OFFICIAL PUBLICATION OF THE AMERICAN SOCIETY OF RECLAMATION SCIENCES

# Fall 2023

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# What can ASRS do for you?

### JULIE LABAR, OKLAHOMA STATE UNIVERSITY

It's hard to believe it's already time for the fall issue of *Reclamation Matters*. As most field seasons seem to do, this summer flew by. Before summer completely ends, I'd like to extend a huge thanks to Dustin Wasley and the team for putting on a fantastic Annual Meeting in Boise in June. We had a great turnout at a great venue – it does not take an insignificant amount of work to pull that off. Plus, not only did we get to see many familiar faces, but we also welcomed a lot of new folks. Welcome!

Thinking about what to write in my first President's Message, I stumbled on a realization. Since I joined ASRS (then ASMR) in 2007, I have missed one Annual Meeting – Tupelo in 2012. (That's not the realization). I joined just as I was finishing my master's thesis that summer and continued to jobs, more school, and more jobs. It turns out the two most consistent things in my academic and professional careers in the past 16 years have been the Society and my mentor. At first maybe a random realization, but it quickly becomes very heartwarming and reassuring to me.

Signing up to run for President of ASRS is not a trivial consideration. What at first seems like a relatively simple and straightforward role quickly becomes something bigger. You've taken on the role of one of the primary caretakers of a professional society whose roots are over five

We have a number of goals for this year. I won't enumerate them all here, but there are a couple we need your help with. Number one is establishing a more robust pipeline of communication between us and our members. decades old and has played an essential role in changing the way the world views mining, its impacts, and now reclamation as a whole. Wow. What an honor and privilege. And plenty of responsibility, to be sure, but an honor, nonetheless.

One of the things the NEC has come to recognize vividly over the past year since the Society changed management (from an Executive Director to an external organization) is that, more than ever before, we need the support and engagement of our membership to keep the Society lively and current. What does that look like? It looks like volunteering to organize a technical session for an annual meeting. It looks like volunteering to sit on a committee, signing up to present a webinar hosted by the Society, bringing your students/ trainees/interns, and sending your ECPs to our Annual Meeting. It looks like a million things I cannot list here but would love to hear from you.

We have a number of goals for this year. I won't enumerate them all here, but there are a couple we

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Science, Engineering and Technology-Based Reclamation Consulting and Implementation Services kcharvey.com need your help with. Number one is establishing a more robust pipeline of communication between us and our members. That was a role the Executive Director played that simply cannot be replaced by an external organization – at least not in the way such a close-knit society deserves. If you were at the meeting in Boise, it may have seemed like I plug president@asrs.us a lot – it's part of the plan! Tell us what you want from the Society. Share your ideas. We want to hear from you throughout the year, not just at our Annual Meeting. We are also working on website updates to facilitate this goal.

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www.biomost.com 724.776.0161 bmi@biomost.com The next goal is to continue to broaden our membership base to bring more reclamationists into our fold. Can you ever have too many reclamationists? I think not. We were joined in Boise this year by folks in oil & gas reclamation not something we usually see a lot of at our meetings. We've heard from folks reclaiming urban areas not impacted by resource extraction, but in need of reclamation, nonetheless. As I learned recently, there's a fair bit of reclamation needed in the pursuit of rural renewal. Reclamation can occur anywhere. and we want to hear about it. More importantly, we want to help you share your reclamation stories, successes, failures, and journeys with other reclamationists. So, what does that mean for you? Tell your network about us. Invite your fellow reclamationists to join us in Knoxville next year. We know there are voices not being heard in ASRS yet and we want to hear them.

As I said before, I've been a part of the Society for a while. I keep coming back because we have a wonderful thing going here. Cool meeting locations, unique tours, but most importantly a brilliant knowledge base in our membership and some of the most welcoming members I've encountered. Who wouldn't want to be a part of that? I look forward to meeting even more of our members and bringing more to join us. And, in one final plug, if you have ideas, comments, suggestions, questions, or want to get involved in any way, I'm just an email away at president@asrs.us. 🧳

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# Reclamation continues and will continue to matter

### MICHAEL CURRAN, ABNOVA ECOLOGICAL SOLUTIONS

It's hard to believe the 40th Annual Meeting of ASRS in Boise happened only a few months ago. As always, it was great to see familiar faces and learn about new reclamation projects, technologies, and practices. As I'm still getting used to being Editor of Reclamation Matters, I'm certainly thankful to Dustin Wasley, Julie LaBar, Michele Coleman, Natalie Kruse Daniels, Jeff Skousen, Tim Danehy, and all the others who made it a point to promote Reclamation Matters on the microphone in Boise and encourage submissions of articles to the Fall 2023 edition.

I know it takes a lot of time and effort to put an article together and get proper permissions from agency or company directors and collaborators. For that, I'm extremely grateful to the authors who submit articles to *Reclamation Matters*. Furthermore, I'm always happy to get an e-mail from Jeff Skousen. It's nice that he continues to check in to make sure things are running smoothly as I'm transitioning into a role which he excelled at for nearly two decades before handing me the reigns. In a conversation Jeff and I had at the Duluth conference in 2022, Jeff talked about the importance of getting a wide range of topics from different geographical areas and a diverse mix of authors. He also spoke about the need for a centralized repository for photos from every conference. As Gwen Geidel notes in the Wild Women of Reclamation section of this edition, an unsung hero is Kelsea Green. Thank you, Kelsea, for your efforts to capture many of the great moments we all shared.

I hope this issue with article contributions from the Atlantic Coast of New Jersey, the Appalachians of Pennsylvania, the Rocky Mountains of Wyoming, the South Island of New Zealand, and authors with varied backgrounds and job titles reflects the importance of reclamation and the diversity associated with it. I especially appreciate Jim Truax's advice to young and upcoming reclamationists – this is a good field to be in as we continue to rely on the planet's resources. We need to protect the planet with reclamation efforts.

As Julie LaBar points out in the President's Message, it was great to see a large presence from the oil & gas industry in Boise. Several years ago, when it was voted on to change the name of this society from American Society of Mining and Reclamation to American Society of Reclamation Sciences, one of the hopes was to see folks from outside the mining world participate in our conferences and other Society offerings. As human populations continue to grow, we will continue to rely on oil, gas, and mining to provide tangible and necessary benefits to mankind. As these industries require land surface disturbance to provide benefits, continuing to learn from each other on how to better reclamation practices is

paramount. We also need to reclaim areas around solar fields, wind farms, brown fields, and urban and suburban areas. Today, just as much as ever, reclamation really does matter.

ASRS, in my opinion, is in a good place to continue playing a huge role in promoting and advancing the field of reclamation. It's exciting to see *Reclamation Sciences* starting to publish peer-reviewed, scientific journal articles. I encourage anyone with data-driven research articles to reach out to Natalie Kruse Daniels, Editor-in-Chief of *Reclamation Sciences*, as these articles are critical to advance our field. My hope is folks who have interesting stories to tell continue reaching out to *Reclamation Matters*. I know it takes a lot of time and effort to put an article together and get proper permissions from agency or company directors and collaborators. For that, I'm extremely grateful to the authors who submit articles to Reclamation Matters.

I would love to see more students start publishing here. Maybe you don't have enough data to go to *Reclamation Sciences* yet, but if you have a cool project, reach out – I hope I can make your first publishing experience an easy one.

Wishing everyone the best and looking forward to seeing you all in Knoxville at the 41st Annual ASRS Conference. A huge thank you to Jennifer Franklin for spearheading the Knoxville Conference. I cannot wait to learn more about reclamation in Tennessee. To reach Natalie for *Reclamation* 

*Sciences*, email reclamationsciences@ asrs.us, or to reach me for inquiries about *Reclamation Matters*, email reclamationmatters@asrs.us. *(* 

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### EARLY CAREER



# Post-internship review and thoughts

BY STUDENT AND EARLY CAREER PROFESSIONALS REPRESENTATIVE ALLEN WELLBORN, NAVAJO TRANSITIONAL ENERGY COMPANY

This Issue of *Reclamation Matters* will find many students back in class or finishing up summer jobs, so I will keep this brief as I know you have lots of studying to do.

Now that you have gone through a summer working as an intern, research assistant, temporary employee, or even if you took the summer off and ate ice cream in the pool, now is the time to reflect on your experiences. Look back at what you learned. Did it relate to your curriculum of choice? What new education did you receive that you can apply to your fall semester classes? Did you take on a job in your field of study and realize you hate it? These are all things to reflect upon and the reason entertaining a work study, internship or seasonal employment in your field is a good choice. It may further your desire to learn more, or it may persuade you that you should choose something different. If you truly enjoyed your experience, I would encourage you to maintain connections with that employer and research other opportunities in the same field to gain experience. If you barely made it through summer and decided that you disliked that line of work, now is the time to talk to an

advisor or a club mentor and decide a path or class schedule that might be of more interest. Are you that person that sat in the pool and ate ice cream all summer? I get it – this was a hot one, and sometimes you just need to take a break. I would, however, encourage you to get out there and find a seasonal, internship, or work study in your field. You will find great satisfaction in using the education you received all summer in a practical sense while earning some extra money for the school year.

As always, stay safe and don't hesitate to contact myself or any other NEC members with questions! *《* 





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# **2023 Wild Women of Reclamation**

BY GWEN GEIDEL



Front row (left to right): Natalie Kruze Daniels holding Lena, Shea Zeman Meghan Blair, Whitney Foulkner, Brenda Schladweiler, Micayla Pearson, Marie Sheperd, Sara Klopf, Guadalupe Fattore, Gwen Geidel, Sam Taylor, and Kelsea Green. Middle row (left to right): Jennifer Franklin, Jenise Bauman, Penny Hunter, Cheyenne Morgan, Summer King, and Erzn Hurley. Back row (left to right): Carrie Monohan, Libia Gonzalez, Meagan Graham, Michele Coleman, Chelsea Harris, Jen Schlotthauer, Linda Johnson, Justine McCann, and M'Kenzie Dorman.

It was wonderful to meet all those who attended the Wild Women of Reclamation (WWR) 9th annual gathering on June 6, 2023, at the 40th Annual American Society for Reclamation Sciences (ASRS) meeting in Boise, ID. As always, we got an early start on the day with our morning meeting, and women in all stages of their careers gathered to have breakfast, enjoy a presentation by Dr. Jenise Bauman, and create networking and mentoring opportunities. We also had a great experience sharing and a few offered some highlights and laughs from the prior year. We thank everyone who participated, brought a friend, or encouraged attendance. From the photo above, you will see the wide participation, and we are thankful for

our new photographer, Kelsea Green, but we also missed having our past ASRS Executive Director, Dr. Robert Darmody, doing the photography honors with his wife Susan. Thank you to Robert and Susan for your assistance with WWR in the past!

The goal of the gathering is comradery, networking, and to discuss common experiences, unique as women, in the pursuit of improving reclamation. With the expansion of ASRS's reclamation reach beyond mining and the size of the ASRS annual meeting, WWR is another tool we can use to empower women to have confidence in our abilities to advance our careers in reclamation science, mentor the future generation of professionals, and to improve the lives of everyone through our interactions. While a number of books and podcasts are available on this topic, see, for example, the podcast How to get more women in science, with Athene Donald (nature.com), WWR is a forum that offers women another opportunity to make new connections.

It's often easier in a smaller setting, such as WWR, to meet new people, which we hope leads to feeling less isolated at the ASRS meeting, especially if you're a new member or do not have a large network. These new connections may allow you to enjoy the conference even more as it expands the number of people you know and talk to more easily about presentations, products, methods, all while learning more about each other.

