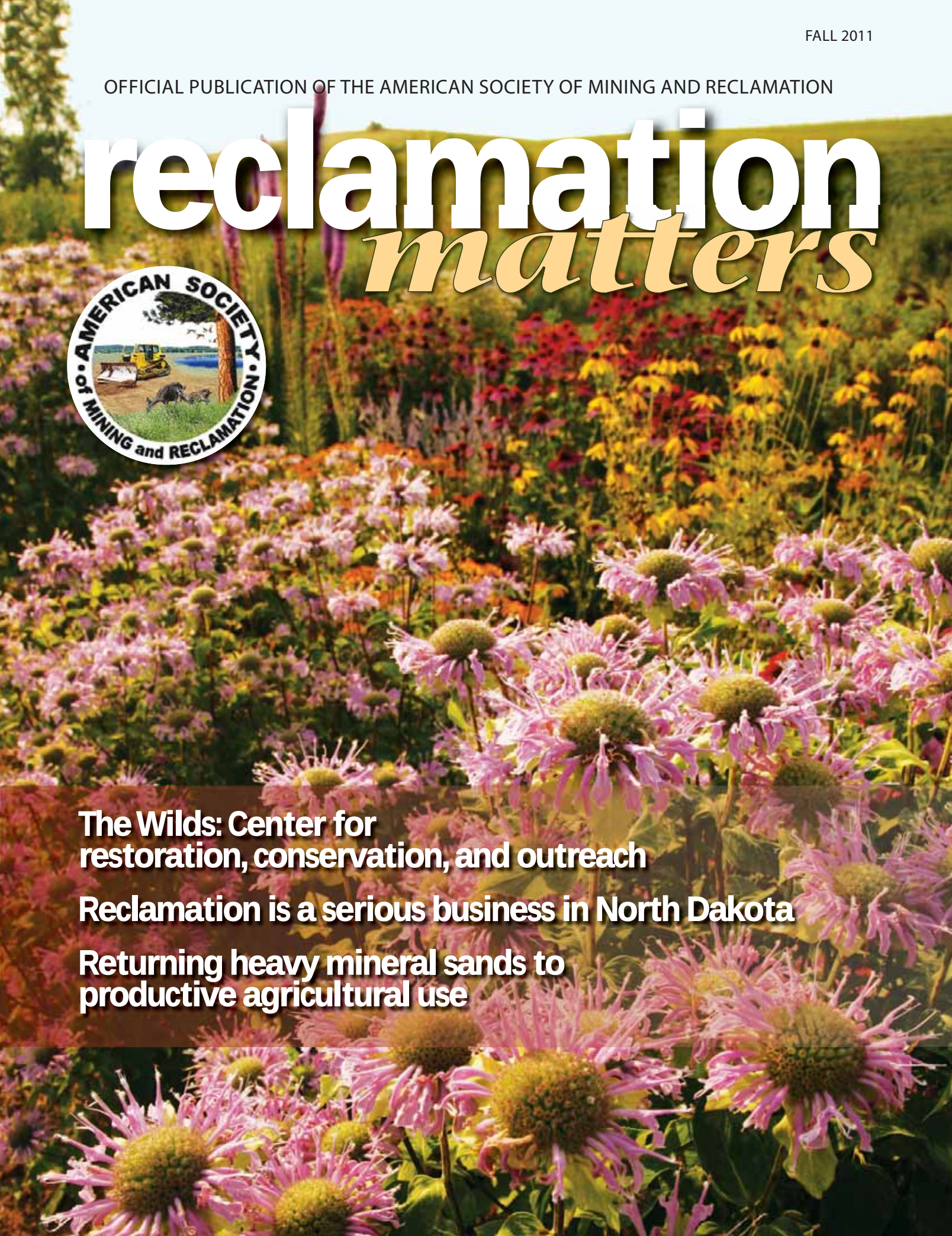
FALL 2011

OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF MINING AND RECLAMATION

reclamation matters



The Wilds: Center for restoration, conservation, and outreach

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Returning heavy mineral sands to productive agricultural use

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AFTER WE'RE DONE.

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reclamation *matters*

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Gratitude and Anticipation

Eddie Bearden, President of ASMR

I know it's still a couple of months until the official Thanksgiving holiday. But it's never untimely to offer thanks when and to whom they are due.

As an organization, ASMR owes a big debt of gratitude to Kimery Vories. Kim was elected as president for the 2010–2011 year and served admirably from the meeting in Pittsburgh until right before the Bismarck meeting when he had to resign his position. He spent countless hours planning agendas, running meetings and conference calls, and just thinking about how to improve our organization.

Another person we need to thank is Dennis Neuman, who served as president before Kim. He did a fantastic job of representing our Society as president in 2009. Many of you may not be aware that the past president continues to serve on the NEC for a year, and Dennis has done so in a very involved manner. And now Dennis has accepted another year as past president since Kim cannot do so.

The NEC members also deserve a word of thanks. Many hours were spent in conference calls this past year as we struggled with the operations of the Society. Other folks to thank are those of you who will step up and allow your names to be placed on the ballot for NEC members in the future. It's somewhat intimidating when you pause to think about accepting the challenge, but it's also very rewarding when you can serve. One area the NEC is asking for volunteers is to help guide the investment policy for the Society. Remember that the Society would cease to exist were it not for volunteers.

And now let's think about anticipation, specifically as it relates to ASMR. Anticipation means "an expectation, foreknowledge." We all anticipate various events in our lives. Remember when you were young (or those of you who are still students), how you anticipated the end of the school year? Or remember how you looked forward to Christmas, or your birthday? Here are some things to anticipate for ASMR.

You should all be aware by now of our Early Career Professionals group. Anticipate becoming involved with this group, whether you have fewer than 10 years in your career or if you have many more than 10. I remember how important it was to me as a young soil scientist to get some career suggestions from someone with more experience or to just have an older soil scientist show some interest in me as a person.

Another thing to anticipate is a new Executive Secretary. You each should have received a letter from Dick Barnhisel announcing that he will be retiring from the position in a couple of years, and the search is beginning to find a replacement.

Anticipate recruiting someone new to the Society. Remember our goal for the year – Recruit One Member. If each of us would recruit just one new member for ASMR, we would double our size. This is important not only for the sake of growing but because many of us are reaching retirement age and becoming less involved in the Society.

Our society has a few needs I would like to address. One of the main things we need to do better (and have needed to improve since I have been involved in the reclamation business) is to publicize our successes. When I was a reclamation specialist working for TXU, I told everyone who would stand still long enough to listen that we needed more exposure in both the mining and reclamation process. And yet, when my sons were playing soccer or I was asked by someone at church what I

do for a living and I told them I work in mining reclamation, they frequently expressed surprise that we have mining in Texas! That still occasionally happens, and I usually point out that about 40% of their electricity comes from burning coal, most of it mined locally.

One way to publicize our story – and something Texas has done well for many years – is in sponsoring teacher workshops. The workshops in Texas began in 1991 and are funded solely by mining companies. The teachers spend an entire week (Sunday evening through Friday noon) learning about mining and reclamation from exploration all the way through final bond release. Many folks from the mining community come together to share their expertise and experience with these teachers. To date, we have trained more than 900 teachers about coal mining, mining of industrial minerals, and uranium mining. The Texas Mining and Reclamation Association (TMRA) estimates over a million students have been reached with the mining and reclamation message via these teachers.

You would think by now that we would have the mining and reclamation business well in hand, right? But think again – there will always be retirements, so new people come into the field every year. I once wished for a brain transplant (or at least an information dump) from some of the folks I worked with who had decades of experience and knowledge. But it doesn't happen that way. So we all have to be in a constant learning mode. God made us curious individuals, so we always want to know how or why something is the way it is. Learning something new, especially to a scientific mind, is actually one of the things that makes it worthwhile to come to work every day.

As an industry, we need to stay the course and not waiver in doing the best job we can possibly do. There was a regulator in Texas with whom I butted heads on a regular basis when I still worked for the mining company. He was the ultimate scientist – show him the data, and he could be convinced that you were doing the right thing – if and only if the data supported it. He eventually became a strong supporter – but then he retired, and we had to start all over with someone new. And the direction of our government changes every few years. Some governmental and regulatory leaders – those who know us best – love us, but others think we're the worst thing to ever walk the face of the earth. So we will always have areas for compromise. Let's all work together and try to educate ourselves and others so we can reach our mutual goals. ■

The Time to Perform is NOW!

