. As forest soils became more acid, declines in forest health and productivity, and changes in species composition and nutrient status have been measured. Liming is a well-known practice used in decreasing the acidity in agricultural soils, but no large-scale liming projects have been done on acid forest soils. A large-scale liming project was conducted near Richwood, Webster County, WV, consisting of liming a total of 700 acres. Due to steep topography and limited road access in the Monongahela National Forest, lime for this project was applied via helicopter to pre-selected units using GIS coordinates. The liming material varied from small sand to small gravel size and the liming rate was between 3 to 5 tons per acre. One year after liming, 10 sampling sites representing limed and unlimed areas were located, and five pits were dug, and soils were sampled at each site. At each pit, horizon thickness was recorded, and soil samples were taken from the O, A, and upper B horizons (150 samples total). Soils were dried and sieved to <2mm, extracted with Mehlich-3 solution, and analyzed for pH, Ca, K, Mg, P, OM, and other elements with ICP-OES at West Virginia University. The average thickness of the soil horizons was 2.6 cm for the O horizons, 16.4 cm for A horizons, and 19.0 cm for B horizons. On unlimed soils, pH in the O, A, and B horizons was 4.1, 3.9, and 3.9, respectively. Average Ca concentrations varied from 206, 59, and 31 ppm in O, A, and B horizons. Average K concentrations varied from 100, 45, and 24 ppm in O, A, and B horizons. Average Mg concentrations varied from 43, 19, and 9 ppm in O, A, and B horizons. Average P concentrations varied from 26, 13, and 2 ppm in O, A, and B horizons. In limed soils, pH in the O, A, and B horizons was 5.2, 4.2, and 4.3. Average Ca concentrations were slightly higher at 1,242, 265, and 76 ppm in O, A, and B horizons. Average concentrations for K, Mg, and P were very similar to unlimed soils in O, A, and B horizons (K concentrations were 89, 53, and 37 ppm; Mg concentrations were 74, 26, and 14 ppm; P concentrations were 26, 14, and 5 ppm) Based from these results, lime particles in the O horizon caused increases in soil pH and Ca concentrations. But as lime dissolves and is integrated into the soil, these parameters will decline. Lime application at these rates should improve soil fertility for improved tree uptake.

Additional Key Words: lime, forest soil, West Virginia.

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2. Jarrett Fowler (* presenter), MS Graduate Student, and Jeff Skousen, Professor, Division of Plant and Soil Science, West Virginia University, Morgantown, WV 26505; Stephanie Connolly, Steffany Mellor, and Adrienne Nottingham, US Forest Service, Elkins, WV 26241.

UNDERSTANDING BACKFILL METHODS AND GROUND CONDITION VARIABILITIES IN ABANDONED MINE MITIGATION [1]

Mohamed Gamal *, Dave Hibbard, Joel James, and Lindsey French [2]

Abstract: This presentation covers subsurface variabilities faced during the abandoned mine reclamation phase and how to weigh mitigation approaches best suited for the existing conditions. The generalized practice for abandoned coal mine reclamation has historically been geared toward utilizing a cementitious grout. This has largely become industry practice because other backfilling materials lack the qualities needed to effectively stabilize historic mine workings after bedrock deformation has taken place. While a single grout mix design is generally considered during the design phase, sufficient understanding of bedrock strengths, mine geometry, mechanics of subsidence propagation, and the geology could vastly alter the design characteristics of the backfill material used, and could require several backfill designs utilizing foamed sand, grout columns and/or sand slurry that uniquely accommodate existing sub-surface conditions. The presentation will cover the effectiveness of different backfilling techniques based on actual observations of mitigation works for more than 30-year time span. This presentation will also discuss grout designing methods and material characteristics best suited for the in-place conditions to maximize sub-surface and ground stabilization.

Additional Key Words: grout design, mitigation methods.

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2. Mohamed Gamal (* presenter), Principal, Brierley Associates Corp, 2000 S. Colorado Blvd Suite 410, Denver, CO 80222; Dave Hibbard, Engineering Geologist, Brierley Associates Corp, 2000 S. Colorado Blvd Suite 410, Denver, CO 80222; Joel James, Geological Engineer, 1482 Commerce Dr, Unit A, Laramie, WY 82070; and Lindsey French, Project Manager, Abandoned Mine Lands (AML) Division, 510 Meadowview Drive, Lander, WY 82520.

VEGETATION RESPONSE TO SURFACE SOIL UNDULATION HEIGHT[1]

Gwendelyn Geidel [2]

Abstract: This case study examines and compares the variation in plant species, height and type within a reclaimed tailings pond that was subject to two different reclamation strategies; one reclaimed with the addition on limestone and organic material and then a surface undulation of furrows 0.7 m high and 1.0 m wide and the other with the addition of limestone and organic material but a surface undulation of only approximately 0.1 m high and 0.1 m wide. During the extraction and processing of kyanite ore from the Graves Mountain mine, Lincoln County, Georgia, fine grained tailings were produced. The tailings were transported by slurry pipeline to various tailings ponds which were created by the construction of dams using on-site materials. The tailings pond in this study, referred to as the West Tailings Pond (WTP), was constructed and filled in the 1970's and early 1980's and was reclaimed in 1995-98, by surface reconfiguration and the addition of soil amendments. Approximately 75% of the 12 ha (30 ac) site was reclaimed initially with a thin soil cap. Subsequently, amendments were added but the amendments and seeds were only harrowed in 0.1 m (4 in.). The 25% eastern end of the tailings pond was filled, amendments added and harrowed to create ridge and furrow undulations 0.7m by 1.0m and vegetated. Similar vegetation was seeded in the entire tailings pond. Over the course of 15 years, the eastern, 25% of the tailings pond with greater undulations, succeeded quickly from grass to shrub and now has a significant tree population. The 75% of the pond with only a 0.1m undulation has not succeeded beyond low grasses and mosses. Some of this diversity is attributed to higher moisture levels measured in the greater undulations and some is attributed to wind born seed species of trees captured in the greater undulations[3].

Additional Key Words:

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2. Gwendelyn Geidel, Research Professor, School of the Earth, Ocean and Environment, University of South Carolina, Columbia, SC 29208.
3. Work reported here was conducted near 33° 44' 11" N; 82° 31' 25" W.

DATA COLLECTION FOR THE CONFLICT AROUND THE CORNER[1]

M. Glenn* and K. Krogstad[2]

Abstract: New challenges are posed to projects every day. Not all of them can be resolved immediately, but recognizing which problems are coming, and what data to have to protect your project can save money and time. Montana Department of Environmental Quality's (DEQ) coal program has been lucky enough to see future problems heading its way and ensure sound decisions with intelligent and adequate data collection. Understanding the nature of those problems and what pieces of information could prove most useful are important in deciding how to protect your projects' futures. Montana DEQ has recognized potential problems and worked within and outside of our work group to find the best path forward. This often involves getting a better understanding of what the problems entail and how best to tackle them. Partnering with others who will benefit from the increased understanding can take projects to another level and help drive your project to expand its applicability. Once you have established a solid team, ensure that the best level of data is collected, using the best science available at the time. Once these foundations have been met, your project will be designed for success and hopefully ready to tackle that conflict you hadn't seen coming.

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2. Mike Glenn (* presenter), Vegetation Ecologist, and Kevin Krogstad, Hydrologist, Montana Department of Environmental Quality, Helena, MT.

APPLIED RESEARCH: BIOGEOCHEMICAL RESPONSE OF PAG MINE WASTE TO BACTERICIDES AND VEGETATION [1]

James Gusek* and Thomas Clark[2]

Abstract: A proposed expansion at a North American gold mine will involve the management of 350 million tonnes of potentially acid generating (PAG) mine waste that contains up to 15% pyrite. Until the PAG is backfilled into existing open pits and submerged about 20 years in the future, it is projected to produce acid rock drainage (ARD). Research was conducted to minimize ARD production through the application of anti-bacterial suppressants. A suite of nine kinetic cell tests, each containing about 20 kg of PAG and varying amounts of anti-bacterial amendments (including a control), were monitored for six months. Liquid amendments included sodium lauryl sulfate, a simulated treatment plant effluent containing thiocyanate, and dilute milk (as a carbon source). Sufficient lime was added initially to some cells to neutralize only residual acidity associated with the rock. The order of addition of reagents was varied. Two of the KCTs also received a layer of biotic soil media, agronomic amendments, and four site-specific species of fast-growing grass seed. As the tests were conducted indoors in the winter, the revegetated KCTs were exposed to grow lights to simulate a natural growing season situation. The biogeochemical response of the PAG-filled KCTs varied; the cells that received diluted milk behaved the best as indicated by a steadily-rising pH trend and commensurate decreases in iron oxidizing bacteria, dissolved iron concentration, and sulfate concentrations. Order of addition of reagents was important to outcome. Additional observations regarding the KCT responses to vegetation will be provided in the presentation.

Additional Key Words: ARD suppression; pyrite; acid generation; biotic soil media.