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10 Years Later Following One Application of Biosol It's these new connections that can become friendships which often add to our reasons to attend the annual ASRS meetings year after year. Therefore, we encourage you to continue to maintain a connection with a mentor or peer you may have met this year.

Getting past why we meet, it's important to also recognize what we learned during our time together. Dr. Jenise Bauman highlighted her experiences, challenges, early role models and how those role models helped enrich her work. She discussed her early days when she loved working with plants in any capacity from retail nursery to landscaping, to her BS degree which led her toward being a horticulturalist, then a landscaper designer. During her graduate degrees (MS from WVU and PhD from Miami Univ), she began to understand the complex role of fungi in forests and various ecosystems, and it was the Cedar-apple rust (Gymnosporangium juniperi-virginianae) fungi which provided her with her "ah-hah" moment that led her down her complex research path. As an engaging speaker, she discussed the limited number of women in this professional field in the 1970s, but how those women used team efforts to expand knowledge of specific fungi and especially those related to the chestnut blight. As in so many systems involving ecological disasters, nature is in equilibrium with many species until new pathogens (or species) are introduced which have no natural predators or controls. Jenise's research couples field methods with molecular techniques to better understand vegetation establishment, plant interactions, and system recovery in disturbed soils. She discussed belowground interactions of beneficial



Cedar-apple rust (Gymnosporangium juniperi-virginianae).

fungi during restoration, impact of invasive species on plant-fungal mutualisms, and plant pathology within forest restoration. As with many in the field of reclamation, her credentials and research foci only touch the surface of her career.

And she taught us life lessons she has learned from fungi (which could apply to any of us).

- 1) Make your presence known,
- 2) Create dynamic equilibriums,
- 3) Form mutualistic symbioses, and
- 4) Clean up after yourself!

Thank you, Jenise, for sharing your pathways and life lessons with us.

Also, when discussing women who have become incredible in their field and who have assisted others moving forward with their careers, we thank Dr. Jennifer Franklin, as she prepares to chair and host the 41st Annual ASRS meeting in Knoxville, TN in 2024. If you are interested in working with the conference, please let her know. Jennifer may be reached at jafranklin@ utk.edu.

We hope that those who made new connections at the meeting will continue those connections throughout the year. I'd like to thank my coorganizers/co-chairs of WWR, Michele Coleman, Rachel Hohn, and Brenda Schladweiler. If any of us can assist you, please let us know.

Gwen Geidel (gwengeidel@gmail.com)

Michele Coleman (michele.m.coleman@gmail.com)

Rachel Hohn (rachelhohn@gmail.com)

Brenda Schladweiler (BSchladweiler@ bksenvironmental.com) 🏈





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### Richard I. & Lela M. Barnhisel Reclamation Researcher of the Year Award

The Richard I. and Lela M. Barnhisel Reclamation Researcher of the Year award recognizes substantial contributions to the advancement of reclamation science and technology through scientific research.



### Kenton Sena | Nominated by Richard Barnhisel

Kenton Sena holds a B.A. in Biology from Asbury University, and an M.S. in Forestry and Ph.D. in Integrated Plant and Soil Sciences from the University of Kentucky. He is currently a lecturer in the Lewis Honors College at the University of Kentucky, where he teaches the Honors Foundations Seminar "Knowledge and Society," as well as honors courses in ecology such as "Restoration Ecology," "Appalachian Natural History," and "The Ecology of Middle earth." His research interests involve reclamation and restoration of sites affected by mining and urbanization. Dr Sena has published multiple research articles

in proceedings and journals that have influenced the fields of reclamation ecology and sustainability. He's currently specializing in the reclamation of urban disturbances to better the culture and living experiences of many individuals. He lives and gardens with his wife and two children in Lexington, KY.

### **Reclamationist of the Year Award**

The Reclamationist of the Year award recognizes individuals demonstrating outstanding accomplishments in the practical application or evaluation of reclamation technology. It also rewards individuals responsible for implementing innovative practices or designs for new reclamation strategies.



### Marie Shepherd | Nominated by Jennifer Schlotthauer

Marie Shepherd is a Navajo born and raised in Ganado, Arizona on the Navajo Nation. She attended Ganado High School and went to college at the University of Arizona in Tucson, where she received a Bachelor of Science degree in Civil Engineering. In 2002, she received a Master of Arts in Organizational Management from the University of Phoenix while working at Chevron's McKinley Mine. She is a registered Professional Engineer in the States of New Mexico and Arizona. She is currently Senior

Manager at Peabody's Kayenta Mine and responsible for all Environmental Department functions, including supporting field reclamation activities, compliance work, regulatory oversight, and managing the environmental monitoring program. She works closely with the regulatory authority's onsite inspection, compliance, bond releases and monitoring programs. Along her career path, she has mentored several young engineers.

At the height of Kayenta's reclamation, she managed to reclaim about 400 acres per year over a five-year period. She has integrated geomorphic concepts into reclamation plans, and because of this effort, Peabody's Kayenta Mine received the 2019 OSMRE National Reclamation Award. This award recognized not only integrated geomorphic concepts but also tied in Peabody's unique cultural planting program. These practices result in a sustainable landform for the Navajo Nation to use. She manages the annual grazing program which the local community participates in utilizing the reclaimed lands for grazing. As a rancher herself, she understands using grazing as a best management practice. Delivering a sustainable product to the Navajo Nation by restoring mother earth aligns with her values and beliefs.

### Early Career Award

This award is intended to recognize an early career member of ASRS that is involved in reclamation research, teaching, and/or on-the-ground reclamation practices within academics, regulatory oversite or in an industry position. The nominee must have been employed in their field for a minimum of three years but not more than 10 years.



### Travis Tasker | Nominated by Julie Labar

Dr. Travis Tasker is an Assistant Professor in Environmental Engineering at Saint Francis University. He received a Biology and Environmental Science dual B.S. from Allegheny College in 2013 and a PhD in Environmental Engineering from Penn State University in 2018. In addition to teaching Environmental Engineering courses at Saint Francis University, Dr. Tasker directs the Center for Watershed Research and Service (also known as the CWRS) which strives to assist nonprofit organizations, government

agencies, and consulting companies on watershed restoration efforts. Since becoming director of the CWRS, Dr. Tasker has led and collaborated on multiple research, service, and technical service projects with a focus on water reclamation and resource recovery. Currently, Dr. Tasker and the CWRS are assisting collaborators with mass balance analyses, water sampling campaigns, and reclamation plans for several mine contaminated watersheds in Pennsylvania. Dr. Tasker is also involved in many outreach campaigns through the CWRS, including working with local high schools to educate their students on mine reclamation and hosting a water reclamation summer academy at Saint Francis University for high school students. Overall, Dr. Tasker's career efforts focus heavily on mitigating the impacts of legacy mining and educating others on how we can all contribute to preserving Earth's valuable resources.



### William T. Plass Award

This award is the highest honor the Society has and recognizes those in research, teaching, outreach, and administration. The award is given to a person who has distinguished themselves in the field of disturbed ecosystem reclamation at the local, regional, national, and international levels.

### Gwendelyn Geidel | Nominated by Michele Coleman

Gwendelyn Geidel, PhD, JD, is a hydrogeologist currently working with mine tailings reclamation and is an environmental attorney focusing on contamination and water quality in the context of land management, reclamation, and utilization. Gwen is an Affiliate faculty member and a Distinguished Research Professor Emerita in the School of the Earth, Ocean, and Environment (SEOE) at the University of South Carolina. After obtaining her PhD in Geology, she began her career in the Department of

Geology at USC focused on the prediction and prevention of water quality impacts from coal and metal mining in the US and internationally, which led to not only interesting research questions but legal issues as well. In 1989, she graduated from the USC School of Law and practiced environmental law in Columbia, SC. When the USC School of the Environment (SOE) was formed in 1994, she returned to USC as the Associate Dean of the SOE until 2006, when it was merged into the College of Arts and Science. While at USC she taught earth resource management and sustainability classes and advised numerous graduate and undergraduate research students through field and laboratory research efforts. She continues her research and consulting related to the remediation of ground and surface water contamination caused by mining and other anthropogenic disturbances and the development of sustainable reclamation practices for improved vegetative, soil and water quality. Her research has been supported by industry and various state and federal government agencies with the goal of improving our understanding of water rock interactions and their impacts on reclamation practices. She has published numerous articles and book chapters and is active in community organizations including the SC Central Midlands Council of Government environmental committee, and Gills Creek Watershed Association. She has also served on several national committees and forums, including the Global Council for Science and the Environment's (GCSE) University Leaders and, within ASRS, she has served on the NEC, Scholarship Committee and was President in 2018-19.

### Distinction in Reclamation Award

This award recognizes a specific project in which a company has demonstrated excellence in reclamation design, implementation, and overall success, resulting in the conservation of natural resources and the ecosystem.

![](_page_23_Picture_8.jpeg)

### Quapaw Nation Environmental Department | Nominated by Robert Nairn

Over a half-century of underground mining and surface milling operations in northeast Oklahoma produced more than 500 million tons of mining waste containing elevated zinc, lead, and cadmium concentrations. As a result, the Tar Creek Superfund Site was placed on the US Environmental Protection Agency (USEPA) National Priorities List (NPL) in 1983, shortly after the Comprehensive Environmental Response Compensation and Liability Act

(CERCLA) was passed. For decades, however, these massive chat piles sat relatively undisturbed on the reservation lands of the Quapaw Nation. In 2012, the Quapaw Nation Environmental Office, along with its construction department Quapaw Services Authority (QSA) commenced remedial action activities at the Catholic 40 site, a former Catholic mission on tribal land.

Based on the exemplary results of an initial pilot project at the Catholic 40 site, the Quapaw Nation and QSA now lead both federal (US EPA) efforts on tribal trust lands and state (Oklahoma Department of Environmental Quality, ODEQ) efforts on non-tribal lands. They are the first tribal nation in the United States to lead Superfund remediation and reclamation effort within their own tribal boundaries. To date, the Quapaw Nation has removed more than 6 million tons of contaminated mine tailings and returned more than 600 acres to productive use.

### Pioneer of Reclamation Award

This award is presented to an individual who has had significant impact and influence in the field of environmental science and reclamation relating to disturbed ecosystems over their entire career.

![](_page_24_Picture_2.jpeg)

### Patrick Angel | Nominated by Kenton Sena

Dr. Patrick Angel, a native of eastern Kentucky, had been employed by United States Department of Interior, Office of Surface Mining Reclamation and Enforcement (OSMRE) in London, Kentucky. His career with the federal government spanned more than 42 years of service. Prior to his tenure with OSMRE, Patrick worked for the Kentucky Division of Reclamation and the University of Kentucky, training Surface Mine Reclamation Technicians and the first group of

federal inspectors hired to implement and enforce SMCRA in 1978. Patrick is a graduate of Stephen F. Austin State University with a BS and MS in Forestry and a graduate of the University of Kentucky with a Ph.D. in Soil Science. The focus of his studies was the reforestation of surface mines. During much of the last half of his 42-year service with the federal government, Dr. Angel served as the Senior Forester and Soil Scientist for OSMRE where he was very active with the Appalachian Regional Reforestation Initiative. Patrick is a co-founder with Dr. Chris Barton with the University of Kentucky of the non-profit conservation organization called Green Forests Work (GFW). GFW focuses on restoring ecosystem services on mine-scarred lands and creating green jobs in the process. Since his retirement from the federal government in 2020, Patrick is continuing his work with GFW planting trees on abandoned surface mines and organizing volunteer tree planting projects across Appalachia. Angel is also operating a 100-acre sheep farm west of London, KY and has an apiary with a 100-hive capacity. He produces honey and high-quality lean lamb. Recently, Patrick created a non-profit called the Southeast Kentucky Sheep Producers Association, Inc., (SEKSPA). A major project of SEKSPA under Patrick's direction is to conduct a three-year "Proof of Concept" project that demonstrates productivity and financial viability of large-scale small ruminant enterprises on reclaimed coal surface mines in Central Appalachia. The economics of utilizing the vast acreage of unused and unmanaged hay and pastureland can be profitable and is beneficial to a healthy and sustained ecosystem.