BY JEFF SKOUSEN, WEST VIRGINIA UNIVERSITY

A recently graduated student of mine was complaining to me about the job he obtained after finishing his degree program this past year. After working for several months, he said the job was not as good as he had anticipated and was searching for another opening somewhere. After listening to him moan about his condition, I told him his current job offered many opportunities for growth and ways to learn new ideas and develop his knowledge and experience than he realized. I said he also was being exposed to a variety of people both in the coal industry and reclamation field that could potentially help him in the future. He should cultivate these relationships, learn everything he can, quit grumbling, and enjoy the benefits of working in the area for which he was trained. Many do not have his opportunities.

It caused me to reflect on my first jobs, most being unrelated to my chosen field of work, and the knowledge and skills they afforded me at an early age. I'm afraid there is a strong tendency for young adults who are searching for their dream job to look past the experiences they are gaining right now. They are certain their most desired job is forthcoming and they need to just barely get by now, doing the minimum, until it comes. So they do poor work in their current position, always thinking the pastures are greener elsewhere, and miss out on many chances for learning and development right now.

I have probably looked over hundreds of resumes in my career. With potential students, I almost insist to see a list of work experiences from the time they graduated high school, even if they worked at a fast food joint, a furniture store, a homeless shelter, or a pet store. I like to see this work history for two reasons. First, a consistent work record shows a desire to be independent and responsible. If there are gaps in their work history, I wonder what they were doing: were they traveling the world on their parent's money, were they in jail, or were they doing something they were ashamed of? When I ask about a gap in their work history, they might say they worked for a daycare center or a grocery store but they felt it wasn't pertinent to applying for this job. In my view as a potential employer, this work history is critical to help me assess their experience and interests and effort. Second, regardless of where they were employed, I learn something about them and I also can evaluate the skills and knowledge they might have gained in these jobs.

None of us knows when or where we will end up, or to which job we will eventually obtain or be placed in. There is probably no perfect job for any of us. But if we are lucky, we will acquire a job which uses our specific talents and strengths to benefit others and which provides personal satisfaction. Each of us, however, can prepare and improve NOW in whatever capacity we are given, to build and develop our skills and enrich those around us regardless of the circumstance. So even if we think we are engaged in a temporary assignment or think we are stuck in a position that is beneath us, we should "live in the present" and enlarge our efforts. Rather than looking and waiting for some dreamy future time when we will be fully utilized and appreciated in some unknown position, we should take every opportunity NOW to expand our knowledge and abilities, strengthen our friendships and forge new relationships, and perform our best in the job we have NOW. Performance time is NOW ! ■

Abbey Foster Wick

The Early Career events were well attended this year in Bismarck. We hosted a social event at a restaurant in downtown Bismarck which was attended by close to 60 people. There was again a good mix of more established and early career members as well as those attending their first ASMR meeting. In looking across the crowd at the event, I noticed people at various stages of their careers at each table getting to know each other. Clearly there was a passing of valuable knowledge as well as jokes across members during this event. There was also a post-conference field tour to the Agricultural Research Service station in Mandan, ND. This was also well attended where 12 seats out of 15 were filled. Valuable information on research design, grazing impacts, trace gas fluxes, carbon sequestration and the economics of various cropping approaches was shared and it was another chance for attendees to get to know each other. Planning of events for next years' meeting in Tupelo has already started…and it's going to be good!

This year the national executive committee (NEC) has started a "Recruit One Member (ROM)" campaign. As an early career member, I think it's important that we do our part to support this idea…after all, it is the future of our society! As early career members, we all are working on creating/maintaining contacts, attending various meetings for different societies and looking for ways to either get more involved to boost our CV or just because we care about the sharing of information in our discipline. Within days of the announcement of this campaign, I was able to find two people that have either let their membership expire or have never heard of ASMR. Both have renewed/joined and I was amazed at how easy it was to ROM. I'm sure that some of you have a student, a new colleague or have met someone at a different national or regional meeting that would benefit from being a member of ASMR. Please extend an invitation for them to join and to attend their first meeting in Tupelo.

Many of you have asked about other ways to get involved with ASMR –so here are a few ideas: the NEC is looking for volunteers to be part of a committee concerned with the societies' finances/investments. If you have a head for financial strategies and are interested in being on a committee, throw your name in the hat by emailing the ASMR president, Eddie Bearden (Eddie.Bearden@hdrinc.com). Also, development of an online journal for the society has been discussed, you can email Dennis Neuman (dneuman@reclamationresearch.net) if you have experience publishing/editing or want to get more involved with this aspect of the society. There's also room for help with the

Members talking about ideas at the social event.

Discussing trace gas fluxes with Rebecca Phillips at the ARS.

Early Career group and you can email me (afwick@vt.edu) about this. I encourage anyone attending the national meetings to get involved by helping out at the registration desk or with AV equipment, this is a great way to meet people (contact David Lang for Tupelo in 2012 - DLang@pss.msstate.edu). You can also email the technical division chairs and offer to help review proceedings papers, they would appreciate the help and you can find their names listed on the ASMR webpage. If you are interested in writing something for Reclamation Matters, contact Jeff Skousen (jskousen@wvu.edu). You can get involved with the planning of the meetings. Entire committees are developed to organize sessions, plan socials, work on registration, select food for the meetings, work on transportation for various events, etc. I've been part of two planning committees (Breckenridge and Gillette) and it gave me a lot of insight into how these meetings operate.

So, as you get excited for the events in Tupelo and look to recruit one member, also think about how you can get more involved. You can contact anyone on the NEC to find areas where the society needs help. Not only is it a good thing to get involved, but it's also a CV booster! ■

Student Scholarships

Marjory Howren, Virginia Tech
B.S. Scholarship Winner

Cally Driessen, Memorial UWY
M.S. Scholarship Winner

Leah Oxenford,
Memorial OU
PhD Scholarship Winner

Oral Presentation Winner

Teresa Hughes, Trinity Ireland
1st Place Oral Presentation Winner

Poster Presentation Winners

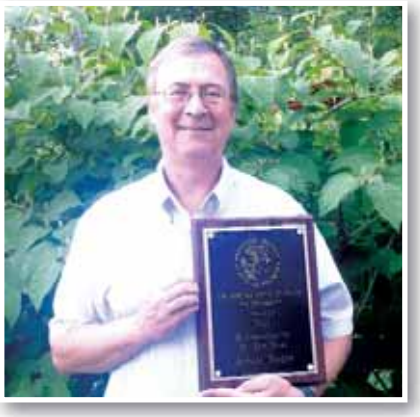
Nina Craig, Virginia Tech
1st Place Poster Winner

Marjory Howren, Virginia Tech
2nd Place Poster Winner (tie)

Justin Ng, TAMU
2nd Place Poster Winner (tie)

Dawn Lemke, Alabama A&M
3rd Place Poster Winner

Robert S. Hedin - Reclamationist of the Year Award



Our recipient of the 2011 Reclamationist of the Year Award has a long and varied career in mined land reclamation and passive treatment of mine drainage. He began his career with the U.S. Bureau of Mines and carried out research on passive treatment of mine drainage and has published numerous papers on the subject. Many of what are now considered "basic" concepts of passive treatment (net alkaline versus net acidic water, the limitations that aluminum place on anoxic limestone drains, how to size aerobic wetlands based on iron loading, etc.) were discovered and written by our recipient. He authored a useful manual on the Passive Treatment of Mine Drainage, which many people refer to as the bible of passive treatment. In 1994, after a long and productive career with the Bureau of Mines, he started his own company. He has continued his work in passive treatment of mine drainage and has designed treatment systems for high acid load and high flow systems. He also founded the company Iron Oxide Recovery; where he has developed technology for recovery of iron oxides for use as paint pigments. He holds a patent on this process and "Bob EnvironOxide Pigments" were named one of the top 10 New Green Products by GreenSpec in 2003. He received numerous awards from the U.S. Bureau of Mines - Pittsburgh Research Center and has also been recognized with the Carnegie Science Center Innovator of the Year and Governor's Award for Environmental Excellence. He received his B.A. in Environmental Studies and Economics from St. Lawrence University and his Ph.D. in Ecology from Rutgers University. It is with pleasure we present the 2011 Reclamationist of the Year Award to Dr. Robert Hedin, President of Hedin Environmental, Inc. from Pittsburgh, PA. ■

