

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation *matters*

Fall 2019



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Abandoned Mine Site
Reclamation Project**

Reclamation of the Poker Flats Mine, Alaska

Preserving Past Research via Geolocation

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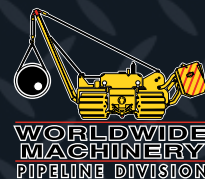
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The Future of the American Society of Mining and Reclamation

By Kevin Harvey,
President of ASMR



I first joined the American Society of Mining and Reclamation (ASMR or hereafter the Society) while I was a graduate student researching the prediction and mitigation of acid-forming overburden at a large open-pit coal mine in eastern Wyoming. I had the pleasure (it was really extreme terror) of presenting my research in front of several hundred reclamation professionals at the second annual conference of the then named American Society of *Surface* Mining and Reclamation held in Denver, Colorado in 1985. I know that when you're young, things sometimes look bigger than when you're older, but nevertheless, it was a huge and exciting conference. Being at that conference literally launched my career as a reclamation scientist.

Like all things, the Society has aged since those days; I know I have! At 46 years old, our Society is nearing middle age and may even be suffering from a mild form of "mid-life identity crisis." While my choice of words to describe what our Society may be going through might not be on target, I do know that our Society has been facing some challenges over the past several years. These challenges include a steadily declining membership and declining interest in its annual conference by attendees, speakers, and exhibitors. Most of the founding leadership has retired or is retiring soon. Interest by young people in reclamation science and the Society appears to be lower than what is necessary to sustain the Society. Yet, there is clear evidence that this nation – and indeed the world – needs what the Society and its members can offer, which is the

development and transfer of knowledge and technology to repair, reclaim, and sustain ecosystems disturbed by mining and numerous other disturbances of land and water resources.

Our society was originally formed to address the reclamation of lands disturbed by surface coal extraction within the Appalachian region of the U.S. A couple of decades later, the Society felt the need to broaden its scope when the "market" for their "products" expanded beyond "surface" mining. This prompted leaders of the Society to adjust the name by dropping the word "surface" from American Society of Surface Mining and Reclamation in an attempt to recognize all forms of mining.

As my Irish friends and relatives are fond of saying, *the only constant in this world is change*. Perhaps the world and its environmental science and technology needs are changing faster than our Society. Regardless, we appear to be facing a time when it may be necessary to broaden the Society's scope again and adjust the identity of our organization to recognize this. There is clearly no doubt that the scope of the Society has continued to organically evolve beyond mining, just as it outgrew an emphasis on only surface coal mining several years ago. It is clear to me why this is the case; mining is not and never was the emphasis of this organization; it is the *discipline* of reclamation science and its application that compels us to come together as a society.

The evidence is clear; our membership is comprised of, and our annual conference is attended by researchers, consultants,

managers, practitioners, teachers, students, product manufacturers, and others interested in the reclamation of land and water resources disturbed by mining, oil & gas production, industrial contamination, agriculture, commercial development, alternative energy production, forest and range fires, noxious weed invasion, etc.

Change can be scary, but I believe that change can also present opportunities. For our Society, change is necessary to respond to shifting needs of our world with respect to the reclamation of disturbed ecosystems. As I indicated above, we are concerned about membership, annual conference attendance, student participation, and other things. Recognizing and assessing these "leading indicators" of the health and sustainability of our non-profit organization prompted the current ASMR leadership team to develop a Strategic Plan to address these issues. Our past president, Dr. Gwen Geidel, penned a terrific summary of the plan in the spring issue of *Reclamation Matters*. If you have not already, I strongly urge members to read the 14-page Plan, which can be found here: <https://www.asmr.us/About-ASMR/By-Laws-and-Policies>.

Our hypothesis is as follows: we must adjust the scope and identity of the Society to recognize the organic change that is occurring anyway in order to capitalize on this groundswell and attract more members, conference participation, donors, students and early career professionals, and leadership from all sectors that rely on reclamation science. Viewed this way, this is really not change; rather it is recognition

of what is happening anyway and an opportunity to recruit a broader segment of this reclamation discipline group.

We have some initial data points that indicate the strategies and tactics presented in the Plan are already working to address these issues and prove our hypothesis. Many of the concepts presented in the Strategic Plan for recognizing the discipline of reclamation science beyond just mining were employed during the planning and execution of the Big Sky conference in 2019. The result was that attendance at the conference was up about 65 percent over the 2018 conference. We believe that we received a record number of abstracts for presentations. Contributions from donors were way up, along with the number of exhibitors. A big goal for me personally and many of the other Society leaders is to increase student participation. We had a significant increase in student attendees in 2019. In addition, we secured a few dozen new members.

We need to keep the momentum going and complete the transition of the Society's identity from a mining-related reclamation organization to an organization that emphasizes the discipline of applied reclamation science associated with all types of disturbance to land and water resources. To do this, the plan calls for us to do the following in the short-term:

- Adjust the name of the Society to recognize the broadening of our scope beyond mining and our focus on the discipline of reclamation science (note that at the time of this writing, the leadership of the Society are summarizing the input from the membership on adjusting the Society's name and preparing to ask for a final vote from the full membership).
- Revise the definition and mission statement of the Society to reflect the objectives of the Strategic Plan and to recognize the organic transition that has already occurred and is called for in the plan.
- Update the "branding" of the Society to reflect the name and scope adjustment, including a new logo and updates to our website, social media sites, periodicals, awards program, and other programs. With respect to the

Society's website, this basic marketing work will include website/search engine optimization tactics to increase interest and membership.

There are many more short- and long-term goals and action items presented in the plan to achieve our overall objective of increasing membership and promoting technology transfer. But if we do nothing

else but execute the action items listed above over the next six months, we will go far in achieving the overall objective of the Strategic Plan. Thank you for electing me president of this outstanding organization. If you have any input for me regarding the future of this society, please feel free to share that by contacting me at kevin@kcharvey.com. ■

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The Re's of Reclamation

By Jeff Skousen,
West Virginia University

In science and technology, terminology is important. Words have specific meanings and writers must honor these meanings to communicate effectively. This point is illustrated in the following story.

Several months ago, I sent a manuscript on tree growth in mine soils to a journal for publication, and the editor of the journal sent it to other subject matter experts for review. One of the reviewers was critical of the term “reclamation.”

The reviewer's comment suggested our manuscript was not current with internationally accepted terminology and cited the International Standards for the Practice of Ecological Restoration (Society of Ecological Restoration (SER); McDonald et al. 2016). He felt this reference clearly articulated vocabulary that should be used in reclaiming lands to different post-disturbance activities. Further, he said that “reclamation” is no longer widely used by the international scientific community. He pointed me to a rebuttal by Cross et al. (2018) entitled “Appropriate aspirations for effective post-mining restoration and rehabilitation: a response to Kaźmierczak et al. (2017).”

I reviewed all three articles and then wrote a detailed response to the editor explaining my position. I'm sharing it here in *Reclamation Matters* since it has relevance to our attempts to rename ASMR using appropriate terminology. Here's what I wrote:

These articles attempt to redefine vocabulary associated with reclamation sciences. The rebuttal in Cross et al. (2018) attempted to clarify terms such as restoration, reclamation, revitalization, and rehabilitation, which were also addressed in Kaźmierczak et al. (2017). Definitions for reclamation science vocabulary is not new. Terms such as these were discussed back in the 1960s as mining and reclamation laws were being drafted. In a classic and respected book entitled *Reclamation of Drastically Disturbed Lands*, Dr. Thadis Box repeated the definitions based on standard terminology published by the National Academy of Sciences (1974).

Restoration means that “the exact conditions of the site and the species present before disturbance will be replicated after disturbance.” Based on this definition, he states, “thus, complete restoration is seldom, if ever, possible.” Restoration suggests that the same individual plant and animal species, including *all* ecosystem components in all their complexity, along with the same conditions (soil, water, and climate) will be returned to the site.



Reclamation implies that the site will be “habitable to organisms originally present in approximately the same composition and density after the reclamation process has been completed.” In principle, this is the terminology used in the Surface Mining Control and Reclamation Act, which establishes standards in the US during reclamation of disturbed lands, and which many countries have mirrored in their reclamation laws.

Rehabilitation means that the disturbed site “will be returned to a form and productivity in conformity with a prior use plan.” This definition infers that the site is rehabilitated with species and conditions that may or may not have been present before mining and the site is developed into a condition that has societal and environmental value.

In the reviewer's mind, these three words do not provide enough clarity for the myriad of ecosystem redevelopment activities that occur on disturbed lands. There are many words that touch upon the concept of bringing back or returning disturbed land to a natural or useful state (Figure 1). Our ability to communicate the type of ecosystem establishment that occurs on disturbed lands is critical to planning, design, implementation, and assessment.

The Re's of Reclamation		
Rebuild	Reclaim	Rehabilitate
Reconstruct	Remediate	Reinvigorate
Recover	Renovate	Renew
Recoup	Replace	Repair
Recycle	Replant	Re-erect
Redesign	Restructure	Remake
Re-establish	Resource	Retain
Regenerate	Restore	Reform
Regreen	Reconstitute	Return
Regrow	Revegetate	Reforest
Re-inhabit	Revitalize	Re-engineer

Figure 1. A short list of potential words that are part of reclamation.

My response continued with...

The definitions of *restoration*, *reclamation*, and *rehabilitation* provided by Box (1978) and NAS (1974) are still relevant. The fact that SER (McDonald et al. 2016) has attempted to redefine these terms and remove reclamation from the list doesn't negate the definitions used previously by others, nor are the new words and meanings described by Kaźmierczak et al. (2017) widely accepted by the international reclamation community. In fact, the test of time has shown no need to redefine these three terms since 1974, not at least until some person(s) in the SER felt it necessary in 2016 (42 years later!). And the fact that Cross et al. (2018) is a rebuttal to the definition of terms recommended by Kaźmierczak et al. (2017) shows that there is hardly consensus on the subject.

Further validation of the term reclamation could be made by an active organization known as the American Society of Mining and Reclamation (ASMR) <https://www.asmr.us/>, which has existed since 1980 and meets annually at a conference with an attendance of 200 to 400 persons.

I think the reviewer is incorrect, and his statement that "reclamation is no longer used by the international scientific literature" to be false. Therefore, we have not changed the manuscript with reference to these comments.

Many of the "Re" words in Figure 1 are pre-associated with specific settings. For example, "restoration" is most often used in the context of restoring a home or automobile to make them as originally built (or appear that way). "Revitalization" (one of the new terms suggested by Cross et al.) is normally thought of in the context of urban environments, where rundown neighborhoods are torn down and built with more current housing and building standards. "Rehabilitation" is commonly connected to integrating ex-convicts or persons addicted to certain substances into society. Each of these terms are more clearly defined when one places the adjective "land" in front of it, and it becomes a more precise description. For example, "land remediation" could mean that the pollution in the soil has been eliminated, rather than remedial reading programs or remediation therapies.

"Reclamation", however, is the term that is typically related and applied to land. Therefore, it is my contention that "reclamation" is still a valuable and useful term for describing the return of useful ecosystems to disturbed lands and that this term relates to those areas which have been transformed in a fashion that is more or less similar in soil and hydrology, species composition, and ecosystem structure and services that existed prior to disturbance.