![](_page_24_Picture_6.jpeg)

#### Bryan Hansen | Nominated by Jennifer Schlotthauer

Bryan Hansen has spent his whole life in the state of Wyoming while earning a BS degree in Wildlife Management from the University of Wyoming. After a two-year stint with the Wyoming State Game and Fish department, he hired on with Peabody's North Antelope Rochelle Mine as an environmental specialist. Over the next 33 years, he progressed into the Environmental Manager for the United States largest surface coal mine with over 32,000 acres of disturbance and

more than 14,300 acres of permanently reclaimed ground. This daunting task has many environmental challenges that require forward thinking and innovation in reclamation practices. Bryan led the way in advancing several reclamation practices that resulted in close to 7,500 acres of final bond release in a semi-arid ecosystem to date. The practices he initiated are still used today to continue to have successful final bond release packages submitted to the State of Wyoming. Bryan always encouraged knowledge transfer and the use of best management practices to better the field of mine land reclamation. NARM has received many national and state awards under Bryan's management including OSMRE Excellence in Reclamation National Award in 2012 and the 2020 WY State Department of Environmental Quality - Excellence in Reclamation award to name a few. After retirement in February of 2023, he continues to push for excellence in the recovery of ecological disturbances and plans to continue to share in his experiences. He also enjoys the outdoors in Wyoming with his family while camping and fishing.

![](_page_25_Picture_0.jpeg)

### Neil Humphries | Nominated by Jeff Skousen

Dr Humphries has shown outstanding leadership in reclamation ecology and research while focusing on soil ecology in the reclamation of disturbed ecosystems in the mining industries throughout the United Kingdom. Dr. Humphries education started a long career (50 years) in the development and research of reclamation practices which can be summarized as management, restoration, and re-creation of soil-based ecosystems and biodiversity after drastic disturbances. Dr Humphries received his BS from University of Exeter, his BA from Cambridge University, and his Ph.D. from the University of Liverpool. Activities by his companies always have maintained high standards to ensure that the reclamation and

research on soils and agricultural use of disturbed sites be carried out in a meaningful manner. Dr Humphries and his associates always maintained a desire to make sure that others could benefit from their experiences. Dr Humphries first published articles in the Proceedings of ASSMR in 1994 and has since publish more than 18 articles in other ASMR and ASRS proceedings and multiple articles in JASMR. Dr Humphries has sought cutting edge technology and practices to find practical and meaningful advancements in the reclamation of disturbed ecosystems. His outstanding reclamation practices and research have led to a large array of honors and awards from ASRS, including the William T. Plass award in 2013 and the Richard and Lela Barnhisel Researcher of the Year award in 2020. Congratulations, Dr Humphries, on another outstanding honor for your dedication to and experience with reclamation ecology.

### ASRS Lifelong Exceptional Service Recognition

This special award is given to an individual(s) who have dedicated exceptional service to the ASRS over their lifelong career in Reclamation Science. This recognition will be given out, at the discretion of the NEC, to deserving recipients who are at or near their retirement from active membership in ASRS. It may be given to multiple recipients in a year but may not be given if there are no notable recipients. This recognition will take place during the professional awards ceremony at the annual ASRS conference, and an appropriate plaque will be given with the accolades.

### Richard & Lela Barnhisel / Jeff Skousen

The 2023 Exceptional Service Recognition Award recipients are Richard & Lela Barnhisel and Jeff Skousen. ASRS is forever grateful for the service Dick, Lela, and Jeff have dedicated over their careers. Their positive impacts to the Society will be felt for many years to come. *#* 

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# Certified Seed Specialist training course hosted by Wyoming Mine Lands

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![](_page_26_Picture_3.jpeg)

RETURNING ACTIVE AND ABANDONED MINE SITES TO THEIR ORIGINAL CONDITIONS COR BETTERD.

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![](_page_27_Picture_0.jpeg)

### **ASRS Student Awards**

At the recent conference, the ASRS's Memorial Scholarship Awards were awarded, in commemoration of deceased ASRS members. They are granted to deserving students from universities, colleges, or community colleges that offer curricula in a scientific discipline directly related to, and leading toward, a profession in reclamation-related work.

This year's recipients were:

- PhD Award Justine McCann
- MS Award Micayla Pearson
- BS Award Kendall Hays

### **Other Student Awards**

Graduate Poster

- 1st place Cheyenne Morgan
- 2nd place Chelsea Harris and Ellen Pokuah

### **Undergraduate Poster**

• 1st place – Samantha Taylor

### **Student Travel Grant Recipients**

- Ellen Pokuah Ohio University
- Cheyenne Morgan University of Oklahoma
- Justine McCann University of Oklahoma
- Samantha Taylor University of Oklahoma

![](_page_27_Picture_18.jpeg)

*Julie LaBar and Gwen Geidel present the PhD award to Justine McCann.* 

Julie LaBar and Gwen Geidel present the MS award to Micayla Pearson.

Gwen Geidel announcing the BS award for Kendall Hays.

### 2023 Student Scholarship Awards

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# A Look Back at the 40th Annual ASRS Conference in Boise, ID

First and foremost, huge thanks to Dustin Wasley and Johanna Combo for their Herculean efforts in hosting the 40th Annual ASRS Conference in Boise, ID. Of course, the National Executive Committee played a huge role here as well, and they deserve a big round of applause. It was a jampacked several days, opening with a tour of the DeLamar Mine courtesy of Integra Resources on Sunday.

On Monday morning the Plenary Session kicked off, and

we saw Michele Coleman hand the gavel to Julie LaBar – big shoes to fill for Julie, but ASRS is in good hands with her as President. We then got to see many well-deserving individuals receive their awards. Of special note, Dick and Lela Barnhisel and Jeff Skousen received Lifelong Exceptional Service Recognition awards at the event – these awards are not given every year.

After the award ceremony, Technical Sessions began - over

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the course of three days, there were five Technical Sessions, each one having three concurrent speakers. On Day 2, the Wyoming Abandoned Mine Lands hosted a Certified Seed Specialist training course, which consisted of a classroomstyle training period where essentials to building sound reclamation plans were discussed. Following the classroomstyle training, participants were taken outdoors to get live training on a Truax drill seeder, which was transported to Boise by Grouse Mountain Environmental Consultants. Here, participants learned how to blend seed mixes, weigh seed mixes, load various seeding boxes, and calibrate seeding equipment. After the training, those who completed it were sent an email to verify them as WY AML Certified Seed Specialists.

Throughout the meeting, the National Executive Committee, technical divisions, and editorial staff for *Reclamation Sciences* fit time in to take care of internal ASRS business. The more fun groups, like Wild Women of Reclamation and Haulin' ASRS also got their own meetings in. The evenings were full of entertainment, with an opening reception after the DeLamar Mine tour, a dinner event after Day 1 of the official conference, and the Student Poster competition and Early Career Professional Social on Nights 2 and 3, respectively.

As always, it was a great conference and we hope to see you all in Tennessee in 2024! *#* 

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# 40th ASRS Annual Meeting Exhibitors

Abnova Ecological Solutions ACZ Laboratories Inc Albemarle American Society of Reclamation Sciences Barr Engineering Co. Brierley Associates Corporation CDM Smith Costmine Energy Laboratories, Inc Foam Concepts LLC Granite Seed Grouse Mountain Environmental Consultants Haley & Aldrich Integra Resources KC Harvey Environmental, LLC OSMRE - Headquarters Pace Analytical Services Perpetua Resources Pioneer Technical Services, Inc. Rocky Mountain Bio Products Stevenson Intermountain Seed SVL Analytical Inc. Tetra Tech Truax Company, Inc. Voss Signs, LLC Western States Reclamation, Inc. Wyoming Department of Environmental Quality, AML

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# Reclaiming the Hackensack Meadowlands of New Jersey as a Climate Change Adaptation Strategy

### BY TERRY DOSS, CO-DIRECTOR OF MEADOWLANDS RESEARCH & RESTORATION INSTITUTE, NEW JERSEY SPORTS AND EXPOSITION AUTHORITY

The Hackensack Meadowlands are a unique complex of urban ecosystems and a vital asset for the State of New Jersey, but for many years they were misused, mistreated, and much maligned. The Meadowlands Research & Restoration Institute (MRRI), the scientific department of the New Jersey Sports & Exposition Authority, has been working to reclaim these public spaces and, over the past 30 years, transform these areas to highly functional habitats that support many fish and wildlife species of concern. However, there's a great deal of work still to take on, and with the growing threat of climate change and rising sea levels, coupled with the continuing threats of development and pollution, these efforts have become even more difficult while also becoming even more important. Building on the State of New Jersey's Climate Change Resiliency Strategy (https://www.nj.gov/ dep/climatechange/resilience-strategy.html), a number of potential opportunities within the Meadowlands have been developed that will restore and preserve a diversity of habitat while also strengthening New Jersey's long-term ability to withstand the impacts of climate change and contribute to the goals of creating more resilient natural areas in the Meadowlands long into the future.

### The Hackensack Meadowlands

The Meadowlands is a 32-square-mile district located just west of New York City, in the counties of Bergen and Hudson in northern New Jersey (Figure 1). Despite the densely populated and urban nature of the area, it's a coastal community that is bisected by the tidal Hackensack River. The river flows from the Oradell Reservoir Dam in Oradell, NJ, through the meadows, connecting with Newark Bay and the Arthur Kill and Kill van Kull, eventually flowing out into the Atlantic Ocean. The district, one of the largest brackish ecosystems in the northeastern US, is well-defined by the infrastructure that surround and bisect it – the roadways, rail lines, and the landfills; but it is less well known for its natural assets – the waters, wetlands, and coastal ecosystems that first defined the area. Despite its urban nature and the fact that millions of people and vehicles flow through the District every day, it supports a remarkable diversity and abundance of fish and wildlife, a fact that is largely unknown by the local population or the many who travel through the area.

![](_page_35_Figure_6.jpeg)

Figure 1: Regional map of the Hackensack Meadowlands.

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Figure 2: View from one of the many closed landfills of the Hackensack River and Meadowlands, with NYC in the background

Since the beginning of colonialism, the history of the Meadowlands has been one of various attempts at reclamation. Old documents discuss the "waste and forbidding wild marshes of East Jersey" and improvements from shutting out the flow of the tides (Annual Report of the State Geologist of NJ, 1869) and there are numerous reports of berms, dams, and fill being used to dry the saturated soils to create some economic use from these peaty and swampy lands. However, despite efforts over the past 400 years to "control nature" and "solve the problem" of the Meadowlands - the unstable and unproductive soils, the underutilized land, and the pestilence – there are still around 8000 acres of marsh, waterways, and open space still in existence right in the center of the New York City metropolitan area. The Meadowlands were so undervalued that even as recently as the 1960s, the U.S. States Fish and Wildlife agency wrote off the Meadowlands, stating in a letter from 1962 to the U.S. Army Corps of Engineers that "the Hackensack Meadows are not at the present time of significance to fish or wildlife" (US Army Corps of Engineers, April 1965, Review of Reports on Newark Bay, Hackensack and Passaic Rivers, NJ).