Robert W. Nairn - Richard and Lela Barnhisel Reclamation Researcher of the Year Award

Our recipient of the 2011 Richard and Lela Barnhisel Reclamation Researcher of the Year Award has been involved in mine reclamation research for over 20 years. He started his career in mined land reclamation research with the U.S. Bureau of Mines involving constructed wetlands as a passive treatment alternative for mine drainage remediation. Some years after receiving his Ph.D., he became Director of the Center for Restoration of Ecosystems and Watersheds (CREW) at the University of Oklahoma. He has mentored 25 graduate students over his career at the University of Oklahoma. The results of his research has resulted in numerous publications in journals and conference proceedings and invitations to speak at local, regional, national and international environmental and mining conferences, workshops and seminars. His most outstanding accomplishment has been the design, construction and success of the first passive treatment system in the Tar Creek Superfund site, considered to be one of the most contaminated sites in the U.S. The success of this process has resulted in the implementation of additional systems with this Superfund Site. During his career he has served as principal or co-principal investigator on over $18 million of research grants. A great testimony of the recipient's accomplishments in the area of passive treatment of mine drainage is noted in one of his letters of support. He says the nation's number 1 Superfund site is no longer "technically impractical." He almost singlehandedly proved the U.S. EPA wrong about the ability to treat the mine discharge waters at Tar Creek." ASMR is pleased to present the 2011 Richard and Lela Barnhisel Researcher of the Year Award to Dr. Robert 'Bob' Nairn, Associate Professor, University of Oklahoma. Bob received his B.S. in Environmental Science from Juniata College, Huntingdon, PA, and his Ph.D from Ohio State University. ■

Arthur W. Rose - William T. Plass Lifetime Achievement Award

Our recipient of the 2011 William T. Plass Award had a long and prestigious career in the area of mining and entered the coal mining sector over 30 years ago doing research in the area of mine drainage water treatment. His research has been very influential in the development of successful passive treatment technologies for mine drainage. His publications provide evidence of his numerous and varied contributions to the field of acid mine drainage and reclamation. He has published over 110 journal articles, presented and written numerous papers for conferences, authored/co-authored 7 books or book chapters, He has also advised 15 Ph.D. and 33 M.S. students. He is internationally recognized for his expertise, as evidenced by his invitations to lecture to the Chinese Ministry of Geology and Mineral Resources, and the East China Geological Institute. He was a major player in developing and designing a program to treat acid mine drainage in the Clearfield Creek watershed and, as chair of the Technical Committee of the watershed association, he received the Mayfly Award at the 11th PA Abandoned Mine Reclamation Conference in 2009. One of the letters of support stated "Dr. Rose is truly a philanthropist of Pennsylvania's streams" and "is an environmental role model for countless reclamation professionals and students." ASMR is pleased to award Dr. Art Rose, Professor Emeritus of Geochemistry at Penn State

University with the William T. Plass Lifetime Achievement Award. He received his B.S. from Antioch College, and M.S. and Ph.D. from California Institute of Technology. ■

Robert E. Dunker - Pioneer in Reclamation Award

This individual was selected as a Pioneer in Reclamation because of his long-term and important research accomplishments in the reclamation of prime farmlands. He has been actively involved in reclamation research for the past 33 years. His research, with the cooperation of the late Dr. Ivan Jansen, was indeed a pioneering program of major importance to the mining industry, federal, and state regulators in Illinois. Because of his expertise and recognition in this subject area, he is presently involved with consulting with the Indiana Department of Natural Resources and the Indiana Coal Council. His most recent research "A system to evaluate prime farmland reclamation success based on spatial soil properties" is focused on a soil-based model to evaluate reclamation success. His nominator, Dr. Robert Darmody, stated that "this project may have a major impact on how regulators approach success of reclamation and bond release." It is with great pleasure that ASMR's Pioneer in Reclamation Award be awarded to Dr. Robert Dunker Bob is an Agronomist with the Department of Crop Sciences at the University of Illinois. Bob received both his B.S and M.S. in Agronomy from the University of Illinois. ■

Please recycle!

Joe Schneider, Western States Reclamation.

Mike and Pam Jenkins, Aquafix Systems.

Dwayne Breyer, Truax Company.

Ron Schreibeis, Rocky Mountain Reclamation.

Michael Sieczkowski, JRW Bioremediation.

Tom Bowman, Rocky Mountain Bio Products.

Brenda Schladweiler, BKS Environmental Services.

Stephanie Dreiling, CDI Northern Colorado Office.

BioMost Stream Restoration

Tom Berg, Minnesota Valley Testing Labs.

Bill Sayward, Itasca Greenhouse.

Kathy Smit, Pace Analytical Services.

Debbra Stokes, DriWater.

Greg Naffz, Sustane Natural Fertilizer.

Jeremiah Vermillion, Environmental Products and Applications.

Damon Winter, Granite Seeds.

Henry Austin, Office of Surface Mining.

Lela Barnhisel, American Society for Mining and Reclamation.

Reclamation is a Serious Business in North Dakota

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Figure 1. Topsoil is replaced at the BNI Mine near Center, ND. Topsoil salvage and replacement on the land surface provides for agriculture post-mining land uses.

"People traveling will not notice land has been mined when fully reclaimed," says Steve Van Dyke, Director of Communications for the Lignite Energy Council, a coalition that supports coal-based electricity. "The feeling I get from mining companies is that long after it is gone, reclaimed land is going to stand as a testament as to how well they did. I think they take that job very seriously."

Jim Deutsch, Director of Reclamation and Abandoned Mine Lands divisions for the State of North Dakota Public Service Commission, agrees that the mining companies take reclamation seriously. "This speaks highly of the mining industry and the work that they do," he explains.

David Straley, Manager of Government and Public Affairs for North American Coal, adds, "We reclaim in a manner that is safest and maximizes our return to the state. There is a financial interest for us to reclaim more. We treat it with the highest priority."

Straley estimates his companies in North Dakota disturb 2,000 acres a year and they touch with equipment approximately 1,500 to 2,000 acres per year. It is estimated that more than three full-time employees do nothing but reclaim land that has been disturbed.

BNI Coal does not view reclamation as simply a regulatory requirement, but more importantly, a commitment to the environment, landowners, neighbors, county, and customers, explains Jay Volk, environmental manager for the company. "BNI strives to reclaim land that is functional, stable, diverse, and productive," he says. "BNI values the wildlife