As stated in my last editorial in *Reclamation Matters* (Spring 2019), *reclamation* today is devoted to *rebuilding* thriving landscapes, *re-establishing* functioning hydrologic systems, *returning* living soils, and *restoring* resilient plant communities that are alive, healthy and sustainable.

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2019 Wild Women of Reclamation

By Michele Coleman

We had an incredible turn out at the 6th Annual Wild Women of Reclamation (WWR) meeting in Big Sky, Montana, held in conjunction with the 36th Annual Meeting of the American Society of Mining and Reclamation on June 3-7, 2019. We had a record turnout for both participants in WWR and for women overall involved in the conference. Forty women participated in the photo shoot or just missed it with additional women showing up later for the two presentations. We thank everyone who participated, brought a friend or encouraged attendance.

This event allows an additional networking opportunity for women in all stages of their careers. It is much easier by being in a smaller group to make new contacts and to feel less isolated at the conference whether you are a new member or don't have a large network. By increasing our networking circle at the conference, women increase their enjoyment of the conference by technical exchange opportunities, which promotes camaraderie through "team building." Connections with others lowers stress levels and improves self-esteem and well-being. Most of us have felt lonely or unconnected at conferences or events because we don't know anyone else or only a few people. All of us can recall a time when someone came up to us at a meeting, introduced themselves and talked to us. They may even have commented on our presentation or poster and encouraged us. A secret to surviving and enjoying large meetings has been to find someone who looks alone and strike up a conversation, find a common interest, and develop a friendship. This technique allowed us an opportunity to make many friends at ASMR events and other venues. This technique is apparently not a secret; check out https://www.huffpost.com/entry/the-importance-of-network_b_9039062.

A new participant to this year's conference, Debby Slovikosky (Saint Francis University), emailed this affirming comment after the conference; "I think that the WWR meeting was great for networking and getting to know other people in the field. It was nice to be able to see familiar faces throughout the week and I really enjoyed all the reclamation talks I attended. Overall, I really enjoyed my first experience at ASMR, and I hope I'll be able to return another year." That is exactly what we are trying to achieve with each year's WWR gathering.

Enough about inspiration...now onto a recap of the WWR event.

Our presentations highlighted that we are not alone. The experiences, challenges and fears of changing directions are felt by many of us during our careers and it is reassuring when we can hear of the obstacles, leaps of faith and or changes that others have weathered. Some challenges are unique to women and Dr. Natalie Kruse-Daniels from Ohio University presented her experiences when bringing nursing babies to work and conferences, and how others dealt with these situations. Additional presentations by two young women illustrated that career paths often require desire, initiative and major leaps of faith to locate in different regions and countries, which are accompanied by new and exciting events along the way.

Some, like Dr. Natalie Kruse, know at a very young age where their interests lie, but may not yet have a straightforward path to get to the final destination. Natalie had been interested in water quality issues at a very young age, and photos of her at science fairs illustrated that she was very focused in a specific area of research by Grade 8. But even while getting her bachelor's degree, she could not have imagined that her next step would be to study abroad and get her PhD and then end up back in the U.S. teaching at Ohio University, teaching at the same place she had started at. Natalie is an incredible woman: she juggles raising a young family of two boys, living on a farm, volunteering to teach students and local residents about water quality while also on a tenure track position at the university. Natalie manages her time effectively, but she also credits understanding and flexible leaders at her university and the willingness to engage her young children into her work schedule. Talent and hard work were instrumental in having the right skill set and tools for when a position opened at Ohio University. And maybe some serendipity helped.





Wild Women 2019 | Big Sky, Montana

Front Row: Staci Shoemaker, Jennifer Franklin, M'Kenzie Dorman, Michele Coleman, Gwen Geidel, Christine Brodsky, Zepei (Maggie) Tang. Second Row: Brea Burton, Kaitlyn Trepanier, Jennifer Buss, Randi Lupardus, Sage Tanck, Karlee Ketelboeter, Debby Slovikosky, Natalie Kruse, Meghan Blair, Ellie Leavitt, Heather De-Quincey. Third Row: Hannah Patton, Ashley Rovder, Gina Clingerman, Julie Lucas, Abby Rosenau, Kara Hass, Hannah Angel, Maggie Eshleman. Back Row: Rachel Wagner, Kari Lagan, Adriane Limmex, Brianna Hall, Rebecca Steinberg, Cassie Phillips, Sara Kloth, Marsha Patelke, Rachel Hohn, Abbey Wick, Danielle Duhé, Summer King.

Missing: Brenda Schladweiler, Rachel Schmidt.

Meghan Blair had a fascinating educational path before becoming a groundwater geologist for Barr Engineering. Meghan talked about not passing up an opportunity for experiences as a field assistant, especially when it led to opportunities to travel to other countries on somebody else's money. She considered the opportunities afforded her could open doors to other opportunities. She also talked about the courage necessary to change the path you are on when you discover an area that is much more interesting than the path you are currently on. Changing early in your degree or career is easier before a large financial or time commitment has been made. It is not that your first decision was a wrong decision, but your thinking and attitudes change with time and learning. And remember, education is never wasted as it always helps to inform future decisions, whether at work or at life. Changing directions just means that you are now aware of an area of considerably more interest and to which you may want to make lifelong contributions. Meghan is also Chair of the ASMR meeting in 2020 so she will have her hands full over the next year. If you have any interest in helping Meghan out, please contact her at MBlair@barr.com. Your help could involve being a moderator, helping to prepare the program or

field trips, or even working a shift at the registration desk, or helping at other times at the conference, volunteers are always welcome.

I counted participants from 12 different Universities at the WWR event, and students came from 10 of those institutions. During the networking event, we each connected to at least one woman who is new to this organization or to the field of reclamation. This interaction is geared so that we can offer encouragement and support both during the conference and throughout the year. Please reach out to your new colleague throughout the year, asking about their work and possibly even encouraging them to attend ASMR in 2020 and submit a poster, presentation, or video.

We would also like to announce that Rachel Hohn has graciously volunteered to assist Cindy and Michele in keeping the WWR group, their newsletters, and their meeting running smoothly. **Welcome aboard, Rachel!** ■

Michele Coleman (mcoleman@nbpower.com)
Cindy Adams (cindy@ecopoint-inc.com)
Rachel Hohn (rachelhohn@gmail.com)

Reflections of a High School Intern working in Geophysics

By Jonathan Bennett, Denver, Colorado



Jon Bennett with Brian Rodriguez of USGS.

This past July, I had the opportunity to work with the USGS (United States Geological Survey) on one of their projects in San Juan County, Colorado. As a high schooler who is not sure of my career path or future direction, this was an excellent opportunity to see if I enjoyed doing geophysical or geological work. It was also a great opportunity to meet, chat, and work in the field with students working in geology. This project received funding from the USGS following the Gold King Mine spill in August 2015 and the subsequent superfund intervention from the EPA. Our work was done in the San Juan and Silverton Calderas, two volcanic structures which collapsed because of magma erupting on a ring fault. These two calderas were heavily altered between the time it was formed until today, resulting in heavy mineralization throughout the San Juan Mountains.

We used natural magnetotellurics (MT) to study the mountains around us, providing a better understanding of what lies beneath our feet. Throughout our studies, I learned about the reason why this method was referred to as natural, instead of controlled-source magnetotellurics. Our group harnessed lightning activity on the equator and solar wind-charged particles as our main sources of signal for the MT method,

hence being known as “natural.” Our MT work tended to be more difficult during daytime hours, as this kind of survey was extremely sensitive towards noise and any metal moving through the electromagnetic field. It also took much longer to set up. Generally, we were set up near a major roadway because our equipment was bulky, making it tough to haul to any remote site (Picture 1). Whenever a car would pass during our low-band readings, we would have to start the process over, as it confounded our data, making it incomprehensible.

A second method used audio magnetotellurics, or AMT for short. These readings were much faster and were next to impossible to interrupt, as we would be taking thousands of samples per second. Unlike its MT counterpart, AMT readings image subsurface resistivities at a much shallower depth.

Both methods required different equipment and recorded data in different ways. For example, the MT measurements needed much larger coils and electrodes because of its deeper range, while the AMT setup was much more compact and easier to put together. Despite AMT being quicker to piece together than MT, our group was only able to survey two sites per day, as collecting data with both methods normally took 60 to 90 minutes.

Our work was done in conjunction with two other studies conducted by the USGS for this overall project. During April and May, when there was still a large amount of snow covering San Juan County, the USGS flew an airborne electromagnetic survey, mapping the apparent conductivity of widespread regions in the mountains around Silverton. This map also showed faults and veins seen while mapping. It gave the USGS an idea of what lies beneath our feet in the San Juans, but this airborne survey could only see a maximum depth of 150 meters into the ground, while our MT surveys could penetrate for tens of kilometers.

Another crew focused on surveying parts of the Silverton Caldera that were not accurately shown on alteration maps. I was only able to spend one day with this group where we measured the magnetic susceptibility of several rock outcroppings. We were successful, finding around seven or eight outcroppings that had not been measured before. From this experience, I learned why the magnetic susceptibility of propylitically altered rocks is much lower than those without alteration. It has to do with the amount of magnetite left in the rock, with propylitic alteration often destroying magnetite. The final goal for the USGS with these surveys was to create a 3D model of both the Silverton and San Juan Calderas. Both surveys I participated in were excellent experiences, helping me understand more about both geophysics and geology.

What I found most interesting about this entire experience were the ways the data could be applied to not just the Silverton region, but to other heavily mineralized and mining-influenced regions of the world as well. First, the data could be used for mineral exploration in the future, especially as mineral exploration gets more and more difficult. Although this setup is expensive, the potential for discovering veins and deposits is great. The second application – and what I see as most important in the Silverton region – is the ability to track water influenced by heavy metals from above ground. Since acid mine drainage is high in conductive ions, the instrument we used can see and track it. With the high amounts of acid mine drainage flowing into the waterways in San Juan County, it's important to see the source of this water in order to develop plans for remediation. Despite the data seeming meaningless as it is being collected, it is truly valuable when processed and applied properly.

The overall experience from the 15 days I spent with the USGS was unforgettable and something I wish I could continue. Even if I never fully understood some of the things we did, I learned much more than I thought I would. For me, these 15 days of long, difficult work showed me that a career in geology or geophysics is something I'm interested in, and something I will have to look into for my future. ■



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Speed Networking Works for ASMR!

By Hannah Angel, Early Career Representative



On the evening of Thursday, June 6th, long-standing members of ASMR gathered with early career professionals (ECP) at Andiamo Italian Grille in Big Sky, Montana, to enjoy food, drinks, lively conversation, and to make new friends. About a half hour into the event, Rachel Schmidt, who helped organize the conference, shared a welcoming note and thanked the ECP event sponsors – Virginia Tech, Inter-Mountain Labs, and one anonymous donor. Because of the gracious support from our sponsors, we are able to organize fun and successful professional early career socials like this one. Following Rachel's opening remarks, I welcomed the crowd and introduced the next phase of the event – ASMR's first ever Speed Networking game. Early career people were situated on one side

of the table, while late-career people sat on the opposite side. Every five minutes, the early career folks were instructed to move one seat down and rotate partners. This promoted an "ice-breaker"-style way to meet and connect with more people than would normally be expected within a two- to three-hour social.