Since the 1980s, views of the wetlands and open spaces surrounding the Hackensack River have changed and the value of these habitats in their natural state is now much better understood. Work to preserve, reclaim, enhance, and restore these habitats reflects these changing views and values. MRRI has been monitoring and documenting the changing conditions in the Meadowlands, providing a clear picture of healthier conditions – improved air and water quality, restored wetland and upland habitats, and increased numbers and diversity of wildlife and fish species. MRRI uses many different technologies to track these changes including Surface Elevation Tables to track marsh elevation changes; tide elevation and water quality sensors to track changes in the water column; and Geographical Information Systems, LIDAR, and hyperspectral mapping to track habitat changes. But it's the wildlife that provides the most important indicators of success from these past efforts.

For example, a fish survey that occurs every 10 years has provided results indicating a growing diversity of fish species. When the study began in the 1980s, 85 percent of the catch was mummichogs, small killifish found in brackish waters that are also known to be able to withstand changes in temperature, salinity, low oxygen, and pollution. But in the most recent study conducted from 2013-2015, over 60 species were observed and mummichog was no longer the dominant species.

MRRI has also found that avian species have been repopulating and breeding in the Meadowlands in recent years including raptors such as bald eagles, osprey, and peregrine falcons; species of concern including saltmarsh sparrow, grasshopper sparrow, and savannah sparrow; and secretive marsh birds such as clapper rails, Virginia rails, and American and least bitterns. In fact, the first ever Meadowlands Breeding Bird survey which took place in 2021 confirmed that over 65 species of birds breed here in the Meadowlands, including many threatened, endangered, and species of concern. The habitat improvement and resultant increase in wildlife and fish species are a direct effect of closing and reclaiming landfills, tighter air and water regulations, improved land uses adjacent to the waterways, and thousands of acres of marsh and open space restoration.

Despite all these improvements over the past 30 years, habitat loss continues to be a primary risk to wildlife, both directly and through the disruption of essential life history and behavior patterns. Historically, land mismanagement and development have been the biggest threats to habitat in the Meadowlands, but now habitats have the added threats brought by climate change. Accelerated sea level rise, stronger storms, drought, flooding, and more intense heat waves are already affecting habitats in the Meadowlands. Fortunately, there are still many opportunities to create more resilient and sustainable habitats to combat the risks of climate change, although working in an urban area requires some innovative techniques and creative thinking.

### **Coastal Ecosystem Restoration**

Over 3,000 acres of wetland and other habitat have been restored and preserved in the Meadowlands over the past 30 years, providing an opportunity to learn from these experiences about nature-based design and its use in an urban system to combat climate change. To build off of these experiences and prepare for the future, there are a number of tools that can be used, including re-nourishing chronically inundated and eroding wetlands; protecting and enhancing rare freshwater marsh systems; conducting research to better understand the hydrology of our few remaining coastal wooded areas to restore and protect these rare habitats; and, re-establishing rare coastal grasslands on closed landfill open spaces, where appropriate. These actions would help to meet the challenges set forth in New Jersey's newly crafted Climate Change Resiliency and Coastal Action Plans and provide additional habitat for State threatened and endangered species. In addition, these efforts would increase the ability of marshes, grasslands and woodlands to sequester carbon from the atmosphere, one of the main goals of the State's Global Warming Response Act (https://www.nj.gov/ dep/climatechange/docs/nj-gwra-80x50-report-2020.pdf). The carbon sequestration of these ecosystems may represent underutilized carbon sinks that potentially can be enhanced with proper management strategies to help the State meet its objectives. Some of these potential restoration efforts (shown in Figure 3) are described in greater detail below.

Sawmill Creek Wildlife Management Area: Sawmill Creek, a 727-acre Wildlife Management Area comprised of marsh and mudflats, is a vital resource to both the Meadowlands and the

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Figure 3: Locations of ecological restoration projects.

surrounding New York/New Jersey Harbor Estuary (Figure 4). The brackish marshes located within Sawmill Creek WMA provide water filtration, storm surge absorption, and wildlife habitat, and offer several forms of recreation, including boating, fishing, and, in the fall and winter months, duck hunting.

Given the multi-faceted benefits that Sawmill Creek provides, ensuring its preservation is paramount to the Meadowlands and surrounding area. Unfortunately, it has undergone significant ecological change in the wake of development, misuse, pollution, and climate change, reducing hundreds of acres of vegetated wetland areas to open water and mudflat habitat (Figure 5). This creates several issues, not the least of which is that these mudflat areas, which once acted as carbon storage while vegetated, are now releasing carbon into the atmosphere (MRRI, Gas emission baselines and carbon sink strength from three wetland surface types in the Meadowlands of NJ, 2022). The loss of vegetation has also led to erosion-diminished wildlife habitats, as well as large expanses of open water that provide little to no storm surge protection for nearby infrastructure, including the NJ Turnpike and the future Essex-Hudson Greenway. As sea

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Figure 4: Drone shot of Sawmill Creek Wildlife Management Area.

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2015

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Figure 5: Comparative aerial views of Sawmill Creek from 1930 to 2015 highlighting the erosion of the marshes over that time.

Figure 6: Remnant Atlantic white cedar stumps in Sawmill Creek.

level rises and erosion continues, further loss of vegetated marsh continues to occur.

The situation is dire but not irreversible. Working under a U.S. Environmental Protection Agency Wetland Program Development Grant, MRRI is currently undertaking the necessary investigations to determine the best path toward restoring the marshes' function and structure to create a diverse coastal ecosystem and strengthening shorelines and potentially increasing carbon storage capacity. Using drones, hyperspectral imagery, and LIDAR, MRRI has created site topographic, bathymetric and habitat maps and, using Sediment Elevation Tables, has established marsh elevation changes over time. MRRI also updated the site's tidal datum and biological benchmark data, used historical maps and geotechnical data to map out the clays, silts, sand and old Atlantic White Cedar stumps on site, and, working with an engineering firm, developed a 2-D hydrodynamic and sediment transport model to better understand the site's dynamics. MRRI continues to monitor site current velocities, water quality and tidal elevations.

Building on these studies, MRRI has developed alternative ecological restoration concept designs to restore the vegetated marshes of Sawmill Creek. The preferred alternative that is being progressed currently entails working under a design/build concept to bring in clean soil/sand and other materials to renourish the brackish marshes in the area where Atlantic white cedar stumps still remain (Figure 6). In addition, shorelines would be strengthened using various types of enhancements such as biohuts, reef balls, large woody debris and living blocks. The goal would be to create a diverse coastal ecosystem with strengthened shorelines, revegetated low and high marshes, and upland islands. The pilot project would include designed experiments that will lead to monitoring that informs future coastal enhancement efforts by identifying how variables influence ecological performance (growth and mortality, infaunal and epibiotic community health, fish utilization and overall structural integrity). The focus of the monitoring will be on constructability, habitat design variables (rugosity of

substrate, location, elevation and protectedness) and site variables (velocity, water quality, tidal range, and scour).

In addition, MRRI will be working with Rutgers University – Edward J. Bloustein School of Planning and Public Policy to engage the local municipalities in an attempt to coordinate resilience efforts and increase the communities' knowledge of coastal resiliency strategies. The Sawmill Creek pilot project will showcase some of these coastal resiliency strategies and allow communities to witness and become a part of the restoration process.

### Kearny Freshwater Marsh

Kearny Freshwater Marsh (KFM) was once one of the most important breeding and year-round feeding habitat for waterbirds in NJ (Figure 7). As a result of human impact over many years, and then winds from Superstorm Sandy that pushed a large proportion of reed stands to the western edge of the marsh, habitat has been lost and the numbers and diversity of birds that use the area have diminished.

There are still a number of species that nest here, such as least bittern and common gallinule, but based on recent avian point counts and the results of the 2021 Meadowlands Breeding Bird Atlas, there are concerns about diminishing populations. There are opportunities to re-create habitat within KFM with a goal of restoring some of the ecological functions and structure that have been lost, without disturbing the sediments on site. There are also long-term goals for re-introducing public access to the marsh, so part

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Figure 8: MRRI staff launching the floating islands.

of the goal of this project is to investigate opportunities for people to re-engage with nature without disturbing the wildlife that has been attracted to an area where not many humans currently venture.

A pilot project was undertaken in the spring and summer of 2023 to recreate an island that could be used for breeding by least terns, a species of concern in NJ and one that's found in the Meadowlands in small numbers but doesn't currently breed in the area. A variety of innovative techniques were explored, and it was determined that a floating ecosystem could be most easily and efficiently constructed to mimic the coastal habitat preferred by least terns for breeding. Since land in urban areas is unavailable or difficult to reshape in a way that restores natural shorelines and wetlands, floating ecosystems hold the promise of returning functions like pollutant uptake and transformation, wave attenuation and habitat in open water. The measured benefits associated with this technology are still being quantified and vary widely from place to place depending on the application and how they are manufactured.

For KFM, a large floating barge built by MRRI was installed temporarily in the open waters, and topped with sand, least tern decoys and shelters, and a solar-powered least tern call box (Figures 8 and 9). A remote camera was also installed to capture images throughout the summer while not disturbing any potential users of the island.

While the island did not attract any breeding behavior this past season, least terns have been observed using the island, including one adult least tern feeding a young tern. MRRI will continue monitoring the island through fall migration, and

40 AMERICAN SOCIETY OF RECLAMATION SCIENCES

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then will redeploy the island next spring in the hopes it will be used by least terns next year for breeding.

The floating island is the first step in attempting to re-create habitat at KFM. Next steps will include adding several planted islands, strengthening shorelines, and monitoring to determine if the systems are replacing previously lost environmental services such as nutrient removal, nutrient processing, reduction of the effects of eutrophication, carbon sequestration into plant biomass, improved water clarity, food, structure and refuge for fish and nekton, and habitat for birds, insects and other biota.

### Losen Slote Creek Park

Losen Slote Creek Park contains one of the few remaining lowland forest and coastal meadow habitats within the

![](_page_40_Picture_6.jpeg)

*Figure 10: Losen Slote Park, one of the last remaining lowland forests and meadow located within the Meadowlands* 

Meadowlands (Figure 10), but its diversity and resilience is threatened by several stressors, including an inconsistent hydrologic regime as climate and rain patterns change, and development continues in the area.

Over the past 10 years, the Borough of Little Ferry has been impacted by a number of named storms as well as heavy rainfall events. These flooding issues highlight existing deficiencies in the area's resiliency and ability to adequately protect vulnerable populations and critical infrastructure from flooding. Losen Slote Creek Park, a 24-acre park located within Little Ferry, is one of the few remaining open spaces in the Borough and has the potential to be used to slow, spread, store and sink stormwater, thereby alleviating some of the flood pressures on the neighboring low-lying community.

In the past, the coastal forests and meadows of Losen Slote naturally retained stormwater, alleviating pressures on the nearby residences. However, over time, the site's hydrology has been altered due to tide gates, development, and the ditching and over-dredging of Losen Slote. As a result, the coastal forests and meadows have been drying up and are not fully functioning as wetland systems, native vegetation is being overtaken by invasive shrubs and vines, and stormwater flows move directly and quickly into the creek and nearby community. In addition, as the soil continues to dry out, tree fall is occurring at alarming rates; these trees provide habitat for many species of concern, including a number of bat and owl species.

MRRI's goals for restoring Losen Slote include improving the hydrological capacity of the site by re-establishing natural streambanks and restoring vernal pools to alleviate some of the flooding issues in the adjacent residential areas,

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Figure 11: Drone shot of Losen Slote forest.

preserving one of the last remaining stands of lowland forest and meadow within the Meadowlands, and further engaging the local community and many stakeholders that use and love the park. This effort grows out of previous efforts by MRRI to remove invasive species and assist in the natural revegetation of native plant species.