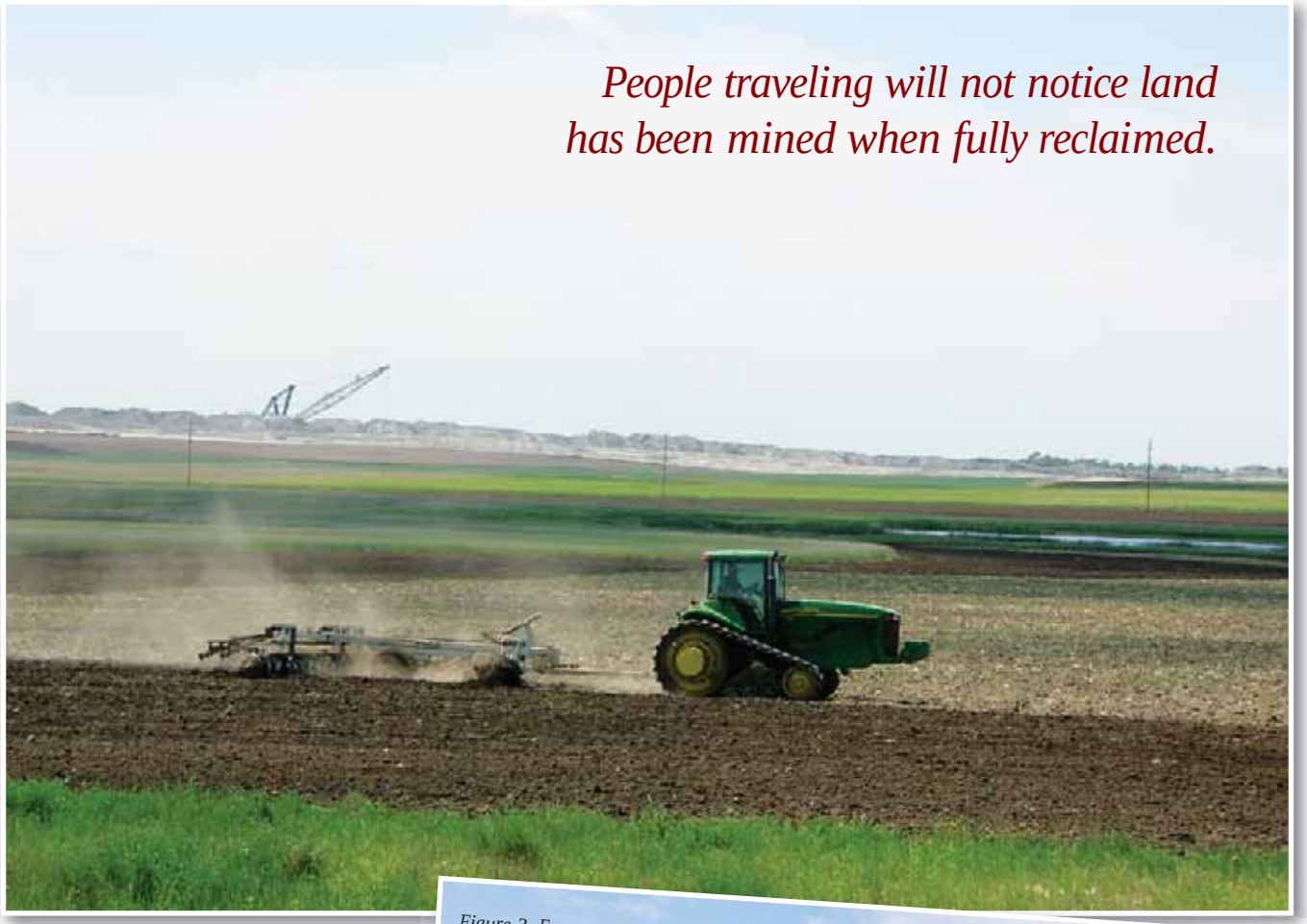

Figure 2. Equipment preparing the land for planting to cropland at the Falkirk Mine.

Figure 3. Forage production at the Freedom Mine for pasture.

(game and non-game species) and does many enhancements to promote a diversified habitat for a large range of species. Additionally, BNI is constantly looking for a way of better reclaiming land."

BNI Coal started mining southeast of Center, ND, in 1970. Today, BNI Coal mines between 4 and 4.5 million tons of coal each year, which consists of slightly more than 200 acres per year. BNI Coal reclaims the same amount each year.

Currently there are four active mines in North Dakota. The largest surface mine in North Dakota, as well as the US, is the Freedom Mine, which produces 15 million tons per year, followed by the Falkirk Mine, 8 million tons per year. BNI Mine at Center, ND, produces 4 to 4.5 million

tons per year, and the Beulah Mine mines 3 million tons per year. Eighty percent of the coal produced is used to make electricity, while 20 percent of coal produced at the Freedom Mine is used for a synfuels plant.

The North Dakota coal mining reclamation program has aspects that go beyond federal standards. The program has two main components. The first involves mine permitting including the approval of detailed mining and reclamation plans. The second is inspection enforcement, which requires the state to monitor the mining and reclamation operations.

The key is that the land must be restored back to productivity to pre-mine levels. An estimated 95 percent of the reclamation has been returned to agriculture. Topsoil is respread on the surface to optimize forage and crop production (Figure 1). In addition, land has been reclaimed for other purposes. For example, the city of Underwood turned 150 acres into a golf course. Others have been turned into industrial uses, as well as recreation areas. Since 1986, mining companies have received 15 national reclamation awards.

Straley sees reclamation having a positive light on the land in the state. "We have been able to correct Mother Nature's harsher moments," he says. "With equipment, we can design topography to curtail erosion. We mine and have kept in natural tree features, as well as habitat for wildlife. We believe we have a very positive impact on the land."

Jay Volk, BNI environmental manager, adds that one of the largest impacts reclamation has on the land is the reduction of steep contours. "Post mine topography usually has gentler slopes than the pre-mine land," he says. "The reason for this is the post mine topography is directly related to the landowner's preference statements which dictate how land should be reclaimed after mining. For example, the landowners may request cropland or hay land to be returned, which could require a gentler slope than was there pre-mine (Figure 2). Likewise, state regulation does not promote slopes greater than nine percent."

In addition, Volk explains that if the soil resources are available a landowner can change the land use from the pre-mine use to a different post mine land use. One example he uses is if a landowner has a rocky steep sloped, shallow soiled pasture, they could, resource dependent, change the land use to a more productive land use.

"In return, reclamation could provide a gentler slope, uniform soil re-spread, and minimal rocks, which would support a variety of different land uses including cropland and hay land, pastureland, or native grassland," he says. "This could add value to the land and make it more profitable to the producer" (Figure 3). ■

The Wilds:
Center for Restoration, Conservation, and Outreach

DR. JENISE M. BAUMAN AND DR. NICOLE CAVENDER

The Wild, is a non-profit conservation and research center, located on nearly 10,000 acres of reclaimed surface-mined land and was generously donated by American Electric Power in 1984. Situated in southeastern Ohio (Figure 1 and 1A), we work to apply our unique resources towards the survival of endangered species and habitats. Scientific staffing at *The Wilds* is comprised of a unique team of professionals in the fields of restoration ecology, veterinary medicine, conservation education, animal management, and conservation science training. Our Animal Management, Restoration Ecology, and Field Conservation programs have contributed to a greater understanding of integrated landscape approaches to managing high quality habitat. Together with our Conservation Education and Conservation Science Training programs, our mission is designed to provide high impact, educational and formal training opportunities that cover the intersections of energy, electricity, economics, the environment, scientific inquiry, and ecotourism. Since 1994 *The Wilds* has been offering a variety of tour options to the public that promote our mission statement: to advance conservation through science, education, and personal experience.

PHOTO CREDIT:
C. SCOTT BROCKMAN OF OHIO DEPARTMENT OF NATURAL RESOURCES

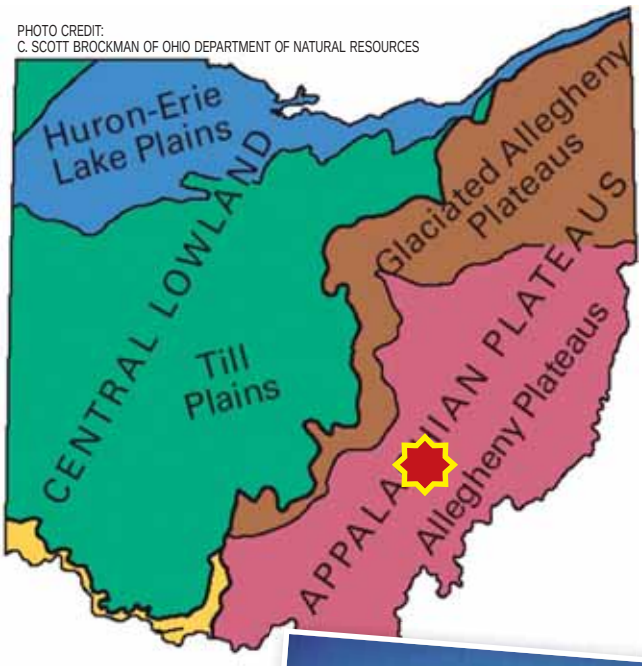

Figure 1 and 1A. The Wilds is located in the Appalachian Plateau, in Muskingum County, Ohio. Mining for coal by the Ohio Power Coal Company (a division of AEP) began in the 1940s and 1950s. After a 10-15 year hiatus, the land was again mined from 1969-1984. A majority of what is now "The Wilds" was coal mined by the Big Muskie, the world's largest coal mining dragline.