With smiles, handshakes, and cheerful energy, the success of this event highlighted the meaning and importance of its intent. ASMR is committed to helping early career professionals discover new perspectives and interests, career opportunities, and establish life-long contacts within the broad field of reclamation sciences. One of the best ways to do this is to build relationships with experienced professionals. With this in mind, we are brainstorming ways to encourage participation at the ASMR conferences and effectively communicate

information and opportunities within the ECP community.

This upcoming year, ASMR's conference will be held in beautiful Duluth, Minnesota, June 7-11, 2020. We are finding an exciting venue for the Early Career Professionals Social that is spacious and representative of the essence and culture of Duluth. In addition, we are planning to host "meet-and-greet breakfasts" throughout the conference week to connect undergraduate and graduate students and other early career people. Group breakfast chats will also be organized for other types of communities within ASMR.

We are looking forward to seeing you in Duluth! As always, please reach out to me if you have any questions and/or suggestions regarding ASMR's ECP community (angelhz@vt.edu). ■

ASMR AWARDS

Dennis Neuman - William T. Plass Lifetime Achievement Award

Dennis Neuman's contributions to the field of land reclamation span more than 40 years – from his first position as a research chemist at the Reclamation Research Unit at Montana State University in 1973 to serving as the director from 1996 to 2006. His dedication and service to the Research Unit at MSU are revealed by his direct supervision or participation in all the key research programs that were carried out for government agencies and industrial clients throughout his time at MSU. Under his direction, the Research Unit earned a world-wide reputation for their contributions to applied reclamation science and developed one of the first graduate degree programs in land rehabilitation.

Dennis has educated and mentored generations of reclamation scientists and practitioners, transferring reclamation knowledge and technological advancements throughout the world. He has directed the implementation of reclamation science-based approaches to remediate some of the most contaminated sites in the world. One such site he was passionately involved in was the Anaconda Smelter and Clarks Fork River CERCLA complex in MT that was the largest superfund site in North America at one time. Dennis also has contributed to the transfer of knowledge and technology by organizing and hosting the well-known and well-attended biannual Billings Land Symposium series from 1996 to 2009. The Symposium Series unfortunately ended



when Dennis retired from MSU, and he has pursued a career in the private sector as a land reclamation consultant since his retirement. While consulting, he has led many successful reclamation and remediation projects and continues to advise many governmental agencies on sound reclamation practices.

Dennis is still actively involved in ASMR and has served many dedicated hours on the NEC board and a term of president, leading at a time of crucial change and growth. Dennis is a modest individual who does not strive for recognition as this is his first ASMR award achievement after years of outstanding beneficial involvement in the reclamation field.

Congratulations Dennis on a well-deserved recognition.

Natalie Kruse-Daniels - R.I. & L.M. Barnhisel Reclamation Researcher of the Year Award

Dr. Natalie Kruse is an associate professor and director of the Environmental Studies Program at Ohio University in Athens, OH. She received her BS degree in civil engineering with a minor in geological sciences at Ohio University in 2004, and then earned her PhD in civil engineering and geosciences at Newcastle University in northern England. She worked as a research associate at the Swan Institute of Energy Research at Newcastle from 2007 to 2009.

Dr. Kruse began her career as an assistant professor at Ohio University in 2009. She has shown outstanding leadership in

reclamation research while focusing on water quality topics in the coal mining and shale oil & gas extraction industries. Her research entails a variety of hydrologic issues of both surface and groundwater. Her work mostly focuses on the effects of AMD on watershed recovery; and the management, characterization, and treatment of hydraulic fracturing waste fluids.

As a member of the Appalachian Watershed Research Group at Ohio University, she manages multiple staff and graduate researchers while securing millions of dollars of research funding. Dr. Kruse's long list of publications and presentations recognizes her passion to return ecological function to many disturbed hydrologic systems. Dr. Kruse's desire to transfer her knowledge and experience is the foundation for which this award was established to recognize. In 2019, she was appointed as Director of the Environmental Studies Program at OU. While most of Dr. Kruse's time is tied up with academic oversight and research, she is still involved in many professional societies, and we wish her continued success in her endeavors.

Congratulations Dr. Kruse!



Derek Launius - Reclamationist of the Year Award

Derek Launius received two BS degrees from the University of Southern Illinois in Carbondale in Plant and Soil Science and Mining Engineering. He then received his MBA from McKendree University while starting his career at Peabody. He is a Senior Engineer at Peabody's Wildcat Hills-Cottage Grove Mine, being responsible for everything involving reclamation. Additionally, he is responsible for the reclamation husbandry and regulatory interactions at multiple other Peabody closed mines in the mid-west region.

For the last 12 years, Derek has implemented multiple agricultural and soil science best management practices into the reclamation planning at various Peabody mine sites. These protocols have improved the disturbed ecosystem in one of the most productive agricultural regions of Illinois. His implementation of these practices has helped under-achieving reclaimed prime farmlands meet or exceed regulatory



standards for Proof of Productivity. This has led to a variety of national and regional honors and awards for the mines for which Derek has reclamation responsibility.

As well as his busy schedule at work, Derek is involved in the agricultural

community surrounding the mines and is often sought to lecture at workshops and conferences to share his knowledge. He also operates his family farm and mentors local youth to become aspiring farmers.

Congratulations Derek!

Cody "Buck" Neely - Early Career Award

Buck Neely completed a BS in Environmental Engineering at Gannon University in 2008 and then received his MS from the University of Oklahoma in Environmental Engineering in May 2010. He then started his career in mine land and water reclamation projects. Buck

also received his Professional Engineer license in three states in 2017, making him a PE in Pennsylvania, West Virginia, and Oklahoma.

According to his nominator, Buck's work ethic, innovative skill set, and positive

attitude are top rate. Buck's work does not stop with design – you are also likely to see him working diligently in project management, construction oversight, equipment operating, and data collection with report writing. Through all the projects that Buck has been involved with during his academic studies and reclamation career, he demonstrates the diversity of skills and competence needed for future achievements. One of Buck's most impressive achievements is that his work has led to fish being observed in a stream that was previously deemed by the US EPA as irreparable. This is an outstanding achievement for anyone with many years of experience, and remarkable for an early career individual. Buck has even gone beyond his work in the US by collaborating with the nonprofit organization Engineers in Action, designing a mine water treatment system in the high Andes mountains of southern Bolivia.

Congratulations Buck, for this recognition of your early career achievements.



The Late Tom Henderson - Pioneer in Reclamation Award



Tom Henderson led a career in reclamation that has left a memorable impression with all those who have been touched by his passion for ecosystem restoration. Tom's career in reclamation started in the south east region of the United States with multiple regulatory positions in Kentucky. He then spent some time in the private sector with a consulting company in Denver, Colorado. In 1997, he returned to the regulatory world with the Montana Department of Environmental Quality Remediation Division, and in 2001, he took time to further his education. In 2004, he received his PhD degree from the University of British Columbia and then returned to the MT DEQ where he continued his reclamation passion until his untimely passing.

His passion for reclamation can be characterized by two projects he conducted while working with the Montana Abandoned Mine Lands Program. His tireless efforts in restoring damaged ecosystems touched the lives in many people in small communities in Montana. The McLaren Mill and Tailings project near the north entrance to Yellowstone National Park in Cooke City addressed heavy metal tailings contamination into Soda Butte Creek. The cleanup efforts were impacted by steep terrain,

challenging weather conditions, and short time periods, making this successful project more of an outstanding achievement. The cleanup included two years of investigations and design followed by five years of construction to restore the ecosystem so close to Yellowstone. Tom was part of the team that coordinated with the National Park Service throughout the project. The project was completed in 2014 and has received national awards and resulted in Soda Butte Creek being removed from the impaired stream list in 2018 by the MT DEQ. Tom also served as project manager for the construction of a new drinking water system for the community of Sand Coulee in Montana. The original water system had been heavily impacted by acid mine drainage, with the new system being recognized by national awards.

At the time of Tom's passing, he was designing an AMD water treatment plant in Belt, Montana to restore Belt Creek to a fishable stream system for all those in the town of Belt.

Congratulations to Tom and to his family. Andrew Ray, of the National Park Service, and Tom's wife and children accepted this award in Tom's honor.



ASMR SCHOLARSHIPS

Michael Nattrass - ASMR Memorial Scholarship - PhD

Michael is a PhD student studying environmental plant and soil sciences at Mississippi State University. His research focuses on constructed wetlands as a passive water treatment strategy. After graduation in December 2019, he hopes to bridge the gap between industry and academia, from either side, by providing soil and water quality management options for public and private stakeholders.

Megan Ostrand - ASMR Memorial Scholarship - Master of Science

Megan is working toward her MS degree in Soil Science at North Dakota State University. She studies surface coal mine reclamation – specifically, methods to alleviate compaction and improve soil physical properties. She will graduate in fall 2019 and pursue a career in environmental consulting. She is excited to utilize her GIS skillset. While not working, she enjoys functional fitness, frisbee golfing, and being outdoors with her dog Avery.



Ashley Rovder - ASMR Memorial Scholarship - Bachelor of Science

As a graduating senior in the environmental engineering department at Saint Francis University, Ashley had many opportunities to explore various areas of the reclamation field. She worked on problems associated with acid mine drainage in Pennsylvania, wetland plants in treatment systems in South Carolina, algae as a nutritional supplement in Bolivia, and sources of turbidity and best management practices concerning a local reservoir's watershed. Throughout all of this, however, she worked with ASMR on a research site location project spanning all four years of her college career, which gave her both experience and a familiarity with the field of mining and

reclamation. After graduation, Ashley is working in South Carolina at the Nuclear Power Training Unit-Charleston as an Associate Reactor/Refueling Operations Engineer. She hopes to eventually volunteer on sustainability and reclamation projects in developing areas using all the abilities gained so far, and in time, share this knowledge and my experiences with young professionals.



ASMR Presentation Awards



Michelle Valkanas, 1st Oral Presentation



Michael Curran, 2nd Oral presentation



Cassie Phillips, 3rd Oral Presentation



Megan Ostrand, 1st Poster Presentation



Charles Spellman, 2nd Poster Presentation



Kaitlyn Trepanier, 3rd Poster Presentation

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EXHIBITORS AT THE 36TH ANNUAL ASMR MEETING IN BIG SKY, MONTANA



Jason Stevenson - Stevenson Seed



Kevin Harvey, Dirk Applegate - KC Harvey



Trihydro



Sam LaMotte - ACZ Labs



Bob Darmody, Meghan Blair, Gwen Geidel - ASMR



Chris Bowles, Kara Haas - Ramboll



Steve Anderson - Water & Environmental Technologies



Hayley Couture - Midas Gold



Len Ballek - Herrera Inc.