The motivation behind the proposed project is to allow for a holistic approach to restoring the ecological functions and services that have been lost in one of the last coastal meadows and forests found in the Meadowlands, while also reducing flooding in the adjacent residential community and engaging with the community and its stakeholders so that they better understand the importance of the park and the many benefits it could potentially offer the surrounding area.

![](_page_41_Picture_4.jpeg)

Figure 12: View from one of the many closed landfills in the Meadowlands.

### **Closed Landfills**

Within the New York-New Jersey metropolitan area, the Meadowlands serve as an oasis for many species of wildlife, providing habitat to more than 500 wildlife species. Despite centuries of decline due to the loss and degradation of habitat, the Meadowlands' wildlife populations have been steadily rebounding. This recovery is due in part to the restoration of hundreds of acres of wetlands, but also to the closure of all the landfills that had been located throughout the Meadowlands together with the subsequent natural vegetative succession along the tops and slopes of the closed landfills. These closed landfills represent one of the greatest opportunities for restoring natural habitat in this urban complex.

MRRI has been working to restore native vegetative communities on the closed landfills in an over-developed area with increasing scarcity of upland habitat. These upland areas are also important due to their adjacency to the wetland and aquatic habitats within the Atlantic Flyway. In addition to providing valuable wildlife opportunities, the diverse habitats have the potential to play an important role in managing stormwater runoff, preventing erosion, and sequestering carbon.

As MRRI revitalizes these open, upland areas, staff has been monitoring avian usage of these newly vegetated sites. Over the past five years, 100 bird species were observed within the Meadowlands' natural landfill habitats including 28 species of songbird that are known to breed in the district, 21 species that are listed as focal species in MRRI's Wildlife Action Plan, and 12 species that are listed as threatened or endangered by the State of New Jersey. Besides providing breeding territory, the diversity of habitats on the landfills provided roosting habitat, an ample food source, hunting grounds, overwintering habitat, and a rest stop during north and southbound migration. These avian species have come to rely on these newly vegetated habitats throughout the year in an increasingly urbanized landscape.

Figure 14: Construction of osprey nesting platform on top of a closed landfill.

![](_page_41_Picture_11.jpeg)

![](_page_42_Picture_0.jpeg)

# Drones: The aerial solution to right-of-way compliance monitoring

### BY PHILLIP BENNER, SENIOR CONSULTANT, GES, INC.: RICHARD K. EVANS, PE, SENIOR VICE PRESIDENT, TECHNICAL SERVICES, GES, INC. AND SCOTT ANDRESINI, DRONE SERVICES TECHNICAL LEAD, GES, INC.

Technology moves fast; about the time one can wrap their head around a topic or new feature of their favorite gadget, the next update is announced and released. sUAS (small unmanned aerial systems, aka "drone") technology is no different! In this article, we'll dive into the ever changing and exciting landscape of drone technology as it pertains to the professional world, and applications with pipeline ROWs.

### **Equipment and Sensors**

A drone is a term that is thrown around a lot in today's vernacular, but few people really know what a drone is. A drone simply refers to a remotely operated vehicle. This could be anything from a pocket-sized toy up to a Boeing 747 jet. Not all drones are aircraft; a drone could also be completely terrestrial, such as crawlers, or even operate underwater as submersibles. However, if it flies, it's an aircraft subject to rules and regulations of the governing body in which you plan to operate the aircraft. In the USA, the Federal Aviation Administration (FAA) in the governing body.

In this article, we'll focus our attention primarily on the sUAS class of drones. We will share information on advances in power systems and sensors – but remember: it's not about the technology, it's about the data you can collect and the ways you can use that data. Surprisingly, drones are not a new concept. As early as the 1930s, the British Royal Navy developed target aircraft that fit the definition. With the invention of microprocessors in the 1970s–90s, the concept took off. The ability to create complex machines that were light, small, and affordable gave the drone industry the tools it needed to take flight in the last two decades. From 2010 until now, the industry exploded with commercial grade aircraft and sensors to meet a myriad of challenges head on.

By far, one of the greatest advancements in safety is the

power system itself. Gone are the days of "dumb" batteries that simply hold power and discharge that power at whatever demand rate is active. "Intelligent" batteries on modern drones are packed with technology, providing longer life and more consistent power output over time. In general, most professional-grade drone systems now achieve at least 30 minutes of flight time, and some up to an hour. This is especially impressive when referring to multirotor systems where all the lift and operation of the drone comes from the battery powering the motors.

![](_page_42_Picture_9.jpeg)

sUAS in flight over ROW.

![](_page_42_Figure_11.jpeg)

Various types of sUAS in use worldwide.

![](_page_43_Figure_0.jpeg)

*Example sUAS sensors for data collection provide additional data and solutions.* 

Smarter batteries now manage their own health and integrity with some incredible features like self-discharge systems if batteries are stored without use over time. Power management and output levels have given way to more cycles for the batteries themselves with fewer failures and better longevity than before.

In addition to better battery life, many systems rely on "redundant" battery systems which allow for no single battery to be responsible for total power output, leading to safer operations as a single-battery fault has some (even if limited) power to help with a return to home or controlled descent. These redundant systems often allow for "hot swappable" options, where one battery can be taken out and replaced with another, providing power so that operations can quickly resume without powering down the entire system and waiting for sensors and systems to come back online. Hot swapping allows for greater operational efficiency, especially when responding to emergency or high-level risk situations.

As the world looks for "greener" ways to operate drones, battery powered UASs often eliminate much of the carbon footprint of inspections and traditional data-collection procedures. Battery manufacturers continue to make strides toward ever cleaner, longer-lasting batteries that help keep emissions from other vehicles down and still make safe operations on scale possible. Rather than flying a manned aircraft or running manned vehicles up and down ROWs, UASs provide an excellent alternative to help keep emissions to a minimum while collecting good if not much better data than ever before.

The real shining point in the evolution of professional grade systems is not only flying the vehicles themselves, but, it's all about the sensors that have developed around the platform, which allow drones the ability to gather professional grade data, often in a quicker, safer and sometimes more accurate way than before.

We'll dive deeper into several sensors in the latter part of this article, but in general, the advancement from being able to collect only visual red, green, blue (RGB) photographs and videos to now being able to gather everything from gas sensing, light detection and ranging (LiDAR), thermal imaging and everything in between makes the use of UASs for industry applications a great solution.

UASs allow for quick and efficient data collection. Dispatching staff to the field still requires logistics that put people in vehicles and often in proximity to hazardous situations. The sUAS industry has a solution for this as well. As large facilities move to operate ever more efficiently, the need to know where issues are before they arise is paramount.

Enter the "Drone-in-a-Box" solution. What if you could conduct routine flights every day, every hour, or right now? Drone-in-a-box solutions offer an onsite, remotely piloted solution that gives operators ongoing situational awareness of their facilities whenever the need arises. Routine security patrols, gas sensing, thermal imaging, jump to response for emergencies are now able to be conducted using these systems.

A drone "box" (generally a climate-controlled charging and protective system) is placed on site for any permanent project area and allows the remote operator to conduct safe, repeatable operations at a moment's notice. The system can

![](_page_43_Picture_11.jpeg)

EXAMPLES OF "DRONE IN A BOX" SOLUTIONS

be programmed to do a routine pattern patrol, looking at key features, sensing for certain parameters, or any other myriad of things that may be desired. The box allows the drone to be securely stored between flights, batteries to be charged, payloads to be swapped, etc. This allows operators to fly from their own secure location, potentially even far removed from the facility if certain clearances are obtained from the FAA (like a beyond visual line of sight [BVLOS] waiver, which we'll discuss later).

### **ROW Application**

While this technology works for a wide variety of industries (in fact, there are very few industries that cannot benefit from drone integration), the energy industry is one of the most natural fits for integration. We'll look at a few ways that data collection on ROW's make UASs the right choice for this sector (keep in mind that this is only a sample of the current sensor technologies available – new sensors/solutions are being developed every day).

One major advantage of using UASs for ROW inspections is that they greatly reduce risk to human life. By flying over a ROW (even offset if necessary), leaks or hazards can be identified and even quantified before "boots on the ground" are at risk. Routine inspections of production well pad sites, pipeline ROWs, breakout and valve stations, and other facilities keep the whole system safer. Areas of known elevated risk can utilize a drone in a box (i.e., large compressor stations) where routine flights are continuously monitored and can provide benefits to operators to ensure safety.

Generally, speed equals money when it comes to managing

ROWs. When a task can be performed quickly and efficiently while being safer, it's a win that directly affects the bottom line. Drone inspections can be done in hard-to-reach areas that are more difficult or impossible to access otherwise. Everything from confined space inspections to long-linear asset monitoring can be completed more efficiently and on scale. Even routine methane monitoring to satisfy regulatory requirements can be done by UAS with verifiable data so that inspectors have confidence in reporting their data.

Using drone-based monitoring and inspection, ROW managers can accomplish their goals and satisfy requirements using newer and better tools. With precision global positioning system (GPS) data, leaks are identified with accuracy and often can be addressed on levels not before detectable by standard inspections. This allows the ability to find small leaks before they become huge problems and hazards. Finding "super producers" is easy; finding the "million tiny cuts" that equal the rest of the problem is where appropriately equipped UASs that carry these sensors shine!

On the most basic level, having up-to-date information for managing a project is key. That all starts with good mapping data sets to work from. While publicly accessible free data can be helpful, professional projects cannot rely on often years-old if not decades-old data sets. Satellite imagery can provide a good overview, but it often lacks the extreme details needed for some projects. It's also very costly to obtain, often meaning you pay for much more area than is needed for a project. UASs offer a great solution for up-todate and very high-resolution aerial imagery. Orthomosaics (created by stitching together high-resolution geo rectified images) provide a great tool for project managers to plan and manage these projects.

![](_page_44_Picture_7.jpeg)

sUASs reduce the risk to staff safety by detecting leaks or hazards before inspectors arrive.

![](_page_44_Picture_9.jpeg)

UASs offer a great solution for up-to-date and high-resolution aerial imagery.

![](_page_45_Picture_0.jpeg)

Camera advancements on drones have raised the bar for highresolution images over current satellite data.

With the high-precision GPS data collected by UASs, the imagery gathered is already very precise when it comes to real-world location, and with the addition of real-time kinematic (RTK) base stations and surveyed ground control points, accuracy can be greatly enhanced to within a few centimeters.

Camera advancements have taken drones to new heights in high-resolution where satellite data often blurs out at around 25 centimeters per pixel (roughly the size of your laptop), current drone camera sensors can be as precise as one centimeter per pixel. This may seem immaterial to some, but when managing extreme detail on ROWs or measuring specific features, precision matters.

Being able to see the unseen is critical to monitoring a ROW and looking for specific geohazards. Two sensors that help make this possible are thermal imaging and LiDAR.

Thermal imaging is simply the process of converting infrared (IR) radiation (heat) into visible images that depict the spatial distribution of temperature differences in a scene viewed by a thermal camera. By looking at the heat or lack thereof, operators can quickly identify issues within a system. By using thermal imaging sensors, inspections can help identify problem areas that are not seen by the naked eye or other sensors.

Professional operators will have thermography training that allows them to understand the differences in the IR returns from the camera. While untrained users can see certain differences that may be helpful, trained operators and processors will be able to correctly interpret the data generated by these sensors.