Role of Conservation Centers towards Educational Outreach

By interfacing with the public, Conservation Centers have great opportunities to have a positive impact that encourages environmental stewardship, while demonstrating methods to enhance the quality and sustainability of our ecosystems. We meet the goal of community outreach by incorporating our science and educational programs as interactive projects open to our 90,000 annual visitor base. Operating directly with the Columbus Zoo and Aquarium, *The Wilds* has an additional ability to connect with our visitors while working directly with other professionals to reach millions of people globally. *The Wilds* offers adventures in conservation through a number of tour types that includes open air safaris (Figure 2), Wildside Tours (Figure 3), Horseback Safari tours, fishing expeditions, and our brand new Zipline Safari. Our research forms the basis of our tours through pastures of endangered species, large-scale research projects, and open access trails throughout our restored habitats (Figure 4). Our science and education staff interprets the ecological and educational data to emphasize the importance of ecosystem function, biodiversity of our native species, and everyday conservationism to the public. Accredited by the Association of Zoos and Aquariums (AZA), this facility has become a unique conservation center that interfaces its science-based programs with personal experience during public tours.

The Wilds is partnering with the Columbus Zoo to promote a series of programs to increase the ability of regional Zoos and Conservation Centers to connect the public with ecological concepts and solutions. These ecological concepts form the basis of our message during public tours. Whether on horseback or soaring over our pastures on a zip line, our visitors get to experience research in action. *The Wilds* also has developed relationships

Figure 2. Greater One-Horned Asian Rhinoceros looks curiously towards the open-air bus tour. This tour provides our guests with a one-of-a kind experience. Native to the wetlands of India or Nepal, this species is currently part of the reproductive and nutrition research at The Wilds. PHOTO CREDIT: TONI KELLAR.

Figure 3. Our Wildside Tour offers an up-close experience with our resident giraffe! The Wilds and other zoos in the region focus on cooperative breeding efforts to preserve the genetics of the Masai subspecies. PHOTO CREDIT: MITCH KEZAR.

Figure 4. The Butterfly Habitat. The vast landscape of The Wilds presents a unique opportunity for increasing healthy habitat for local populations through prairie establishment. In the past six years, the Butterfly Habitat has grown to nearly 90 acres and monitoring has shown a 247% increase in butterfly abundance. PHOTO CREDIT: IAN ADAMS.

with other conservation partners throughout the nation and was a founding member of the Conservation Centers for Species Survival (C_2S_2, www.conservationcenters.org); a consortium of professionals from Fossil Rim Wildlife Center (Glen Rose, TX), Smithsonian's Conservation Biology Institute (Front Royal, VA), San Diego Zoo's Wild Animal Park (Escondido, CA), and White Oak Conservation Center (Yulee, FL). Working together, zoological institutions and conservation professionals can develop breakthrough solutions for endangered species and environmental concerns with the potential of broad public outreach. To accomplish this, a synergistic approach is used to network professionals in the field, train future leaders, and then disseminate findings to the large constituency of conservation and zoological institutions.

The Wilds: Research in Action

The Wilds large land base allows our animals to live in semi-free ranging conditions. Almost 2,000 acres of the grassland area provides pastures for the 28 species involved in our animal conservation programs (Figure 5). Animal management areas available to visitors by bus tour include five pastures, a 27-acre carnivore center, and a perimeter 8-foot fenced area of 682 acres housing a herd of 94 American bison. *The Wilds*, working in conjunction with our partners of C_2S_2 and AZA, investigate the potential benefits to managing ungulate species (hoofed animals) in large herds and wide open spaces. The primary goal is maintaining sustainable captive populations that will be genetically and demographically stable. In addition, these more naturalistic groups may help produce behaviorally-adaptable offspring for reintroduction programs. The idea is that animals being raised in large herds with natural social groups and open spaces have an advantage. They not only have the ability to be candidates for release programs, but will be able to quickly adapt and thrive in large natural areas after reintroduction (Figure 6).

PHOTO CREDIT: JOE CLARK

Figure 5. Almost 2,000 acres of the grassland area at The Wilds provides pastures for 28 species of wildlife in our animal conservation programs.

Captive reproduction of some species can be challenging, however, conservation centers such as *The Wilds* offer new dimensions for social behaviors not found in a typical zoo setting. The white rhino breeding program at *The Wilds* has been very successful, producing a total of eight calves in the past seven years. We believe that the wide open spaces and herd management strategies at *The Wilds* are an important part of our success, particularly in minimizing stress and allowing for social interaction and mate selection. *The Wilds* boasts the only known fourth generation white rhino calf born in captivity in 2010 (Figure 7)! Our efforts to represent and support diverse threatened animal populations extend beyond our vast pastures and into other *The Wilds* facilities. The Mid-sized Carnivore Conservation Center was designed as part of an initiative to conserve this group of threatened and endangered species. Working with the AZA's Species Survival Plan® (SSP), a cooperative program designed to maintain a healthy, genetically diverse breeding population of typically threatened or endangered

Figure 6. The Scimitar-Horned Oryx is considered extinct. A young male born at The Wilds was selected to be part of a group of animals returned to augment breeding efforts in a reintroduction project in Tunisia. We believe that animals raised in larger herds and wide open spaces of The Wilds have an advantage when adapting to release programs. PHOTO CREDIT: TONI KELLAR.

Figure 7. The Southern White Rhinoceros was near extinction in the late 1800s to early 1900s due to poaching. Reproduction of the southern white rhinoceros has been challenging in captivity. Very few captive born animals go on to produce offspring of their own. The Wilds herd boasts the only known fourth generation captive born white rhino calf. In addition, this animal's mother is notable for being the first white rhino born at The Wilds. PHOTO CREDIT: TONI KELLAR.

Figure 8. Cheetahs are native to sub-Saharan Africa and Northern Iran. Habitat loss and poaching have also contributed to the decline of this species and only about 10,000 remain. Here at The Wilds our cheetahs are part of an Association of Zoos and Aquariums (AZA) Species Survival Plan® (SSP). In 2010, The Wilds cheetah breeding program produced three litters of cubs. PHOTO CREDIT: BONNIE MILLER.

species across North American zoos. Working with the SSP, the cheetah breeding program at *The Wilds* proudly welcomed nine new cheetah cubs to *The Wilds* in the fall of 2010! These cubs can be seen by our visitors on our regular tours (Figure 8).

The Wilds is home to North America's largest herd of the unique Sichuan Takin. This species inhabits sub-alpine forests and alpine meadows across high elevation regions in south-central Asia. Although this species can be found in a few zoos, they are typically not able to handle a group of this size in a conventional display yard. Our large pastures allow us to manage this herd of animals in a multi-male, multi-female herd (Figure 9). Research projects completed at *The Wilds* have been used to develop research techniques that are currently being used to study Takin in their native mountain regions of China. This work, done using the herd at *The Wilds*, helped develop field immobilization techniques, design and test satellite collars, and create a behavioral database. This work, done in collaboration with the Smithsonian Conservation Biological Institute and the Wildlife Conservation Society, will expand our understanding of wild Takin behavior and ecology, and be implemented in future conservation strategies.

The Wilds: Conservation of Ohio Native Species and Habitats

From beetles to bobcats, *The Wilds* is working with wildlife professionals from across the state to assess both reintroduction

Figure 9. The Wilds currently maintains the largest group of Sichuan Takin in North America. The large pastures allow us to manage this species as they would be found in nature in multi-male, multi-female herds. These animals have served as a model population to develop research techniques that have been used to study wild Takin in China. PHOTO CREDIT: MITCH KEZAR.

and assessment of Ohio's native species. In cooperation with the state agencies and regional universities, *The Wilds* science team has been instrumental in the reintroduction of American burying beetles, conducting health surveys of Eastern hellbenders and freshwater mussels, and the reintroduction of American chestnut. We are discovering new ways to study the health and well-being of these vital members of our native ecosystems. *The Wilds* collaborated with the Ohio Division of Wildlife and other facilities reintroduction programs for trumpeter swan and osprey. Though both populations were imperiled in the early and mid 1900s, *The Wilds* reintroduction efforts were deemed successful and their numbers are stabilizing throughout the region. The field conservation program is working in collaboration with wildlife professionals to investigate the range and community health of native carnivores such as bobcats and coyotes. Future assessments will test new strategies for monitoring these species that could be used at other locations to determine their population status and inform management decisions.

Our conservation philosophy is rooted in restoring our native habitats through our Restoration Ecology program. *The Wilds* large land base represents post-Surface Mining Control and Reclamation Act (SMCRA) landscapes. This presents us with a unique opportunity to improve upon restoration methods to increase healthy habitats for local populations. Our current projects include prairie establishment, wetland restoration, reforestation initiatives, and invasive species management. *The Wilds* is in the final stages of restoring a 40-acre area into a high quality wetland refuge that will support a wide diversity of vegetation, waterfowl and aquatic wildlife. Riparian plantings and tree plantings using the Forestry Restoration Approach (FRA) have installed over 25 acres of native forest species. In addition, 354 acres of prairie have been planted for the enhancement of habitat. New in 2011, a demonstration 60-acre study site was initiated to compare biomass production and carbon sequestration in prairies. Each study implements a course of action that works cooperatively toward an environmentally and economically healthy ecosystem while broadening opportunities for the public, researchers, and

Figure 10. WildeCamp is a unique opportunity for campers 8-19 years of age to explore the native flora and fauna of Ohio. This unique The Wilds camp experience provides adventures in conservation education in natural and restored habitats. Our campers are surrounded by lakes, forests, wetlands, and habitats of all kinds while discovering exciting, rare, and endangered species.

students to engage in conservation science and restoration ecology. The Restoration Ecology program works collaboratively with state partners to incorporate conservation science activities through workshops free to the community. Working closely with the Conservation Education program, the development of project-specific public outreach through guided interpretive tours, innovative educational materials and open-access trails are available to over 90,000 visitors each year (Figure 10).

Conservation Science Training at *The Wilds*

From the beginning, *The Wilds* has always had a clear intention of advancing conservation through a strong scientific approach. Therefore, it is very important that we allow for advanced science training using our own research as models for conservation. Our science team contributes to the collaborative dissemination of conservation research and participates in cooperative projects with a number of universities, zoological institutions, federal agencies, and other partners. Our new Conservation Science Training Center functions as a unique and innovative research center, allowing *The Wilds* to work collaboratively with these institutions to initiate long-term projects in the environmental and conservation sciences. From local students to world-renowned researchers, *The Wilds* provide a unique, inspiring back-drop to explore and discover the natural world. On-site cabins and state-of-the art classroom and lab space enable the dissemination of knowledge throughout the region and the world, networking scientists directly to conservation and wildlife (Figure 11).

The Wilds' Conservation Medicine Residency Program is one of only 19 training programs worldwide accredited by the American College of Zoological Medicine. Our program is unique in offering training to veterinarians in field techniques, wildlife epidemiology and medical management of semi-free ranging populations. In addition, we offer *The Wilds* Scholar Internship Program, a 10-week intensive training program designed to mentor the professional growth of undergraduate students. This program couples hands-on field training with intern ownership in a project offered through *The Wilds*. Mentored directly by our research staff, undergraduate interns are responsible for an independent study in one of three areas of emphasis: Restoration Ecology, Conservation Education, and Field Conservation. In addition, Conservation Educators at *The Wilds* have developed a number of programs to take advantage of the "living laboratory" at *The Wilds*. Day-long and overnight programs are designed to align

Figure 11. To allow for the expansion of conservation biology, ecological research, and animal science, The Wilds has constructed a cutting-edge Conservation Science Training Center equipped with classroom, laboratory, office, conference space, and on-site lodging. Functioning as a unique and innovative research and education venue, The Wilds is equipped for further development of its vast landscape as an Ecological Field Station.

with Ohio's academic content standards, so they fit in easily with classroom curriculum.

Come visit *The Wilds*!

Whether it is conservation of rhinos, mussels, cheetahs, or pollinator habitat, our research forms the basis of ecological knowledge that we can share with the public. Our educational and outreach component is designed to provide an interactive venue to educate our visitors, students of all educational levels, professional conservationists, and researchers. Our final message to all of our visitors is that advancing conservation does not stop after a bus tour. We challenge all of our visitors to make great strides within their own communities with regard to environmental stewardship and local habitat restoration. Our guests can keep up to date with citizen science initiatives, camp programs for children and adults, internship opportunities, *Wilds* memberships, Nomad Ridge, and the newest tour options by visiting www.thewilds.org. Our pledge is to continue to use our educational data to be an informative voice towards ecosystem conservation through science, education, and personal experience.

Senior Staff: Dr. Jenise Bauman (Director of Conservation Science Training), Dan Beetem (Director of Animal Management), Denise Natoli Brooks (Director of Conservation Education), Shana Byrd (Coordinator of Restoration Ecology), Dr. Nicole Cavender (Chief Programs Officer), Bobbie Dozer (Director of Visitor Services), Amy Drobina (Director of Parks Operations), Jason Drobina (Director of Maintenance and Construction), Julie Jack-Graham (Administrative Assistant and Program Coordinator), Rob McBurney (Chief Operations Officer), and Dr. Barbara Wolfe (Director of Wildlife and Conservation Medicine). ■

Returning Heavy Mineral Sands Mines to Productive Agricultural Use

BY ZENAH W. ORNDORFF, W. LEE DANIELS, KELLY MEREDITH AND ABBEY WICK - DEPARTMENT OF CROP AND SOIL ENVIRONMENTAL SCIENCES, VIRGINIA TECH, BLACKSBURG, VA, USA

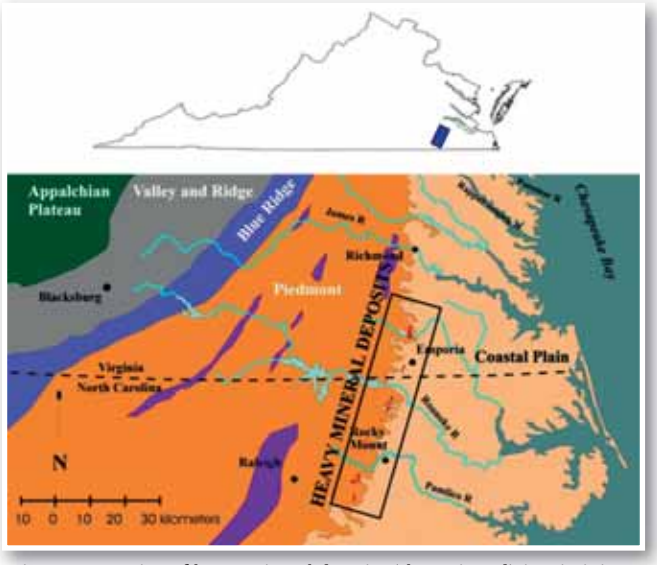

Figure 1. Location of heavy mineral deposits (shown in red) in Virginia and North Carolina. The northern-most deposit is the Old Hickory mine.

Figure 2. Pre-mining agricultural landscape at the Old Hickory Project Area in Dinwiddie County, Virginia, USA. Heavy minerals (ilmenite, rutile and zircon) are enriched in the upper 5 to 20 m of the surface, with significant accumulations commonly occurring in the topsoil layer. The dark color in the roadway here is ilmenite and not organic matter.

INTRODUCTION

Significant mineral sands deposits (ilmenite, rutile and zircon) were discovered along the Upper Coastal Plain of Virginia, USA, in the late 1980's (Berquist and Goodwin, 1989; Carpenter and Carpenter, 1991), and subsequently in similar landscapes in North Carolina. Much of the recoverable mineralized area, which potentially could disturb up to 4,000 ha, occurs under prime farmlands (Figs. 1 and 2). This is an important region for peanut, soybean, tobacco, and cotton production. The Old Hickory deposit in Dinwiddie and Sussex Counties, Virginia, is the largest ore body at approximately 1500 ha. Mining leases for Old Hickory and two smaller deposits in North Carolina were finalized with the landowners in 1990/1991 by RGC Mineral Sands. Active mining at Old Hickory commenced in the summer of 1997, and Iluka Resources Inc. subsequently acquired RGC's mineral sands holdings, and is the current operating company.

The majority of the Old Hickory ore body has been in intensive agricultural production for over 150 years, with extensive forestry practiced on minor inclusions of less productive soils or wetlands. Most of the farms have been in the same family for multiple generations, and are <300 ha in size. On an individual landowner basis, the royalty return value of the processed mineral is much greater than the local current market value of prime agricultural lands. The economic return to the landowner is further improved when mineral-rich topsoil is processed and returned to the site during reclamation; however, the topsoil is altered by processing, thereby affecting its post-mining productivity potential. While there is some uncertainty regarding how much of this landscape would remain in intensive agricultural production over the next few decades in the absence of mining, the inherent agricultural productivity potential of the land is beyond question. Thus, any decision to permanently alter these lands via mining generates a number of questions and implications for individual landowners, regulatory authorities, and the Commonwealth as a whole. Two important components of the Old Hickory mining lease negotiation process were 1) assurances by RGC of their intent to return the lands to intensive agricultural production following mining, and 2) RGC's willingness to employ our university (Virginia Tech) to develop a dedicated reclamation research program.

The mining and reclamation operations at Old Hickory are

regulated by the Virginia Division of Mineral Mining (VDMM) under their non-coal minerals mining regulations. These regulations do not require post-mining return to set productivity levels, but they do require that self-sustaining vegetation consistent with the agreed-upon post-mining land use be viable for at least two complete growing seasons. A reclamation closure plan must be submitted and approved by VDMM, and presumably should be consistent with landowner expectations. Early versions (before 2001) of the VDMM approved reclamation and closure plan specified topsoil return and the associated subsoil reconstruction procedures discussed below. Recent revisions have allowed for direct revegetation of the tailings/slimes without topsoil where approved by the landowner. The regulatory permitting and approval process for these operations was remarkably free of dissent from non-governmental citizen and environmental advocacy groups. This was primarily due to the fact that the operation was permitting as a "no discharge facility" with respect to surface waters, and strong assurances by the company (RGC) of effective return to post-mining agricultural use.

Many current landowners have assumed that their lands will be returned to some level of agricultural productivity with varying levels of expectations among differing individuals. Worldwide, mineral sands mines have been successfully returned to a variety of post-mining land uses including grazing, forestry, native heath/shrub land communities, and wetlands/nature preserves (Brooks, 1989). Before the initiation of this research program, the return of mineral sands mines to intensive agricultural use had not been studied or documented. However, considerable research literature is available regarding the return of coal-mined lands to prime farmland status. In general, soil physical conditions such as compaction, water holding capacity, and permeability are limiting to rowcrop production in restored prime farmlands in the USA (Barnhisel and Gray, 1990). Crop yields are affected also by the quality and thickness of replaced topsoil (Jansen and Dancer, 1981). Collectively, the majority of prime farmland restoration studies indicate that return of post-mining landscapes to productivity levels that approach (90 to 95%) pre-mining conditions is possible with appropriate soil reconstruction, deep tillage, soil amendment and fertilization practices (Dunker et al., 1992).

Familiarity with the mining process is important to understanding the challenges of reclaiming these mine soils.

Figure 3. Dewatering tailings and slimes at Old Hickory Project. The light colored dike material in the foreground is topsoil that is forming a section of the enclosing dike wall. Once the surface of this pit has dewatered sufficiently, it will be limed, fertilized, and deep ripped to prepare it for revegetation. Significant swell in the slimes often results in a final elevation above the pre-mined lands, which complicated topsoil return during the early years of mining. Later mining operations have kept topsoil berms isolated away from enclosing mine pit dikes.

THE MINING AND RECLAMATION PROCESS

Familiarity with the mining process is important to understanding the challenges of reclaiming these mine soils. Before mining, existing vegetation (e.g. forests or old fields) is removed

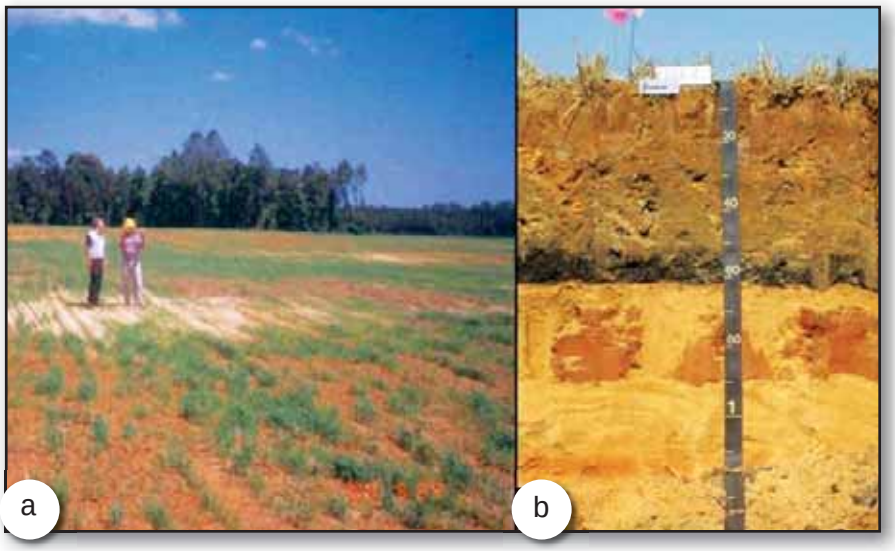

Figure 4. (a) Early revegetated pit at Old Hickory exhibiting strong lateral variability in texture due to lateral segregation of tailings and slimes. The white patches are areas of pure tailings while the darker-colored, better vegetated zones were capped with a layer of finer-textured slimes. Topsoil was not available as a cover material as this pit was closed. In later years (post 2001), advanced pit slimes management practices were developed by Iluka to minimize this lateral variability and lead to more homogenous surface texture. (b) Soil profile from the Carraway-Winn Reclamation Research Farm at Old Hickory exhibiting strong vertical variability of tailings, slimes, and other materials. Note topsoil material which was buried at approximately 30 – 50 cm over a layer of wood ash. The red blocks in the subsoil are a layer of slimes that cracked upon dewatering and then was covered and filled over by a layer of sandy tailings. This profile is much more variable with depth that typically encountered, but is shown here to exhibit a number of interesting and commonly encountered features in these mine soils.

and raked as necessary. Salvaged topsoil is bulldozed into windrows around the edges of the mining pits, and before 2001, commonly became a portion of the enclosing dikes (Fig. 3). Additional low-grade subsoil material is utilized to build up the dikes (up to 4 m above grade) as necessary.

Mineral enriched weathered soil and underlying Coastal Plain sediments are dry-excavated using conventional loaders and haulers, dumped locally through a trommel-screen, and then pumped with water to the wet separation (concentrator) facility. The suspended soil:water mixture is passed through separatory spirals where the finer textured slimes (clays, silts, and some very fine sands) are separated away from the mineral bearing sand fraction. On average, the deposit generates from 35% to 45% slimes, depending on the weathering extent of the soil landscape unit being mined. The heavy mineral sands (density >4.0 g/cm3) are further separated via spirals from the lighter host quartz. No additives or chemicals are used in the separatory process.

The two processed waste streams, dominantly quartz sands (tailings) from the spirals and the slimes which are partially dewatered in a thickener by a flocculating agent, are pumped back to the reclamation pits in a 35 to 50% solids slurry. Depending on weather conditions, it takes several months to a year for the pit surface to dry down sufficiently to support machinery. Once accessible, the surface contour of the dewatered pits is graded with a bulldozer to ensure adequate surface drainage, and areas of highly contrasting materials are worked out to the best extent possible.

DEVELOPING RECLAMATION STRATEGIES

The most challenging aspect of developing effective and sustainable rehabilitation strategies for the Old Hickory deposit is the fact that much of this deposit underlies prime farmland. Several compounding factors include 1) the

Table 1. Crop yields from treatments established at the Carraway-Winn Reclamation Research Farm and a local unmined soil from 2005-2010, and yield averages over five years from Dinwiddie County.

	Corn		Wheat			Soybeans		Cotton (lint)	
	2005	2007	2006	2008	2010	2008	2010	2009	
Treatment[1]				Mg ha^{-1}					%
LBS-CT	10.85a[2]	3.62b	5.04a	5.97a	2.74a	2.24ab	0.96a	1.17a	0.424
LBS-NT	10.90a	3.43b	5.16a	5.65a	2.76a	2.51a	1.11a	1.18a	0.442
TS	3.79c	7.23a	4.29b	4.89b	2.68a	2.20ab	1.15a	1.18a	0.453
C	8.53b	7.30a	4.10b	4.64b	2.51a	2.11b	1.10a	1.05a	0.446
UM	14.36	9.91	6.90	3.90	4.72	3.20	1.73	1.62	0.400
COMP	6.07	3.18	4.33	nd	nd	1.75	nd	nd	nd
Dinwiddie Co. Ave. (04 – 08)	5.78								
Ave. (06 –10)			4.19			1.54			

[1] Treatments are LBS-CT = biosolids (78 dry Mg/ha) with conventional tillage, LBS-NT = (biosolids (78 dry Mg/ha) with no-tillage, TS = topsoil replacement, C = control, COMP = compacted area not ripped, UM = nearby unmined area (UM).

[2] Means in the same column followed by the same letter are not significantly different at = 0.05

silt+clay (slimes) content of the mineralized ore body is higher than this industry has mined before, generating a wide array of operational issues, 2) heavy compaction occurs during final grading and is readily observed in these soils (Meredith, 2008; Orndorff et al., 2005), 3) dewatering of the slimes/tailings mixtures results in soils that are highly variable both laterally and vertically (Fig. 4; Meredith, 2008; Orndorff et al., 2005), and 4) the topsoils are often the most profitable material for HMS mining (Milnes and Fitzpatrick, 1989) generating a need for topsoil substitution amendments where the topsoils are processed.

Our agricultural soil reconstruction research initially involved greenhouse experiments to explore plant growth response to various mixes of tailings: slimes. We found that the simulated mine soils (without topsoil) could serve as suitable plant growth media if significant levels of P were added to offset fixation potentials along with appropriate pH adjustment via liming. In a follow-up study (Daniels et al., 1999) on pilot mining pits between 1995 and 1998, we compared the effects of thick (25 cm) topsoil return vs. topsoil substitution via the addition of yardwaste compost (112 Mg/ha) to mixed tailings and slimes following heavy P-fertilization, liming, and ripping of the reclamation surface. Over a four-year cropping rotation, post-mining productivity compared to adjacent prime farmland plots was reduced by 23%, 3%, 27%, and 20% for each crop (wheat/soybeans/corn/cotton) in sequence. Response to topsoiling versus compost addition was variable and nei-

ther treatment appeared superior. However, the addition of topsoil significantly reduced lateral short-range yield variability and effectively buffered the effects of subsoil texture on crop yields.

In 2004, we established the Carraway-Winn Reclamation Research Farm to further evaluate soil reconstruction techniques on row crop productivity. Our row crop study focused on corn, wheat, cotton and double-crop soybean yields from four different reclamation treatments – biosolids (78 dry Mg/ha) with conventional tillage (LBS-CT), biosolids (78 dry Mg/ha) with no-tillage (LBS-NT), topsoil replacement (TS), and a control (C) – as well as yields from a compacted area which was never ripped (COMP) and a nearby unmined area (UM). Results from six years of management are shown in Table 1 (Orndorff et al., 2011). With few exceptions, crop yields from the four reclamation treatments routinely exceeded local (Dinwiddie County) five-year county averages for all crops tested. However, in making this comparison it is important to note that the research crops had the advantage of being irrigated when necessary to protect against crop failure, while the county average data were based on the combined data for all non-irrigated and irrigated croplands across all soil types. In comparison to nearby unmined prime farmland, crop yields from the treatment plots typically were reduced by 25 to 40%, and the greatest one-time reduction was as high as 74%. In fairness, we must reiterate that the UM plots were located on extremely productive farmland (Orangeburg series soils) and therefore represent a very high standard for comparison.

The most challenging aspect of developing effective and sustainable rehabilitation strategies for the Old Hickory deposit is the fact that much of this deposit underlies prime farmland.

Although the exact pit reclamation process has varied over time, typical practices employed by Iluka include the application of agricultural lime (4 to 10 Mg/ha depending on texture and pH) and P-fertilizer (350 kg/ha P_20_5). Some pits may receive additional P_20_5 (150 to 200 kg/ha) when very low soil test P values are found. The bulk soil amendments are incorporated via a sequence of deep (75 cm) shank ripping followed by chisel-plowing and/or offset disking in order to physically loosen, lime and P-fertilize the mine soil materials to a depth of at least 30 cm. If topsoil has been retained, and is accessible, it is returned at varying thickness over the conditioned subsoil materials, and disked again. Additional lime and N-P-K fertilizers are added to the reclaimed surface per the intended revegetation mixture.

CONCLUSIONS

The development and implementation of effective restoration protocols at the Old Hickory mineral sands mining operation in Virginia was complicated by the lack of a pre-existing research or industry knowledge base. Heavy minerals (ilmenite, rutile and zircon) are enriched in the upper 5 to 20 m of the surface, with significant accumulations occurring in the topsoil layer. Over twenty years of collaborative work by Virginia Tech and the mining company (Iluka Resource) has led to a detailed understanding of the mining process and a reasonable prediction of reclamation outcomes. Processing the ore body results in a higher percentage of slimes than any mineral sands deposit mined to date and the slimes replaced as topsoil require high levels of lime and fertilizer. With respect to long-term sustainability, it is clear that these heavy mineral deposits can be developed, and with intensive soil reconstruction, they can be successfully returned to post-mining agricultural uses. However, a minimum yield decrease of 25% over the initial five years following soil reconstruction should be expected in comparison to the most highly productive pre-mined prime farmland soils. That being said, these reconstructed mine soils can be expected

to be quite similar to surrounding local soils on average in terms of post-mining productivity. We hypothesize that over longer periods of time, mine soil productivity will slowly increase due to improved aggregation of the surface and subsoil horizons assuming optimal tillage and fertility management practices are followed. Obviously, any permanent reduction in prime farmland productivity must be weighed against 1) societal needs for these strategic minerals, 2) the economic return to landowners, the mining company and its employees, and 3) the associated tax revenue stream to various local, state, and federal governments.

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    http://www.mississippipower.com/kemper/TRIGTechnology.asp
- Walter Energy - http://www.walterenergy.com/
  – Choctaw Mine – Bituminous
  – http://www.walterenergy.com/operationscenter/coal.html
  – Jasper, AL 75 miles from Tupelo


Bancorp South Arena, Conference Center & Hilton Garden Inn

http://www.bcsarena.com


Hilton Garden Inn & Convention Centrer - adjacent to Convention Center and area

Other Attractions

- Elvis Presley's Birthplace
  – http://www.elvispresleybirthplace.com/
- Brice's Crossroads Battlefield – June 10, 1864
  – http://www.bricescrossroads.com/commission.aspx
  – Potential Re-Enactment of Battle on June 9, 2012
- Natchez Trace Visitor Center
  – http://www.nps.gov/natr/index.htm
- Tenn-Tom Waterway Visitor Center
  – http://tenntom.sam.usace.army.mil/pdf/rec/isheet/visitor_centers/jlwhc.pdf
- Private John Allen National Fish Hatchery
  – http://www.fws.gov/pvtjohnallen/
- Tupelo Auto Museum – site of the evening social "Taste of Mississippi"
  – http://www.tupeloautomuseum.com/index.php
- Tupelo Buffalo Park and Zoo
  – http://www.tupelobuffalopark.com/
- Tupelo Visitor's Center
  – http://www.tupelo.net/about/

mining & reclamation services

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434 Spring Street Ext., Mars, PA 16046
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RECEIVING STREAM MONITORING

Downstream Point	pH	Acid (mg/L)	Alk. (mg/L)	T. Fe (mg/L)	T. Mn (mg/L)	T. Al (mg/L)	SO_4 (mg/L)
21 (Pre Constr. Avg.)	3.0	498	0	51	21	27	1337
21 (2009 Average)	6.5	12	22	2	13	3	829

WATER QUALITY (AVERAGE)

Point	Flow (gpm)	pH	Acid (mg/L)	Alk. (mg/L)	D. Fe (mg/L)	D. Mn (mg/L)	D. Al (mg/L)	SO_4 (mg/L)
Raw	n.m.	2.8	1390	0	243	18	113	2622
Phase 1	n.m.	5.0	62	10	4	10	9	1506
Final	44	7.3	-181	307	<1	8	<1	1170

Data for this and more sites designed by BioMost available at www.datashed.org

COMPREHENSIVE MINE DRAINAGE SERVICES

- Passive & Active Treatment Design
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- Resource Recovery
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