EXHIBITORS AT THE 36TH ANNUAL ASMR MEETING IN BIG SKY, MONTANA



Jon Hager - Energy Labs



Mohamed Gamal, Robert Mascarenas,
Dave Hibbard - Brierley Assoc



Lauren Alaniz - ECB Verdyol



GeoEngineers



Mark Sembach - Bio Lynceus



Eric and Bill Krippaehne -
Pacific Inter-Mountain



Marcus Anderson - Foam Concepts



Chris Liller - ERTEC



James Truax, Maurice Davis - Truax Co.



Office of Surface Mining

EXHIBITORS AT THE 36TH ANNUAL ASMR MEETING IN BIG SKY, MONTANA



Pace Analytical



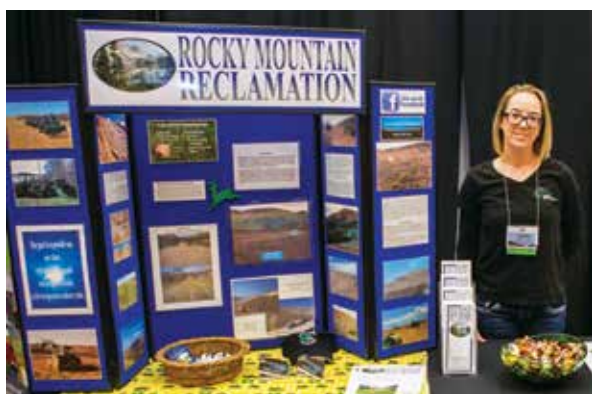
David Weigand - Arkansas Valley Seed



Gord Pearce, Daryle Bennett - Granite Seed



Tom Tenerovicz - Voss Signs



Amber Trevizo - Rocky Mtn Reclamation



Cedar Richards, Marty Bennett, Pierre LeMieux - Pioneer Technical Services



Joe Naughton, James Brown, Seth Cude - RESPEC



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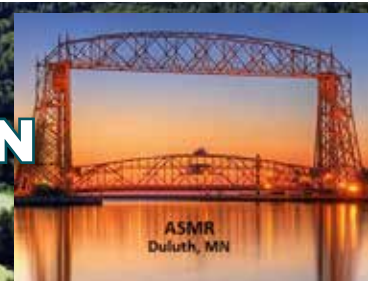
AMERICAN SOCIETY OF MINING AND RECLAMATION

37th Annual Meeting

June 7-11, 2020

Duluth, MN

Transforming Pits and Piles into Lakes and Landscapes



Call for Abstracts

This conference will focus on, but will not be limited to, the technical areas identified below and will provide a forum for the dissemination of information through presentation of research findings, field tours, workshops, and open discussion of public policy relating to mining and other mineral extractions, reclamation, restoration, reforestation, and land management issues.

Submission of abstracts and other items should be sent to Robert Darmody, ASMR Executive Director: rdarmody@illinois.edu.

If you are interested in moderating and/or organizing a session, or developing a workshop, please contact Meghan Blair, local planning committee chair: MBlair@barr.com

Paper Categories

Abstracts can be for oral Power Point presentations (25 minutes max), posters, or video presentations. **Draft copies of**

abstracts are due by January 11, 2020. Abstracts will be placed on the ASMR.US web page prior to the meeting and Power Point presentations and videos will be uploaded to the web after the meeting, pending the author's permission. Four types of papers will be considered. Blatant "Infomercials" are not allowed.

1. Research paper – these papers should be replicated lab or field research.

2. Case Studies – include, but are not limited to, non-replicated field or lab studies and may be examples of mitigation tactics that have been employed at a field site. They could be replicated projects in space and time, but have not been subjected to statistical analyses.

3. Demonstration project – these may be demonstrations of a new product, method, or technology of commercial value, but presented with defensible data and be more than just a clever sales pitch.

4. Other – these may include such presentations as a policy paper.

Program and Other Important Dates

The Program Committee invites the submission of abstracts - deadlines are as follows:

1. Abstracts (200-350 words, see example) and submittal forms, should be received by **January 11, 2020**.
2. Acceptance of the abstract will be sent to the author after review, by January 25, 2020.
3. Abstract revisions, if necessary, must be received by **April 12, 2020**.
4. All PowerPoint presentations must be turned in upon arrival at the registration desk so that they may be placed on the appropriate computers. A cloud site will be established for abstract uploading as well.
5. Times for individual presentations will be posted on the ASMR.US web page as soon as the program has been finalized.
6. Presenters must register for the meeting before **May 3, 2020**.

ASMR 2020 Conference Abstract Submission Form



Corresponding Author: _____

Paper Title _____

Agency/Company: _____

Address: _____

City, State, Zip _____

E-Mail: _____ Telephone: _____

Presenter Name _____ *Student? _____ Yes _____ No

Co-Authors: _____

Submit your abstract and this form as Word or pdf files by January 11, 2020 to: rdarmody@illinois.edu

Presentation Format: _____ Oral _____ Poster _____ Video (see video info)**

Presentation Type: _____ Research Paper _____ Case Study _____ Demonstration Project _____ Other

Will you submit a written paper to JASMR? _____ Yes _____ No

If yes, please contact R. Barnhisel, JASMR editor, for specifics: asmrjournal@twc.com

Allow presentation to be posted on ASMR.US _____ Yes _____ No

Number the top three technical divisions in which you feel your presentation best fits for review and approval of your abstract:

_____ Ecology _____ Forestry/Wildlife _____ Geotechnical Engineering _____ Refuse and Tailings

_____ Land Use Planning and Design _____ Soils and Overburden _____ Water Management _____ Revegetation

***** Workshop Sessions *****

If you have ideas for workshops/symposia, please contact Meghan Blair, MBlair@barr.com 218-343-1835

* ASMR Student members who are presenting a paper may be eligible for a Student Travel Grant and/or to compete for cash awards in the Student Presentation Competition. See the ASMR.US web site for details.

** Oral presentations will be in 30 min. time slots, posters need to be < 4 x 6 ft., videos 2-10 min. length

***** ASMR CONFERENCE ABSTRACT EXAMPLE *****

The Use of Spectral Reflectance as a Reclamation Tool¹

A.J. Smith*, B.C. Jones, and C.D. Doe²

Abstract: Detailed abstracts are limited to 200 to 350 words and should provide statement of the problem, methods and materials, experimental design, major results, and conclusions. The language of the Conference is English. The title of your abstract should be short and descriptive. The footnote 1 refers to the meeting. Indicate the presenter by an asterisk after their name. The footnote 2 refers to the author's credentials. The text of your abstract should use 12-point font, Times Roman preferred, single-spaced. The margins of the text should be 1 inch on all sides. Units of measure are to be expressed in SI Units, such as g m⁻² (grams per square meter), mmols kg⁻² (millimole per kilogram). Non-SI Units and English units are to be avoided. The use of color graphics and electronic images is acceptable. Please indicate the Technical Session in which you think your paper should be considered from the list on the submission form. Identify additional key words. Indicate title and organization for each author, students should be identified as such. Give the location of the work, if it is field-based and OK with the principles, as footnote³.

Additional Key Words: Listing of those not in the title.

1. Oral (or Poster or Video) paper presented at the 2020 National Meeting of the American Society of Mining and Reclamation, Duluth, MN. June 7 - 710, 2020. Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

2. Allen J. Smith (* presenter), PhD Student, and Barbara C. Jones, Professor, Plant and Soil Sciences, University of Kentucky, Lexington, KY 40546; and Charles D. Doe, PhD Candidate, University of Illinois, Urbana IL 61801.

3. Work reported here was conducted near 40° 06' 07" N; 88° 14' 59" W.

Abstracts are to in 12 point Times New Roman and sent electronically to rdarmody@illinois.edu along with the completed submission form. For additional information contact: Robert Darmody or Meghan Blair, ASMR 2020 Conference Chair: MBlair@barr.com, 218-343-1835.

The McLaren Tailings Abandoned Mine Site Reclamation Project

By Marty Bennett

Sitting at an elevation of 7,550 feet, the McLaren Tailings Abandoned Mine Site is adjacent to Cooke City, Montana, and immediately upgradient of the Lamar River located in Yellowstone National Park (Picture 1). From 1934 to 1953, the McLaren Mill processed gold and copper, and the mining operations dumped tailings into Soda Butte Creek, a tributary of the Lamar River. For more than 80 years the McLaren tailings leached metals into Soda Butte Creek impacting aquatic life below the site. By 1960, Soda Butte Creek was the most contaminated stream entering Yellowstone. The McLaren Tailings Abandoned Mine Site Reclamation Project (McLaren Tailings Project) was successful in restoring Soda Butte Creek, restoring the aquatic habitat, and protecting the water resources of Yellowstone.



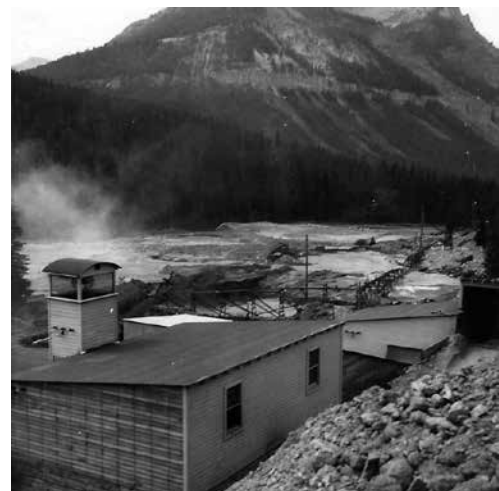
Picture 1. Location of the McLaren Tailings site near Cooke City, MT, and just north of Yellowstone National Park.



Picture 2. Location of McLaren Tailings, north of Cooke City and Yellowstone National Park.

McLaren Tailings Beginning

In 1933, the McLaren Gold Mines Company discovered the McLaren deposit on Henderson Mountain. In 1934, they constructed a mill (Picture 3) and a tailings impoundment. The McLaren Mill produced a gold and copper concentrate. During operations, tailings from the mill were dumped into Soda Butte Creek as well as placed in a tailings impoundment. Park Rangers from Yellowstone documented a regular pattern of leaks and breaks in the dam surrounding



Picture 3. McLaren Gold Mines Mill (1934).

the tailings impoundment. Tailings from both the creek and the impoundment were flushed downstream into Yellowstone National Park. The mill operated until 1953; however, closure did not end the downstream environmental impacts. By the late 1960s, Soda Butte Creek was considered the most polluted stream entering Yellowstone National Park. Investigations showed that ferrous iron precipitates and heavy silt loads from the tailings were adversely affecting the fish-producing capacity of Soda Butte Creek within the Park. In 1969, Bear Creek Mining, the site owner and a Kennecott Corporation subsidiary, rehabilitated the site by covering the eroding tailings with soil, demolished the buildings, and excavated a new channel for Soda Butte Creek along the north side of the tailings impoundment. The problem, however, persisted.

Subject to an Emergency Response Action by the U.S. Environmental Protection Agency (EPA) in 1988, Kennecott completed corrective actions from 1988 to 1990. In March 1991, the Bureau of Reclamation evaluated the effectiveness of the stability actions and concluded the tailings dam was only "marginally stable." Directed by the EPA, Kennecott completed additional construction activities in 1991. On August 10, 1993, Pioneer Technical Services, Inc. (Pioneer) completed a site investigation for the Montana Abandoned Mine Reclamation Bureau as part of an inventory project and collected samples of

waste rock, tailings, groundwater, surface water, sediment, and background soils.