When managing ROWs there are quite a few uses for thermal technology. A few examples include the following:

![](_page_45_Picture_8.jpeg)

Thermal imaging sensors can help identify problem areas that are not seen by the naked eye or other sensors.

- Looking for seeps of groundwater that may result in slips, slumps, or other erosion.
- Damage to pipes or wire insulation, and physical installations such as pump/compressor stations or permanent buildings
- Security issues that identify intruders or missing persons along managed areas
- Leaks along water transmission lines, especially surface lines.

Thermal data gives a perspective that just simply cannot be seen in the visible light spectrum.

LiDAR is a remote sensing method that uses light in the form of a pulsed laser to measure ranges (variable distances) to the surface and back to the sensor. LiDAR allows real-world assets to be recreated in the digital world. Using laser pulses, the return distances can be modeled into millions of digital pixel points to create a three-dimensional model. From these models an abundance of information can be derived.

![](_page_45_Picture_16.jpeg)

LiDAR data is extremely precise and provides true values to support surveyors and land planners.

Operators can determine extremely precise topographic lines for project planning, impacts, water-flow analysis, grades, and other project logistics. LiDAR can strip away ground cover and help users identify unseen geological features that may not be seen by the eye.

When a geohazard is identified such as a slip, ongoing LiDAR data can be obtained to help track and measure the volume and impact of damage. With recurring and routine flights, digital modeling allows the operator to work from valid and defensible data rather than only a few ground pictures.

LiDAR data is extremely precise and gives true values in the real world. With its ability to strip away layers (tree cover, buildings etc.), getting ground-level measurements is very helpful to surveyors and engineers. It's always preferable to collect LiDAR data with leaf off conditions to obtain best data. While this technology is generally accurate from one or two centimeters with ground control enabled, it doesn't replace surveyors or land planners. It's a wonderful complimentary tool for what they do every day.

Fugitive emission gas monitoring has become a huge use of UAS data in the last few years. Whether looking for orphaned and abandoned oil & gas wells or monitoring more modern assets, UASs offer a safer, faster, and more complete view of emissions monitoring. A few of the tools in this developing field include optical gas imaging (OGI) cameras, turnable diode laser absorption spectroscopy (TDLAS) laser detectors, magnetometers, and sniffers, with more options coming online every day.

In the USA, the initiative to create a cleaner world and greatly reduce fugitive methane emissions has led to a boom

in the search for, identification of, and plugging of orphaned and abandoned gas wells. Across the country agencies are using UASs to locate these ancient wellheads. Using a variety of drone-based sensors, companies are able to narrow the search, remove dangerous emitters identified, and plug the wells with greater efficiency. The technological advances and precision of drone-based magnetometers have allowed operators to find forgotten well casings and pump heads within areas of dense vegetation. The ability to narrow the search field means more time can be focused on plugging and restoration, and less time on searching. When the addition of an OGI camera is incorporated, it allows operators to "see" the gas as never before and, when mounted on a drone, allows rapid coverage of large areas while boots on the ground remain at safe operating distances to conduct surveys. As regulatory demands increase, sUAS equipped with various sensors provides new tools to respond safely, quickly and economically to comply with the various state and federal requirements. As these requirements unfold, drone and sensor technologies are keeping pace to provide a viable solution to monitoring orphaned and abandoned gas wells.

A picture is worth a thousand words, and sometimes it's the only line of defense for monitoring a project. Repeated photos, videos, orthomosaics, and LiDAR data are key tools for monitoring projects as they are built. Comparable data week-to-week, or year-to-year allows accurate tracking of a project, a wealth of permit and regulatory compliance documentation, and defensible data if an issue arises.

Limits of disturbance monitoring, earth-moving volumetrics, contractor management and more can all be done with UASs.

![](_page_46_Picture_8.jpeg)

Tools in this developing field include OGI cameras, TDLAS laser detectors, magnetometers, and sniffers to locate abandoned and orphaned oil and gas wells and monitor methane emissions.

![](_page_47_Picture_0.jpeg)

sUAS-collected data provides project managers with the data integrity to enable project and permit.

sUAS provide a quick, safe, and efficient way to patrol ROWs using thermal cameras.

Keeping a project on track and seeing issues before they become a problem often saves project managers both time and money in the long run. sUAS-collected data provides project managers with the data integrity to enable project and permit closeouts. This can save significant financial resources and allow human and capital resources to be assigned to the next task.

As much as operators would like it to be otherwise, avoiding disputes with landowners and regulatory agencies is nearly impossible. Operators need to have good data to defend and identify issues that arise. Identifying issues proactively before they become a problem, and addressing landowner issues before they require litigation, are key examples of how a quick ongoing monitoring program can greatly reduce the resources spent in dispute resolution.

When keeping an eye on assets – especially on hostile builds – is critical, UASs provide a quick, safe and efficient way to patrol ROWs. Using thermal cameras, UASs can see intrusions day or night. With quick response, a UAS can be in a potentially volatile area without risk to human life and set "eyes on" before a patrol vehicle is even dispatched.

Routine perimeter surveillance flights provide confidence in repeatable patterns of information gathered along a project area. With easily changeable batteries, many flights can be repeated on the hour or continuously by operating multiple systems.

UASs can respond very rapidly to any situation that arises, whether deviating from a predetermined flight plan already in action, or from a rapidly deployable base location. UASs can often fly to a location and get eyes on the situation well in advance of responding vehicles. Especially along complex ROWs where manned vehicle traffic can be hazardous, UAS technologies provide operational intelligence in a timely manner. After the building phase of projects, the ROW must still be restored to predetermined conditions. Using UASs equipped with multispectral sensors, hoop data can be compared to data collected from the UASs for a defensible report on revegetation and restoration.

Multispectral imaging is a technique that captures image data within specific wavelength ranges across the electromagnetic spectrum. The wavelengths may be separated by filters or detected with the use of instruments that are sensitive to

![](_page_47_Picture_10.jpeg)

sUASs can be used to identify and monitor wetlands, stream crossings, and waterbody intrusion from major storm events.

particular wavelengths, including light from frequencies beyond the visible light range (i.e., infrared and ultra-violet). Trained operators can determine plant health based on the return of wavelengths off the vegetation. Unhealthy, stressed, or non-growing plants along a ROW can be identified and operators can either replant or fertilize areas in need. When flown on scale, a percentage of re-vegetation can be calculated and permits closed if allowable.

Identifying and monitoring of wetlands, stream crossings, and waterbody intrusion after major storm events can be accomplished with a host of sensors and can greatly benefit from ongoing monitoring using UASs. Often wetlands can be "pre-delineated" from the air by wetland and ecological professionals with following-up and flagging to reduce the time spent in the field.

The goal of any project is to get it completed on time and within budget. Gathering good data makes the entire process easier, and by maintaining highly accurate, defensible data along the entire project scope, the closeout phase and completion of open permits can be greatly aided. Defending scope, water control, reseeding, limit of disturbance (LOD) issues and other environmental impacts can be done with good UAS data collected during project implementation and execution.

#### Challenges

While UASs are amazing tools, they're not fully without limitations, both physical and regulatory. The industry is quickly evolving to adapt new technologies to address operational, logistical, and regulatory challenges.

One major limit for UAS operation in the USA is the regulatory need to keep the UAS within visual line of sight (VLOS). This means that anyone operating the drone must always have "eyes on" the UAS. This may employ visual observers but limits the distance the UAS can travel in a single flight, even though the technology to fly farther exists. We will end this article focusing on beyond visual line of sight (BVLOS), but for now this hurdle constrains general UAS operations.

BVLOS allows operators to fly long distances without the need to constantly reposition their base of operations, vastly increasing the efficiency of flight operations and requiring less human based travel with all its facets (lowering pollution, time on the road, boots in hazardous areas, and vehicle traffic). As battery technology evolves, GPS receivers gain power, satellites increase, anti-collision sensors are developed, and communication technology advances, these drones can fly farther on a single charge with complete control and accuracy. What once was only surveyable by manned aircraft flying dangerously low and consuming massive amounts of fuel can now be safely and efficiently achieved and managed safely from the ground.

With all these technological advancements, the FAA and other regulatory agencies are increasingly more open to justifiable waivers for VLOS to be granted. Generally, parties wanting to unlock these waivers present a use case to the FAA for review, and when granted can begin operations under their waiver. This process at present is still laborious, but we're seeing increased acceptance every day. A few remotely operated systems have even been approved for fully autonomous operations as of this writing.

Another challenge revolves around the simple topography of the operations area. When operating in very flat terrain with little to no canopy cover, UASs can cover large areas quickly and safely with few obstructions to their flight, other than the potential for other air traffic. However, in locations with

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Construction monitoring and permit compliance for ROWs are a great application for aerial monitoring with sUAS.

significant terrain challenges (e.g., steep slopes) or canopy covering the project area, drone flight systems and pilots need to be able to adapt to the situation. Some systems can use a feature known as "terrain following" where the sUAS operates at a fixed altitude above ground level or ground features (e.g., tree canopy). New technology hitting the market uses sonar to maintain the distance between the UAS and the ground to keep a consistent and set height over the project area. This is a promising next step in conducting terrain following flights along ROWs where terrain poses a significant challenge to operations.

The FAA also restricts drone flights over people. However, flights can be conducted safely by using highly trained personnel, and the FAA does consider waivers for these operations. While accurate data is being generated like never before using UASs, as with any developing technology, full adoption by the regulatory agencies takes time. Thankfully many good organizations are actively helping to educate regulators and the public alike on the significant positive benefits these tools bring to the market. Regulatory and other government agencies are now beginning to consider UAS data as reliable and defensible, leaving the industry wideopen for new technologies to be considered as alternatives to traditional data collection and reporting.

One area currently on all UAS operators' radar is the new regulations proposed to severely restrict or even ban certain foreign manufactured UAS and communication systems. As a response to these concerns, the Department of Defense (DOD) released the Blue sUAS list for federal government use. While this has not fully restricted the use of UASs manufactured in certain countries (China being the biggest concern), they have set a precedent for industries to seek NDAA compliant sUAS.

The National Defense Authorization Act (NDAA) is a federal law that prohibits the use of certain telecommunications and video surveillance equipment, or services from specific Chinese companies by the US Department of Defense, its contractors, and its grant or loan recipients. The purpose for this compliance is to protect the US's national security and cybersecurity from potential threats posed by these companies, which may share data with the Chinese government. NDAA compliant equipment is not produced in or does not contain components provided by the banned companies. Security is the main benefit of using these compliant UASs; however, the downside is that many current UASs are either directly manufactured or use part manufactured in these countries. This will be an ongoing challenge as other manufacturers play catch-up with the larger companies, but the result will certainly be better, safer, more secure UASs from a wide variety of providers.

At this point, it's predominantly the federal government enforcing Blue UAS compliance, but some other state and even commercial level companies are beginning to follow suit.

As this industry and many others embrace the growth of this great technology, the UAS world is soaring further than ever before and continuing to develop revolutionary technological advances. These advancements take the world of UAS operations to a whole new level of performing inspection and monitoring tasks at scale more safely, rapidly, and cost effectively than traditional boots on the ground methods alone.

ROW management is one of the many places where UASs are taking flight, bringing new technologies to the market and creating a safer, more informed world for us to live in. These advances bring intelligence to the market in ways that were never before achievable and add significant value to operators willing to learn something new. *#* 

![](_page_49_Picture_8.jpeg)

*Example of the small space and equipment needed to launch, fly, and land a drone.* 

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Rangelands: the foundation of millions of livelihoods and the underpinning of several recreational industries.

Although these systems have worked naturally since Earth's creation, man's use of rangelands has promoted us to the position of caretaker. With further economic use of rangelands, more intensive management of these areas is required to maintain the historic ecosystem services they provide.

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# Decades of improving reclamation: Insights from Jim Truax and reclamationists who have benefited from the Truax Company

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Jim Truax and Maurice Davis at the Truax Company exhibitor booth from a previous American Society of Mining and Reclamation conference.

Truax Company has been in business in Minneapolis, Minnesota since 1974. Started by Jim Truax to improve the planting process for prairie grasses, Truax Company has evolved to assist with a variety of seeding techniques across 49 United States, Canada, Mexico, the Falkland Islands, Germany, Saudia Arabia, Tunisia, and South Africa. Jim won the American Society of Mining and Reclamation's Reclamationist of the Year award in 2016 and is widely recognized by reclamation specialists across the US as a true pioneer in reclamation. Here, we ask Mr. Truax a few questions and have several individuals discussing what Jim and the Truax Company have meant to reclamation in the western US.

**Reclamation Matters:** Jim, you've been named the Reclamationist of the Year by our Society and are widely recognized as a pioneer in reclamation. What would you say is your, or the Truax Company's, biggest contribution to reclamation over your career?

Former ASRS President Brenda Schladweiler presenting Jim the 2016 Reclamationist of the Year Award.

*Jim Truax:* Providing the tools to optimize direct seeding of mine sites with the highest probability of success. Mine sites can be harsh sites, and the best placement of seed is critical.

**Reclamation Matters:** What advice would you give to new folks entering the field of reclamation?

*Jim Truax:* Review prior reclamation work in the field before starting out so you don't reinvent the wheel. Do a historical review of past efforts.

Reclamation Matters: Would you do anything different in your life regarding your career?

*Jim Truax:* I would get more education early on. My education came from try-fail-try-fail. I did not do adequate research on what had been done before.

**Reclamation Matters:** What do you see as the future for reclamation?

Jim Truax: Based on the pressure of population growth on

fragile lands, there are no bounds on solutions needed as we use this planet's resources. It's a good field to be in, if you love the outdoors, appreciate the planet, but understand the need to develop resources and at the same time protect the planet for future generations. There isn't enough time in the day to address these problems...it's huge.

**Reclamation Matters:** You've all been involved with reclamation for quite some time. Could you describe what Mr. Jim Truax and the Truax Company have meant to reclamation over the course of your career?

Daryle Bennett, Former Manager of Denver Office, Granite

Seed: Jim Truax has been an incredible contributor to reclamation efforts for many decades, making it feasible and functional to successfully plant a wide diversity of types and sizes of native cool and warm season grass, forb, and shrub seed with the versatility of his rangeland drills. I've seen his designs empirically mastered by many years of on-theground testing with proven results under a wide variety of site conditions. I first became aware of his Flex II drill used on thousands of acres back in the mid-1980s when I was with the NRCS in SD involved with the precursor of what evolved into the highly popular USDA Conservation Reserve Program. Since then, I've seen the very widespread use of his line of rangeland drills used across the West. His personal commitment to providing the best planting solution for successful reclamation is second to none.

Paul Griswold, Senior Environmental Technician, Peabody Energy: Jim Truax and his reclamation products bring together the research and practical sides of reclamation by offering a product to bridge the two. When I first started in the western reclamation business over 31 years ago, the best available technology to seed the western region vegetative species was very limited. One of the first seeders that I used in mine reclamation was one of the Truax Company's first products. Over time, Best Management Practices have caused the technology to advance, and, in my opinion, Jim still offers the best products for seeding in the rangeland of the western US. Jim has always stayed in touch with industry representatives and listened to their suggestions and needs for a product that can keep up with the ever-changing world of reclamation. In the intermountain west, sagebrush habitat

![](_page_52_Picture_5.jpeg)

The Truax Company's Rough Rider rangeland drill seeder.

is vital to the ecology, and the Truax products have been very successful in establishing sagebrush habitat from seed for many years. He and his team want the world to be a better place. I believe that this shows the dedication and desire to improve the reclamation industry and health of the ecology that makes up our great planet.

Josh Oakleaf, Project Manager & Vegetation Coordinator, Wyoming Department of Environmental Quality, Abandoned Mine Lands Division: Jim Truax and the Truax Company's seeding equipment have been playing a crucial role in supporting the goals of the Wyoming Abandoned Mine Land division to establish native and diverse vegetation communities. The fact that Truax seeding equipment can provide a repeatable and reliable ground-driven calibrated seeding effort while accurately placing native seeds within the soil profile is a significant advantage for achieving desirable vegetation outcomes. The precision and reliability offered by Truax seeding equipment can greatly contribute to the success of these restoration projects.

Brenda Schladweiler, President & Principal Scientist, BKS Environmental: I have known Jim Truax for a very long time both from ASRS and the Society for Range Management. He has been proponents of both societies for many years. Jim truly is a self-made entrepreneur who wants to give back to science and the people he has come to know and help. His generosity in time, resources, and financial support is to be commended. He has never been or is now a person who likes the limelight and being out front. Thank you, Jim, for showing us humility and your willingness to share knowledge and resources. Here's to many more years to come.

Nancy Shaw, Emeritus Scientist, USDA Forest Service, Rocky Mountain Research Station: In the Intermountain West, Jim Truax has, over his long career, collaborated closely with land managers and researchers to design equipment for improving seed placement of the highly diverse species included in mixes for re-establishing native communities following wildfires, mining, energy development and other disturbances. Jim has been a long-time member of the Revegetation Technology and Equipment Council, donating time, resources, and innovative ideas for meeting new seedbased revegetation challenges in the West and elsewhere. He has also provided generous and ongoing support for professional societies, particularly for student and young professional programs to ensure that talented and dedicated individuals will be ready to meet the revegetation challenges of the future. His dedication, knowledge, and experience are inspirational and serve to improve restoration outcomes.

Josh Sorenson, Lead Reclamation Specialist, Jonah Energy: At Jonah Energy LLC we have planted over 7,300 acres of land in the process of developing the Jonah Field. Since 2008, the products offered by Jim Truax and the Truax Company LLC have been the only ones used to restore suitable habitat with native species. The drills developed by Truax allow Jonah Energy to plant a diverse, native seed mix efficiently and effectively. A component of a successful restoration program includes utilizing appropriate equipment for the job. The Truax seeders fulfill this requirement on the Jonah Field. Jonah Energy is very pleased with the documented results observed on the ground as well as the products offered by Truax in addition to improvements made over the years.

*Kyle Wendtland, Administrator, Wyoming Department of Environmental Quality, Land Quality Division:* I have worked with Jim Truax since the late 1980s. Jim has been an innovator in no-till rangeland agricultural drilling equipment since the founding of the Truax Inc. Company. Jim has provided the reclamation industry with innovative equipment that has enabled reclamation professionals to successfully plant and establish a wide range of native plants from seed. The ability to drill large-scale sagebrush planting from seed has been a technological improvement and of particular importance to western reclamation. I have the utmost respect and appreciation for Jim and his talented team and have enjoyed working with them.

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54 AMERICAN SOCIETY OF RECLAMATION SCIENCES

# FAST, ACCURATE, RELIABLE The Only Reclamation Cost Estimation Tool You Need

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![](_page_54_Picture_13.jpeg)

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# McDonald, PA carbon dioxide mine gas investigation and remediation

### BY OMAR BECKFORD, PH.D., P.E. AND PAUL HUEMMRICH, P.E.

A Washington County, PA resident, watching TV in their basement, started to feel lightheaded, felt some chest pain, and found it hard to catch their breath. Thinking they were having a heart attack, they yelled for their spouse to call an ambulance. Medical personnel discovered their oxygen levels were low. The medical personnel supplied oxygen, and they made a full recovery. A fire department investigation found elevated carbon dioxide (CO<sub>2</sub>) levels in the house, which were displacing oxygen (O<sub>2</sub>) levels.

A source of  $CO_2$  could not be identified inside the residence. With no obvious explanations remaining, the state of Pennsylvania was contacted to investigate.

### Investigation

On September 7, 2021, the Office of Surface Mining Reclamation and Enforcement, Regions 1 & 2 Technical

![](_page_55_Figure_6.jpeg)

Figure 1: Montour No. 9 historical mine map overlain on a world imagery map.

Support Division (OSMRE) was asked to provide technical assistance by the Pennsylvania Department of Environmental Protection, Bureau of Abandoned Mine Reclamation (PADEP-BAMR) to investigate elevated  $CO_2$  levels with low  $O_2$  levels at the residence. The residence was a singlefamily home on approximately one acre plot of land. The goal of this investigation was to remediate the indoor air quality.

![](_page_55_Picture_10.jpeg)

Figure 2: Laptop with gas meter (left) and barometer (right).

![](_page_56_Figure_0.jpeg)

Figure 3: Oxygen levels from October 1, 2021 to November 18, 2021.

![](_page_56_Picture_2.jpeg)

*Figure 4: Drilled boreholes used to fill the mine void space under the residence with grout.* 

![](_page_56_Figure_4.jpeg)

Figure 5: Oxygen levels, November 19, 2021 to March 5, 2022.

Remediation would be considered successful if the O2 levels remain above the minimum level required by the Mine Safety and Health Administration (MSHA); 19.5 percent by volume (MSHA, 2014) for 30 days. Additionally, CO<sub>2</sub> levels should be kept around 0.1 percent by volume to keep the health effects to a minimum as recognized by the Environmental Protection Agency (EPA) (Erdman et al., 2002). However, CO<sub>2</sub> levels below one percent have an indefinite maximum exposure limit (EPA, 2015). By finding and eliminating the source of the CO<sub>2</sub>, it was expected that O2 would return to near atmospheric levels (20.0 - 20.9 percent).

### **Historical Mining**

Abandoned coal mines can produce  $CO_2$ from the oxidation of the remaining coal and other organics in the mine (Wang et al., 2002). Old mine maps were georeferenced in relation to the residence to determine if there is a pathway for the  $CO_2$  from the mine to enter the house (See Appendix for Figure 1). The residence is near the outcrop of a coal mine. If the abandoned coal mine is emitting  $CO_2$ , the gas could be entering the house.

### Methodology

A Drager X-am 7000 gas meter was placed inside the residence to record gas values every 10 minutes during the investigation. Since  $CO_2$  is heavier than  $O_2$ , the gas meter was placed in the basement. Refer to Figure 2 in the Appendix for a picture of the gas meter used.

Barometric pressure was tracked during the investigation using an In-situ Baro Troll<sup>1</sup> in the basement. Falling barometric pressure is associated with mine gases being released to the atmosphere (Yuan et al., 2010). As a

![](_page_57_Picture_0.jpeg)

*Figure 6: Exhaust fan (white) installed on top of de-gas pipe (gray/black). One of two pipes shown here.* 

![](_page_57_Figure_2.jpeg)

Figure 7: Oxygen levels from March 25, 2022 to May 20, 2022.

result, falling barometric pressure corresponds to elevated levels of CO<sub>2</sub> and reduced levels of O<sub>2</sub>. Refer to Figure 2 in the Appendix for a picture of the barometer used.

### Site Characterization

During site characterization, long-term data was collected from the residence. Figure 3 contains a graph of the O<sub>2</sub> levels and barometric pressures from October 1, 2021 to November 18, 2021. Depressed O<sub>2</sub> levels (< 19.5 percent) occurred numerous times during the sample period which were generally correlated to periods of decreasing barometric pressure.

### PADEP-BAMR Remediation Plan

PADEP-BAMR proposed a remediation plan that included filling the mine void space under the residence by drilling boreholes and filling them with grout, while adding two degasification (degas) pipes. Filling the underground mine void space should remove most pathways for CO<sub>2</sub> to enter the house.

Work began November 19, 2021 and finished December 3, 2021 for the drilled and grouted boreholes (Refer to Figure 4 in the Appendix). The two degasification pipes were installed between December 4 and 10, 2021.

### **Remediation Plan (Phase 1)**

During and after the remediation plan, long-term monitoring continued. Figure 5 contains a graph of the recorded  $O_2$  levels and barometric pressures from November 19, 2021 to March 25, 2022. Depressed  $O_2$  levels occurred (<19.5 percent) numerous times and corresponded to periods of decreasing barometric pressure. Long-term monitoring showed that the residence was still experiencing elevated  $CO_2$  levels ( $CO_2$  > one percent).

Air flow from the de-gas pipes was minimal. As such, PADEP-BAMR decided to ameliorate their remediation plan by proposing to install exhaust ventilation fans on the top of the de-gas pipes.

Installing the ventilation fans would create a pressure gradient, venting more  $CO_2$  gas into the atmosphere. On March 25, 2022, the ventilation fans were installed atop the de-gas pipes (Refer to Figure 6 in the Appendix).

### Remediation Plan Effectiveness (Phase 2)

Long-term monitoring continued. Figure 7 contains a graph of the  $O_2$ levels and barometric pressures from March 25 to May 20, 2022. From April 14 to May 13, 2022,  $O_2$  levels were not recorded due to the gas meter being removed from the charging dock. The homeowner reported no incidents of low  $O_2$  during the data gap. The  $O_2$  levels were not depressed below 19.5 percent once the ventilation fans were installed on top of the de-gas pipes.

Long-term gas monitoring was discontinued on May 20, 2022. At that point, the  $O_2$  levels remained above 19.5 percent for approximately 30 days (March 25 to April 14 and May 13 to 20, 2022). Additionally, the  $CO_2$  levels were near the EPA recommended level of 0.1 percent ( $CO_2$  graphs not shown) during the sample period.

### Conclusion

The combination of filling the mine void space with grout, adding de-gas pipes, and installing exhaust ventilation fans was effective at remediating this relatively large (approximately one acre) site. The key factor was the installation of the exhaust fans on the de-gas pipes, after which O<sub>2</sub> levels remained above 20 percent. It is hypothesized that the drilling and grouting alone wasn't as successful as it has been in the past due to the larger size of this property (i.e., more mine void space under the property). PADEP-BAMR has completed many successful CO<sub>2</sub> gas remediation projects by only filling in the mine void space by way of boreholes with grouting and/or sealing cracks in a basement/garage at smaller sites (approximately 0.5 acres). This project demonstrated that additional remediation measures may be necessary for larger size sites.

Special thanks are extended to PADEP-BAMR for allowing OSMRE to share their mine gas remediation project with the reclamation community.

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<sup>1</sup> The use of this monitoring equipment should not be considered an endorsement from OSMRE. *@* 

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![](_page_58_Picture_16.jpeg)

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# In Wyoming, we develop oil and natural gas the right way

### BY COLIN MCKEE, REGULATORY AFFAIRS DIRECTOR, PETROLEUM ASSOCIATION OF WYOMING

The Petroleum Association of Wyoming represents companies involved in all aspects of responsible oil and natural gas development in Wyoming, including upstream production, oilfield services, midstream processing, pipeline transportation and essential work such as legal services, accounting, consulting and more. PAW advocates for oil & gas development that supports sustainable production of Wyoming's abundant resources; fosters mutually beneficial relationships with Wyoming's landowners, businesses, and communities; and upholds the values of science-based, environmental stewardship.

Recent studies show this industry supports over 20,000 jobs in Wyoming

and contributes \$8 billion in economic activity. Our industry generates significant tax revenue to the state of Wyoming, funding state and local government operations, education, and public infrastructure. Eighty-five percent of the oil & gas companies operating in Wyoming are classified as small businesses.

On average, nearly three-fourths of the oil and natural gas produced in Wyoming has a federal nexus – it is produced from land owned by the American public and managed by the federal government. In order to proceed with development, operators must go through typically no less than three rounds of environmental reviews. These reviews are coordinated by natural resource specialists, wildlife biologists, reclamationists, and more. Through these reviews, multiple opportunities are available for participation by state and local governments, direct stakeholders, and the public. In approving development, best practices are appended to the action as stipulations and conditions relate for interim and final reclamation and consideration of wildlife. For the opportunity to access oil & gas resources, the industry in Wyoming takes seriously their responsibility to abide by these stipulations.

PAW works to encourage information development and distribution to ensure companies operating in this state know the latest techniques and

![](_page_59_Picture_8.jpeg)

The edge of a well pad in the Jonah Infill natural gas field abutting a stand of old sagebrush. Jonah Energy utilizes diverse, native seed mixes to combat weeds while improving wildlife and pollinator habitat.

The center of this photo is the edge of a PureWest well pad in the Pinedale Anticline natural gas field. The right side demonstrates PureWest's effort to establish diversity for a wildlife diet to include sagebrush, native grasses, forbs, and shrubs.

procedures. One way we accomplish this is by hosting an annual Wildlife & **Reclamation Conference.** Approaching its 15th anniversary, this conference is an opportunity to share new and improved reclamation practices, monitoring and data management (Figure 1). We highlight case studies on successfully implementing development while integrating consideration to wildlife conservation. The conference is inclusive to all – academics, consultants, government agencies, NGOs, operators and others. The structure of the meeting is a one-day, jampacked event typically including over a dozen speakers covering diverse topics. A snapshot of topics last year included seed availability during drought, the role of monitoring and reporting for adaptive management and an update on sagebrush restoration efforts. This format ensures everyone at the conference walks away with some new knowledge relevant to their interest. Importantly, this is also a great avenue to network with those in or related to your field of expertise.

Internally at PAW, we have numerous committees with specific focuses. Of relevance to ASRS readers is PAW's Public Lands Committee. Much of the work through this committee is focused on actions initiated by federal agencies which influence company's abilities to develop federally managed minerals. It also encompasses wildlife issues and actions at the state government level. We hold calls as necessary to discuss new proposals and ongoing efforts, all to keep those we represent up to date on the latest activity occurring in Wyoming and nationally. PAW's membership includes many accomplished reclamationists who join these calls and offer their

![](_page_60_Picture_2.jpeg)

Brenda Schladweiler gives a talk at the 14th Annual PAW Wildlife and Reclamation Conference.

expertise, including Josh Sorenson, the first oil & gas industry reclamationist to win the ASRS Reclamationist of the Year Award for his extensive efforts in the Jonah Field, a prolific natural gas field in western Wyoming. His efforts led to increased floral diversity, net primary productivity, terrestrial food web structure through promotion of insect diversity and enhanced pollinator diversity. He was also able to take his company's herbicide budget down by almost 90 percent by using sound monitoring data to inform decision management and by improving seed mix development. He presented his efforts at our conference in 2021.

Additionally, PAW and our members look for opportunities to partner with federal and state agencies or the University of Wyoming to expand our depth of knowledge. When unknowns are presented through the course of environmental reviews, PAW members rise to the challenge and allocate funding to find answers. The answers aren't always in the best interest of the business but are in the best interest for the issue at hand. We prefer to approach our operations with the best science available from step one.

The industry has pursued many initiatives centered on advancing technologies to extract oil and gas. These efforts typically result in reduced costs, increased production, and lessening surface and wildlife disturbances. PAW members have learned from science and technological advances how to avoid and minimize surface disturbance through things like horizontal and directional drilling or optimizing placement of disturbance. This can be observed through data collected by the state. In the year 2000, over 4,000 wells were spud (initiating drilling operations) in Wyoming and the following year (2001) saw combined oil and natural gas production of 327 million barrels of oil equivalent (BOE). In 2019, just over 650 wells were spud and the production in 2020 was 334 million BOE. That is a nearly 85 percent reduction in the number of wells spud while production of oil and natural gas in 2020 exceeded 2001.

Further, it's important to emphasize

that vertical wells, more prevalent in the 2000s, were drilled on single-well pads. Horizontal and directional wells, becoming more prevalent around and after 2010, have multiple wells per pad. Only considering well count is no longer a surrogate for surface disturbance. Estimates show that the decrease in surface disturbance and access roads resulting from the transition to horizontal drilling, and the reduction in habitat fragmentation, has reduced surface disturbance by up 70 percent in Wyoming.

This industry has invested significant time and resources to improve reclamation practices. Companies are required to reclaim well sites after initial surface disturbance, with 70 to 80 percent of well pads entering interim reclamation within one year after construction. Nearly 100 percent of pipeline disturbance undergoes reclamation soon after initial disturbance. There have been efforts in the last decade for reclamation to go beyond site stabilization, erosion control and prevention of noxious and invasive weed species towards restoring lands to suitable wildlife habitat with emphasis on the Greater Sage-grouse (Figures 2 & 3).

Prior to the 2015 Endangered Species Act decision to not list the Greater Sage-grouse, 26 PAW operating companies worked with University of Wyoming scientists and researchers to provide upwards of 55,000 acres of reclamation data on well pads and pipelines. These efforts were recognized as important to the U.S. Fish and Wildlife Services' Conservation Efforts Database to inform their decision. At the time, then-U.S. Secretary of the Interior Sally Jewel called the unprecedented conservation effort across 11 western States a "truly a historic effort – one that represents extraordinary collaboration across the American West." The current Deputy Secretary at the Department of the Interior, Tommy Beaudreau, called Wyoming's sage grouse conservation plan "the most successful state-run plan in the country."

PAW advocates for sustainable production of oil and natural gas resources in Wyoming. A component of that is providing opportunities for our members to stay up on the latest on reclamation and wildlife conservation. We're proud of the work we do. Next year, PAW will see its 50th anniversary. We intend to continue our efforts for the next 50 years. *(* 

![](_page_61_Picture_6.jpeg)

![](_page_61_Picture_7.jpeg)

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# Spreading your sampling effort

### BY DR. BLAIR ROBERTSON, SCHOOL OF MATHEMATICS AND STATISTICS, UNIVERSITY OF CANTERBURY, CHRISTCHURCH, NEW ZEALAND

Monitoring natural resources often starts with data collection. This is a crucial step to ensure valid scientific inferences are possible. Observing the entire population (a census) is usually impractical because it is too expensive and time-consuming. In practice, a sample drawn from the population is observed. Ideally, the sample is a scaled-down version of the population, reflecting as many of its features as possible. The study variable is measured at the sampled units and subsequently used to estimate population characteristics. Sampling offers several practical advantages over a census, including cost, time, and data quality. The veracity of sample data is often better than census data because a cohesive team of well-trained field practitioners is used for data collection. This article considers the practical problem of drawing sample locations from two-dimensional study areas or maps.

The main objective of a spatial sampling design is to determine where sample locations are placed in a study region so that population characteristics can be estimated with high precision. A common goal is to estimate the mean or total of an environmental variable, but other population characteristics may also be of interest. Some studies select sample locations haphazardly or subjectively based on expert opinion or convenience. These approaches don't use a probability mechanism and can be difficult to analyze statistically. With probability designs, the chance of drawing a sampling location from a specific area is known, and designbased estimation methods for population characteristics can be used. This article focuses on probability designs.

Simple random sampling (SRS) is the most straightforward probability design, where sample locations are independently drawn from a uniform distribution over the study area. SRS yields unbiased estimates of population characteristics, but the sample is not necessarily representative. Natural resources are spatially distributed populations, and their spatial structure should be considered when sampling them. The exact spatial structure is usually unknown, but a reasonable assumption is that nearby sites tend to have more similar study variable values than distant ones. