

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF RECLAMATION SCIENCES

reclamation *matters*

Spring 2022



**A history of iron
mining in Minnesota**

**Breaking new ground at
Redhead Mountain Bike Park**

**Usibelli Coal Mine achieves
historic reclamation milestone**

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reclamation matters

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"Our projects focus on supporting regional conservation objectives on a landscape scale. Clients look to WES to provide environmental offsets for their projects - balancing natural resource protection with community growth."



Travis Hemmen,
President and General
Manager of WES



Get out!

BY TIM DANEHY, BIOMOST

It is with great optimism and excitement that this edition of *Reclamation Matters* has a schedule for our first Annual Meeting since 2019!

In the last issue, I pontificated on the need to ask 'Why?'; now my message is for you to get out!

One of my biggest regrets is that I didn't skip enough classes in college. Not that I think missing class is good thing but taking advantage of every chance to have a learning experience outside of the classroom, or the office, is a better thing. Getting out and having new experiences, meeting different people, and attending in-person meetings offer chances to learn the unintended.

The off-hand comment by a presenter, a conversation in the hallway, a pause before responding while sampling some tasty charcuterie with a colleague – these are the experiences I am talking about. Get out and see things. Get out and meet people.

Take advantage of technical tours. Yes, it will take you longer to get home. Yes, it will cost you another day in the hotel. And yes, you will learn something. It may not seem like a particular experience is directly related to what you want to learn, but the experience will benefit you, and what you share will benefit others.

As a small business owner, it becomes too easy to focus on checking the boxes, jumping when the client calls, dealing with the broken internet, figuring out the best way to hire a new engineer and have them work 100 percent remote. It is challenging. How do I have time to take a week off in mid-June? First cut hay is coming in! But I know the feeling of traveling home from the meeting will be like past years; actually, I am sure that it will be better than past years. The excitement of seeing the success of others and that spark of new ideas igniting a desire to try new things to make our work better.

I have made some mistakes, I have had to react to some challenging field conditions, and sometimes things worked better than expected. I look forward to sharing some of these experiences, and the data we collected along the way, in Duluth this June.

I hope that you will claim the time and come to Duluth this year and learn something new, and especially something you didn't think you would. 🌱

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CASE STUDY

Cibolo Creek Municipal Authority Lift Station Project: Cibolo, TX

Why is it so often the very last step that trips us up? Pesado Construction had finished their project for the Cibolo



1

Within one month Pesado Construction was able to close out their project due to quickly achieving excellent vegetation on the site. A year and a half later the site remained fully vegetated, a testament to the results that Biotic Earth can help ensure!

Creek Municipal Authority Lift Station behind the Cibolo, Texas police station, all they were waiting for was successful vegetation. They watered daily. They knew their seed was viable. Fertilizer was sufficient. And yet the area remained unvegetated after over a month of waiting. A soil test was pulled and showed that while the pH was fine at 7.8, the organic matter was extremely low at 1%, the lack of vegetation began to make sense.

ECBVerdyol recommended Biotic Earth to address the lack of organic matter, and the site was reseeded and covered with paper hydromulch for short term erosion control. Biotic Earth is an excellent option for increasing germination and expression of vegetation, and has been shown to increase plant mass by 419% per ASTM D 7322.

2



3

1: Before Installation, July 2018 (failed seeding done 5 weeks previously)
2: Biotic Earth Black being applied in July of 2018. No need to remove any existing vegetation with this product.
3: Full Vegetation was achieved quickly: August 2018. Just one month!



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Learning to teach, teaching to learn

BY JEFF SKOUSEN, WEST VIRGINIA UNIVERSITY

When I arrived at West Virginia University, I was required to teach the Reclamation of Disturbed Soils course that John Sencindiver and Richard M. Smith taught prior to my arrival. Being a new faculty member, the task of gathering all the information and preparing and developing the materials for 35 lectures was quite daunting. Fortunately, I had my notes from a reclamation class I took from Kirk Brown at Texas A&M a few years earlier, and John Sencindiver gave me his notes. Teaching the reclamation class for the

first time was exciting. With the aids and my own reclamation experiences in Oregon, Utah, and Texas, the class moved along pretty well; not always smoothly but with lots of enthusiasm. I still teach this class today, and it has improved significantly over 35 years!

I realized I would not obtain tenure and promotion at WVU unless I taught additional classes even though I was not required to do so. My department chair and I decided that I should teach the Principles of Soil Science course, which had been taught by Everett Jencks, who

was retiring. This was a different matter for me, and the amount of labor would be significant because I hadn't taken a basic soils course since 1978 (12 years prior to this), nor did I have materials from which to build the course (Everett did not use notes!). There was no internet nor online courses available then, so my best course of action was to purchase a couple of basic Soil Science textbooks from which to develop my lecture notes. So, I dug in, pun intended.

The first semester I taught this course was a scorching trial, and it nearly

buried me. While I knew a lot about soils and had taken several soils courses over the years, this was not my major emphasis in school. And there were significant gaps in my knowledge of soils, especially topics in soil genesis and classification, and soil chemistry and mineralogy. The class enrollment was around 120 students from a variety of majors, and I found it challenging to keep their interest and convey the material in an engaging way. Without lesson materials, I was scrambling to stay ahead of the students by preparing lectures from textbooks almost right up until I walked into the class each period. After completing the lecture, I had to start preparing the next lecture. I was also teaching my reclamation class, and I had other research and service and consulting duties. The effort and energy to learn the material so I could teach was exhausting. It was one of the more

difficult assignments I had ever had, but it greatly increased my knowledge of soils, and I gained so many valuable lessons about teaching and learning.

One of the things I learned was that the level of knowledge I gained to teach this soils course was exhilarating and built my self-confidence. Learning a subject as a student brings understanding, but teaching that same subject brings *mastery*. The actions of preparing lessons, composing explanations, and presenting the material expanded my knowledge well beyond anything I anticipated. By teaching the course, I obtained a deeper understanding of the soil topics and was constantly thinking of new and innovative ways to teach this material, and in turn was teaching myself. This transformation happens to anyone who teaches another person and who desires to teach the material better and in a different way.

As we contemplate various ways and perspectives to teach a principle, this knowledge becomes part of our consciousness, and it is refined and clarified. Teaching benefits both students and teachers, and it always seems that the teacher learns more than the students.

Even if you are not a professor who teaches formal classes, all of us have opportunities to teach and relay our knowledge to others in a variety of settings. Those who are professionals with expertise must hear the call to teach those who are less experienced. As you share knowledge with others, you will simultaneously learn. We can be life-long learners as we teach.

Appreciation is extended to William Monroe for the ideas presented here and to James Thompson for editorial help and suggestions. 🌱



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Early Career Professionals update

BY HANNAH PATTON, VIRGINIA TECH

Dear ASRS Members,

I would like to thank the ASRS members, students, and Early Career Professionals (ECPs) who joined us for our ECP virtual trivia night in Fall of 2021! During the event, ECPs, students, and our more seasoned ASRS members were split into teams. After getting to know each other, teams worked together to answer trivia questions about sports, pop culture, science, and reclamation. The virtual trivia night was a success, and we had good participation from the ASRS community, as well as students/ECPs interested in joining ASRS. We are looking forward to future ECP networking events in 2022 including the Early Career Professionals event at our 2022 Annual Meeting in Duluth, MN (June 12th – June 16th). Register now to reserve your spot!

As my term as NEC ECP Representative comes to a close in June, I want to



extend my sincere gratitude to the ASRS community and the NEC board for the support and guidance over the last two years. I have enjoyed my term immensely. In addition to learning about leadership, professionalism, and the inner

workings of a national organization, I was able to meet many people in the ASRS community, and I am thankful for the relationships that I have fostered over the last two years. I look forward to participating in the ASRS community in the future, and I look forward to seeing what our next NEC ECP Representative, Allen Wellborn, accomplishes during his tenure. In the meantime, please feel free to reach out to me with any questions or concerns relating to students or ECPs (hpatton@vt.edu). 🌱

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ASRS Haulin' ASRS

Who/What:

Anyone attending the conference is welcome and encouraged to meet up for a social pace run or walk to enjoy the sites and scenery Duluth has to offer. The Lakewalk along Canal Park is one of the must-see recreation areas in Duluth. A short distance from the Duluth Entertainment Convention Center, the area will be an excellent place to get some exercise prior to conference proceedings each day. Some people stay with the group for part of the run and then branch off to go faster, farther or slow down. Some years we have a running group, a walking group, and a fast-paced training group. These morning activities are a wonderful way to network, catch up with old friends, and get some exercise. Remember to bring your walking or running shoes!

Where/When:

Meet at 6:30 a.m. at the Arena Waterfront Park (south corner of the Convention Center adjacent Little Sister of Liberty), Monday June 13th through Thursday June 16th during the conference.

Contact: Dan Guy dan@biomost.com 🌱

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To: All women involved in reclamation are invited; feel free to bring a colleague!

When: 7:00 - 8:15 a.m., Tuesday, June 14th.

Where: Duluth Entertainment Convention Center (French River Room).

Wild Women of Reclamation (WWR) originated in Laramie in 2013 as an idea of Brenda Schladweiler. WWR became an integral part of the agenda at the 2014 national meeting of the former American Society of Mining and Reclamation, now rebranded as the American Society of Reclamation Sciences. Participants meet at a kickoff breakfast before morning technical sessions at the beginning of the conference. Every woman is welcome. We have a few presentations, some networking, get to meet new attendees and catch up with life with old friends! Presentations in the past have covered choosing your own path, mentoring, starting your own business, and juggling a research career with family and community obligations. The presentations have one theme in common: adaptability. We are invigorated by the successes of our colleagues. Feedback from

participants at the breakfast meeting and after indicated that those participants just starting their careers appreciated the honest feedback on “how it used to be” and “how it still is” but also in what we can accomplish.

To keep the energy going throughout the year, we divide the group into “more experienced” individuals (i.e., greater than five years in your career) and “less experienced” (i.e., less than five years). One person from each group is paired with one from the other group. Those mentors and “mentorees” are then given the assignment to keep in touch with each other throughout the coming year. This is an easy way to build up contacts, bounce off ideas and to learn about other careers. We also have a newsletter that, pre-pandemic, went out several times a year, or as often as we got stories. The content is a way to inform and to share. After the first newsletter went out, we had many requests from women not yet members of ASRS to be added to the circulation list. Please keep those stories coming!

This will be the seventh annual WWR meeting at ASRS. We will continue this tradition by meeting Tuesday morning at 7:00 a.m., so please join us. We are lining up two more incredibly inspirational women speakers on the agenda. So far, Dr. Abbey Wick, Assistant Professor, Extension Soil Health Specialist at North Dakota State University, has confirmed her speaking engagement. Abbey has a way of making soil science very interesting – just check out her videos on <https://www.youtube.com/watch?v=GZ7ypBybI7k>. We hope to announce the second speaker in the very near future!

There is no membership to Wild Women of Reclamation – just camaraderie and networking! We will have a light breakfast of coffee/ tea/ muffins, so just come on over to the Convention Center on Tuesday June 14 at 7 a.m. and join us! If you end up arriving late for whatever reason, still come on into the room. We will be there until 8:15 a.m. We look forward to seeing as many of you that can make it. Feel free to bring a friend or new colleague.

Contacts:

- Cindy Adams: cadams517@gmail.com (co-chair)
- Rachel Hohn: rachelhohn@gmail.com (co-chair)
- Brenda Schladweiler: BSchladweiler@bksenvironmental.com (advisor) 🌱



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The 39th Annual Meeting of the American Society of Reclamation Sciences (ASRS) is June 12-16, 2022, in Duluth, MN. This conference will focus on the research, technical, and regulatory issues associated with the land and water implications of anthropogenic land disturbances. It will provide a forum for the dissemination of information through presentation of research findings, field tours, and open discussion of public policy relating to the applied science of reclamation, rehabilitation, remediation, and restoration of areas disturbed by mining, oil and gas, conventional and alternative energy production, contaminated sites, agriculture, road construction, large-scale commercial development, and other disturbances to land and water resources.