In 2000, Montana Department of Environmental Quality (DEQ)/ Mine Waste Cleanup Bureau initiated a limited site investigation to determine how to prevent releases of heavy metals and the potential release of tailings into Soda Butte Creek. One of the major challenges to cleaning up the site was the saturated tailings. Due to shallow groundwater at the site, the tailings were highly saturated (45 to 100 percent water content). In 2008, Pioneer conducted a design investigation that included additional test pitting, soil borings, and groundwater pumping tests to develop a dewatering model to deal with the saturated tailings.

Reclamation Plan

From the 2008 investigation, a reclamation plan for the site was developed that included key components:

- A dewatering system that included 17 pumping wells installed around the perimeter of the site and within the tailings.
- A water treatment system and dewatering control building that would treat approximately 100 million gallons of low pH (less than 4) heavy metal-contaminated water.
- Stabilization of and removal of 239,000 cubic yards of tailings, waste rock, and impacted soils.
- An on-site repository.
- Realignment of 2,000 linear feet of Soda Butte and Miller Creeks.
- Revegetation of 27 acres using native grasses, shrubs and trees.

A timeline for the project is shown in Picture 4.

The McLaren Tailings Reclamation Project posed complex design and construction challenges such as limited space, short construction seasons, shallow groundwater, limited repository capacity, remoteness of the site, and limited site access for materials delivery. The major challenges, however, to completing the reclamation included shallow groundwater and saturated tailings. To overcome these main challenges, two innovative techniques were developed that were crucial to the project's success and resulted in a reduction in the schedule and total costs: dewatering and using quicklime to stabilize the tailings.

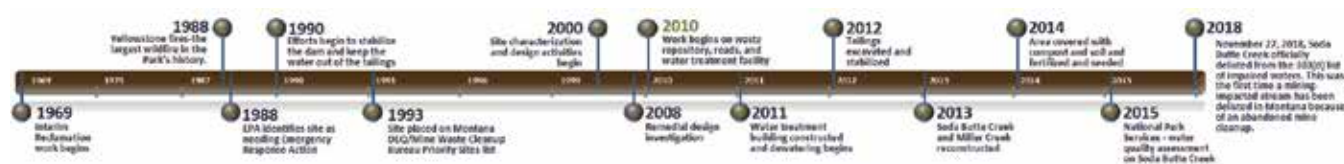
Dewatering - The first innovative technique was the method of dewatering the tailings for removal. The results of a 24-hour pumping test and groundwater modeling indicated that the shallow groundwater within the tailings could be effectively dewatered by pumping the water from the site perimeter and from the underlying alluvial aquifer. Groundwater was pumped from the alluvium underneath the tailings which caused the water from



Picture 5. Sediment detention pond.

the saturated tailings to be drawn into the underlying dewatered alluvium. The alluvium underneath the tailings was a highly conductive and thick alluvial zone surrounded by a less conductive and thinner alluvium. The highly conductive zone was the original Soda Butte Creek channel and larger pumping wells with higher production rates were installed. The surrounding thinner and less conductive alluvium was dewatered with clusters of smaller wells with lower production rates. There were 14 dewatering wells installed around the perimeter that were operated year-round to maintain a cone of depression within the tailings impoundment. This minimized recharge to the tailings during spring runoff and maintained the flow of water through the lined sediment detention pond (Picture 5). Flow through the sediment detention pond was necessary to keep the liner from floating during spring recharge and the pond from freezing solid during the winter months. The water from the perimeter wells was clean and did not require treatment during winter operations. This unique method of dewatering was very successful at the site and allowed the contractor to excavate and stabilize dryer than expected tailings with reduced quantities of quicklime.

Quicklime to Stabilize the Tailings - The second unique technique was to inject quicklime to stabilize the tailings. Based on bench-scale testing conducted during the geotechnical investigations, Pioneer found that adding three to five percent quicklime by weight to the tailings was needed to attain the optimum moisture content for compaction in the on-site repository. To meter the correct quantity of quicklime into the tailings and to incorporate the lime at depth, the team used a system developed by ALLU Finland Ltd to inject lime to stabilize the tailings (Picture 6). Using the ALLU equipment allowed the contractor to stabilize the tailings in 10-foot depth intervals to maximum tailing thicknesses of 40 feet. To expedite the tailings placement in the repository, additional lime was added



Picture 4. Timeline of the major milestones related to the project.



Picture 6. ALLU System placing lime.

to the repository with a spreader and disk. Using the quicklime resulted in a stable repository and reduced the leachability of metals from the tailings.

Construction

In June 2010, the construction contractor, Knife River Yellowstone Division from Billings, Montana, began construction activities. The list below summarizes the major remedial activities implemented during the four years of construction work:

- Operated, maintained, and monitored water treatment system for 23 consecutive months, treating over 100 million gallons of impacted groundwater.
- Excavated, stabilized, and placed 235,000 bank cubic yards of tailings, waste rock, and impacted soils into the on-site repository.
- Constructed a five-acre repository. Due to the high precipitation received at the site, primarily snow with typical depths ranging from five to 10 feet annually, an interim liner was placed over the compacted tailings at the end of each construction season. This allowed placement of tailings into the repository at the start of construction in the spring, without having to wait for them to dry out. This was also used as a best management practice during spring melt to avoid erosion and sediment issues.
- Used 4,800 dry tons of compost for organic amendment into 45,000 cubic yards of cover soils.
- Installed 23,500 square yards of geocushion (60-mil textured high-density polyethylene [HDPE]) and geocomposite as part of the geocomposite portion of the repository cap. The repository final soil cap consisted of two feet of unamended soil overlain by one foot of amended soil. The final slopes of the repository were graded to a maximum slope of five horizontal to one vertical to ensure long-term stability of the placed tailings and cap system.
- Constructed 1,317 linear feet of Soda Butte Creek and 467 linear feet of Miller Creek in approximately the pre-mine location.
- Fertilized, seeded with native species, and mulched 27 acres.
- Installed 1,000 trees/shrubs.

Complex Project and Stakeholders

The project required a complex site dewatering system, a system to treat the water to state water quality standards prior to discharge to Soda Butte Creek, stabilization of very wet tailings materials, and an on-site repository. As an extra complex element, all activities occurred within a quarter mile of the community of Cooke City and roughly four miles from the perimeter of Yellowstone Park. The work was under constant public view. Because of the site location and the potential impacts to surface waters entering Yellowstone, the work also required close communications and cooperation between the National Park Service, US Forest Service, Beartooth Coalition and Park County, and the contractors.

Given the complexity of the project, Pioneer worked with all stakeholders to develop a flexible remedial design to meet the remediation objectives and to ultimately eliminate the future impacts from the site to the downgradient Soda Butte Creek and Lamar River in Yellowstone. The completed project provides an ecosystem to enhance the fishery in the downgradient reaches of Soda Butte Creek and winter/summer recreational opportunities for the community not available since 1935 (Picture 7).

Construction was completed in October of 2014, a year ahead of schedule and \$2.5 million under budget.



Picture 7. Soda Butte Creek in 2010 (left photograph) and 2013 (right photograph).

The Rest of the Story

For more than 80 years the McLaren Tailings has leached metals into Soda Butte Creek impacting aquatic life below the site. Surveys in the 1970s showed no trout directly below the site. An instream bioassay resulted in 80 percent mortality of fingerling trout after 48 hours of exposure to Soda Butte Creek water. In 1996, Montana DEQ added Soda Butte and Miller Creek to the Clean Water Act Section 303(d) list of impaired waters. The contaminated stream at McLaren acted as a fish barrier from fish migrating downstream. This kept non-native species, primarily brook trout, from migrating downstream and entering the Lamar River and the Yellowstone ecosystem.



Picture 8. McLaren Tailings Site in 2008.

After the final reclamation in 2016, Montana Fish and Wyoming Game and Fish, along with biologists from the National Park Service and US Forest Service removed brook trout from Soda Butte Creek and placed approximately 3,000 Yellowstone Cutthroat Trout into Soda Butte Creek. Recent fish inventories show that these efforts have been successful in restoring Yellowstone Cutthroat Trout to their historical ranges.

Also in 2016, Montana DEQ partnered with National Park Service scientists to conduct a comprehensive characterization of post-reclamation water quality in Soda Butte Creek. Water and sediment monitoring were completed at nine sites on 11 occasions from the Yellowstone boundary to above the McLaren Site. The 2016 study demonstrated that reclamation of the McLaren Tailings Abandoned Mine Site effectively eliminated the source of metal loading to Soda Butte and Miller Creeks (Pictures 8 and 9 show before and after at one location). On November 27, 2018, Soda Butte Creek was officially delisted from the 303(d) list of impaired waters. This marked the first time a mining-impacted stream has been delisted in Montana because of an abandoned mine cleanup.



Picture 9. McLaren Tailings Site in 2019.

Acknowledgements

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Reclamation of the Poker Flats Mine, Alaska

By Richard C. Sivils

The Poker Flats Mine (PFM) began in 1975 when Usibelli Coal Mine (UCM) constructed a haul road to connect its mining operations in the Healy Creek Valley to the prospective new mining area located several miles to the northwest in the Hoseanna Creek Valley (Figure 1). The new mine was required to keep pace with growing coal demand during the 1970s and today consists of a 2,565-acre surface mine. UCM continues operating as Alaska's only coal mine, serving to meet the needs of interior Alaska including the city of Fairbanks



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

in supplying nearly all electricity and heat generation needs. The coal-burning utility generating stations include the Eielson Air Force Base, Fort Wainwright Army Base, University of Alaska-Fairbanks and the Aurora Energy power plant, along with the two power plants in Healy operated by Golden Valley Electric Association.

The UCM mining area is located north of the Alaska Range in interior Alaska, near Healy, Alaska. It is characterized by mountainous terrain, continental climate, short growing season and a northern latitude. The "Poker Flats" name might suggest flat terrain, but in fact, the area

is predominately steep terrain. The geological forces related to the uprising of the Alaska Range have yielded the outcrops of coal deposits that make surface mining possible, but this also poses a significant challenge in creating post-mining landscapes that are both stable and natural in appearance.

The PFM area can be divided into four main quadrants. The entire north half consists of several extended north-facing slopes of roughly 15 degrees or 1:3 gradient. The south half is slightly smaller in size and was the last area reclaimed. A single haul road provides access to the Poker Flats Shop, a facility that serves as warm storage for equipment during the winter and additional space for working on longer term projects like dragline bucket repairs or retrofitting older equipment into new roles. As with any good coal mine, coal-fired boilers serve both the Poker main shop and tippie facilities for heat.

The development of PFM led to UCM's acquisition in 1977 of the largest mobile

land machine in Alaska, a Bucyrus-Erie 1300W dragline (Figure 2). The 2,100-ton dragline was christened the "Ace in the Hole" by local school children, and this name is still proudly displayed on the back of the dragline as it works in the nearby Two Bull Ridge Mine, which is also operated by UCM.

Mining and reclamation are governed by the Surface Mining Control and Reclamation Act (SMCRA) in 1977, which established a nationwide program to regulate surface coal mining and reclamation. In 1983, the State of Alaska enacted the Alaska Surface Coal Mining Control and Reclamation Act (ASCMCRA) to assume jurisdiction over all coal mining activities occurring within the state. The regulations require reclamation to a designated post-mining land use, and the post-mining land use of all areas mined by UCM is wildlife habitat.

UCM is by far the northernmost operational coal mine in the nation, and this has required the company to



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.

pioneer new ideas for successful land reclamation. Discontinuous permafrost is found across the entire area and presents significant challenges. Topsoil in recoverable quantities was almost non-existent within the planned disturbance area at PFM. However, prior experience with reclamation on other company leases showed that topsoil wasn't essential for achieving sufficient plant growth to provide erosion control and encourage the succession of native plants.

Once the areas are backfilled, a reclamation crew is hired to do numerous chores associated with revegetation during the short planting season. For example, during summer 2019 the reclamation crew planted 27,000 trees on over 200 acres of mined lands (Figure 3). Seeding was also performed over large areas by hydroseeding or aerial seeding, both of which are very effective. Two main drainages were constructed, flowing east and west from the center of the mine, to re-establish hydrology and to connect drainages to streams.



Figure 3. Summer Reclamation Crew employees plant over 20,000 trees annually and outside contractors hydroseed/aerial seed backfilled areas around the operation during the short summer.

Reclamation at PFM was accomplished concurrently with the mining operation, and today nearly all land mined for coal is held in either Phase I (backfilled with drainage control) or Phase II (vegetation established) bond release categories. In 2018, UCM engaged outside contractors to perform the required study of vegetation diversity and cover analysis to qualify 430 acres for Phase III bond release in 2019 (Figure 4). In 2010, UCM achieved the only Phase III bond release under ASCMCRA in Alaska at its nearby Gold Run Pass Mine covering 94 acres

(Figure 1). Over the past five years, UCM has diligently applied for and achieved Phase I and II bond release with the Alaska Department of Natural Resources on numerous areas totaling over 600 acres.



Figure 4. Reclamation at Poker Flats Mine includes effective herbaceous cover and tree planting with alder, birch and white spruce.

The western half of the mine contains an active ash dump for the two coal-fired power plants operated by Golden Valley Electric Association, a local electric cooperative utility. A solid waste permit was acquired from the Alaska Department of Environmental Conservation and a landfill has been maintained for the entire mine site, which will be reclaimed once at full capacity in 10 years.

Coal mining in the northern half of the PFM area was initiated prior to SMCRA and is an exemption area. Despite this, UCM reclaimed the entire area with the same practices and standards as if it were under the ASCMCRA. Numerous surface drains crisscross this exemption area and have been successful in controlling runoff and directing surface water flows to sedimentation ponds. A substantial challenge was the short growing season coupled with the north-facing slope, which made establishing significant plant growth a continuous struggle. Establishing native grasses to hold spoil in place was the first step in achieving stability once drainages and regrading activities concluded. Reclamation efforts then focused on transplanting woody species by hand throughout the entire mining area, with white spruce being the main planted species.

Alder cones were collected from mature plants onsite and spread across the PFM to assist in the natural re-colonization process. Alder is an excellent soil

stabilization species and is present naturally where recent disturbances have occurred throughout Alaska in areas such as wildfires, landslides or other man-made disturbances. It is usually one of the first species to become established and shows hardy growth up to its mature height of around eight to 10 feet. Once alder is established, it provides cover for slower-growing trees such as white spruce and birch, which eventually overtake the alder and provide the cover canopy. Today the entire area supports a robust vegetation community consisting mainly of alder, with white spruce, birch, willow, poplar and aspen following in succession. The understory consists of mosses, lichens, dwarf birch, grasses and sedges that are also native to the area.

This northern area of PFM also experienced significant sliding of the regraded slope during vegetation establishment, leading UCM to place three large buttresses at the toe to stop the gradual sliding that threatened the slope itself, the main access road and Hoseanna Creek, if left unchecked. These buttresses total over a mile in length and are roughly 1 million yards in volume (Figure 5). Today they are barely noticeable to the untrained eye and are well vegetated, stable and blend into the surrounding landscape, still serving their purpose of maintaining a stable and safe outslope.



Figure 5. Buttresses were constructed at the base of the slope across the main haul road to support the reclaimed hillside from sliding onto the road and into the creek.

The far eastern portion of PFM is named Runaway Ridge. Runaway Ridge is an example of successfully re-establishing a stream through previously mined spoils. This was one of the last pits reclaimed within the permit area. It was reclaimed by employing wing walls as grade breaks, riprap armoring of the channel, and placement of fill to reduce the overall slope of the creek channel (Figure 6).



Figure 6. Re-establishing a stream on old spoils was accomplished at Runaway Ridge at the far eastern edge of the Poker Flats Mine.

The channel sees the development of aufeis, which is common in Alaska and forms every winter due to a continual flow of water through this drainage. Aufeis is liquid water that finds its way to the surface of the channel, on top of the existing frozen surface, then refreezes and gradually forms a thickening ice sheet starting around November until daytime temperatures return to above freezing sometime in

late March (Figure 7). Aufeis at Runaway Ridge has resulted in ice buildup within the channel to a height of 10 feet, lingering sometimes until July. During spring breakup, which occurs in April or May, flowing meltwater is forced around the main channel by the aufeis blockage. Riprap armoring of the channel bottom and sides was necessary to reduce extensive erosion that would occur during these conditions. With time, vegetation has again taken hold within the channel and sedimentation loads in the downstream collection ponds has declined significantly. Monitoring of the stream channel is ongoing, and small repairs are still necessary to ensure water remains flowing within the main channel and not around the sides. Downstream of Runaway Creek, Poker Ponds 1 and 2 are still functional under UCM's National Pollutant Discharge Elimination System (NPDES) permit and require cleanout of only around 1,000 yards of sediment every year, a 95 percent reduction from the early 2000s.

All methods used to reclaim PFM are still being refined after more than 40 years since the mine went into operation (Figures 8 and 9). This summer UCM successfully completed a two-year study on vegetation cover and diversity for 430 acres spread over most of the south half of the disturbance area. This is a significant milestone, with only a small percentage of the mined area still requiring Phase III Release. Currently, there are 86 acres



Figure 7. Aufeis is liquid water that refreezes on the surface of ice that forms thick sheets of ice, which persist long after spring melt, causing problems with drainage.

approved for Phase I Release and 430 acres approved for Phase II Release. The remainder of the acreage held under the PFM bond is occupied by the mine facilities, crusher, tipples, and train loadout facility, sediment ponds and access roads.

Conclusions

Over the mine life at Poker Flats, which supplied 27 million tons of coal, the land has been reclaimed to a stable, suitable habitat for wildlife, while also supporting the operating coal permit areas which currently produce 1.1 million tons of coal annually. The success of the surface mine has continued with successful reclamation of nearly all 890 acres. UCM is proud of the legacy that it continues to have on the State of Alaska by providing low cost, abundant energy to its citizens. ■



Figure 8. Poker Flats Mine in 1990.



Figure 9. Poker Flats Mine in May 2019.

Preserving Past Research via Geolocation: A Tool for the Next Generation of Reclamationists

By Ashley Rovder, Undergraduate Student, Environmental Engineering Program, Saint Francis University; and William Strosnider, Director, Belle W. Baruch Marine Field Laboratory, University of South Carolina

Introduction

Since 1973, the American Society of Mining and Reclamation (ASMR) has brought together like-minded professionals with the common goal of reclaiming mined lands. In 1984, the first conference was hosted in Owensboro, Kentucky, and meetings have been held annually. At every conference, professionals share their research and case studies concerning mining and reclamation to other members. The topics vary from water management to soils and overburden to international tailings reclamation. In 2012, the first edition of the *Journal of the American Society of Mining and Reclamation (JASMR)* was published. As of 2018, over 2,800 proceedings, papers, and posters were published and/or presented at ASMR conferences. As new members join and reclamation research continues, the amount of published works is continually expanding.

As new research builds upon old, it is critical that the results of past projects and the knowledge gained from the work do not get lost. In recognition of this, ASMR commissioned Saint Francis University and Southern Illinois University to sort through all Proceedings and *JASMR* articles and determine the location of the research or project. Once coordinates of these locations were determined, a map could be coded to highlight every site on the planet in a Google Earth file. When this map is complete, ASMR members will be able to reference it and identify the location of the work done in the past.

Trends can be noted based on year or technical division, and anyone who wants to conduct research at a particular site might find past projects at that same site by utilizing this tool. Perhaps most importantly, the resource should enable long-term follow-up studies on topics such as vegetation succession, soil development, and water quality dynamics.

Research

At Saint Francis University, teams of undergraduate students worked together to georeference each Proceeding paper from 1998 to 2007 and 2011 to 2012 as well as all *JASMR* articles from

its inception in 2011 to 2016. The Proceedings papers from 1984 to 1997 and 2008 to 2010 were catalogued by a parallel group of undergraduate students at Southern Illinois University under Dr. Ruopu Li. These teams collectively read thousands of Proceedings articles and searched for the location of each one. Some authors explicitly listed coordinates, but most papers only included vague descriptions of the site and sometimes a picture. In order to locate these sites, the students at Saint Francis University utilized Google Earth and started the search with limited clues, which varied from county names to entire mountain ranges. Ideally, the

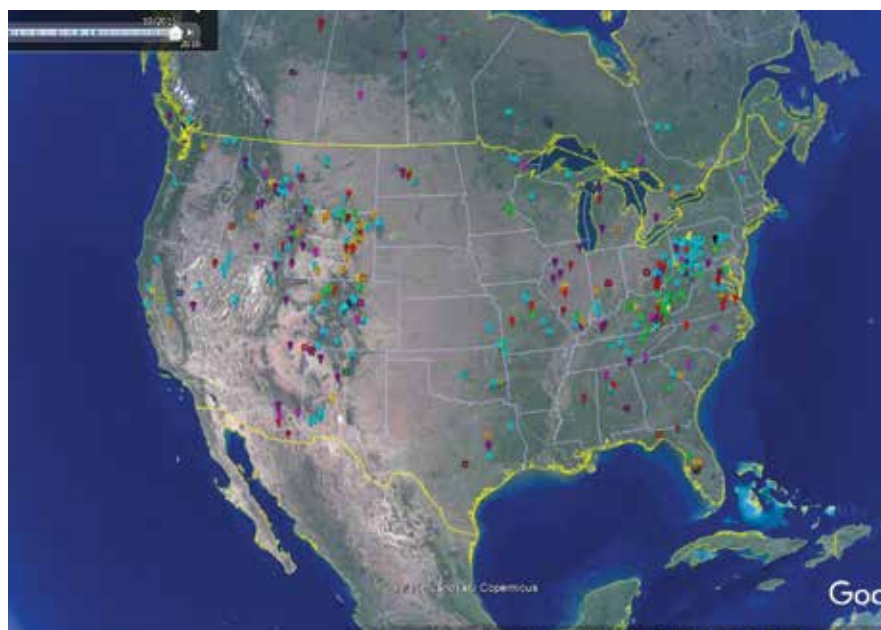


Figure 1. US map locations of research sites developed by ASMR researchers.

search would result in a visible tailings pile or treatment system, but in many cases the reclamation efforts proved so successful that the research site resembled the surrounding natural habitat and therefore could not be located. In such a scenario, the student

would reference Google Earth imagery from past years until the site prior to its recovery was discovered (Figure 1).

Once all the coordinates were located, a map was formatted based on this data. The goal is to make this map accessible to ASMR members on the official website.

“The goal is to make this map accessible to ASMR members on the official website.”

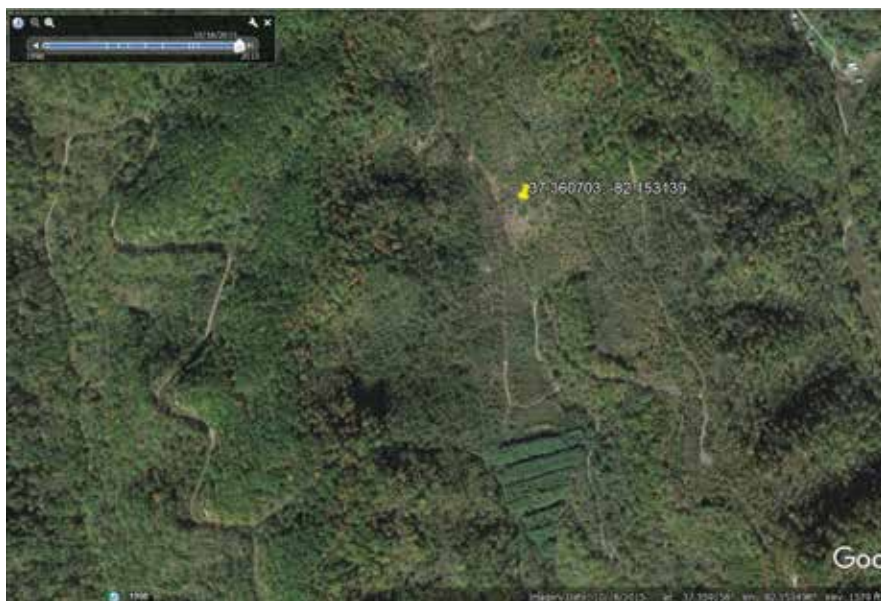
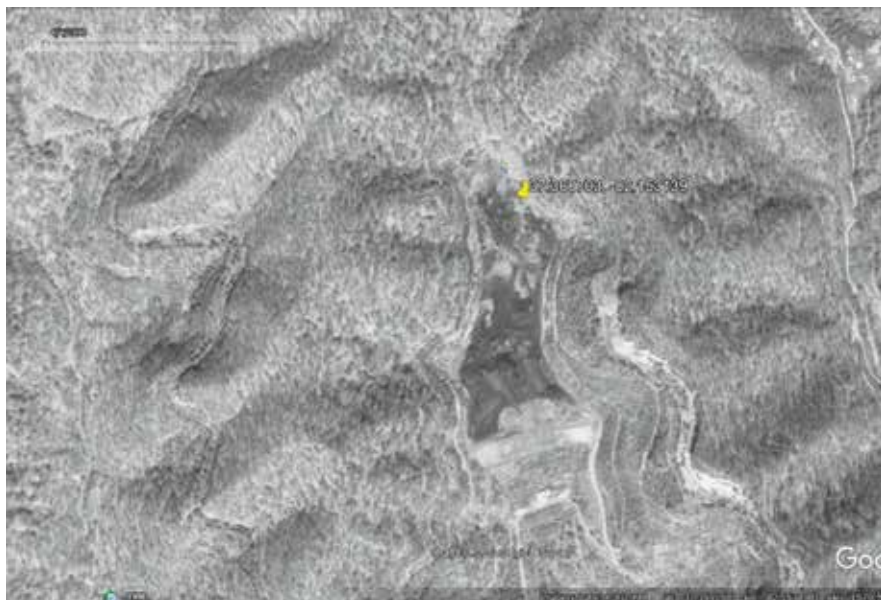


Figure 2. a. Google Earth imagery of a reclaimed surface coal mine site in Virginia in 2015 (top) b. Google Earth imagery of the same site in 1998 using historical imagery, where mining disturbance is more easily identifiable (bottom)



Each pair of coordinates is represented by a pin color coded according to technical divisions. These divisions can be checked individually for visibility. For example, if one wanted to see where work involving land use and design was completed, one would only check that technical division. The pins will reveal information about the particular Proceedings paper once clicked on, including the paper title, authors, abstract, and year (Figure 3). This database is not limited to the United States and research conducted internationally is documented in the same way (Figure 4). As the project progresses, more years were included in the study, and thus more study locations were found and added to this map. Future research can be recorded and uploaded by the same process in order to keep the database up to date.

Student Impact

At Saint Francis University, we value hands-on learning for undergraduate students and this research presents such an opportunity. While the students scanned through each Proceeding article to find the location, they were exposed to key mining reclamation terms, techniques, and common issues in the field before even touching upon reclamation topics and acid mine drainage in class. The more Proceedings papers the students sifted through, the more familiar they became to the field of mining and reclamation, and the easier it became to understand new research in the domain. As the students involved are environmental engineering majors, this experience is invaluable

because reclamation is a key topic in this profession and is a major focus area of Saint Francis University's Environmental Engineering program.

This project was primarily student-led with Dr. William Strosnider as advisor. After a preliminary meeting discussing the purpose of the research and the general techniques to be employed, the students were left to their own devices to work towards the successful completion of the project under the oversight of Dr. Strosnider. Students determined their own pace, delegated which team members covered which group of Proceedings, and modified the techniques used in response to problems and uncertainties encountered during the research process. Once the coordinates for each publication were collected, the information was sent to Dr. Peter Smyntek at Saint Vincent College to organize the data points into a user-friendly database within Google Earth.

As this project progressed, some of the original students graduated. In turn, the team picked up two new underclassmen, and the remaining, seasoned teammates shared their experiences and advised their new teammates. This gave the upperclassmen the opportunity to both teach and lead the group, which are both skills applicable to real-world engineering projects. The independence and self-discipline necessary to result in the successful completion of this project was demonstrated by every member of the group, which resulted in the development of both the educational and professional aspects of each student's career.

Moving Forward

The preservation of past reclamation research is crucial to any future work in the field, as it provides a pattern from which to learn and a process to help others in the future. With this in mind, it is important to keep the database up to date with each new paper presented at ASMR being entered into the database. The best way to do this is for all authors to include the latitude and longitude coordinates of the location of the study in their paper (assuming the location

"The preservation of past reclamation research is crucial to any future work in the field."



Figure 3. Information on each publication is available to view by clicking on the pin of interest



Figure 4. Overview of pins documented throughout Europe

is not confidential). These coordinates can be easily found and then processed for inclusion in the data set. Future researchers can then reference this map to see if any past research was conducted at a particular site, to determine locations where research might be lacking or nonexistent, and to identify areas for further reclamation work. Users can find the author(s) of any paper from the Proceedings or JASMR and connect with other ASMR members, both past and present. It is and will continue to be a useful tool for ASMR members, as well as a valuable way to help expand the field of mining and reclamation by means of a window to the past.

How Can I Use This Resource?

As of now, the database has hundreds of placemarks representing hundreds of research locations. When the file is ready, it will be shared with all ASMR members to navigate and review. Past authors can find their own pins on the map and verify the accuracy of the placements; any potential corrections should be directed to a team dedicated to updating and improving the database. As the field of mining and reclamation grows and more research is published, the database will be updated. The georeferencing method of preserving research may strike other professional

organizations with inspiration, and similar resources may begin to emerge where they do not already exist. The approach would seem to hold special promise to professionals in scientific and applied domains where field research, and the location of that work, holds special value for future projects. Fields such as wildlife conservation, civil/environmental engineering, aquatic and terrestrial ecology, geology, anthropology, epidemiology, and international development could benefit and are benefiting from similar data conservation approaches. Focusing back on mining reclamation, other groups and organizations such as the International Mine Water Association and the West Virginia Mine Drainage Task Force would find great value in similar georeferencing efforts in papers contained in their Proceedings and journals. As our workforce turns over, future reclamation practitioners will benefit from this engaging form of data conservation. ■



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Effects of Stream Restoration on Macroinvertebrate Community Assemblages in a Mined Ohio Watershed

Are Macroinvertebrates Picky About Their Food?

By Taylor Snelick and Rebecca Swab, *The Wilds, Cumberland, OH*

Streams are a vital source of ecosystem well-being, yet their condition can be easily altered and deteriorated through a variety of anthropogenic activities such as surface mining (Bernhardt and Palmer, 2011). In the past, Miller Valley streams, part of The Wilds Conservation Center located in southeast Ohio, have been subject to non-point source pollution resulting from surface coal mining that occurred in the late 1960s to early 1970s (Figure 1). In 2014, a watershed restoration project took place in Miller Valley at the Wilds, and since then a variety of tools have been

used to monitor the success of the restoration project and to guide future efforts to improve the Miller Valley stream system. Monitoring the quality of Miller Valley streams over time is critical to determine the long-term effects of surface mining and subsequent stream restoration efforts. Some of the questions we are trying to answer with our monitoring are:

- 1) Is this restoration successful?
- 2) Does conversion from invasive plant material to native plant material entering the stream impact the macroinvertebrate community?

Initial restoration efforts

Miller Valley streams were restored in 2014 as part of a legally mandated mitigation for loss of riparian habitat quality elsewhere in the watershed due to pipeline construction. Mitigation was in the form of instream habitat enhancements, riparian vegetation enhancement, and stream and riparian preservation along approximately 17,276 linear feet of streams. Enhancements were conducted in both the stream corridor and native upland/floodplain buffer, and included restoring native woody plants, removing invasive species through selective herbicide, and reducing erosion, sedimentation, and degradation through riffle installation. Miller Valley stream enhancements included the installation of three habitat structures in the form of boulders and flat stones within the furthest upstream portion of the mitigation reach. These structures have performed well as habitat for macroinvertebrates and water snakes. There have been no negative morphology changes observed as a result of the installation of the instream structures.

Monitoring of the mitigation area is required by Ohio law for five years after restoration. At the end of five years, five performance standards must be met. All five were met during the 2018 monitoring inspections, four years post-mitigation.

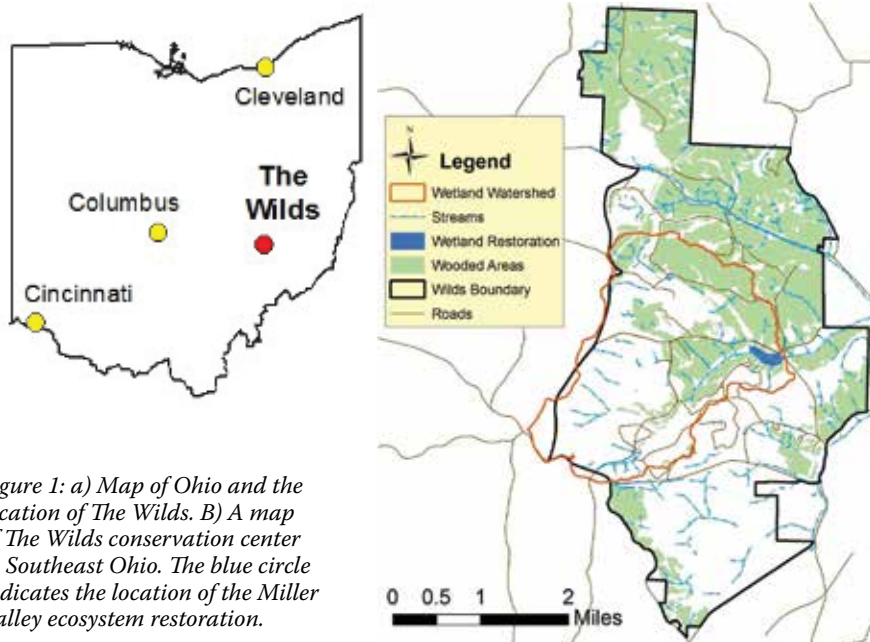


Figure 1: a) Map of Ohio and the location of The Wilds. b) A map of The Wilds conservation center in Southeast Ohio. The blue circle indicates the location of the Miller Valley ecosystem restoration.

Post-restoration Monitoring Requirements

1. **Total Restored Area:** Approximately 17,276 linear feet (LF) of Miller Valley streams were enhanced via a combination of native seeding, invasive species control, and native tree and shrub installation.
2. **Native Woody Cover:** Tree counts, including canopy and sub-canopy trees and shrubs, were assessed across the site five years post mitigation by Cardno JFNew. In total, the mitigation buffers for all streams in the Miller Valley stream matrix had about 395 native woody stems per acre pre-restoration. After installing supplemental stems yearly as needed, the buffers for all streams had over 960 native woody stems per acre and survival of these stems exceeded 70 percent.
3. **Invasive Species:** Invasive species coverage prior to the mitigation work was approximately 90 percent across the site. Now in 2019, many areas (approximately 50 percent of the site) displayed less than 10 percent coverage by invasive species.
4. **Stream Quality Scores:** Miller Valley streams and its tributaries all received a QHEI/HHEI score equal to or greater than their pre-mitigation assessment scores.
5. **Erosion Control:** Reshaping of a channel in Miller Valley Stream 5 that was exhibiting erosion and head-cutting in 2015 was addressed in February 2016 and has remained stable since. No signs of bank erosion, sedimentation, head-cutting, or degradation were observed during the year 4 monitoring inspections.

Subsequent Biological Monitoring of MVS by Wilds Interns

Additional water quality testing, assessment of macroinvertebrate assemblages, and riparian vegetation assessments were conducted by Wilds interns annually (2013 to 2018) to determine the success of site restoration.

Vegetation surveys - Pre-restoration woody invasive coverage in the riparian buffer around Miller Valley streams was studied in 2013 by Wilds apprentice Win Fox. Unsurprisingly, forest and shrub habitats within the riparian area had high amounts of woody invasive plants. Two species were of particular importance: Autumn olive (*Elaeagnus umbellata*) was seen far more frequently than honeysuckle species, (*Lonicera spp.*). Autumn olive is known as a common invader of woodland and grassland in Ohio and was even planted on reclaimed mine land (Wade et. al., 1985, Skousen et al., 1994), including at The Wilds.

A modified Daubenmire vegetation survey conducted by Wilds apprentice Ben Evick in 2014 showed a drastic decrease in the number of invasive woody shrubs from the surveys in 2013 due to the invasive control efforts. In their place, a variety of grasses and plants emerged. Species most commonly found in each of the quadrats were tall fescue (*Festuca arundinacea*), Maximilian sunflower (*Helianthus maximiliani*), and wingstem (*Verbesina alternifolia*).

In 2019, apprentice Kaylie Callihan replicated the surveys completed by Ben Evick in 2014. The most abundant species found were Canada goldenrod (*Solidago canadensis*), wingstem (*Verbesina alternifolia*), and tall fescue (*Festuca arundinacea*). Abundances of



Figure 2: Photos of Miller Creek headwaters before 2013 (left) and after 2016 (right) autumn olive removal

woody invasive honeysuckle species remained drastically decreased since the surveys completed in 2013. Invasive autumn olive re-emerged as number nine on the list of most abundant species along the stream.

Water Quality - From 2014-2016 and again in 2018, water pH was taken at Miller Valley Streams 1, 2, 4, and 5. Based on the water quality data collected, the pH of the streams remained relatively similar across all sample sites from 2014 to 2018 (average 7.7).

Table 1: MAIS Scores in Miller Valley Stream 1

2013	2014	2015	2016	2017	2018
8	9	9	9	-	8

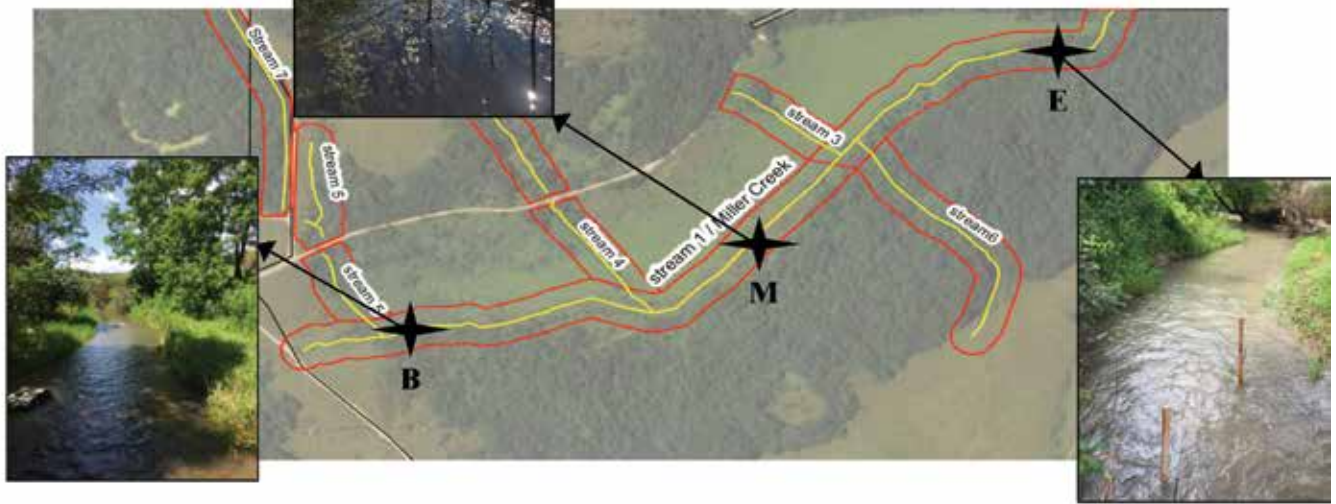
According to the EPA national recommendations for water quality criteria pertaining to aquatic life, adequate water should be between 6.5 and 9 for stream pH, and all measurements fell within these parameters for Miller Valley streams (EPA 2016).

MAIS Scores - The abundance of members from each family were used to calculate the Macroinvertebrate Aggregated Index for Streams (MAIS) score for each transect within Miller Valley Stream 1 (Johnson, 2007). Results are shown in Table 1.

Water quality of the stream was based on the categories of 0-7 being very poor, 8-11 as poor, 12-15 as good, and 16-18 as very good (Johnson, 2007). The results for Miller Valley Stream 1 showed poor water quality conditions. It is possible that not enough time has passed since restoration efforts to allow new macroinvertebrate species to colonize the stream and to raise the MSIS scores to good. With time, the stream ecosystem should stabilize and allow for increased migration of macroinvertebrate species.

Leaf Pack Assessments - An experimental leaf pack study was conducted by Wilds apprentices Danielle Bara and Kevin Li in 2016 and 2018 to determine the differences in decomposition rates and macroinvertebrate colonization of leaf packs composed

Figure 3: Map of Miller Creek Stream 1 within Miller Valley ecosystem matrix. Leaf pack sites are represented by labels beginning (B), middle (M), and end (E) respectively.



entirely of invasive autumn olive leaves or native tree leaves. Since the riparian mitigation efforts are changing the vegetation community composition along the stream bank, changes in leaf types entering the stream will change. These studies focused on whether changes in leaf material would alter the macroinvertebrate community. Native tree leaves were chosen from species that were planted as part of the restoration efforts and equal parts of box elder (*Acer negundo*), sycamore (*Platanus occidentalis*), and white oak (*Quercus alba*) leaves composed the native tree leaf packs. Several packs of each type were placed within the stream at three different locations: the headwaters with minimal overhead vegetation cover, the middle with almost no cover, and the mouth of the stream with >50 percent cover (Figure 3).

Macroinvertebrate assemblages in the native tree leaf and invasive tree leaf packs at the three sites were compared, with each specimen identified to the lowest taxonomic level possible. At each site, there was no significant difference in abundance, richness, or diversity between native and invasive leaf packs, and decomposition rates were also similar between the two types. Additionally, there was no difference in macroinvertebrate abundance, richness, or diversity across the three sites. This shows that the macroinvertebrates do not seem to have a preference between native and invasive leaf packs. Other studies have shown that macroinvertebrates favor leaves with faster break down rates (Petersen and Cummins, 1973; Shaftel et al., 2011). In this case, there was no difference in decomposition between the native and invasive leaf packs, which may explain why there was no macroinvertebrate preference.

The same methods using leaf packs were duplicated in 2018 except that the native leaf pack only included box elder and sycamore leaves. The same results of no significance difference were noted between native and invasive leaf pack assessments across all three sites in Miller Valley streams. Further study of leaf pack and macroinvertebrate communities in streams will continue for a few more years to assess changes as the streams return to natural conditions.

Conclusions and Future Recommendations

Completion of the mitigation restoration plans in streams at Miller Valley have improved the riparian vegetation communities from largely invasive species to native species dominated communities. Mitigation work done by Cardno JFNew in the form of instream habitat enhancements, riparian vegetation enhancement, and stream and riparian preservation has been successful from a plant perspective. However, the macroinvertebrate community has not responded to restoration efforts. Miller Valley streams continue

to have MAIS scores that fall in the poor water quality category. Macroinvertebrates seem unaffected by leaf type material within streams, having no preference for native tree leaves versus invasive tree leaves. Thus, their communities may not change significantly with the restoration efforts based on leaf inputs. Perhaps with time, increases in the MAIS scores will be observed. Other studies have shown that macroinvertebrate communities impacted by acid mine drainage in Appalachian Ohio streams may take more than three years to recover after restoration work has been conducted (Johnson, 2007). Continued monitoring is important to see how the macroinvertebrate community changes over time. In this case, the law requires only five years of monitoring, but this study shows that more than the 5 years may be needed to fully understand the impact of restoration on the stream ecosystem. ■

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Before



After



Mine closure: **reclamation** for future generations

Our approach to mine closure is simple – we partner with clients to develop and implement tailored solutions that streamline reclamation and meet project objectives – all while considering stakeholder needs. Stantec is a world leader in the closure of operating, inactive, historic, and abandoned mines.

stantec.com/mine-closure