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2. James Gusek (* presenter) Linkan Engineering Ltd., 651 Corporate Circle, Suite 102, Golden, CO 80401 (720) 590-850 jim.gusek@linkan.biz and Thomas Clark, Solfatara Laboratories LLC, 5916 McIntyre Street, Golden, CO USA.
3. Project Location: Lat. +15°N, Long. 50°W to 170°W

EFFECT OF FORESTRY RECLAMATION APPROACH PRACTICES ON SOIL WATER CHEMISTRY [1]

A. Hass, J.G. Skousen*, and R. Cantrell[2]

Abstract: Proper reclamation of surface mined lands is essential for restoration of ecosystem services. Reclamation practices, especially those in mountainous / steep-terrain areas, tend to incorporate spoils of different weathering stages (e.g. saprolite, blast-rock fragments), mixed at different proportions with and without soil as topsoil-replacement material. This is likely to greatly alter soil properties as compared to the pre-existing native soils (e.g. organic matter, pH, free iron/manganese oxides, etc.), and which affect soil biogeochemical processes. In this presentation we emphasize the role of redox as a process that promotes dissolution and release of constituents in reclaimed mine sites. Sites reclaimed using sandstone spoils of different weathering stages, placed at different compaction efforts, were instrumented with water sampling devices 12 years after reclamation. Water samples were collected weekly during the 3- year study and analyzed for total metals concentrations, ionic composition, total alkalinity, and dissolved organic carbon, in addition to *in-situ* measurement of dissolved oxygen, pH, temperature, total dissolved solids (TDS), and redox potential. On average, solution attributes were similar to that of stream water from non-disturbed watersheds and did not exceed regulatory thresholds values (e.g. TDS < 300 µS cm^{-1}). Yet, wide within-season fluctuation was observed, resulting in many (statistical) 'outliers.' For example, TDS fluctuated during the 2017 growing season in non-compacted brown mine soils as much as an order of magnitude, from 178 to 1,762 µS cm^{-1}, which was associated with corresponding increases in pH (5.47 to 6.73). Both pH and TDS were inversely correlated with changes in Eh (from 363 down to 67 mV, respectively). The TDS values exceeding the regulatory thresholds were mostly associated with low Eh and circumneutral pH values, pointing to the role of redox in promoting dissolution (rather than acid dissolution). The high variability in the data likely pointed to a limited ability of the soil to buffer changes in moisture, pH, and redox potential. The results are discussed in the context of current FRA practices and of expected future trends as soil development continues.[3]

Additional Key Words: redox-potential, spoil, TDS, buffer capacity.

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2. Amir Hass, Associate Research Professor, Agricultural and Environmental Research Station & Biology Department, West Virginia State University, Institute, WV 25112; Jeffery G. Skousen (* presenter), Professor, Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506; and Robert Cantrell, Soil, Water and Natural Resources Lab manager, Agricultural and Environmental Research Station, West Virginia State University, Institute, WV 25112.
3. Work reported here was conducted near 38° 02' 42" N; 81° 30' 30" W.

IMPLEMENTING THERMAL IMAGING DEVICES EQUIPPED TO UNMANNED AERIAL VEHICLES (UAVS) TO IDENTIFY GRASSLAND BIRD NESTS IN RECLAIMED NATIVE GRASSLANDS [1]

L.M. Hearon [*], J.I. Morrison, and B.S. Baldwin [2]

Abstract: Grassland bird populations are declining at greater rates than any other group of birds. Declining populations are due to ecosystems experiencing anthropogenic changes such as habitat loss due to degradation and fragmentation. However, revegetation of mine landscapes, once mining is complete, can create a positive impact on wildlife and avian populations due to increased early successional plant communities and grassland habitats created. A well-established method of monitoring these populations is by locating and identifying active nests, but these studies tend to have low statistical power due to low sample sizes, high labor costs, and high levels of disturbance - associated with difficulty finding nests. However, advances in unmanned aerial vehicles (UAVs) and thermographic imaging technologies have potential to improve efficiency of locating nests, while causing minimal disruption. Early research has evaluated nest detectability using a thermal imaging system equipped to a UAV. The UAV was flown at three different altitudes to detect simulated nests at incremental depths in monoculture native warm-season grass canopies. This study evaluated nest detection accuracy using two different methods. The first required creating a flight plan for map construction of the research area using third-party software to later identify nests by heat signatures within the map. The second method required analyzing recordings of real-time video feed to identify and pin-point nest locations. Both methodologies were tested in a blind evaluation method, using multiple test subjects and replications. Results from this study have suggested that mapping software does not optimize nest detectability and identification. Future research will implement video analysis of UAV flights for nest detection in reclaimed native grasslands. This will allow for quantification of use and fitness of reclaimed native grasslands as habitat for grassland bird populations.[3]

Additional Key Words: thermography, revegetation.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Lori Hearon (* presenter), master's student; Jesse I. Morrison, Assistant Research Professor; Brian S. Baldwin, Professor, Plant and Soil Sciences, Mississippi State University, Mississippi State, MS 39762.
3. Work Reported here was conducted near 33°28'04.4" N 88°45'17.7" W.

MERCURY CONTAMINATION FROM HISTORIC MINING IN NEW IDRIA, CALIFORNIA [1]

Rachel A. Hohn*, Scott C. Hauswirth, Byran C. Fuhrmann; Danielle L. Bram, Marc W. Beutel, and Priya M. Ganguli [2]

Abstract: We investigated water quality downstream from the former New Idria Mercury Mine in the California Coast Ranges during the 2019 El Niño winter season. Mercury (Hg), which is mined from cinnabar (HgS), is an economic resource used extensively in California to extract gold and silver. Although Hg is no longer mined in the US, abandoned mines continue to impact watersheds throughout California. The former New Idria Mine, located in the California Coast Range Mountains, was the second largest mercury producer in North America. It was designated a Superfund Site in 2011, with initial remediation completed in 2015. These cleanup efforts included redirecting acid mine drainage (AMD) at the site, but >40 acres of mine tailings remain. Previous studies demonstrate dispersion of particles from the tailings is the primary fate pathway for mercury to the local watershed. Water upstream from the mine contains up to 100 pM total mercury (HgT), similar to previously reported values. We observed extreme variability in HgT along a downstream transect, with concentrations dropping from ~10,000 to 450 pM at over approximately 5 km. We hypothesize this decrease is due to mercury settling out with iron precipitated from the AMD. We also observe seasonal attenuation with the highest mercury concentrations occurring in the winter. Organic bioaccumulative monomethyllmercury (MeHg) concentrations along the same transect varied from 1.0 to 3.2 pM. HgT in waters near the Mendota Wildlife Area (~100 km downstream) were <20 pM, suggesting current water quality impacts occur closer to the mine site. Our results indicate that remediation efforts to date have not reduced the flux of mercury from New Idria. Future work will include sediment analyses, wet and dry season sampling, and evaluating the importance of shallow groundwater as a mercury source.

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2. Rachel A. Hohn (* presenter), Scott C. Hauswirth, Danielle L. Bram, and Priya M. Ganguli, California State University, Northridge (CSUN), Department of Geological Sciences Northridge, CA 91330-8266; and Byran C. Fuhrmann and Marc W. Beutel, University of California, Merced, Merced, CA.

ON LAND RECLAMATION SCIENCE[1]

Zhenqi Hu [2]

Abstract: The research purpose is to systematically summarize and analyze the research and practice of land reclamation in China for more than 30 years, trying to further refine the land reclamation science, after promulgation and implementation of the Stipulation of Land Reclamation for 30 years. The research results included further recognition on the concept of land reclamation, the development history and progress of land reclamation in China, some basic issues such as research object, content and discipline system of land reclamation, and prospect. The research conclusions demonstrated that the concept of land reclamation cannot be defined by its Chinese words. It is aimed at restoring the dual objectives of reuse of land and eco-environment restoration. It is advisable to regard "restoring farmland" as "land reclamation in a narrow sense". The kernel task of land reclamation science is regeneration and utilization of destruction land and the restoration of its ecosystem. The main contents of the science are the basic theory of land reclamation, reclamation technology and reclamation management. The concept of the science of land reclamation was proposed. The tendency of reclamation technology and science was prospected.

Additional Key Words: land reclamation; discipline construction; literature review; prospect.

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2. Zhenqi Hu, Professor, School of Environment Science and Spatial Information, China University of Ming and Technology, Xuzhou 221116, China and, Professor, Institute of Land Reclamation and Ecological Restoration, China University of Mining and Technology-Beijing, Beijing, China, 100083.

TOWARDS UNDERSTANDING THE MICROBIAL MECHANISMS UNDERLYING THE SUCCESS OF *MISCANTHUS × GIGANTEUS* ON APPALACHIAN MARGINAL LANDS[1]

J. Kane*, L. McDonald, J. Skousen, E. Morrissey, and Z. Freedman[2]

Abstract: The Appalachian region contains vast amounts of land disturbed by mining practices, and these environments may be sub-optimal for traditional agriculture due to low soil carbon (C) and nutrient content, as well as altered hydrology, among other factors. However, *Miscanthus × giganteus* (hereafter, Miscanthus) is robust even under the conditions often found on these lands. Miscanthus is a sterile, perennial grass with a deep rooting system that can reach heights of up to 10 feet. Adequate management of Miscanthus systems could lead to high yields while improving soil fertility and C storage. Microbial influence can govern the fate of soil C inputs (*e.g.*, plant litter). For example, microbial decomposition products can associate with the soil matrix, stabilizing soil C. Further, the cycling of nutrients critical for plant growth (*e.g.*, N and P) is largely microbially driven. Hence, an improved understanding of microbial influence on system-wide processes may help develop land management strategies to optimize agroecosystems on marginal lands. Promoting soil amendment strategies to enhance microbial processing could result in both increased soil C storage and yield. To determine land management effects on soil microbial processes mediating soil C storage, nutrient availability and crop yield, a large-scale field experiment was initiated at the West Virginia University research farms[3] in the spring of 2019. Sixty-four plots were established and treated with one of four amendment treatments (low- and high-level inorganic, organic, and control) on marginal and sub-marginal soils in a randomized block design. We propose that varying amendment strategies differentially affect microbial C and N use efficiencies (*i.e.*, how much C and N is incorporated into microbial biomass versus lost to the environment), and can be managed to enhance both yield and soil C and N retention. Early data has revealed that soil C flux and microbial C use efficiency differ between sites (*i.e.*, the two farms) and site type, possibly driven by differences in the bioavailable C stock. This suggest links between soil C quantity and microbial processes. Through this project we hope to elucidate the mechanisms underlying productive, sustainable agroecosystems on marginal lands.[3]

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2. Jenni Kane (* presenter), PhD Student, Louis McDonald, Professor, Jeffrey Skousen, Professor, Ember Morrissey, Assistant Professor, and Zachary Freedman, Assistant Professor, Division of Plant and Soil Sciences, West Virginia University, Morgantown, WV 26506.
3. Work reported here was conducted near 39˚39’42” N; 79˚55’46” W.

CONVERTING A FORMER MINE TO A WINTER WONDERLAND[1]

Dale Kolstad[2], Laurie Goldner

Abstract: The Mayflower Mine in Wasatch County Utah once produced more gold than the rest of the Park City District mines combined. After nearly 50 years of dormancy, the mine site is being reclaimed and converted into a ski resort with luxury hotels and residences. An extensive site characterization was completed to determine the nature and extent of impacts. The investigation revealed an unstable waste rock pile at the mouth of the portal, widespread lead and arsenic in topsoil, portal drainage containing dissolved metals above receiving water standards, and metals-impacted sediments within drainages and wetlands. Petroleum impacts to soil from previous operations near the portal entry were also discovered during the investigation. The remedial design included diverting the portal drainage from the wetlands, removing the sediment, and then placing the excavated topsoil and sediment with waste rock in an onsite sealed repository. The repository was purposefully designed to accommodate a range in material quantities and qualities while maintaining a consolidated footprint. Petroleum impacted soils were to be removed and disposed offsite to mitigate any future soil vapor issues. Remedial actions were strategically incorporated into the overall redevelopment plan, providing protection of human health and the environment without affecting the building plans or future site aesthetics. The design used cost-effective onsite materials unsuitable for development construction but useful for the repository. The site is enrolled in the Utah Department of Environmental Quality (UDEQ) Voluntary Cleanup Program (VCP).

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2 Dale Kolstad, P.E. (presenter). Senior Environmental Engineer and Vice President. Barr Engineering Company. Minneapolis, MN. 1 Laurie Goldner. PhD. Senior Environmental Consultant. Barr Engineering Company. Salt Lake City, UT.

SCRAM TAILINGS MINELAND RECLAMATION 3-YEAR CASE STUDY AND RECOMMENDATIONS[1]

A. Kramer*, J. Asp, and N. White [2]

Abstract: Minnesota's robust reclamation standards have proven results in the taconite mining industry. Reclamation of overburden spoils, lean ore spoils and fine tailings from taconite production has generally been successful on the Iron Range, using a low input standard reclamation practice. However, new breakthroughs in iron ore scram mining technologies are producing fine and coarse tailings that have not been encountered nor reclaimed in northern Minnesota. This presentation is the culmination of three years of innovative research to investigate potential successful reclamation strategies for scram mining tailings in Minnesota. This presentation will focus on the results of the 3-year study (2016-2018) by briefly summarizing Phase I (Year 1 research proposal and bench scale results), subsequent Phase II (design and Year 2 field trial results), and finally the Phase III (Year 3 results and reclamation recommendations). The research program will also describe collaboration between private industry and a public agency to provide research funding support. This paper should align with Technical Sessions Revegetation, Soils and Overburden, and/or Refuse and Tailings.[3]

Additional Key Words: native vegetation, soil, ecological restoration, mine closure, Chisholm, Minnesota.

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2. Allyz Kramer (* presenter), Sr. Biologist | Principal, Joel Asp, Sr. Ecologist, and Natalie White, Sr. Biologist, Short Elliott Hendrickson Inc., 418 W. Superior Street, Suite 200, Duluth, Minnesota 55802.
3. Work reported here was conducted near 47° 28' 07.5" N; 92° 50' 23.5" W.

COMPARING MONITORING DATA TO A MOVING BASELINE[1]

Kevin Krogstad* and Mike Glenn[2]

Abstract: Monitoring for mining related impacts to the environment means looking for change. In order to identify a change, we must establish a baseline. The problem is, baselines are not consistent. Natural conditions vary, and over the life of a mine the natural variation can be significant. Baseline data must, above all, be representative of the undisturbed condition of the target area. In order to fully represent the undisturbed condition, baseline data must include the range of natural variation and any regional trends unrelated to mining disturbance. Particularly when comparison to a baseline determines acceptability for bond release or violation of a rule, it is critical to understand the nature of the entire baseline dataset. In reclamation, baseline is our goal, but if it keeps moving it can be challenging to meet it. New challenges appear from time to time. When baseline data is being collected before a mine is open, every effort is made to address all reasonable issues. Standards change, practices change, conditions change, and we may need to adapt to meet unforeseen problems. Monitoring data must be compared to baseline data, but we need to remain aware of what that baseline really means.

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2. Kevin Krogstad, Hydrologist, and Mike Glenn, Vegetation Ecologist, Montana Department of Environmental Quality, Helena, MT.

EROSION AND SEDIMENT CONTROL AT SURFACE COAL MINES OF SEMI-ARID ENVIRONMENTS[1]

A. Krzyszowska Waitkus[2]

Abstract: All surface coal mines should have installed techniques preventing soil erosion and sedimentation caused by water activities. Additionally, in semi-arid environments it is important to control dust due to wind activity. Factors effecting erosion and sedimentation depend on climate conditions, topography, soil properties, vegetation cover and conservation practices. It is important to be able to identify these various factors in surface coal mines that affect erosion processes especially those that can be altered or minimized. Conservation practices to reduce soil erosion include maintaining a vegetative cover, shortening slope lengths and steepness, increasing roughness of the area by tillage management, and roughening the area on a contour. The most important is permanent or temporary vegetation cover or cover crops that stabilize the soil surface and add nutrients to soil. Geomorphic approach to rebuild postmine topography over traditional approaches was proven to create the least amount of erosional features and sediment. Mulching, hydromulching, soil binders and tackifiers, and erosion control blankets help to prevent erosion and reduce sedimentation. Bonded fiber matrix are used on steep slopes unsuited for erosion control blankets. In some of the USA western mining sites, specific rock structures were developed to prevent headcuts from continuing to migrate upstream. Mycorrhizal inoculant is one of the bioengineering methods used in some sites to promote plant growth, increase uptake of mineral nutrients, and reduce tolerance to stress. Dust control due to erosional wind activities in coal mining areas is limited to establishing a vegetative cover, forming ridges, and creating roughness of bare areas, forming shelter barriers, and using stabilizers to suppress dust. Sedimentation following erosion requires different control techniques. Sedimentation control facilities require a pond or structure designed to capture runoff from disturbed areas for the purposes of treating water for sediment and suspended solids removal. Besides, sediment pond structures, other methods are implemented in the mine areas. All of them are temporary such as silt and filter fences, straw bale barriers, rock riprap, gabions, wattles, or filter socks. They can be removed when sedimentation processes are eliminated from the site.

Additional Key Words: soil conservation practices, dust control, water and wind erosion.

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2. Anna Krzyszowska Waitkus, Environmental Consulting, 80 Eagle Nest Ln., Laramie, WY 82070, enviro@wyoming.com.

SCREENING NATIVE/INDIGENOUS SPECIES FOR TOLERANCE TO PB/ZN/CU TAILINGS AND USING IMAGE-BASED ANALYSIS AS A NEW ASSESSMENT APPROACH[1]

M. K. Al-Lami*, D. Nguyen, G. Sutton, C. Neaville, and J. G. Burken [2]

Abstract: Selection of appropriate plant species for revegetation of mining impacted lands is crucial. When revegetating highly nutrient-deficient mine lands such as tailings, addition of appropriate soil amendments is also crucial to improve substrate functionality and enable sustainable plant growth. Therefore, screening of plant species for their tolerance along with screening soil amendments should be considered to achieve successful revegetation strategy. Assessment typically involves destructive sampling and time-consuming and expensive chemical analyses. This pot experiment aimed to screening locally available rich-carbon waste byproducts for their potential to support cultivation of ecologically viable native species on Pb/Zn/Cu tailings and the use of image analysis and computer vision to assess plant response and tolerance. Substrates prepared by treating tailings with different amendments including: biosolids, compost, charcoal, woodchips, and sawdust. Several native and prairie grasses and forbs were planted in the potted substrates and photographed weekly using side-view and top-view raspberry pi cameras attached to a portable computer. Temporal plant trait data were then extracted from the images using an open source platform called PlantCV. To allow phenotypic attributes to be analyzed, first, a pipeline was developed to segment plant material out of the background. Plant responses were then quantified using shape parameters (16 measurable outputs) and color (hue and intensity). Phenotypic data revealed significant differences between species in their responses to stress induced by tailings, indicating some species more tolerant than others, and in assessing amendment strategies. Amendments significantly impacted these responses, especially the color traits, indicating alteration in metal and nutrient availability, which manifests in leaves. Correlations of the PlantCV results with the end of experiment destructive testing will be discussed to demonstrate potential for more efficient assessment of revegetation efforts for mine impacted sites and other remediation and restoration efforts.

Additional Key Words: Phenotyping, Computer Vision, Revegetation, Metal Stress.

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2. Mariam K. Al-Lami*, PhD Candidate, Dane Nguyen, MSc Student, and Joel Burken, Professor, Department of Civil, Architectural and Environmental Engineering, Missouri Univ. of Science and Technology, Rolla, MO, 65409; Genevieve Sutton, EHS Technical Supervisor, and Chris Neaville, Asset Development Director, Doe Run Company, St. Louis, MO, 63146.

POTENTIALLY ACID-GENERATING MATERIALS IN TRANSPORTATION CORRIDORS: THE ROLE OF REGIONAL GEOLOGY IN ASSESSMENT [1]

D.M. Levitan *, W.L. Daniels, and M.M. Blair [2]

Abstract: The process of assessing geological materials for their potential to generate acid rock drainage (ARD), including techniques such as acid-base accounting, was initially developed with a focus on coal mining regions. However, over the past several decades, methods have been adapted for the characterization of materials associated with other types of mining as well as non-mining industries. Several state transportation agencies have released guidance documents and ARD risk maps. These documents and related projects recommend a variety of analytical methods for evaluating whether disturbed rock or overburden may generate ARD. In many cases, the specifics of the methods may be modified to consider local and regional geology. Examples include case studies presented at previous meetings of the American Society of Mining and Reclamation (Daniels et al., 2019; Blair et al., 2018)[3]. The overall project objectives were similar, but a range of field screening techniques and subsequent laboratory analyses were adapted for regional geological formations, specifically Devonian black shales in Virginia and a banded iron formation in Minnesota, respectively. Currently, newer field sampling and lab analysis specifications for design-build projects are being developed for an extensive segment of road widening efforts around I-95 in eastern Virginia in a mix of sulfidic Coastal Plain sediments and Piedmont metamorphic rocks. This presentation will compare geology-driven ARD assessment project decisions in highway construction to provide a survey of current practices.

Additional Key Words: acid rock drainage, acid-base accounting, Minnesota, Virginia, highway construction.

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2. Denise Levitan (* presenter), Environmental Scientist, Barr Engineering Co., Minneapolis, MN 55435; W. Lee Daniels, Professor, School of Plant & Environmental Sciences, Virginia Tech, Blacksburg, VA 24061; and Mehgan M. Blair, Senior Geologist, Barr Engineering Co., Duluth, MN 55802.
3. Daniels, W.L., et al., "Development of a Reliable Field Testing Protocol for Acid-Forming Materials," ASMR 2019 National Meeting, Big Sky, MT; and Blair, M.M., et al., "Integrating Geochemical Characterization and Field Procedures in Construction to Mitigate Potentially Acid-Generating Materials in Northern Minnesota, USA," ASMR 2018 National Meeting, St. Louis, MO.

5036 INNOVATIVE SHORELINE PLANNING ON THE MESABI IRON RANGE IN HIBBING, MINNESOTA [1]

P. A. Lillesve [2]

Abstract: The Pit Lake Littoral Zone and Associated Upland Development Project was a first-of-its-kind undertaking intended to develop practical and replicable practices to use current mining activities to shape the future aquatic and upland landscape of the Mesabi Iron Range. The project took advantage of ongoing mining activity, in this case the relocating of stockpiled mine overburden (5036 stockpile) at Hibbing Taconite Company (HTC), to shape future aquatic, shoreline, and upland areas. As the project unfolded it became an experiment to recreate, within limits, the historical terrain and vegetation of the Laurentian Divide. The project's base objective was to develop practical and replicable practices to use current mining activities to shape the future aquatic and upland landscape of mined areas of the Mesabi Iron Range. Creating the desired vegetation habitat on the site was initiated through a vegetation plan comprised of seeding and planting of stock. The plan created five general habitat areas on the 5036 stockpile site: northern mesic hardwood forest, northern we-mesic boreal hardwood-conifer forest, northern mesic hardwood forest- oak/maple, wetlands, and aquatic. The seed were chosen to specifically be non-mat forming to allow establishment of woody plant species. As the project progressed a set of more detailed objectives emerged that could serve as guidelines for future similar reclamation efforts. The project is currently almost ten years old creating a good look back period to evaluate the effectiveness of these efforts. The presentation will review the guidelines, lessons learned, and provide an update on the status of the 5036 stockpile vegetation.[3]

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2. Paula Lillesve, Environmental Representative at Hibbing Taconite Company.
3. Work reported here was conducted near 47° 28' 36.74" N, 92° 57' 51.84" W.

NEW REAGENT MEDIUM FOR PASSIVE AMD TREATMENT [1]

M.J. McCluskey[2]

Abstract: Removal of watershed-polluting dissolved metals from Acid Mine Drainage, or AMD, is a constant challenge to mine operators and state agencies. These organizations treat many current and legacy AMD sites, often at significant cost in both financial and human capital. New treatment methods are always being sought to decrease the amount of labor and chemicals required to treat the water. InnoH2O Solutions has performed research into a new treatment process using a passive alkaline medium. This process, unlike active chemical addition, is similar to anoxic limestone drains (ALDs) that are currently used in passive AMD treatment – only with a new and exciting reagent medium. This medium, which is of alkaline nature, has a two-fold effect; 1) It provides alkalinity, like limestone, to reduce the total acidity of the water, and 2) It provides reactivity zones to remove some of the more exotic anions/cations in the water, such as the selenium-related anions (selenite/selenate). The passing of AMD over the medium provides a self-regenerating effect. In further implementation in the field, this new process is anticipated to be used in conjunction with current passive treatment options, including ALDs, vertical flow systems (VFSs), successive-alkaline-producing-systems (SAPS), and the like. Field trials are being commenced and will be completed by June 2020.

Additional Key Words: acid rock drainage, net acidic water remediation.

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2. Michel J. McCluskey, President and SME, InnoH2O Solutions, LLC, Somerset, PA 15501.

BURIED WOOD EFFECTS ON NUTRIENTS AND MICROBIAL COMMUNITIES IN DIFFERENT RECLAMATION SOILS IN WESTERN CANADA OIL SANDS[1]

L. A. Manchola-Rojas* and B. Pinno[2]

Abstract: Bitumen extraction through surface mining has been conducted since 1967 in northern Alberta, Canada with thousands of hectares currently in varying stages of reclamation. Land reclamation aims to bring back the soil conditions to a range suitable for plant establishment and growth after a disturbance. In the mineable oil sands of Alberta, the reclamation processes include the use of cover soils derived from both uplands and lowlands which vary in physical and chemical characteristics. In natural soils, because of its slow decomposition rate, buried woody material plays a substantial and long-term role in carbon sequestration, nutrient cycling, microbial communities dynamics, soil oxygen levels, water retention and temperature patterns throughout the seasons. However, it is not known how prevalent buried wood is in reclamation soils or its impact on soil chemical and biological properties. One concern that has been raised by practitioners is the possibility of nutrient immobilization and reduced nutrient supply for the developing plant community post disturbance. Therefore, a study that evaluates the impact of different sources, amounts and sizes of buried wood on nutrient supply and microbial communities is needed to contribute to land reclamation effectiveness and new technical possibilities. This work will include both a field and lab component where the impact of different types and amounts of buried wood will be evaluated on nutrient supply rates and microbial community functionality. This will be done for different reclamation soil types as well as a natural soil reference. The overall goal of this project is to begin identifying the roles and impacts of buried wood, a highly understudied soil component, in reclamation soils.[3]

Additional Key Words: Reclamation soils, nutrient supply, soil properties.

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2. Laura, A. Manchola (* presenter), MSc Student, University of Alberta, Edmonton, Alberta, Canada; Brad Pinno, Assistant Professor, Department of Renewable Resources, University of Alberta, Edmonton Alberta, Canada.
3. This study will be conducted at an oil sands mine site (57.377N, -111.849W) 75 km northwest of Fort McMurray, Alberta, Canada.

THE EFFECT OF COARSE WOODY DEBRIS ON A RECLAMATION SITE [1]

L. Newstead*, B. Pinno [2]

Abstract: Coarse woody debris (CWD) has the potential to impact the regenerating plant community on reclamation sites by changing the microsite in the immediate area around the log, which could impact species richness and diversity. But should CWD become a mainstay in newly regenerated reclamation areas? We studied the impacts of purposely-placed CWD, as reclamation treatments, on organic rich peat mineral mix soil (PMM) and mineral based forest floor mineral mix soils (FFMM) at an oil sands mine in northern Alberta, Canada[3]. Soil and plant data were collected from the upslope, downslope and in the center between CWD logs. Overall, there were significant differences in soil properties between the PMM and FFMM but more subtle differences due to CWD placement. Total species richness and cover were similar between the two soil types but there were differences among functional groups. Graminoids and native plants had higher cover and richness in FFMM, whereas PMM soils had higher cover of non-native and woody perennials. The CWD treatment increased native forb and total vegetation cover adjacent to the logs relative to areas in the center between logs, possibly due to the additional protection the log provides the young plants. The CWD also influenced soil nutrients by reducing nitrate supply rates in the upslope position. It would appear that CWD had an impact on microsite soil properties and regenerating plant communities in reclamation areas. CWD is a natural part of the boreal forest ecosystem and should be studied further to determine its role in landscape reclamation.

Additional Key Words: CWD placement, microsites, plant communities, soil properties.

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2. Laura Newstead (* presenter), MSc student, University of Alberta, Edmonton, Alberta, Canada; Brad Pinno, Assistant Professor, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada.
4. This study was conducted at an oil sands mine site (57.377N, -111.849W) 75 km northwest of Fort McMurray, Alberta, Canada.

BENEFICIAL USE OF DREDGE SEDIMENT FOR RECLAMATION OF MINING SITES [1]

M. M. Patelke *, S. Post, and L. M. Zanko [2]

Abstract: Between 2011 and 2019 fine grained dredge sediment from the Duluth Superior Harbor has been transported and placed on three different mining sites in northeastern Minnesota to evaluate the beneficial use of the material for revegetation. Each demonstration project is located in a different mine-related setting. Sites included use of 30,000 cubic yards (cy) on a barren tailings basin at Keewatin Taconite (2011-2012), 3,700 cy at a Hibbing Taconite gravel pit (2012-2014), and 4,500 cy on a historic waste rock stockpile (2014-2019) located at the Virginia Landfill. At each site, sediment was placed at varying thicknesses between 6 and 12 inches and in different plot configurations, then a variety of tree and/or shrub seedlings were planted. Sediment was placed at the first two tailings basin and gravel pit sites and planted without follow up evaluation until 2019. Harbor dredge sediment promotes vegetation growth on disturbed land in areas of low soil fertility. In general, a thicker sediment layer can have a positive effect on survival rates for some tree species. However, evidence of overgrowth of grasses and weeds was observed at the sites. Trees were found "buried" by thick vegetation that had caused stress, deformation, and sometimes death. This competition from other vegetation likely affected the survival and growth of tree seedlings at all three sites. Application of dredge sediment enhances re-establishment of grassy type vegetation.[3]

Additional Key Words: revegetation, soil fertility, tree growth.

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2. Marsha Meinders Patelke (* presenter), Researcher-Geologist, Sara Post, Researcher – Geological Engineer, and Larry M. Zanko, Senior Research Fellow – Geological Engineer, Natural Resource Research Institute University of Minnesota Duluth, Duluth, MN 55811

3. Work reported here was conducted across the Mesabi Iron Range in Northeastern Minnesota, USA.

INTRODUCTORY FIELD SCHOOLS AT THE UNIVERSITY OF ALBERTA[1]

Brad Pinno* and Alex Drummond[2]

Abstract: Every August, the Department of Renewable Resources at the University of Alberta leads first year forestry students on a week-long field course that introduces the students to key topics in the field before they ever get to a classroom. The success of this course over the past 20 years has motivated the development of a similar introductory field school for the Environmental Science program which includes Land Reclamation. From an academic perspective, the goal of the course is to provide students with a context for their program, a glossary of relevant terminology, imagery of key topics that will be developed later in the program, and basic field skills. But beyond the academic goals, introductory field school also builds student cohorts and skills for navigating through their program. In order to keep the focus on providing context and student bonding, no tests or assignments are given other than individual self-assessments. From a departmental perspective, the course relies on in-kind support from industry, government, and alumni to be successful and further builds the relationship between these groups and our programs. For the new introductory land reclamation field course, topics to be covered include energy extraction (coal, oil, and gas), power generation and transmission, and basic land reclamation issues related to soils, vegetation, and disturbance. Overall, introductory field courses are considered critical components of our programs with long-lasting positive benefits.

Additional Key Words: field school, forestry, land reclamation, teaching.

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2. Brad Pinno (* presenter), Assistant Professor, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Alex Drummond, Manager Field Program, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada
3. This work was based at the University of Alberta (53.528N, -111.523W), Edmonton, Alberta, Canada.

LAURENTIAN VISION PARTNERSHIP – TRANSFORMING PITS AND PILES INTO LAKES AND LANDSCAPES[1]

James B. Plummer[2]

Abstract: My presentation will provide background and overview of the Laurentian Vision Partnership's (LVP) members, purpose, and activities over the last two decades. LVP is a coalition of mining, business, government, education, professional and community interests representing all parts of the Mesabi Iron Range, located in northeast Minnesota. LVP has been working collaboratively to promote sustainable mining and the reshaping of mining sites into productive landscapes for the future. LVP promotes efforts to transform underutilized mining lands of the past and guide future land use decisions that will maintain the long-term economic viability of the region, which is driven by mining. By working together and building trust around common interests, stakeholders are breaking down past barriers and tackling old and new challenges related to land use, maintaining environmental integrity, creating new economic development opportunities, and sustaining the economic health of the region well into the future. The LVP Mission Statement is:

- Preserving lands to sustain current and future mining,
- Promoting landscape options for post mining uses,
- Identifying and discussing new development opportunities, and
- Providing the tools to achieve these goals.

LVP focuses its efforts in the following three areas.

- Partner Engagement and Shared Visioning: Provides a forum for local communities, mining companies and regional partners to communicate, envision, design, and collaborate on subjects related to the mining economy and providing livable communities across the Mesabi Iron Range. It does this by hosting three half-day meetings per year.
- Tools and Resources: Develop, update, and deploy LVP land use and design tools, to define future regional mining reserve areas and provide reclamation tools for sustainable future development. This is accomplished through GIS mapping and reclamation strategies.
- Priority Projects: Fund land reclamation projects that reclaims or repurposes mining impacted lands. This is achieved through a grant program.

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2. James B. Plummer, Planning Director, Iron Range Resources and Rehabilitation.

ALLEVIATING SOIL COMPACTION AND IMPROVING RECLAIMED GRASSLANDS [1]

M.A. Puffer * and R.F. Limb [2]

Abstract: The need for ecological restoration is increasingly more important as anthropogenically derived land degradation continues to expand. Surface mining and mining associated extraction and reclamation methods create large-scale alterations to ecosystems. The practice of deconstructing and reconstructing landscapes creates compacted soil conditions, resulting in challenging conditions for re-establishing desirable ecosystems. We compare how different mechanical de-compacting practices, and two different seed mixes, will alleviate soil compaction and influence the quality of reclaimed grasslands. Methods used were chosen with the intention of being both feasible and cost-efficient to the current routine. Treatments involve ripping either at the subsoil or topsoil horizons, the integration of straw mulch into the subsoil horizon, and the seeding of either a native grass mix or a native grass and forb mix. We use a Delta-T, PR2 Profile Probe to collect volumetric water content data and a Vertek Automatic Dynamic Cone Penetrometer (ADCP) to collect penetration resistance data. Additionally, we use a 0.5 x 0.5-m frame to collect plant community composition and a modified Daubenmier cover class to classify vegetation cover. Ascertaining the best treatment for alleviating soil compaction can provide mining companies new methods to aid in grassland restoration without substantial additional costs and/or disruptions to the reclamation routine.[3]

Additional Key Words: reclamation, vegetation, ecosystems.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Maureen A. Puffer (*presenter), Graduate Student, and Ryan F. Limb, Associate Professor, School of Natural Resource Sciences; North Dakota State University, Fargo, ND, 58104.
3. Work was conducted on BNI Mine Ltd. property, 47° 03’ 22” N; 101°18’ 35” W.

EFFECT OF BACTERIA ENCAPSULATED IN AGAR BEADS ON SULFATE REDUCTION IN AMD [1]

Taylor Rosso*, Michelle M. Valkanas, and Nancy J. Trun [2]

Abstract: Passive remediation systems are being used to remove soluble heavy metals resulting from AMD, but in circum-neutral systems sulfate levels remain extremely high. These systems depend on aeration to remove some contaminants, while sulfate reduction is usually an anaerobic process that is heavily dependent on microbes. Even in the predominantly aerobic environment in the passive systems, sulfur-cycling bacteria have been found throughout the system in the soil-water slurry. Sulfate is reduced to sulfide mainly by microbes and the sulfide can complex to the heavy metals and form stable metal sulfides or geochemically converted into a number of sulfur intermediates. Metal sulfides cannot easily be converted back to sulfate, lowering the levels of both the sulfate and the metals. In order to stimulate sulfate reduction via anaerobic bacteria in an aerobic environment, agar beads were inoculated with bacterial communities and placed into sterilized AMD. Bacterial slurries were collected from ponds 1, 3, and 7 at the Lowber Passive Remediation System. Sulfate and sulfide levels were measured, and sulfide formation was observed. This suggests that we are able to stimulate sulfate reduction by encapsulating the bacteria in agar, protecting them from oxygen and toxic compounds. Further studies will determine the bacteria present and if this technique can be used in field experiments in the passive system.[3]

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Taylor Rosso (* presenter), Post-baccalaureate; Michelle M. Valkanas, PhD Candidate; Nancy J. Trun, Associate Professor, Biological Sciences, Duquesne University, Pittsburgh, PA 15282.
3. Work reported here was conducted at Lowber Passive Remediation System (40.250394, -79.764429).

CREATIVE SOLUTIONS TO COMPLEX ECOLOGICAL CHALLENGES: LESSONS FROM AN EXPERIMENTAL LOBLOLLY PINE PLANTATION IN KENTUCKY[1]

K. Sena*, J. Metzmeier, B. Smith, E. Hansen, and C. Barton[2]

Abstract: Climate change and harsh environmental conditions present significant barriers to reforestation of surface mined sites in Appalachia. An experimental site was established on a reclaimed surface mine in eastern Kentucky to investigate the impacts of soil amendments (fertilizer additions and mycorrhizal inoculations) on the growth and survival of northern red oak and loblolly pine, and the effects of amendments and species planted on soil development. While early effects of soil fertility and mycorrhizae treatments were apparent, these did not affect growth or survival of either species after ten growing seasons. Overall, loblolly pine exhibited greater growth and survival than northern red oak. While the poor growth and survival of northern red oak were attributed to heavy vegetative competition from nonnative species, especially sericea lespedeza and autumn olive, loblolly pine rapidly achieved canopy closure and shaded out competitive understory vegetation. This study documents that non-native loblolly pine may serve as an important pioneering tree species in reforestation of reclaimed mine sites by potentially outcompeting invasive exotic plant species from the understory.

Additional Keywords: forestry reclamation approach, invasive species, forest restoration, compost, *Pinus taeda*, *Quercus rubra.*

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Kenton Sena (* presenter), Lecturer, Josh Metzmeier and Brandon Smith, students, Lewis Honors College, University of Kentucky, Lexington, KY 40526; Elizabeth Hansen, student, and Chris Barton, Professor, Department of Forestry and Natural Resources, University of Kentucky, Lexington, KY, 40546.
3. Work reported here was conducted near 37° 25' 40.4" N; 83° 10' 37.1" W.

RESTORATION ECOLOGY AS A FIRST-YEAR HONORS COURSE: LESSONS LEARNED AND CHANGES MADE[1]

K. L. Sena2

Abstract: Restoration ecology presents powerful opportunities for engaging students from a wide variety of backgrounds, professional interests, and academic preparation. Taught as an interdisciplinary Honors course fulfilling the University of Kentucky core curriculum requirements for natural science, "Restoration Ecology in the Commonwealth" engaged students from a variety of academic disciplines in hands-on, accessible environmental education. The interdisciplinary nature of this subject lends itself well to fulfilling core requirements—no prerequisites are necessary, and students from nearly any major can readily link the course to their personal and professional interests. In addition, the course presents ready opportunities for student engagement, especially through in-field research and service-learning. Students in this course participated in a research project investigating the impacts of encroachment by non-native bush honeysuckle on native spring ephemeral wildflower communities, collecting data in the field as part of small group instructor-led field trips, and writing a full manuscript-style research report as a final class product. In addition, students participated in a service-learning field trip to Appalachian Kentucky to help with a broader effort to reforest formerly surface-mined land. This presentation will highlight successes and challenges associated with teaching this course in a manner accessible to first-year college students from a variety of majors, and with varying degrees of formal academic training in environmental issues. Overall, the presentation endeavors to show that a restoration ecology course can achieve a number of pedagogical goals, including student engagement in research and service-learning activities, and broadly educate students in environmental issues, and thus functions well as a core course option.

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2. Kenton L. Sena, Lecturer, Lewis Honors College, University of Kentucky, Lexington, KY 40526.

ECOLOGICAL RECOVERY OF TEMPLETON FORK WATERSHED FOLLOWING LARGE-SCALE STREAM AND WETLAND MITIGATION [1]

M.L. Shema*, M.R. Haibach, and M.A. Takacs [2]

Abstract: In 2010, CONSOL Energy, Inc. initiated construction on a large-scale stream and wetland mitigation project to provide functional compensation for unavoidable aquatic resource impacts associated with a 750-acre coal refuse disposal facility in Southwestern Pennsylvania2. The restoration utilized a watershed-based approach to address stream and riparian stressors as they were encountered. CONSOL restored 40,677 linear feet of impaired stream, created 6.64 acres of wetland, and preserved 69 acres of riparian habitat. This presentation will review the restoration design approach and the ecological metrics that were used to measure success of the project during seven years of monitoring. Monitored stream parameters included sediment loadin g, instream habitat quality, benthic macroinvertebrate productivity and indices of biotic integrity, substrate particle size, and riparian vegetation survivorship and growth. The data show that the mitigation project successfully reduced sediment loading, improved habitat, and increased biological productivity within the restoration reaches.[3]

Additional Key Words: Restoration, Compensation, Macroinvertebrates, Riparian.

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2. Michael L. Shema (*presenter), Vice President and Ecologist, Mark R. Haibach, Vice President and Ecologist; and Michael A. Takacs, Project Manager and Ecologist, Civil & Environmental Consultants, Inc., Pittsburgh, PA 15205.
3. Work reported here was conducted near 40° 2' 43.51" N; 80° 23' 44.31" W.

CO-TREATMENT OF CIRCUMNEUTRAL MINE DRAINAGE WITH SECONDARY MUNICIPAL WASTEWATER FOR IMPROVED WATER QUALITY[1]

Charles Spellman Jr.*, Travis Tasker, William Strosnider, Joseph Goodwill[2]

Abstract: Acid mine drainage (AMD) and municipal wastewater (MWW) are two pollutants that pose serious risks to the water environment if left untreated. MWW can cause eutrophication and introduce pathogenic microorganisms into downstream freshwaters while AMD discharges to surface waters can lead to acidification and increased metal loadings that are harmful to aquatic organisms. Co-treatment with municipal wastewater (MWW) at existing wastewater treatment plants (WWTPs) has some known advantages and may offer a unique form of abatement; however, potential impacts on downstream physicochemical and biological processes are not completely known. This bench-scale study examined the impact of co-treatment by combining a mild AMD at various ratios with MWW a conventional wastewater treatment plant in Johnstown, Pennsylvania[3], followed by sludge settling and supernatant comparative analysis by a variety of effluent water quality parameters including sludge settleability, BOD_5, COD, turbidity, solids, and other important water chemistry parameters and physico-chemical process analysis. These measurements were combined with carbonate system and adsorption isotherm modeling to elucidate the underlying mechanisms of the experimental results. These results demonstrate secondary co-treatment enables mitigation of mild AMD without adversely affecting WWTP processes and improving some processes. Reported results also frame required future studies to address extant questions prior to full-scale adaptation. [3]

Additional Key Words: Physico-chemical processes; Acid mine drainage; Active treatment.

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2. Charles Spellman Jr. (* presenter), Graduate Student, & Joseph Goodwill, Assistant Professor, Department of Civil & Environmental Engineering, University of Rhode Island, Kingston, RI 02881; Travis Tasker, Assistant Professor, Department of Environmental Engineering, Saint Francis University, Loretto, PA 15940. William Strosnider, Director, Baruch Marine Field Laboratory, University of South Carolina.
3. AMD discharge located near 40° 19' 41" N, 78° 55' 34" W; Wastewater was obtained from the Dornick Point Wastewater Treatment Facility at 241 Asphalt Rd, Johnstown, PA 15906 (near 40° 21' 51" N, 78° 57' 8" W).

REMEDIATION OF THE ABANDONED HILLSIDE MINE IN RURAL ARIZONA; A PHASED APPROACH [1]

L. Steele*, D. Longwell, J. Nuttall, J. Sutter, J, Patricki [2]

Abstract: The currently inactive Hillside Mine is located approximately four miles north of the town of Bagdad in the Eureka Mining District of Yavapai County, Arizona. The abandoned mine was identified by the Arizona Department of Environmental Quality (ADEQ) as a contributing source of surface water quality impacts to Boulder Creek, primarily related to an uncontrolled discharge of mine water from a suspected adit. Tetra Tech, Inc., in conjunction with the ADEQ, developed and implemented a plan to investigate, characterize, and remediate the mine related environmental issues. The use of new tools and technology including: 3D modeling of underground workings and surface features, Unmanned Aerial System (UAS) surveys, and borehole sonar mapping were employed to develop a strong understanding of the site prior to the development of a remediation plan. Ultimately the main adit was dewatered and reopened to allow the construction of concrete hydraulic plugs within the adit to mitigate the direct discharge of impacted mine water to Boulder Creek. Additionally, the mine tailings pile, identified as a non-point source of metals loading, was regraded and covered to prevent further erosion and transport of tailings into Boulder Creek. The construction phase of this project was completed in June 2019 and is currently being monitored quarterly by ADEQ. This presentation will highlight the techniques used to confirm the location of underground workings and safely assess conditions of the flooded mine, and a summary of the entire characterization, design, and construction process.

Additional Key Words: Drainage, Mine Closure, UAS, 3D model.

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2. Lincoln Steele (*presenter), Project Geophysicist; Daryl Longwell, Principal Civil Engineer; Jeff Nuttall, Senior Geologist/Manager, Tetra Tech Inc. Golden, CO 80401. Jason Sutter, Senior Surface Water Hydrogeologist, John Patricki, Project Manager; ADEQ, Phoenix, AZ 85007.
3. Work reported here was conducted near 34° 38’ 0.6” N, 113° 12’ 39.7” W.

PENNSYLVANIA'S ENVIRONMENTAL GOOD SAMARITAN PROGRAM[1]

John J. Stefanko* and Eric E. Cavazza

Abstract: Pennsylvania enacted an Environmental Good Samaritan Act (PA EGSA) in 1999. The law is intended to encourage landowners and others to reclaim abandoned mineral extraction lands and abate water pollution caused by abandoned mines or orphaned oil and gas wells. The law protects landowners, groups and individuals who volunteer to do such projects from civil and environmental liability under Pennsylvania law. Prior to the PA EGSA, anyone who voluntarily reclaimed abandoned lands or treated water pollution for which they were not liable could be held responsible for treating the residual pollution under Pennsylvania law. This dissuaded people and groups from pursuing these types of projects. Only projects approved by the Pennsylvania Department of Environmental protection (PA DEP) prior to construction are eligible for protections under the PA EGSA. PA DEP has developed a project proposal form for participants and landowners. Each proposal must identify the project participants and landowners; describe the location of the project and the environmental problems that will be addressed; and establish a work plan for the proposed project. The PA DEP evaluates each proposal to determine if the project is capable of reclaiming the land or improving water quality. The PA DEP will also advise participants on any permits that may be required. Once the project is approved, PA DEP will maintain a permanent record of the participants and landowners who are protected under the PA EGSA. Pennsylvanians have undertaken and completed 86 Good Samaritan projects as of December 2019. These 86 projects have been undertaken by 44 different groups/participants and have included local governments, individuals, watershed groups and associations, corporations, municipal authorities, and conservancies. This presentation will cover key aspects of the EGSA Program, highlight several EGSA projects in PA, and touch on the need for national Good Samaritan legislation.

Additional Key Words: Mine Drainage, Abandoned Mine Reclamation, Oil and Gas Wells.

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2. John J. Stefanko (*presenter), Deputy Secretary, Pennsylvania Department of Environmental Protection, Office of Active and Abandoned Mining Operations, Harrisburg, PA 17106, and Eric E. Cavazza, P.E., Director, Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation, Harrisburg, PA 17106.

THE XAS – USING "BIG SCIENCE" TO EVALUATE METAL REMOVAL [1]

Brandy Stewart, Paul Eger, Brandy Toner, and Cody Shiek[2]

Abstract: X-Ray Absorption Spectroscopy (XAS) is a powerful tool to examine the oxidation state and chemical form of metals removed during treatment that offers an alternative to the time consuming and often less definitive sequential extraction methods traditionally used. Peat media that had been effectively removing chromium, cadmium and zinc from stormwater was analyzed to identify the form of the attenuated chromium. Based on the chemistry of the input water, much of the chromium appeared to be present as a fine particulate. The peat media has a size distribution similar to coarse sand which typically can filter particles 10 – 20 microns in size but is not be expected to remove the fine chromium particles. The media has also removed similar fine particulate copper and aluminum from mine water. The removal of fine particulate chromium and the lack of any chromium release in a standard TCLP test suggest that the mechanism might involve some type of chemical bonding or microbial removal as opposed to just filtration. Understanding the specific removal mechanisms will help to predict how effective the media may be with retaining other fine particulates from various mine wastewater streams. In 2018 samples of the media were collected to help identify the specific retention mechanisms. DNA was extracted from solid peat samples and incubations containing hexavalent chromium and spent peat media were setup in both aerobic and anaerobic conditions. Samples were also analyzed with X-ray Absorption Spectroscopy to identify the form of the removed metals. Preliminary data show that microbial reactions do not appear to play a major role in chromium removal and that the removed chromium is associated with the media and appears to be present primarily as a chromium organic complex and as chromium hydroxide.[3]

Additional Key Words: chromium, x-ray absorption spectroscopy, peat sorption media

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2. Brandy Stewart (* presenter), Post Doc, University of Minnesota, Department of Soil, Water & Climate University of Minnesota - Twin Cities, MN 55455; Paul Eger, Environmental Engineer, Global Minerals Engineering, Hibbing, MN 55746; Brandy Toner, Professor, Department of Soil, Water, & Climate, University of Minnesota - Twin Cities, MN 55455; and Cody Shiek, Assistant Professor, Department of Biology, Large Lakes Observatory, University of Minnesota Duluth, Duluth, MN 55812.
3. Work reported here was conducted near 42° 36' 11.03" N; 83° 155' 57" W.

DETERMINING FACTORS AFFECTING PEAT RECLAMATION IN MINED PEATLAND AREAS[1]

L.J. Swenson*, C.L. Kairies-Beatty, P. Eger, and P. Jones[2]

Abstract: Peat can be used to remove trace metals from various industrial sources, including mining. In Minnesota, American Peat Technology® (APT) harvests and manufactures reed-sedge peat products to be used in the agricultural and water remediation industries. All peat harvesting operations need a permit to mine from the Minnesota Department of Natural Resources. This permit requires all disturbed areas be reclaimed. In 2016, APT began testing reclamation methods, including the use of live stakes. After two growing seasons, stake survival was estimated to be less than 5%. The exact reason for the low survival was not known but potential causes could include live stake diameter, planting depth, and/or poor soil fertility. The purpose of this work is to characterize aspects of soil health and fertility (including pH, cation exchange capacity, elemental, nutrient content, etc.) in an area scheduled for reclamation, in addition to background samples from undisturbed areas, to determine potential causes for lack of regrowth. Peat soils from a sloped area to be reclaimed were collected along a grid. Additional grab samples were collected from another non-vegetated area on the north end of the site that was previously disturbed about 15 years ago. Samples from an area of undisturbed peatland not subject to human interference will also be collected. All samples will be analyzed for pH, % organic matter, phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), zinc (Zn), sodium (Na), sulfur (S), copper (Cu), manganese (Mn), iron (Fe), boron (B), and nitrate-nitrogen (NO_3-N). Sample results from the disturbed areas will be compared to undisturbed natural peat and fertility guidelines to determine fertilization recommendations and potentially explain the low live stake survival in the first reclamation attempt.

Additional Key Words: live-stake revegetation, peat soil fertility.

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2. Logan J. Swenson (* presenter), Undergraduate Student and Candace L. Kairies-Beatty, Professor, Department of Geoscience, Winona State University, Winona, MN, 55987; Paul Eger, Environmental Engineer, Global Minerals Engineering LLC, Hibbing, MN 55746; Peggy Jones, Vice President Sales and Research, American Peat Technology, Aitkin, MN 56431.

MEETING THE CHALLENGE OF INTEGRATING HABITAT AND AESTHETICS INTO FUNCTIONING TREATMENT WETLANDS FOR ZINC AND MANGANESE [1]

R.C. Thomas*, J.S. Bays, R.P. Bitely, A.M. Lewis, J.H. Pries, A.C. Pia, J.L. Meyer, and J.F. Strunk, Jr.[2]

Abstract: One of the challenges of mine closure is creating sustainable remedial systems that will continue to provide low-cost, low-maintenance treatment post-closure. Passive treatment systems offer one option for sustainable, low-maintenance water treatment; however, in the post-closure environment there is a secondary desire for these treatment systems to blend into the natural surroundings and provide a benefit to the future landowner beyond simple water treatment and a benefit to native flora and fauna. This presentation describes two constructed wetlands designed to meet these expectations at a mine closure site in the south-central United States. The first system reduces zinc concentration/loading and increases hardness of the effluent of a pit lake. The second system includes three separate wetlands that reduce iron, manganese, and zinc concentrations/loadings from groundwater seeps. Both wetland complexes include open water and subsurface flow components designed for long-term hardness addition and metal retention. The surface flow marshes were planted with native vegetation and designed with diverse habitat features that create a natural aesthetic that blends into the surrounding environment. Both systems meet treatment goals: zinc is reduced below detection limits in the first system and manganese is reduced by more than 90% in the second system.[3]

Additional Key Words: Passive Treatment Systems.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Robert C. Thomas (* presenter), Geochemist, Jacobs Engineering Group, 10 10th Street NW, Suite 1400, Atlanta, GA 30312; James S. Bays, Technology Fellow – Natural Treatment Systems, Jacobs Engineering Group, 4350 West Cypress St, Tampa, FL 33607; Ryan P. Bitely, Jacobs Engineering Group, 25 W. Cedar St., Suite 300, Pensacola, FL 32502; Allison M. Lewis, Project Engineer, Jacobs Engineering Group, 201 N Franklin St, Suite 1400, Tampa, FL 33602; John H. Pries, Senior Principal Technologist, Natural Treatment Systems, Jacobs Engineering Group, 72 Victoria St S, Suite 300, Kitchener, Ontario, Canada N2G 4Y9; Amy C. Pia, Restoration Project Manager, USA Environment, 96 Midland Ave, #2, Montclair, NJ 07042; Jeremy L. Meyer, Project Manager, Jacobs Engineering Group, 30800 Telegraph Rd, Suite 4900, Bingham Farms, MI 48025; and James F. Strunk, Jr., Remediation Leader, Authorized Representative, Umetco Minerals Corporation, 310 George Patterson Blvd., Suite 100, Bristol, PA, 19007.
3. Work reported here was conducted in the southern mid-central United States.

NAVIGATING GRADUATE SCHOOL[1]

K.E. Trepanier*, L.J. Newstead*, L.A. Manchola Rojas*, and K.M.E. Trudel*[2]

Abstract: As graduate students, our goals, expectations, and backgrounds coming into a Master's degree are different. We will be sharing our perspectives and discussing how our undergraduate education gave us the tools to succeed in graduate school, but also those skills we feel are lacking in the undergraduate experience that might have helped better prepare us. Often, when we start a graduate degree, we believed that our project would define our future career path, and the concern was that our skill set will become too focused. Our projects do not define our professional path. Through our Masters we build skills and broaden our scope of knowledge allowing us to work in multiple disciplines. We will share how we are successfully navigating the transition throughout our graduate program in learning how to be a researcher, project management, as well as identifying the abilities we want to gain and reinforce as we become professionals. One of the setbacks of graduate school is that the program is focused on research skills while other areas of professional development are overlooked. We come into graduate school being required to adapt to a whole new set of skills and often times not having affordable access to resources or supports. In contrast one of the main benefits of the graduate program is having a mentor, lab group, and the chance to interact with other developing professionals. The opportunity to have open communication with your supervisor and lab group can help you with the process of dealing with the challenges that come with entering a graduate program.

Additional Key Words: Graduate Student, Teaching, Research Skills, Project Management, Perspectives.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Kaitlyn E. Trepanier (* presenter), M.Sc. student, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Laura J. Newstead (* presenter), M.Sc. student, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Laura A, Manchola Rojas (* presenter), M.Sc. student, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Keana M.E. Trudel (* presenter), M.Sc. student, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada.

VEGETATION COMMUNITY DYNAMICS ON SOIL ISLANDS IN OIL SANDS RECLAMATION[1]

K.E. Trepanier* and B.D. Pinno[2]

Abstract: Following oil sand mining in the boreal forest in Canada, one of the objectives of land reclamation is to create a self-sustaining ecosystem, which includes establishing native vegetation. The goal of this project was to evaluate the different modes of plant establishment and survival, including, soil seed bank, seed rain, vegetative expansion, and competition, on a new reclamation design known as "Islands." This technique integrates islands of plant diversity rich forest floor mineral mix (FFMM) within a matrix of plant diversity poor peat mineral mix (PMM). Initial vegetation community was very different between the FFMM and PMM, with greater diversity and cover in the FFMM. This initial difference was linked to the seed bank which had 5x more seeds in the FFMM than the PMM and was dominated by native forbs and graminoids. Over four years the total vegetation cover in the FFMM increased on average by 12.5% total cover and in the PMM by 40% total cover resulting in similar plant communities averaging 40% total vegetation cover in both soil types. This differential plant community development was likely due to the continuing seed rain and vegetative expansion. Seed rain was similar across both soil types but appeared to have the biggest impact on the PMM which had more available seedbeds the most common species in the seed rain were wind dispersed invasive forbs and some native forbs**.** There is also evidence of vegetative expansion of some native forbs from the FFMM out into the surrounding PMM. Finally, competition is emerging as a factor with a decrease in invasive forbs associated with an increase in total vegetative cover. Some differences in initial plant community composition have maintained themselves over time. For example, higher woody cover on PMM, likely related to the initial favorable seed bed conditions. Overall, it is clear that multiple factors are involved in structuring plant communities on reclamation sites and all of these should be considered when developing reclamation plans.[3]

Additional Key Words: vegetation community, vegetation succession, vegetation dispersal, land reclamation, restoration ecology, soil salvage, soil placement, reclamation soils, minable oil sands.

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1. Originally intended as an oral paper to have been presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN: Transforming Pits and Piles into Lakes and Landscapes, June 7-11, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821. Meeting was canceled due to pandemic.
2. Kaitlyn E. Trepanier (* presenter), M.Sc. student, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Brad D. Pinno, Professor, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada
3. This study was conducted at an oil sands mine site (57.377N, -111.849W) 75 km northwest of Fort McMurray, Alberta, Canada.

RECLAMATION SOIL PLACEMENT: PHYSICAL AND BIOLOGICAL EFFECTS OF TOPSOIL STOCKPILES VS. DIRECT PLACEMENT[1]

K. M. Trudel* and B. Pinno[2]

Abstract: Typical reclamation soils are salvaged at varying depths and mixed as stockpiles reserved for use in future projects. Altered soil profiles, mixed growth mediums, changed chemical and physical properties, and reduced propagule banks are some of the potentially harmful effects thought to be associated with topsoil stockpiles. More recently, the direct placement of salvaged soils onto a desired landscape is being promoted. However, topsoil stockpiles remain an important resource that will be used to reclaim thousands of hectares of land in northern Alberta; It is critical to understand the impacts of using stockpiled vs directly place soils on developing ecosystems. Previous studies focused on plant diversity and abundance, along with soil chemical and physical properties. Short term findings show physical properties such as compaction and drainage are impacted the most by the use of topsoil stockpiles, with mechanical agitation (tilling) having minimal impacts on soil quality. Propagule banks found within the soils vary, with direct placement soils containing higher diversity and success and topsoil piles containing little diversity or viable seeds. Follow up research will be conducted in the spring and summer of 2020 observing soil compaction, drainage, water retention and plant community composition to quantify reclamation success related to soil placement and characteristics.[3]

Additional Key Words: soil, mine reclamation, plant community, forest ecology, compaction, biodiversity, Topsoil stockpiles, soil salvage.

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2. Keana Trudel (* presenter), MSc. Candidate, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada; Brad Pinno, Assistant Professor, Department of Renewable Resources, University of Alberta, Edmonton, Alberta, Canada.
3. This study was conducted at an oil sands mine site (57.377N, -111.849W) 75 km northwest of Fort McMurray, Alberta, Canada.

NITRATE-DEPENDENT IRON OXIDATION DRIVEN BY BACTERIAL SYMBIONTS FOUND IN ACID MINE DRAINAGE [1]

Michelle M. Valkanas*, Taylor Rosso, and Nancy J. Trun [2]

Abstract: Legacy mining has heavily impacted watersheds nationwide. In Pennsylvania alone, there are 5500 miles of impacted streams. Passive remediation systems are increasingly becoming a cost-effective choice for treatment of abandoned mine drainage. While the geochemical processes involved are well understood, less is known about the impacts the naturally forming microbial communities have on system efficiency. We designed an in vitro system to determine the influence bacteria have on soluble iron, manganese, and sulfate levels in Boyce Park Passive Remediation System located in southwestern Pennsylvania. Our in vitro studies suggested that iron oxidation was a result of biotic influences throughout this acidic system. We found a nitrate-dependent iron oxidation process that resulted in the removal of dissolved ferrous iron from the Boyce samples that relies on a symbiotic relationship between two different bacterial species. Our findings suggest that rapid cycling of nitrogen provides an alternative pathway for iron oxidation in acidic mine drainage. We have found two different sets of symbiotic bacteria capable of nitrate-dependent iron oxidation, suggesting this process is more widespread than previously thought. Future studies will continue to provide insight on the metabolic capabilities of the organisms growing in passive remediation systems and how they can be advantageous to system efficiency and longevity. [3]

Additional Key Words: Microbial Communities, Bioremediation, Passive Remediation Systems.

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2. Michelle M. Valkanas (* presenter), PhD Candidate, Taylor Rosso, Post-Baccalaureate, and Nancy J. Trun, Associate Professor, Biological Sciences, Duquesne University, Pittsburgh, PA 15282.
3. Work reported here was conducted at Boyce Park AMD Passive Remediation System (40.463740, -79.74855

EVALUATION OF PEAT SORPTION MEDIA FOR METAL REMOVAL FROM STORMWATER FROM A MINERAL PROCESSING FACILITY[1]

A.D. Vaslow*, C.L. Kairies-Beatty, P. Eger, P. Jones, and D. Green[2]

Abstract: Peat is commonly used in passive and semi-passive systems designed to treat mine drainage, industrial storm water and other wastewater where trace metal concentrations are above regulatory limits. Peat is known for its natural ability to remove metals through multiple mechanisms, including ion-exchange, surface adsorption, and complexation. American Peat Technology® (APT) developed a patented process whereby reed-sedge peat is converted into a hardened granular sorption media called APTsorb™, The hardened granule maintains the natural ability of the peat to remove both suspended and dissolved metals and increases the hydraulic conductivity of the media to about 0.5 cm/sec, comparable to coarse sand. . The purpose of this study was to evaluate removal of zinc (Zn), cadmium (Cd), copper (Cu), and lead (Pb), from stormwater obtained from a mineral processing facility using the media in a laboratory-scale up-flow column. The three-layer column (150 cm^3 empty bed volume) was constructed using 2 mm glass beads on the bottom, followed by 72 g media, and glass wool at the top, and pre-treated with 200 bed volumes (BV) of DI water (1 BV = 150 mL). Water was pumped uniformly through the column at a rate of 20 mL/min with a total run time of just over seven days. Effluent samples were collected in 125 mL HDPE bottles and sent to APT for analysis via atomic absorption spectroscopy (AAS). A total of 1344 bed volumes were treated. Influent concentrations of Zn (6814 µg/L), Cd (153 µg/L), Cu (3.42 µg/L), and Pb (177.1 ug/L) were reduced by up to 98.88%, 99.92%, 60.23%, and 98.93%, respectively. By the end of the run, initially high removal of Zn gradually decreased to about 50% and Pb removal remained around 99% throughout. Cd removal decreased to 78.05% by the end of the run and Cu removal fluctuated throughout the run, ranging from 57.89% to 73.86%. The column will be sampled, and the substrate will be analyzed for total metal content. Another column will be run to determine the maximum removal capacity of the media.

Additional Key Words: zinc, cadmium, lead, copper, ion-exchange, complexation, adsorption.

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2. Alex D. Vaslow (* presenter), Undergraduate Student and Candace L. Kairies-Beatty, Professor, Department of Geoscience, Winona State University, Winona, MN, 55987; Paul Eger, Environmental Engineer, Global Minerals Engineering LLC, Hibbing, MN 55746; Peggy Jones, Vice President Sales and Research, and Doug Green, President and CEO American Peat Technology, Aitkin, MN 56431.

PEAT MINE RESTORATION, NEW MONITORING TECHNOLOGIES, AND 5 YEARS OF PROGRESS AT THE SUPERIOR WETLAND BANK[1]

N. A. White*, D. Deuschle[2]

Abstract: Construction of the Lake Superior Wetland Bank was initiated in 2015 and is on the way to restore more than 23,000 acres of partially drained bog/fen habitat through permanent removal of a 65-mile ditch network. This includes 160 acres of a former peat mine, which was drained through a series of parallel ditching to allow for scraping, compressing, and excavation of surface peat material. Restoration of the peat mine is being achieved through filling the ditches with vegetation and soil native to the site, in conjunction with restoring overall site hydrology of the surrounding bog/fen. This leads to increased access challenges for ongoing monitoring. The use of drone technology to survey the restoration site, including the peat mine, is used to create a digital elevation model of the site. The drone survey data is also used to evaluate vegetation reestablishment for evaluating floristic quality. The pre-restoration conditions, regulatory process, construction methods, success criteria, and on-going results will be discussed along with lessons learned and adjustments to monitoring techniques.[3]

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2. Natalie A. White (*presenter), Sr. Biologist, Short Elliott Hendrickson Inc., Duluth, MN 55802 and Deric Deuschle, Aquatic Ecologist, Short Elliott Hendrickson Inc., St. Paul, MN 55110.
3. Work reported here was conducted near 47°12'03.2"N 92°33'48.6"W.

AN INTEGRATED METHOD TO ANALYSIS COAL MINING IMPACTS ON ECOLOGICAL ENVIRONMENT IN A SEMI-ARID AREA: A CASE STUDY IN NORTHERN CHINA[1]

Wu Xiao*, Xuejiao Lv, and Zhenqi Hu[2]

Abstract: The exploitation of coal resources affects the change of ecological environment. How the high-intensity coal mining area effect the ecological environment? How to make the coordinated development between resources exploitation and ecological environment protection? This paper takes the Shendong mining area whose coal production is 92.84% of that of United States in 2015 in the semi-arid region of northern China as an example to analyze and optimize the ecological environment considering the ecological vulnerability, ecological capital, and ecological security. The specific research content is as follows: (1) Constructing an overground-underground index system frame to delineate the ecological vulnerability areas and identify the main impactors for different zones; (2) Analyzing changes in ecological vulnerability and ecological capital in the study area from 2005 to 2015, and reveal the driven factors that affect eco-environment; (3) Considering of the core area extracted based on morphological spatial pattern analysis (MSPA), ecosystem services importance, and ecological risk index, combining the model of linking different ecological source grades to multi-process minimum cumulative resistance (multi-process MCRE model) and kernel density to analysis ecological security patterns and related reclamation strategy. The results show that the coal resource exploitation have an impact on the ecological environment, but it is not significant, and the main influence factors of ecological environment changes come from natural environmental factors in a regional scale. The proposed method provides a highly efficient, immediate, and accurate references for identifying, analyzing, and evaluating the ecological environment. The approach can not only facilitate sustainable development while preserving the integrity and stability of ecosystems but also suitable for global region to achieve the sustainability between resource exploitation, urban development, and ecological protection[3].

Additional Key Words: Ecological environment; Ecological vulnerability; Ecological capital; Semi-arid; Ecological security.

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2. Wu Xiao (*presenter), Professor, Land Management, Zhejiang University, Hangzhou, 310058; Xuejiao Lv, Ph.D. student, Survey and Mapping, China University of Mining and Technology, Beijing, 100083; Zhenqi Hu, Professor, Land Reclamation, China University of Mining and Technology, Beijing, 100083.
3. Work reported here was conducted near 32°13′00″－40°18′00″N, 108°55′30″－111°27′30″E.