ASRS National Meeting Safety Protocols

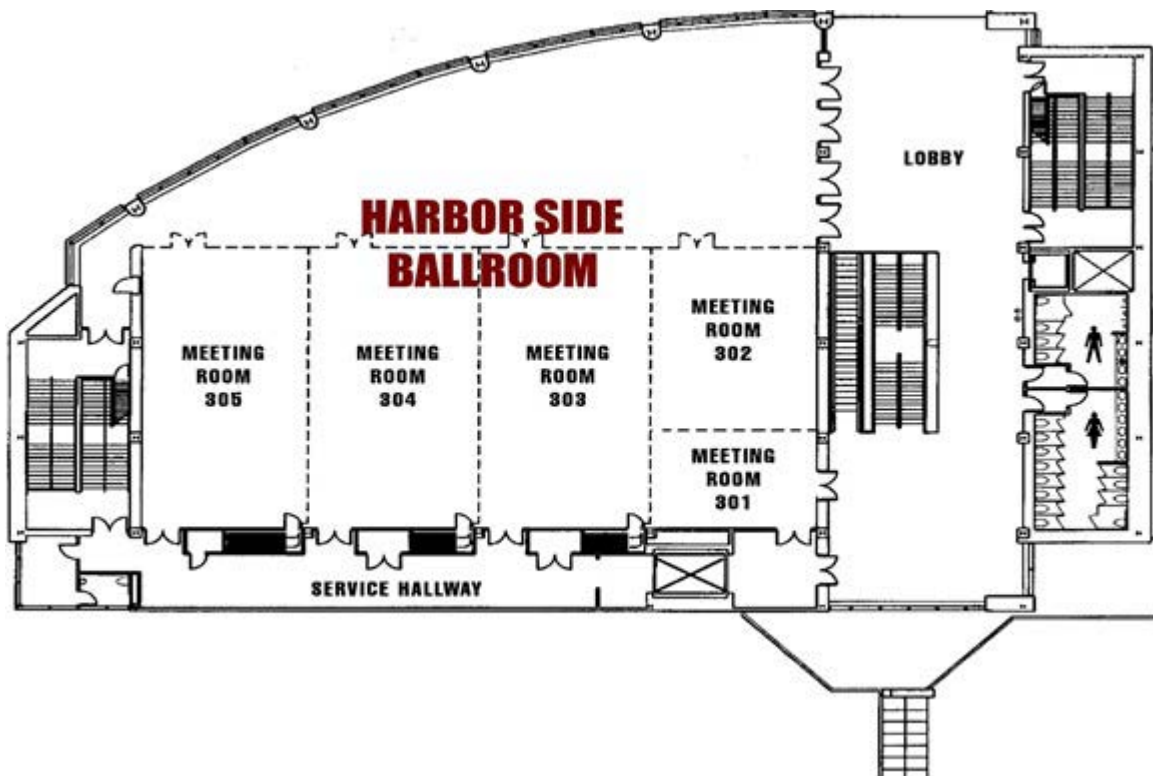
COVID-19 and its variants continue to add uncertainty to travel and public gatherings, which complicates safely and successfully conducting an in-person meeting this year. The ASRS leadership, the National Executive Committee (NEC) has approved moving forward with our Annual Meeting as scheduled. While we are excited to be able to gather in-person this year, we want to emphasize that the health and safety of our attendees is paramount. Consequently, in addition to following all US Centers for Disease Control and Prevention guidelines and locally mandated safety protocols, the NEC voted to require attendees to wear a mask and show proof of vaccination, a card or a photo of your card, at the registration desk. Also, please consider getting a booster in addition to your basic vaccinations. We will continue to track local and federal policies in making determinations for masks as the meeting date approaches. The COVID situation is fluid, so we will continue to update you as our meeting nears. In the meantime, please stay safe. We look forward to seeing you in Duluth.



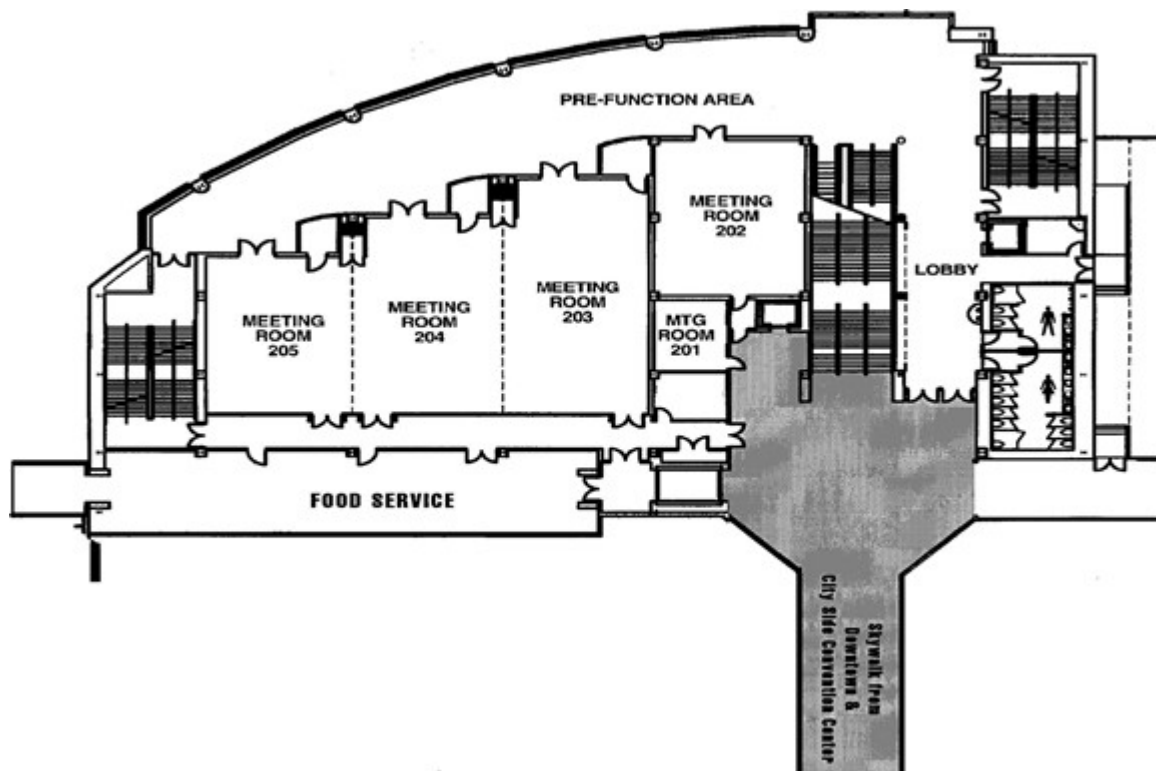
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For updates and more detailed information of the meeting go to:

<https://www.asrs.us/2022-annual-meeting/>

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MINNESOTA DEPARTMENT OF IRON RANGE
RESOURCES & REHABILITATION



TETRA TECH



SHORT ELLIOT HENDRICKSON



OFFICE OF SURFACE MINING RECLAMATION AND
ENFORCEMENT

EARLY CAREER PROFESSIONAL EVENT



ANONYMOUS DONOR



VIRGINIA TECH
COLLEGE OF AGRICULTURE AND LIFE SCIENCES

Sunday June 12, 2022

| | | |
|------------------------|-------|---|
| 8:00 a.m. - 5:00 p.m. | ----- | Registration - Harbor Side Lobby |
| 10:00 a.m. - 5:00 p.m. | ----- | Exhibitor Setup – Harbor Side Ballroom Foyer |
| 4:30 p.m. - 6:00 p.m. | ----- | NEC Lunch/Meeting – Meeting Room 202 |
| 6:00 p.m. - 8:00 p.m. | ----- | Welcome Reception – Harbor Side Ballroom Foyer |
| All Day | ----- | ASRS Office – Meeting Room 201 |

SUNDAY JUNE 12, PROFESSIONAL TOURS



Taconite (Full Day)

7:30 a.m. - 4:00 p.m. - Professional Tour #1

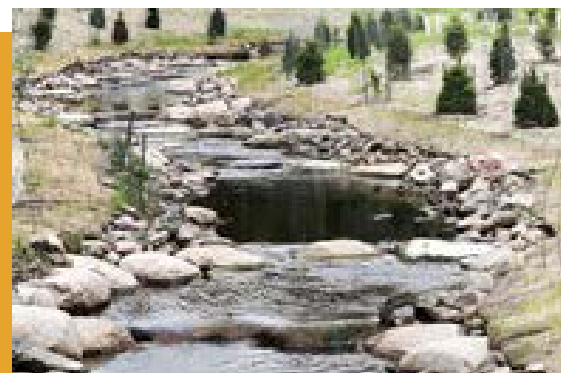
Take in Minnesota's Iron Range mining district at the newly renovated Hibbing Mine View overlooking the Hull Rust Mahoning Mine complex, the "Grand Canyon of the North." From the unique 360° vantage point, one can see the evolution of reclamation on the Iron Range. One of these sites is United Taconite's tailings basin, which has been reclaimed to productive use as farmland, wetland, and a hybrid poplar stand. Another is Hibbing Taconite's 5036 stockpile, an innovative,

proactive reclamation site that will become the future pit lake's littoral zone. In Hibbing, we'll also stop at the Minnesota Department of Natural Resources mine reclamation research facility, home to field- and pilot-scale reclamation demonstration projects and Minnesota's exploration drillcore library. We will visit the Redhead Mountain Bike project to view the development of off-road trails on mined land and the Minnesota Museum of Mining.

PolyMet and Giant's Ridge (Full Day)

7:30 a.m. - 4:00 p.m. - Professional Tour #2

The former LTV Steel Mining Company site is home to Minnesota's first permitted Cu/Ni +/- PGE project. PolyMet's Northmet deposit is situated adjacent to the Iron Formation, and features of the site include the former mill which will be repurposed for mining. The partially reclaimed tailings basin has since become wildlife habitat and work to study those populations is ongoing. The tour will also cover the future Cu/Ni project plans, including planned operational and reclamation activities. We will also make stops near Giant's Ridge, a year-round ski and gold recreational destination in Northern Minnesota, which includes the Quarry, a golf course built on a former iron mining property. We'll visit the restored creek area near the facility, which was scoured after the Hector mine pit lake overtopped its spillway in 2017.



For descriptions of Professional Field Tours, please visit <https://www.asrs.us/2022-annual-meeting/>

Monday June 13, 2022

6:30 a.m. - 7:30 a.m. ----- **Haulin' ASRS - Meet at Hampton Inn Lobby**

The ASRS Running group, meets every morning. From the Hampton Inn run will go up to Gichi-Ode' Akiing (Lake Place Park) and get onto the Lakewalk.

7:00 a.m. - 8:30 a.m. ----- **Breakfast - Harbor Side Ballroom**

7:30 a.m. - 5:00 p.m. ----- **Registration - Harbor Side Lobby**

9:00 a.m. - 5:00 p.m. ----- **Exhibitor Displays - Harbor Side Ballroom Foyer**

9:00 a.m. - 6:00 p.m. ----- **Silent Auction opens - Meeting Room 202**

10:00 a.m. - 12:00 noon ----- **Cultural Event #1 - Vista Boat Tour (~2 hours)**

9:00 a.m. - 10:00 a.m. ----- **Plenary Session - Harbor Side Ballroom**

Mehgan Blair - Conference Chair - Welcome

Tim Danehy - ASRS President - President's Welcome and Keynote Address

Dr. Robert Darmody - ASRS Executive Director - Welcome & Announcements

10:00 a.m. - 10:30 a.m. ----- **Keynote Speaker**

Pete Kero - Vice President, Barr Engineering Company

Mineland Reclamation on Minnesota's Iron Range: Five Generations of Innovation

10:30 a.m. - 11:00 a.m. ----- **Break - Harbor Side Ballroom Foyer**

11:00 a.m. - 12:00 noon ----- **Keynote Speakers**

Melissa Sjolund - MN Department of Natural Resources St. Louis River Restoration Initiative
Remediation, Restoration, and Revitalization in the St. Louis River Area of Concern

Dan Powell - Chief of the Technology Integration and Information Branch, U.S. Environmental Protection
Agency's Office of Land and Emergency Management will provide an update federal reclamation initiatives.

Chris Lenhart - President, Midwest - Great Lakes Chapter for Ecological Restoration
Discussion of International Reclamation Standards

12:00 noon - 2:00 p.m. ----- **AWARDS LUNCHEON / ASRS BUSINESS MEETING**

2:30 p.m. - 5:30 p.m. ----- **Technical sessions - Harbor Side Meeting Rooms
203-205**

6:00 p.m. - 9:00 p.m. ----- **Social Dinner at Pier B Waterfront Resort**

Monday June 13, Technical Sessions

| | TREATMENT WASTES (Session 1A) Harbor Side Room 203 | VEGETATION: DEVELOPING TECHNIQUES (Session 1B) Harbor Side Room 204 | SOILS AND SPOILS (Session 1C) Harbor Side Room 205 |
|--|---|--|---|
| 2:00 p.m. - 2:30 p.m. | Assessing Fate and Potential Reuse of Hard Rock Mine Drainage Passive Treatment Residual Solids Justine McCann* | Reducing Seed Dormancy in Southern-Adapted Native Forage Grasses Brian Baldwin | Forest Soil Response Three-Years After Aerial Liming Application in West Virginia Loren Gormley* |
| 2:30 p.m. - 3:00 p.m. | Determination and Prediction of Rare Earth Element Geochemical Associations in Acid Mine Drainage Treatment Wastes Robert Hedin | Development of Locally Adapted Native Germplasms for Commercial Use Anthony Falk | Effect of Forest Reclamation Approach Practices on Soil Water Chemistry Amir Hass |
| 3:00 p.m. - 3:30 p.m. | Using "Big Science" to Evaluate Metal Removal Brandy Stewart | Seed-Spec: A Native Seed Blend Development Tool Rob Cook | Scram Tailings Mineland Reclamation 3-year Case Study and Recommendations Allyz Kramer |
| 3:30 p.m. - 4:00 p.m. BREAK - Harbor Side Ballroom Foyer | | | |

| | RECLAMATION REGULATIONS (Session 2A) Harbor Side Room 203 | VEGETATION: DEVELOPING TECHNIQUES (Session 2B) Harbor Side Room 204 | SOILS AND SPOILS (Session 2C) Harbor Side Room 205 |
|-----------------------|--|---|--|
| 4:00 p.m. - 4:30 p.m. | Enforcement of surface coal mine rules and regulations, case study (Wyoming, USA) Anna Waitkus | Discovery of Australian Native Hyperaccumulator Plants for Developing Phytoremediation Applications Farida Abubakari* | Short and Long-term Groundwater Impacts Associated with the Reclamation of Acid-Water Seeping Historical Tailings in the Central and West Rand Basins, South Africa Robel Gebrekristos |

Monday June 13, Technical Sessions (Continued)

| | | | |
|-----------------------|--|--|--|
| 4:30 p.m. - 5:00 p.m. | Development of International (ISO) Standards for Mine Reclamation | Bamboo as a Potential Option for Land Reclamation and Restoration | Field Testing of Geomorphic Landform Design Features in Central Appalachia |
| | Lee Daniels | Apsana Kafle* | Iuri Lira Santos* |
| 5:00 p.m. - 5:30 p.m. | An Argument for Long-Term Care and Maintenance at Reclaimed Mine Sites | Planning, Implementation, and Analysis of Success in Revegetating Lignite Mines in Texas | |
| | Peter Werner | Jeremiah McKinney | |

*Indicates Student Presentation

MONDAY JUNE 13, CULTURAL EVENTS



Social Event and Dinner

6:00 p.m. - 9:00 p.m.

Join us for a catered dinner and drinks on the lakefront grounds of the Pier B Resort. We'll enjoy appetizers and cocktails on the rooftop deck while the lakers come through the iconic Aerial Lift Bridge on their way to load with taconite pellets. The beautiful waterfront views await you.

Vista Boat Tour

10:00 a.m. - 12:00 noon - Cultural Event #1

Enjoy Duluth's Waterfront Tour by hopping on the Vista Star!



Tuesday June 14, 2022

| | | |
|-----------------------|-------|---|
| 6:30 a.m. - 7:30 a.m. | ----- | Haulin' ASRS - Meet in Hampton Inn Lobby |
| 7:00 a.m. - 8:15 a.m. | ----- | Wild Women of Reclamation – Rooftop Deck (weather-permitting) |

Participants meet before the morning talks. Every woman is welcome. Presentations in the past have dealt with choosing your own path, mentoring, starting your own business, and juggling a research career with family and community obligations. Coffee, tea, and pastries will be provided.

| | | |
|------------------------|-------|--|
| 7:45 a.m. - 8:30 a.m. | ----- | Reclamation Sciences Editorial Meeting – Meeting Room 202 |
| 8:00 a.m. - 5:00 p.m. | ----- | Exhibitors – Harbor Side Ballroom Foyer |
| 8:00 a.m. - 6:00 p.m. | ----- | Silent Auction – Meeting Room 202 |
| 7:30 a.m. - 5:00 p.m. | ----- | Registration – Harbor Side Lobby |
| 9:00 a.m. - 12:00 noon | ----- | Cultural Event #2 Glensheen Mansion Tour |

Tuesday June 14, Technical Sessions

| | WATERSHED CHARACTERIZATION AND RESTORATION (Session 3A) Harbor Side Room 203 | PARTNERS IN RECLAMATION (Session 3B) Harbor Side Room 204 | VEGETATION: DIVERSE PERSPECTIVES (Session 3C) Harbor Side Room 205 |
|---|---|--|---|
| 8:30 a.m. - 9:00 a.m. | Analyzing Floodplain Reconnection as a Restoration Method Natalie Kruse Daniels | Teaching Young and Old Pups New Tricks Terry Toy | A "Two-Roads Approach" Evaluation of Oil Sands Mine Closure Plans for Traditional Land Uses Christine Daly* |
| 9:00 a.m. - 9:30 a.m. | Effects of the Palmiter Method, Adapted to Protect Infrastructure, on Stream Health Jonathan Viti* | Keeping the Research Relevant Lee Daniels | Indigenous Led Environmental Monitoring, Trends, and Best Practices Across Canada Alexandra Post* |
| 9:30 a.m. - 10:00 a.m. | Evaluating the Water Quantity and Quality of Mine Drainage Discharges in a Hydrologically and Topographically Challenging Location Nick Shepherd* | Industry Applying Multiple Minds at the Mine Sarah Flath | Abundance of Lichens and Mosses on the Restored Landscape in the Nickel-Copper City of Greater Sudbury, Ontario, Canada Peter Beckett |
| 10:00 a.m. - 10:30 a.m. BREAK - Harbor Side Ballroom Foyer | | | |

Tuesday June 14, Technical Sessions

WATERSHED CHARACTERIZATION AND RESTORATION (Session 4A) Harbor Side Room 203

PARTNERS IN RECLAMATION (Session 4B) Harbor Side Room 204

REFORESTATION (Session 4C) Harbor Side Room 205

10:30 a.m. - 11:00 a.m.

Spatial Variations in Trace Metal Concentrations in Stream and Reservoir Sediments Downstream of the Tri-State Mining District, USA

Carlton Folz*

Extension Ain't Your Grandpa's Program Anymore

Abbey Wick

Forest restoration on the exposed sediments along the Elwha River: assessing riverbank lupine's (*Lupinus rivularis*) influence on conifer growth, vegetation, and mycorrhizal fungi

Jenise Bauman

11:00 a.m. - 11:30 a.m.

Evaluating Sources, Mass Loadings, and Fate of Total and Dissolved Metals to Prioritize Restoration in a Mining-Impacted Watershed

Robert Nairn

Consulting Approaches Considering Multiple Partners

Brenda Schladweiler

Bringing Back the Forest: Reforestation Provides Climate Mitigation Opportunities for Mining Regions of the World

Christopher Barton

11:30 a.m. - 12:00 noon

Water Quality of Reclaimed Mountaintop Removal Valley Fill Mine Site 15 Years After Final Reclamation - An Unexpected Remedy

Amir Hass

Partnerships in Reclamation

Abbey Wick

Overcoming Arrested Succession and Invasive Species on Older Reclaimed Surface Mines

Jennifer Franklin

12:00 noon - 1:30 p.m. LUNCH

RECLAMATION INNOVATIONS (Session 5A) Harbor Side Room 203

TEACHING IN RECLAMATION (Session 5B) Harbor Side Room 204

ADVANCEMENTS IN RECLAMATION TECHNOLOGIES (Session 5C) Harbor Side Room 205

1:30 p.m. - 2:00 p.m.

Applied Research: Biogeochemical Response of PAG Mine Waste to Bactericides and Vegetation

James Gusek

Teaching Reclamation in Honors: Engaging Students with Diverse Majors and Prior Coursework

Kenton Sena

Characterizing Subsurface Heterogeneity on Gold Post-Mining Sites

Adegbite Adesipo*

2:00 p.m. - 2:30 p.m.

Sorption of Metals from Mining Polluted Water Bodies and Reusability in Land Reclamation Using Hydrochar

Benjamin Quardey*

Using Experiential Learning in an Upper-Level Forestry Class to Teach Reclamation Techniques

Jennifer Franklin

Peat Mine restoration, New Monitoring Technologies, and 7 Years of Progress at the Superior Wetland Bank

Natalie White

| | | | |
|-----------------------|--|--|--|
| 2:30 p.m. - 3:00 p.m. | Evaluation of Peat Sorption Media for Metal Removal from Stormwater from a Mineral Processing Facility Paul Eger | "Reclamation of Disturbed Soils" - A West Virginia University Senior-Level Course Jeff Skousen | Using sUAS for the Development and Validation of Surface Water Quality Models in Optically Deep Mine Waters Brandon Holzbauer-Schweitzer |
|-----------------------|--|--|--|

3:00 p.m. - 3:30 p.m. BREAK - Harbor Side Ballroom Foyer

| | RECLAMATION INNOVATIONS (Session 6A) Harbor Side Room 203 | TEACHING IN RECLAMATION (Session 6B) Harbor Side Room 204 | ADVANCEMENTS IN RECLAMATION TECHNOLOGIES (Session 6C) Harbor Side Room 205 |
|-----------------------|--|---|---|
| 3:30 p.m. - 4:00 p.m. | Advances in the Electro-Biochemical Reactor Design for Denitrification Ola Opara | Teaching Reclamation Through Applied Curricular and Co-Curricular Experiences Natalie Kruse Daniels | Prioritization of Site Selection for Subsidence Mitigation of Abandoned Mine Lands Using GIS and Attribute Criteria Hierarchy Henry Plendl |
| 4:00 p.m. - 4:30 p.m. | Heavy Metal Recovery Using Manganese-oxidizing Microbes and Recycled Carpet Fiber Brandy Stewart | Eighteen Years of Natural Infrastructure Research Partnerships through the Center for Restoration of Ecosystems and Watersheds at the University of Oklahoma Robert Nairn | Implementation of an Enterprise Geographic Information System (GIS) for Abandoned Mine Land Reclamation Project Data Collection and Efficiency of Client Reporting Henry Plendl |
| 4:30 p.m. - 5:00 p.m. | Opportunities for Carbon Sequestration in Mined Materials Joel Bandstra | Translating International Experience to Graduate School Apsana Kafle* | Drone Use Along with Spatially Balanced Sampling and Route Optimization for Rapid Monitoring of Reclaimed Areas Michael Curran |
| 5:00 p.m. - 5:30 p.m. | Case-Study - The Gladden Acid Mine Drainage (AMD) Treatment Facility Project Eric Cavazza | My Experience as a MSC Candidate Studying Reclamation Keana Trudel* | Remote Sensing and Benefits for Abandoned Mine Subsidence Investigation and Mitigation Ike Isaacson |

*Indicates Student Presentation

TUESDAY JUNE 14, EVENTS

Poster Session and Networking Event

5:30 p.m.- 7:30 p.m. - Harbor Side Ballroom Foyer

Poster presentations will be on display with authors after the technical sessions finish.

Film Festival

7:30 p.m. - 9:00 p.m.

Join us for the Second Annual ASRS Film Festival. We will bring reclamation-related topics to you via short (~5-15 minute) films highlighting exciting and intriguing reclamation projects. Awards will be presented to the best in show in Pro and Non-Pro Categories, classic movie theater snacks will be provided.

Glensheen Mansion Tour

9:00 a.m. - 12:00 noon - Cultural Event #2

See the gilded-age historic Congdon estate in detail! Chartered transportation to Glensheen is included.



Wednesday June 15, 2022

| | | |
|------------------------|-------|--|
| 6:30 a.m. - 7:30 a.m. | ----- | Haulin' ASRS - Meet in Hampton Inn Lobby |
| 7:30 a.m. - 8:30 a.m. | ----- | Student Breakfast – Rooftop Deck (weather permitting) |
| 7:30 a.m. - 5:00 p.m. | ----- | Registration – Harbor Side Lobby |
| 8:00 a.m. - 5:00 p.m. | ----- | Exhibitors – Harbor Side Ballroom Foyer |
| 8:00 a.m. - 11:00 a.m. | ----- | Silent Auction – Winners announced at lunch |
| 12:30 a.m. - 2:30 p.m. | ----- | Cultural Event #3 - North Shore Scenic Railroad Train Excursion |

Wednesday June 15, Technical Sessions

| | PASSIVE TREATMENT: PAST, PRESENT, FUTURE (Session 7A) Harbor Side Room 203 | BETTER LIVING THROUGH DESIGN AND CONSTRUCTION (Session 7B) Harbor Side Room 204 | SOIL HEALTH: IMPACT ON VEGETATION (Session 7C) Harbor Side Room 205 |
|---|--|---|--|
| 8:30 a.m. - 9:00 a.m. | Early Discoveries and Development of Passive Treatment Systems Jeff Skousen | Abandoned Coal Mine Mitigation in High Pressure Artesian Conditions Josh Zimmermann | Beneficial Use of Dredge Sediment for Reclamation of Mining Sites Marsha Patelke |
| 9:00 a.m. - 9:30 a.m. | Mine Drainage Co-Treatment in Municipal Wastewater Sequencing Batch Reactors Charles Spellman* | Design and Construction of Barrier Berms Using Innovative Reclamation Techniques to Benefit Mineland Operational Safety and Community Viewshed Joel Asp | An Examination of Pipeline Site-Preparation Methods for Improving Plant Establishment Jarrett Lardy* |
| 9:30 a.m. - 10:00 a.m. | The Use of Solar-Powered Float-Mix Aerators to Increase Iron Retention in Topographically Limited Passive Treatment Oxidation Ponds Dayton Dorman* | Techniques and Challenges for Material Stabilization within Historically Mitigated Underground Abandoned Coal Mines Joel James | Calcium Acetate: An Alternative for Gypsum in Improving Water Flow in Oilfield, Brine Impacted Soils Annalie Peterson* |
| 10:00 a.m. - 10:30 a.m. BREAK - Harbor Side Ballroom Foyer | | | |

Wednesday June 15, Technical Sessions

**PASSIVE TREATMENT: PAST,
PRESENT, FUTURE
(Session 8A)**
Harbor Side Room 203

**BETTER LIVING
THROUGH DESIGN AND
CONSTRUCTION
(Session 8B)**
Harbor Side Room 204

**SOIL HEALTH: IMPACT ON
VEGETATION
(Session 8C)**
Harbor Side Room 205

10:30 a.m. - 11:00 a.m.

Passive Removal of
Mn from Mine Water
by Heterogeneous Mn
Oxidation

Robert Hedin

Mitigation of Rock Springs
No. 9 Mine Below Pipeline
Utility Corridor

Ryan Reed

Vegetation Response to
Surface Soil Undulation
Height

Gwen Geidel

11:00 a.m. - 11:30 a.m.

Passive Treatment of
Manganese-Bearing
Postmining Discharge

Tim Danehy

Converting a Former Mine
to a Winter Wonderland

Dale Kolstad

Mine Soil Health on 2- to
32-Year-Old Reclaimed
Pasturelands

Jeff Skousen

11:30 a.m. - 12:00 noon

Treating Extreme Acid
Mine Drainage with
Passive Techniques

Shaun Busler

Alaskan Active Coal Mine
Reclamation - Two Bull
Ridge

Rich Sivils

Superfund Remediation at
Tar Creek

Summer King

12:00 noon - 1:30 p.m. LUNCH & STUDENT AWARDS - Harbor Side Ballroom

*Indicates Student Presentation

WEDNESDAY JUNE 15, CULTURAL EVENT



North Shore Scenic Railroad Train Excursion

12:30 p.m. - 2:30 p.m. - Cultural Event #3

Ride the Duluth Zephyr, which brings you through downtown Duluth, a little way up the North Shore, through Congdon Park, and to the neighborhood of Lakeside for spectacular lake viewing.

WEDNESDAY JUNE 15, EVENTS

NEC Wrap-Up Meeting

4:00 p.m. - 6:00 p.m. Meeting Room 202



After Lunch: Field Trip - Duluth Stream Reconstruction

In 2012, Duluth experienced a two-day, 500-year rainfall event that flooded the creeks running through Duluth's hillside and resulted in millions of dollars of infrastructure damage. Many of these creeks were subsequently restored and are some of the city's most beautiful features and are accessible by hiking trails. You will be able to follow along with maps and materials to take a look at these restoration projects. Allow 2+ hours.

6:00 p.m. - 9:00 p.m. - EARLY CAREER PROFESSIONAL EVENT: HOOPS BAR

This event will bring together early career professionals and experienced professionals for valuable mentorship. The event will include food, beverages, and fun ways for early career professionals and mentors to interact.



HOOPS
BREWING



WEDNESDAY JUNE 15, WORKSHOPS

Mine Subsidence Workshop

1:30 p.m. - 5:00 p.m. Harbor Side Rooms

The workshop will be broken down into a more in-depth study of land subsidence from the underground mining of coal. It will cover key aspects of mine subsidence, a subject that is not well understood, and embraces several engineering disciplines. The workshop focuses on the causes of mine subsidence and how mine stability relates to the resulting ground movements. Different mining and geologic conditions determine the mode of failure of the mine. The mode of mine failure in turn affects the resulting subsidence movement and consequently the resulting damage. Prediction of subsidence and damage potential and mitigation alternatives are also key aspects of subsidence engineering. Workshop outline consists of causation and risk of subsidence, subsidence movement, and the effect of these movements on structures and pipelines. Also, in the last portion of the workshop, subsidence mitigation alternatives will be discussed. After each section of the workshop, there will be a question-and-answer period. This workshop will be presented in a manner that will be understandable to anyone that would be interested in learning more about mine subsidence engineering. Handouts will be provided.



Instructor Bio: Dr. Gennaro G. Marino has a Ph.D. in Civil Engineering from the University of Illinois. His thesis involved mine subsidence and structural response over room and pillar mines. He presently is a licensed P.E. in 27 states. He has authored numerous articles on subsidence and has received multiple awards for his work, expertise, ethics, and professional development. His work spanning over 40 years includes all aspects of subsidence engineering with government agencies, engineering and architectural firms, surface owners, pipeline, insurance, and mining companies, including planning, mining, and abandonment stages of room and pillar to high extraction workings, and cause and origin investigations

WEDNESDAY JUNE 15, WORKSHOPS

GeoFluv Approach to Fluvial Geomorphic Reclamation Workshop

1:30 p.m. - 5:00 p.m. Harbor Side Rooms

Fluvial geomorphic landform design has become recognized globally as a reclamation best practice. Functional fluvial geomorphic design is more than just bending contours to 'look natural' and this workshop will explain how to design fluvial geomorphic reclamation correctly to get the desired results. Participants will get an overview of the geomorphic elements that comprise functional reclamation landform design and an explanation of how these elements are measured from reference areas for design input. We will discuss common errors that are made in the design and construction of fluvial geomorphic reclamation projects. How a multi-year quantitative study documented sediment yield comparable to adjacent undisturbed natural land in the most erosive environments was used to validate constructed reclamation performance will be presented. GeoFluv is a patented reclamation landform design method that is the basis for the Natural Regrade CAD software that helps designers make these complex designs efficiently. Participants will have the opportunity to apply these concepts to make a fluvial geomorphic design for a stream channel and a waste dump landform using the Natural Regrade CAD software.



Instructor Bio: Nicholas Bugosh is the inventor of GeoFluv upon which Natural Regrade is based (OSM TIPS core software). He has conducted field research on bedload transportation, worked for numerous state agencies, and with mining and water quality regulation, been a hydrologic consultant on projects across the U.S., and was Senior Hydrologist for the largest mining company in the world. His fluvial geomorphic method has received numerous awards and has been recognized by U.S. states and the European Union as Best Technology Currently Available. He formed the company GeoFluv in 2009 to provide training, coaching, and consulting services in his method and he is the GeoFluv Technical Director for Carlson Software.

THURSDAY JUNE 16, PROFESSIONAL TOURS



Peat Mining and Reclamation (Full Day)

8:00 a.m. - 5:00 p.m. - Professional Tour #3

This tour heads south and west out of Duluth to visit active peat mining sites that undergo progressive wetland reclamation. We'll see the novel harvesting equipment and bagging operations along with reclaimed wetland sites at the Premier Peat and American Peat Technology sites. We'll also have lunch in Tamarack, where Talon Metals has been actively exploring a high-grade Cu/Ni+PGE deposit. Last, we'll stop to look at some unique geology and beautiful

views at Jay Cooke State Park, located just west of Duluth.

Estuary Restoration Boat Tour (~2 Hours)

9:00 a.m. - 11:30 a.m. - Professional Tour #4

The St. Louis River flows into western Lake Superior to create one of the most remarkable coastal systems on the Great Lakes: the St. Louis estuary and harbor. This boat excursion will highlight several of the remediation and restoration projects taking place within the estuary. These projects are part of the St. Louis River Area of Concern, a series of management activities and projects with partial funding through the Great Lakes Restoration Initiative to address several beneficial use impairments within the harbor and river corridor. Projects have included sediment capping and habitat improvements supporting fish and bird populations.



For descriptions of Professional Field Tours,
please visit <https://www.asrs.us/2022-annual-meeting/>

2022 ASRS KEYNOTE SPEAKERS



PETE KERO

Pete Kero is a senior environmental engineer and Vice President for Barr Engineering Company in Hibbing, Minnesota. Over the past 28 years, he has worked on remediating, restoring and repurposing more than 20 mine sites across the Midwest and Western United States. His recent experiences include the creation of the Redhead Mountain Bike Park on 1,225 acres of idled iron mining land in Chisholm, Minnesota and the hydraulic restoration of the Hector Mine outlet and Embarrass River Diversion Channel following the breach of an earthen berm and sediment washout. Pete is writing a book for the Minnesota Historical Society Press, tentatively titled *Minescapes: Reclaiming Minnesota's Mined Lands* that is scheduled for publication in Spring 2023.

MELISSA SJOLUND

Melissa Sjolund supervises the Minnesota Department of Natural Resources St. Louis River and Lake Superior Program and also serves as the agency's Area of Concern Coordinator. She has participated in past ASRS conferences, first as a Montana State University graduate student in Land Rehabilitation, and later as a consultant in reclamation and permitting specialist for the Montana Department of Environmental Quality's Coal Program. Since moving to Duluth five years ago, Melissa has been working hard with the Area of Concern team to remove the St. Louis River from an international list of degraded waterbodies.



DAN POWELL

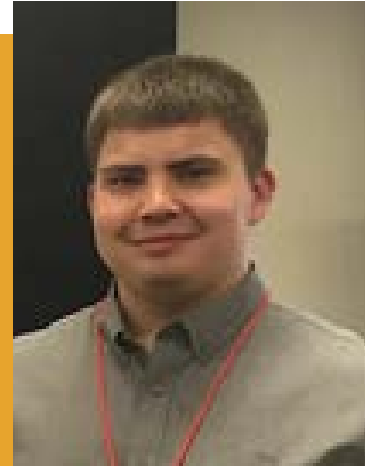
Dan is the Chief of the Technology Integration and Information Branch in the Headquarters Superfund program at the U.S. EPA's Office of Land and Emergency Management. In this capacity, he leads efforts to promote awareness and use of best practices and innovative technologies for site clean-up at hazardous waste sites. Dan has over 30 years of experience in Superfund and waste site cleanup, he has been with the Technology Innovation Program, now part of the Office of Superfund Remediation and Technology Innovation, since 1990, and has served as a Branch Chief for 14 years. Dan received his MA in Public Administration from the Woodrow Wilson School of Government at the University of Virginia in 1988, and graduated summa cum laude as the class

Valedictorian with his BA degree as a double-major in political science and urban studies from Roanoke College (Salem, VA) in 1985.

TUESDAY LUNCH SPEAKER

RYAN EDWARD PETERSON

Ryan Edward Peterson is an archaeology doctoral candidate in Indiana University's Department of Anthropology. His research focuses on native copper production and metal-working techniques in the Northern Lake Superior Basin during the Nipissing high paleo-lake level event (4,000-6,000 years ago). Mr. Peterson has conducted archaeological field work on multiple islands and coastlines throughout the Great Lakes, including Beaver Island, Isle Royale, as well as the north and south shores of Lake Superior. His most recent field work in the summer of 2021 uncovered several native copper working sites on Isle Royale.



QUESTIONS?

Dustin Wasley, PE, GeoEngineers
2023 Annual Meeting Chair
asrs2023.boise@gmail.com



PLANNING COMMITTEE

GeoEngineers • Perpetua Resources
Hedra Mining Company • Montana Rail Link
JR Simplot • Trilhydro Corporation
Haley & Aldrich • Brown and Caldwell
Pace Analytical • Morrison-Maierle
KC Harvey • Idaho Mining Association
Integra Resources



Call for Exhibitors and Sponsors!

Register here: <https://www.asrs.us/conference-sponsors/>

Or use form below!



American Society of Reclamation Sciences

39th Annual Meeting

June 12-16, 2022; Duluth, Minnesota

Transforming Pits and Piles into Lakes and Landscapes

Sponsor/Exhibitor Information

The 39th Annual Meeting of the American Society of Mining and Reclamation will provide an exceptional opportunity for your company or organization to interface with reclamation professionals and those who influence decisions about the purchase of products and services for the reclamation industry. Vendor exhibits and sponsors are valuable parts of this conference, and we urge you to join us!

There are a limited number of exhibit spaces at the Duluth Entertainment Convention Center (DECC). Register now to be a sponsor or to bring your company to exhibit in Duluth, Minnesota, 2022.

- An “Ice Breaker” social will be held the evening of Sunday, June 12 at the DECC.
- An Evening Social Event, featuring drinks and hors d’oeuvres, will be held the evening of Monday, June 13.
- The Annual ASMR Awards Banquet will be held Monday, June 13, at noon.
- Catered lunches Monday through Wednesday at the DECC.
- An early evening poster session will be held on Tuesday, June 14.
- The ASMR Film Festival will be the evening of Tuesday, June 14.
- All refreshment breaks (coffee and tea in the mornings and soft drinks in the afternoons) will be held in the exhibit area (see exhibitor maps on the ASMR webpage under “Upcoming Meetings”).

Exhibitor Information

Exhibitors will be listed on the ASMR website (<https://www.asmr.us/>) by name and logo, which includes a link to your company's website. The website listing will stay on the main ASMR website for the year leading up to the 2023 Annual Meeting. The displays will be in the atrium overlooking Lake Superior in the Harbor Side Ballroom at the DECC. Display space is 10- foot by 10-foot and includes one 8-foot skirted table, two chairs and low drape side dividers. Electrical service, drayage (shipping equipment to and from the venue) and additional chairs can be ordered online thru this link: <https://decc.org/exhibitor-info-resources-exhibit/>

Sunday June 12: Move In/Setup: 10:00am-5:00pm, Show Opens at 5:00pm, Closes at 9:00pm

Monday, June 13: Show Opens at 8:00am, Closes at 5:00

Tuesday, June 14: Opens at 8:00, Closes at 7:00

Wednesday, June 15: Show Opens at 8:00, Closes at 5:00. Move Out begins: 5:00pm

Thursday, June 16: Move out completed by 2:00pm

The exhibit area will be open daily during the conference and locked at night. Valuable items should not be left in the exhibit area.

Reservations will be made upon receipt of funds (**\$1,200 per booth**) on a first-come, first- served basis. Your \$1,200 exhibitor fee includes the following:

- Two complimentary nonrefundable conference registrations
- Two tickets to the Monday evening social event
- Your logo on the conference app
- Your logo on the ASMR website, with a link to your website
- Recognition as an exhibitor in the conference program
- Fee does not include field trips or the Early Career Professionals Event

The exhibitor map is attached to this form. Check the ASMR website for available booths, as spaces sell. Fill out the Sponsor/Exhibitor Registration Form and return with payment by **May 6, 2022**.

If you have questions or need more information, please contact:

| | |
|--|--|
| Kennet Bertelsen ASMR 2020 Conference Committee Kbertelsen@m-m.net 509-315-5303 | Robert Darmody ASMR Executive Secretary rdarmody@illinois.edu 217-493-7847 |
| Mehgan Blair ASMR 2020 Conference Co- Chair MBlair@barr.com 218-529-8237 | Linda Johnson ASMR 2020 Conference Co-Chair linda.l.johnson@state.mn.us 218-274-7007 |

Sponsor Information

Please complete the Exhibitor/Sponsor Form and Meeting Registration Form for your attending personnel, indicating the comped and extra-cost events desired

Platinum level: \$7,000 and above

- Two complementary exhibitor booths, five complementary nonrefundable conference registrations, five tickets to the Monday evening social event, five professional field tour passes to the field trips, and five early career professional event tickets
- Special recognition and award at the awards luncheon
- Prominent placement of your logo on the inside of the program cover
- Display of your logo on the ASMR website from one month prior to the 2022 Duluth Meeting until one month prior to the 2023 meeting
- Recognition as a platinum-level sponsor on the conference app

Gold level: \$5,000

- Two complementary exhibitor booths, four complementary nonrefundable conference registrations, and Monday evening social event, early career professional event, and professional field tour tickets
- Top billing of your logo on the inside of the program cover, listed in the order received
- Placement of your logo on the inside of the program cover
- Display of your logo on the ASMR website from one month prior to the 2022 Duluth Meeting until one month prior to the 2023 meeting
- Recognition as a gold-level sponsor on the conference app

Silver level: \$3,000

- One complementary exhibitor booth, three complementary nonrefundable conference registrations, and Monday evening social event and early career professional event tickets (professional tours not included)
- A link to your company website on the ASMR website from one month prior to the 2022 Duluth Meeting until one month prior to the 2023 meeting
- Placement of your logo on the inside of the program cover
- Recognition as a silver-level sponsor on the conference app

Bronze level: \$2,000

- One complementary exhibitor booth, two complementary nonrefundable conference registrations, and Monday evening social and early career event tickets (does not include professional field tours)
- A link to your company website on the ASMR website from one month prior to the 2022 Duluth Meeting until one month prior to the 2023 meeting
- Recognition as a bronze-level sponsor on the conference app

Meal and Break Sponsor

Your company's name will appear on a board located in the food and beverage area. If interested in a meal sponsorship, please specify the date and meal you are interested. Multiple sponsorships are available for each event.

| | |
|---------------------------------|---------|
| Awards luncheon | \$1,000 |
| Student Breakfast | \$400 |
| Lunch | \$750 |
| Morning break | \$300 |
| Afternoon break | \$300 |
| Early career professional event | \$600 |
| Social event dinner | \$2,500 |

SPONSOR/EXHIBITOR REGISTRATION FORM

Registrant(s)/contact name(s): _____

Company name: _____

Address: _____

City, state, zip: _____

Telephone: _____ Email: _____

Company website: _____

BOOTH SELECTIONS AND COSTS FOR SPONSORS AND EXHIBITORS (circle level)

Sponsors: _____ Platinum \$7,000 _____ Gold \$5,000 _____ Silver \$3,000 _____ Bronze \$2,000

Silver and Bronze sponsors receive one and Platinum and Gold sponsors receive two, complementary exhibit space(s), if desired, and complimentary registrations/tickets specified by sponsorship levels above.

Exhibitors: _____ \$1,200

Exhibitors receive two complementary conference registrations & Monday evening social event tickets

Please fill out individual registration forms for each complementary registration, with extra costs events indicated.

Name of registrants: _____

MEAL SPONSORSHIPS (check sponsorship desired)

_____ Lunch \$750 _____ Award luncheon \$1,000 _____ Student Breakfast \$400

_____ Refreshment sponsorships @ \$300 _____ Day(s) morning break _____ Day(s) afternoon break

_____ Social dinner \$2,500 _____ Early career professional event \$600

MEAL SPONSORSHIP TOTAL: \$ _____

PAYMENT

Visa or MasterCard #: _____ Expiration date: _____ Security code: _____

Name on card (print): _____ Charge total: \$ _____

Payment by check or credit card payable to ASMR by **March 4, 2020**, or until all booth spaces have been sold. Send this form with payment to Dr. Robert Darmody, ASMR, 1305 Weathervane Dr., Champaign, IL 61821, or by email (rdarmody@illinois.edu). If you have questions or need more information, please contact Robert Darmody (director@asrs.us) or Meghan Blair (MBlair@barr.com).

GOLD RUSH GONE RED: A history of Iron Mining in Minnesota



BY KELSEY JOHNSON, PRESIDENT, IRON MINING ASSOCIATION OF MINNESOTA

"The eye takes in a score or more graceful promontories, capes and peninsulas, — running their moss and pine covered points down into the Lake, as if to cool their metallic palates already burning to be unbosomed by the restless hands of enterprising miners... The gold fields in this section will probably be full of enterprising miners; and Vermilion City, at the Falls on the South Vermilion River, be peopled by a population not less than ten thousand."

- Ossian E. Dodge, 1865

When Ossian E. Dodge wrote these words in the St. Paul Pioneer during the fall of 1865, he was correct about a few things: the natural beauty of northern Minnesota was breathtaking; miners would flock to the region; and mining would indeed lead the population to surge. However, unbeknownst to Dodge or the general population at the time, the real success of the industry would not be



Photo 1: Location of the Vermilion, Mesabi and Cuyuna iron ranges in northern Minnesota (Mnopedia.org)

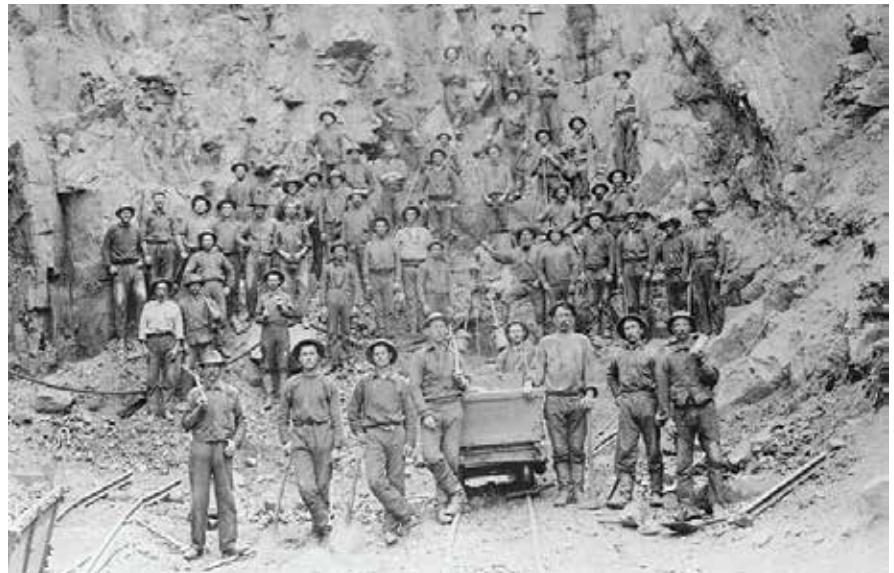


Photo 2: Minnesota's first iron mine opened at Tower-Soudan in 1884. This picture was taken in 1890 before the mine was converted from open pit to underground. (Taconite.org).

from gold; it would be from the region's deep-running veins of iron ore.

Beginning in the mid-19th century, the possible mineral wealth of Minnesota's northeastern region intrigued early northern pioneers. Initially, indications of copper led prospectors up the St. Louis River. In 1865, geologist H. H. Eames and his team journeyed north, paddling the bays of Lake Vermilion and Fond Du Lac River in a birchbark canoe. On their return, they presented samples of superior quality iron ore, as well as specimens of gold-bearing quartz.

In an instant, excitement for the region exploded—but not because of the iron. Publications across the country shared the news of Minnesota's extensive gold deposits and a stampede of eager prospectors rushed toward the nation's

new gold opportunities. Companies were created, thousands of dollars of capital were invested, and valuable machinery was shipped to the sites. Importantly, the rush of people, supplies and money to the Vermilion Range led to the cutting of the first road heading north of Duluth, Minnesota.

George R. Stuntz, a Pennsylvanian who had come to Minnesota as a land surveyor in the 1850s, was likely one of the region's first gold prospectors. In his personal narrative, he described the boom and bust of the Minnesota gold rush:

"Did they find any gold? Not that I ever heard of. There were thousands of men scattered over the range for a year or so, prospecting, but finally the excitement died out."



Photo 3: Open pit iron mining in the Mesabi Iron Range. (ss.sites.mtu.edu, commons.wikimedia.org)

The fact is, there was gold, but not enough to pay. While Stuntz's gold prospect proved unsuccessful, his exploration brought light to the region's red-toned mineral that, until this point, had been greatly overlooked. Stuntz had first heard of Vermilion's iron ore deposits third-hand in 1863, a tip that came from the Bois Forte Band of Chippewa. While Stuntz had not considered this information critical at the time, seeing the deposits for himself destined his opinion to change. In his narrative, Stuntz recalled his change of heart:

"I saw the location, at the east end of the bluff, where it showed the richest, and where I got the specimens that finally called the attention of the capitalists to that part of the country."

Stuntz also famously stated, "When this country is developed, that big mountain of iron will do it. When they get to hauling that iron out, they will haul in its supplies cheap."

While the scores of iron ore hidden

beneath the Vermilion Range would lie untouched for another nearly two decades, the disappointing gold rush had led to one important change in the region: a road providing accessibility to the land under which the ore was buried.

Throughout the late 1870s, further exploration was conducted on the Vermilion and the Mesabi Ranges, located near Lake Vermilion (Photo 1). Rumors of a mountain made of solid iron and enticing samples of the rock had led eastern capitalists to grow interested in the potential of Minnesota's iron mining industry. It was through such capitalists that George Stone, one of the major supporters of early Minnesota mining, was rumored to come home from a trip to Philadelphia with "a check for \$50,000 tucked in his pocket" and a commission to proceed at once with the preliminary plans necessary for opening a mine at Lake Vermilion on a large scale. Whether this is exactly true or not, it is confirmed that Stone devoted years of his life to develop the Vermilion Range.

In 1882, a small crew of men began to test putting mines on the Vermilion Range. In their first winter in Soudan at one of the initial mines, miners suffered a frigid winter with minimal comforts, only eating cans of beans and tomatoes. However, this group had a lucky break when they found an old steam boiler, brought to the site during the gold rush, and used it as a stove.

The small crew's test work and struggles paid off. In December, the Minnesota Iron Mining Company was formed surrounding the Soudan area. After a lapse of two decades, the Minnesota mining industry flourished again—and this time, in a lasting way. The new iron mining industry built on a solid base of mineral deposits and grew with the infrastructure and means to succeed. Once again, miners flocked north.

July 31st, 1884 marked a momentous day for the Vermilion Range and Minnesota's

iron mining industry, as a train first arrived at Soudan via a newly completed railroad connecting the Soudan Mine with Two Harbors, located east on Lake Superior. Elisha Morcom Jr. said of the day:

"All the men of the mines had a half holiday in celebration of the completion of the railroad. The Indians came in from the forest and helped the celebration along with a big 'pow-wow.' The men all got busy and shipped five cars containing one hundred tons of ore on the same day."

Over the course of the next 10 years, iron ore shipments from Soudan to Two Harbors continued to grow, through 1892, in which more than 1 million tons journeyed east via rail (Photo 2). And while the quantity of iron ore was impressive, it's been said that the quality is what made it famous. After the immensely successful outset of the Soudan Mine on the Vermilion Range, it didn't take long for more mines to begin blasting the vast stores of iron ore across northeastern Minnesota.

Following the Vermilion Range, the Mesabi Range's first shipment of iron ore was in 1892, followed by the Cuyana Range's first shipment in 1911. Through the first half of the 20th century, the mines of these ranges led Minnesota to produce more than 80 percent of iron ore in the United States (Photo 3).

While the Soudan Mine and the majority of mines on the Vermilion and Cuyana Ranges stopped operation in the 1960s, mining continues to this day on the Mesabi Range. The initial burst of activity in the region in the late 19th and early 20th centuries led to the settlements of approximately 75 separate Minnesota townsites that would otherwise not exist. The city of Tower, the location of the Soudan Mine, had the honor of being the first Minnesota city located north of Duluth. Lake Vermilion, where



Photo 4: Taconite mining continues in the Mesabi Iron Range today.



Photo 5: Reclamation of iron ore surface mines includes revegetation with grasses, flowers and trees (shown in the background).

prospectors first flocked for gold and then paddled to iron ore deposits, is now a beloved tourist destination, thanks to the infrastructure brought on by iron mining. Additionally, the Lake Vermilion-Soudan Underground Mine State Park offers visitors the chance to experience the early days of iron mining. Wearing a hard hat and travelling a half-mile below the Earth's surface for a guided tour of the former mine at Soudan, visitors experience what the first iron miner's daily experience was like.

The Mesabi Range still holds valuable taconite deposits with active mining operations taking place to this day

(Photos 4 and 5). Minnesota currently has six active taconite mines along the Mesabi Range. The iron mining industry in Minnesota contributes over \$3 billion to Minnesota's economy each year, while providing over 16,000 high-skill, family supporting jobs in the state. Minnesota currently produces approximately 90 percent of the nation's iron, providing the steel citizens use every day—whether driving to work or doing the laundry.

Minnesota's gold rush didn't last. But it led to the development of the previously untouched northern edge of the state and taught us that, sometimes, red iron is more valuable than gold. 🌱

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REDHEAD MOUNTAIN BIKE PARK:

Breaking new ground in the intermediate repurposing of mined lands

BY PETE KATO, BARR ENGINEERING, HIBBING, MN

On a pleasantly cool June day in 2021, a crowd of hundreds gathered on the rim of an idled mine pit in northern Minnesota. It was, perhaps, the largest crowd at the mine since it stopped shipping iron ore in the 1970s. The celebration included food trucks, bicycle vendors, a health-screening van, a makerspace showcase, and an organic aromatherapy vendor. The event was live broadcast on the radio and reported on TV and newsprint. The crowd was addressed by the leaders from each of the organizations that had banded together to support an experiment in repurposing of the mine – namely, the Minnesota Discovery Center (the museum of the Iron Range), the Iron Mining Association, the City of Chisholm, St. Louis County, the Department of Iron Range Resources and Rehabilitation, and the Iron Range Off-road Cyclists non-profit bike club. The climax occurred when giant scissors sliced a ribbon to officially open a 25-mile mountain bike park that *Outside Magazine* had already dubbed one of “9 New U.S. Trails You Should Try This Year.”

It was a day that almost did not happen. Over the 12 years that it took to transform 1,225 acres of idled mine land into the Redhead Mountain Bike Park (Redhead), it narrowly escaped more than one premature death. However, in the tradition of Minnesota’s Iron Range, thorny problems were addressed through a combination of innovation and gritty determination as people from across the mining industry, public sector and non-profit organizations came together to bring this novel concept into fruition.

Innovations in mining are often narrowly ascribed to the technologies that advance extraction and mineral processing, such as the implementation of steam-shovel mining in the early 1900s or the perfection of taconite processing that breathed new life into Minnesota’s Iron Range in the 1950s. But innovations in mine land reclamation and repurposing, including those of a legal and social nature, are arguably just as important – and perhaps even more important – in an era when the chief concern of mining executives is the social license to operate. Some of these latter types of innovations – as well as the challenges that demanded them during the creation of Redhead – are discussed below.

The first challenge that had to be addressed in creating Redhead was one of a perceptual nature. Redhead is located atop the Biwabik Iron Formation, the 120-mile long ore body that gave birth to Minnesota’s Mesabi Iron Range and has sustained its mining industry and its numerous small cities for the past 130 years. Traditional land use planning held that development of any sort atop the iron formation was best avoided – a lesson that had been engrained over the history of the Iron Range when whole cities, such as my hometown of Hibbing, had to be moved to make way for mining. This tradition stood firm, even when it meant that mine lands that often surround the small Iron Range cities on two or three sides lay idle and off-limits for development for half a century or more while no mining companies had interest in them. Meanwhile, these idled mine

lands were being reclaimed by nature, creating stunning red rock canyons that were beautifully offset by the white trunks of paper birches that had repopulated the land and the clean, azure waters that had flooded back into the mine pits (Figure 1).

The park-like atmosphere of these reclaimed mine lands gave rise to a new concept: they could be redeveloped using a light touch with naturally-surfaced trails that would not permanently encumber the future mineral value of the lands. By the mid-2010s, it was clear that destination-quality, natural-surface trail systems could bring incredible social benefits to small towns by creating both a tourism draw that could bring millions of dollars per year into their host communities as well as a quality-of-life amenity that would attract and retain a high-quality workforce. In the time between periods of active mining, such “intermediate” uses of mine lands could easily pay for themselves in terms of economic vibrancy they would create for the region. Over a few years of debate and discussion, a coalition of support was built to experiment with this idea of “temporary” or “intermediate” recreational use of mine lands to create the Redhead Mountain Bike Park. The idea was that if mining ever returned to the area, the economic boost to the community would have exceeded the initial investment and the trails could easily be moved to a new location, perhaps one that had recently completed a cycle of mining and was under-going reclamation. In this way, mining and recreation could be symbiotic, with mining activity creating a dramatic



Figure 1. Abandoned iron-ore mine pits in Minnesota's Iron Range have been converted into a new trail system for mountain bikers and hikers. This pit, 400 feet deep and filled with water, provides kayaking, canoeing, and paddle boarding.

landscape for trails and the trails making the community attractive for workers and tourists.

After the idea of intermediate recreational use was embraced, a second challenge arose, this one of a legal nature. In Minnesota, a statute instituted in the 1950s required that all open mine pits and shafts be permanently fenced off from the public. While this law had certainly prevented people from getting injured by accidentally stumbling into a mine pit, it had the unintended consequence of

preventing any public access onto the beautifully reclaimed mine lands, even when it was intentional and sponsored by a governmental organization. Thus began a multi-year effort to amend the legislation to allow for government-sanctioned recreational use of mine land behind the fence line, an effort that was principally led by St. Louis County, whose mine inspectors were charged with enforcing the original mine pit fencing statute. Ultimately, after much debate and the inclusion of provisions for signage and other risk management measures that

would provide equal public protections as the original statute while allowing for intentional recreational repurposing, the law passed. The change in the mine pit fencing law allowed Redhead to be built, but it also legitimized other government-sanctioned recreational uses of idled mine pits, such as fishing and all-terrain vehicle (ATV) trails. Today, Redhead embraces all of these uses with two dozen miles of mountain biking and hiking trails (Figure 2), a speed-controlled ATV trail and non-motorized water recreation inside the former mine pit complex (Figure 3).



Figure 2. Redhead now contains 25 miles of trails suitable for hiking and mountain biking.



Figure 3. Water-filled, iron-ore pits provide opportunities for non-motorized water recreation in the form of kayaking, canoeing, and paddle boarding.



It took years and several near project-killing experiences to build the regional consensus necessary to undertake the

experiment in intermediate recreational use that is Redhead Mountain Bike Park. Despite the 12-year wait, the park

could not have opened at a better time than 2021. Amidst societal pressure to improve environmental, social and government (ESG) performance, the park demonstrates that mine land can be used for social benefit not only after mining, but also during idle periods between episodes of mining. And, it shows that mining and recreation can not only coexist but can purposefully collaborate to create unique and beautiful recreational destinations that contribute to a vibrant, well-rounded local economy that embraces both industry and outdoor recreation. Finally, with its opening during the COVID-19 pandemic, when much of the world was rediscovering outdoor recreation, Redhead provides a safe and healthy way to connect with nature and one another amongst the fresh air, waterfalls, pines and paper birches that have come to characterize Redhead's reclaimed mine lands.

Since its opening, Redhead has attracted tens of thousands of tourists to Minnesota's Iron Range, including nearly 4,000 people in a single weekend when it hosted a Minnesota high school league mountain bike race (an event that temporarily doubled the population of host city Chisholm and sold-out hotels in every town for a 50-mile radius). The project has attracted press coverage in nearly all the regional news outlets, as well as Minnesota Public Radio and the Sierra Club. In 2022, it will be featured in the national documentary "Bike Town" being produced by Free Hub Magazine. The positive public and press reception of Redhead stand as evidence that the experiment is working and that the intermediate repurposing of mine lands using a "light touch" can indeed yield significant social benefits without permanently encumbering future mineral development. It is a type of mining innovation that is a perfect fit for today's economy in which we strive for both increased domestic supply of critical minerals and better environmental and social performance for industry. 🌱

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Usibelli Coal Mine achieves historic reclamation milestone

BY RICHARD C. SIVILS, USIBELLI COAL MINE, HEALY, ALASKA

Usibelli Coal Mine (UCM) has reached an historic milestone at one of its mines located near Healy, Alaska. On August 27, 2021, the Alaska Department of Natural Resources (DNR) notified UCM that the application for Phase III Bond Release for an area in the Poker Flats Mine had been approved (Figure 1). This bond release covers 367 acres of land leased from the State of Alaska on which over 20 million tons of coal were safely and economically mined from the early 1970s to 2000. [See the earlier article “Reclamation of the Poker Flats Mine, Alaska” in the Fall 2019 *Reclamation Matters* magazine (<https://www.asrs.us/wp-content/uploads/2021/08/ASMR-Reclamation-Matters-2019-Fall.pdf>).]



Figure 1. Map of reserves and location of the Poker Flats mine in central Alaska.

Mining

UCM is based in Healy, Alaska, which is located 250 miles north of Anchorage and maintains six active surface coal mining permits east of the Nenana River. Coal mined from Poker Flats has a long history of supplying the essential energy necessary to Interior Alaska in fueling power plants for electricity and heat generation. It was also a source for export sales, being highly valuable to other countries due to its extremely

low sulfur content. The 1970s were a time of exciting change for UCM, with the expansion of its operations into the Hoseanna Valley by acquiring permits and leases that would become the Poker Flats Mine.

In 1976, the haul road and Poker Flat shop and office complex were built, followed by the construction of the iconic “Ace in the Hole” Bucyrus Erie 1300W dragline with a 33-cubic-yard bucket capable of moving 35,000 cubic yards of overburden in 24 hours (Figure 2).

The dragline arrived by rail and truck and took nearly two years to fully assemble, after which it immediately began overburden stripping. The Poker mine fed the tipples, completed in 1981, on the west side of the Nenana River. The Poker permit was renewed every five years by the Alaska DNR, and several expansions continued mining operations until the

nearby Two Bull Ridge mine permit was approved in 1997. Mining began there in 2000 when the dragline finished at Poker.

The first area mined at Poker Flats was an extensive north-facing slope which predated the SMCRA laws put in place by the federal government in 1977. UCM was not obligated to reclaim this area to meet the new federal guidelines, but instead chose to fully reclaim the areas disturbed before 1977.

Reclamation

Reclamation of the Poker permit began long before the first truckload of topsoil was removed. Soil, water, and vegetation studies were conducted to provide a baseline for what future reclamation efforts would achieve. Contemporaneous reclamation work began and will continue until the entire mine area reaches final bond release.



Figure 2. Bucyrus-Erie 1300W dragline, named “Ace in the Hole,” moves the overburden overlying the coal seams at Poker Flats and Two Bull Ridge Mines.



Figure 3. Furrowing and seeding at Two Bull Ridge in early June 2021 is shown in the foreground with active regrading in the background. Two Bull is across the valley from Poker.



Figure 4. Native grasses and forbs (including native fireweed) were aerial seeded and hydroseeded on the reclaimed areas.



Figure 5. Summer reclamation crews (Yellow Hard Hats) helped local elementary school students plant 150 white spruce and birch trees in 15 minutes!

Usibelli began its concerted reclamation program in the early 1970s and by 1973 had successfully seeded 1,600 acres of formerly mined land. By 1977, that number had grown to 2,300 acres. This effort also had the added bonus of providing valuable information for the soon-to-be-built Trans Alaska Pipeline System, which borrowed techniques pioneered by UCM in reclaiming its own footprint.

One of the easiest reclamation tricks is to move overburden material only once, which the dragline did efficiently. Additional fill was placed by the truck-shovel crews and the dozer fleet finished with final regrade of slopes and the establishment of drainages. Furrowing is a proven erosion control method which is the final step before seeding. As mining progressed across Poker, regrade was completed in contiguous areas and seeded with the goal of reducing erosion and quickly re-establishing vegetation.

UCM has utilized aerial seeding for the bulk of its reclamation work, followed up with hydroseeding and hand seeding as needed on selected areas. After native grasses are established (Figure 4), summer reclamation crews followed up several years later with supplemental seedling transplants (Figure 5). White spruce, birch, alder, and willow are the primary species hand-planted, and all seed stock is locally sourced from the Healy area, so it is already accustomed to the climate and growing conditions (Figure 6). Summer reclamation crews are primarily tasked with transplanting an average of 25,000 seedlings during the brief summers.

UCM's long standing reclamation goal is to put the land back to better than what it was before mining occurred and to provide quality wildlife habitat. Wildlife quickly found the area to be excellent habitat for both summer and winter browse. Dall sheep and caribou herds utilized the newly reclaimed land, which brought grizzly bears and other predators to the reclaimed areas (Figures 7 and 8).

Bond Release

The southern half of Poker was approved for Phase I bond release in 2011, which occurred after grading had been completed. This same 430 acres was approved for Phase II release in 2016, and plans were made for the required vegetation study to commence in 2018 in order to apply for Phase III bond release. A joint meeting with DNR/UCM and the consulting firm ABR (ABR, Inc. – Environmental Research & Services) was held in January 2018 to review the final bond release standards and permit language which would facilitate the Phase III bond release.

The only other mining area to achieve Phase III bond release in the State of Alaska is located nearby at another coal mining permit UCM reclaimed at Gold Run Pass (Figure 1). The majority of the Gold Run Pass mine area was approved for Phase III release in 2011 and consisted of 94 acres. Being the first Phase III release in Alaska, this set the precedent for future work. ABR was selected as the consulting firm to conduct the field work necessary to complete an application request for final bond release. The field work, statistical methods, and final report from the 94 acres at Gold Run proved invaluable as the model for the Poker bond release procedure and process which concluded in 2021.

The bond release package was submitted to Alaska DNR in 2020 and provided the necessary vegetation cover and diversity reports for the two-year study conducted in 2018-2019. This bond release request was for the entire 430 acres previously approved in 2016 for Phase II release. Alaska DNR conducted a joint inspection with the Office of Surface Mining in June 2021. This inspection consisted of traversing the entire area, photographing the site, and collecting drone data. Drone imagery was used to validate vegetation cover and density data in the report and to help regulators determine any deficiencies that would require additional

work before final bond release could be granted.

UCM is pleased that out of the 430 acres submitted for consideration, 367 acres were approved by Alaska DNR for final bond release after decades of work has been put into reaching this milestone. UCM will complete several small projects and resubmit the remaining 63 acres with the goal of additional Phase III approval in 2022.

A secondary benefit of completing timely reclamation is to reduce the bond liability a mining company carries. In terms of the outstanding bond amount for Poker Flats, UCM significantly reduced its total outstanding bond liability from \$2.5 million to the current amount of roughly \$400,000. This was only made possible by the relentless work of the employees of UCM, who successfully completed the reclamation work resulting in the beautifully restored landscape. 🌱



Figure 6. Woody species planted and established at Poker Flats.

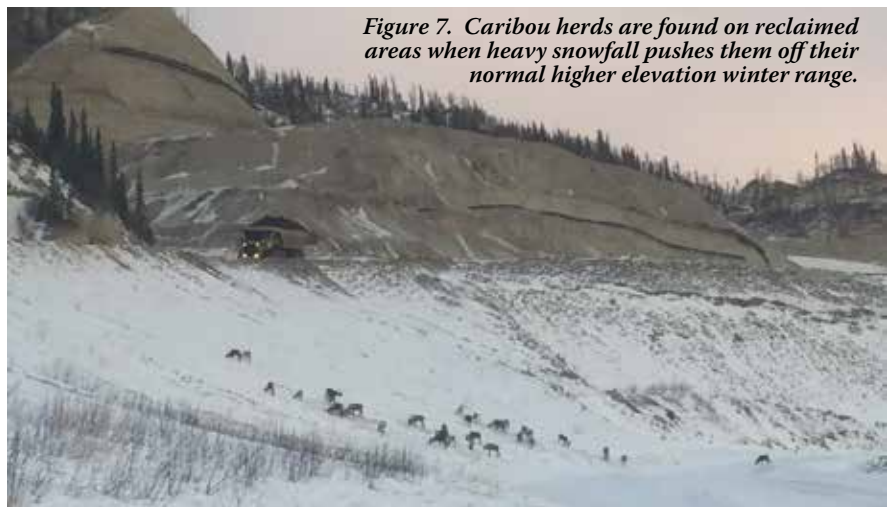


Figure 7. Caribou herds are found on reclaimed areas when heavy snowfall pushes them off their normal higher elevation winter range.

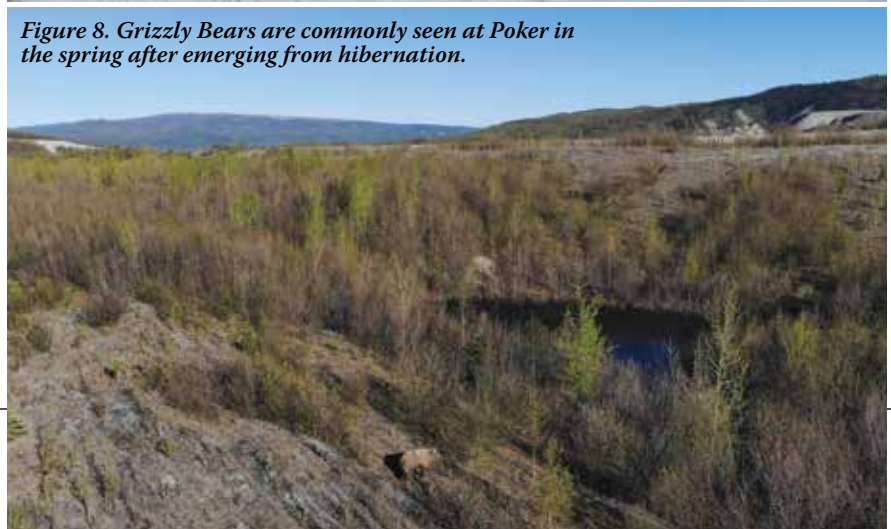


Figure 8. Grizzly Bears are commonly seen at Poker in the spring after emerging from hibernation.

Boreal forest restoration in the Kenai National Wildlife Refuge, Alaska

BY LORENE LYNN, RED MOUNTAIN CONSULTING, PALMER, AK

Sunrise Gas Exploratory Well Site (grandfathered into the KNWR)

Restoration of disturbed sites within the Kenai National Wildlife Refuge (KNWR) necessitates meeting regulatory requirements of the refuge. Restoration within a wildlife refuge also puts onus upon the restorationist to honor the mission of these public lands and to the people who use the land. The refuge prohibits the importation of soil or plant materials from outside the KNWR, which left us wondering how to begin restoring the Sunrise 2.5-acre exploratory gas pad with a bare, compacted soil located deep within the refuge (Figure 1).



Figure 1. View of the Sunrise exploratory well pad after plugging and abandoning the wellhead, showing the condition of the pad before the start of restoration activities.

To address the need to recontour the surface elevations and to acquire soil and vegetation, we cut the trees surrounding the area, harvested the vegetative mat, and used the soil from an additional 2.5 acres of virgin forest around the perimeter of the pad. Prior to construction activities, we tied long, crumpled strips of mylar to tree branches and placed shiny pinwheel toys along the forest edge as bird deterrent and conducted a bird survey.

All trees in the perimeter were cut near ground level and stored for later use in restoration. The vegetative mat was harvested as intact pieces and placed on the newly contoured surface. The soil provided microbes and fungi adapted to local conditions, the vegetative mat provided immediate ground cover with indigenous plants, and the woody debris provided shade and improved water retention in soil. The ground surface was dimpled, creating a “rough and loose” configuration (Figure 2), a technique I learned from David Polster, a restoration ecologist

with more than 40 years of experience in western Canada. The dimpled ground provides different aspects, slopes, and water collection sites, comparable to what occurs in natural landscapes.



Figure 2. Dimpled ground with interspersed vegetative mat and woody debris.

We salvaged hundreds of spruce saplings that were growing around the perimeter of the former pad and transplanted them into the dimpled ground with the help of the U.S. Fish and Wildlife Service (USFWS) intern crew. The final restoration product was described by a USFWS staff member as looking like a “nature bomb” went off (Figure 3). We took that as a compliment. The performance standards for this site included cover by indigenous plants that were equivalent to 60 percent of that found at a reference site, to be met within five years following restoration work.

We installed and operated an irrigation system for two years following restoration work. Because the site is in a remote location within the KNWR, a 40,000-gallon water truck was driven to the site twice each week to provide water for irrigation.

In 2021, hundreds of naturally colonizing spruce seedlings were observed growing on the site. Approximately 60 percent of the transplanted vegetative mat survived. The performance standards were designed to assess whether the site is on a trajectory towards a plant community that will eventually have ecological values and aesthetic qualities that closely resemble the surrounding undisturbed plant communities. The goal is that eventually, the site will blend in with the surrounding terrain and provide suitable habitat for some wildlife species. Although



Figure 3. A view of the restoration site upon completion that includes dimpled ground that was mostly covered by the transplanted vegetative mat in which saplings were transplanted.

50 to 100 years may be needed for this site to reach this goal, it appears to be well on its way.

Thirty-five-acre Gravel Pit Site (grandfathered into the KNWR)

During upgrades to the Sterling Highway near Cooper Landing, Alaska, the managing construction company was using an old Department of Transportation gravel pit that had been grandfathered into the formation of the KNWR (Figure 4). The USFWS requested the construction of two wildlife under crossings, which required weed-free, high-quality gravel. The construction company wanted to expand the gravel pit to obtain gravel for the under crossings, but the USFWS is not in the business of selling gravel. The agency staff suggested the company contact Red Mountain, based on their work at the Sunrise well pad site described above, to determine how they might responsibly expand the gravel pit.

We decided to use techniques similar to those used at the Sunrise site. As work progressed, this project became more



Figure 4. A view of the active gravel mining operations.

complicated because mining was actively progressing as restoration work began. We first cut trees, stored them in piles along the perimeter of the future pit boundaries, and then harvested four acres of vegetative mat, some of which was stored on the pit floor until it could be used later (Figure 5). We hired a local landscaping company, Moore's Landscaping, to provide labor and heavy equipment for this project.

A portion of the vegetative mat was placed directly on recontoured ground where gravel mining activities were complete. As the work was progressing, a nearby wildfire was becoming a threat to this project (Figure 6). In mid-summer, and in the middle of our increasingly smoky restoration work, the fire service forced us to evacuate so they could use the gravel pit as a base for the fire-fighting activities.

One worker was able to return to the pit just two days after the fire had passed through and took pictures of the burned moonscape that remained (Figure 7). The 287,000-acre fire ended up passing through the restoration area twice. While mining activities resumed in September, restoration activities did not resume until the following year due to safety concerns.



Figure 5. Harvest of vegetative mat from a 4-acre expansion area adjacent to the existing gravel pit.



Figure 6. With a massive wildfire burning just three miles away in late July, we continued to place vegetative mat directly onto recontoured ground.

Inset: Figure 7. Picture taken just two days after the fire passed through. We lost nearly all the vegetative mat and stored woody debris.

In response to the fire, the original restoration plan was amended to account for the loss of vegetative mat and woody debris. This change was unfortunately paired with a reduced budget. In an amazing turn of luck, the vegetation growing along the edges of a nearby dirt road survived the fire. The focus of revegetation was shifted to transplanting the roadside vegetation into the restoration site. The roadside vegetation is regularly cut to keep the road open, so harvesting and transplanting the roadside vegetation salvaged valuable plant materials that otherwise would have been lost. Nearly the entire 35-acre site was dimpled in preparation for transplanting (Figure 8).

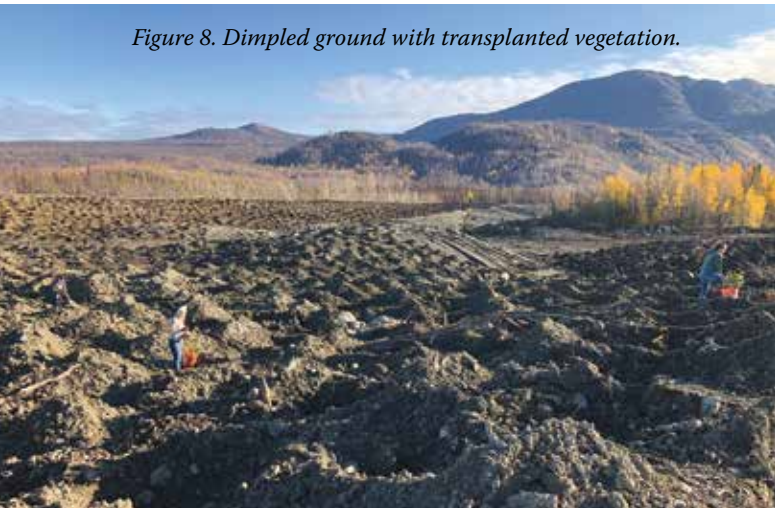


Figure 8. Dimpled ground with transplanted vegetation.

Transplanting individual plants across 35 acres was much more labor-intensive than transplanting vegetative mats with heavy equipment. The site was supposed to be topped with a minimum of six inches of organic topsoil, but either too little topsoil was placed or no topsoil was placed on a portion of the site. Much of this soil was a mixture of rocks and other mineral soil devoid of nutrients. We selected transplant sites based on the best available soil characteristics and seeded native grasses on the remaining areas where the substrates were of lower quality. We applied a granular NPK fertilizer to most of the site and will continue to do so for several years to facilitate the establishment of vegetation.

We used four-wheelers and 4x4 trucks to collect vegetation from the side of the nearby dirt road, hand-carried vegetation onto the site with five-gallon buckets and tree-planting bags, planted one or two plants in the bottom of each dimple to provide the best possible moisture regime and shade to minimize transpiration loss, and to facilitate plant establishment (Figures 9 and 10).

The first year of monitoring was in 2021. Even with irrigation, not all the transplanted plants survived. We are currently in discussion with the USFWS about doing some additional work at the site to help meet the long-term goal for the site: to restore ecological functions and values similar to those present in the surrounding, unburned forest. 🌱



Figure 9. Collecting vegetation from the narrow strip of ground adjacent to the dirt road that wasn't burned by the fire and vegetation collected by a student volunteer in a four-wheeler trailer to haul to the site for planting.



Figure 10. Transplanting of individual plants into dimples.

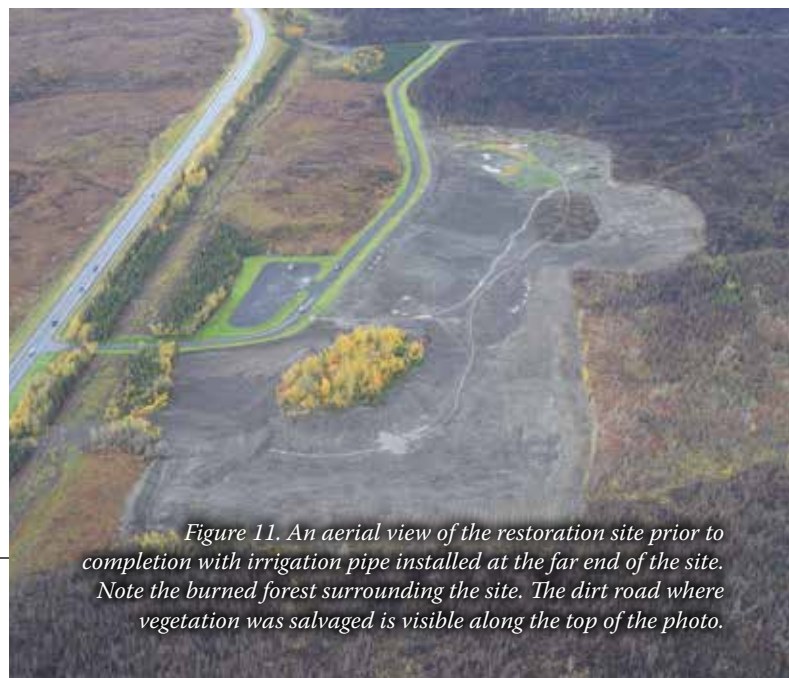


Figure 11. An aerial view of the restoration site prior to completion with irrigation pipe installed at the far end of the site. Note the burned forest surrounding the site. The dirt road where vegetation was salvaged is visible along the top of the photo.



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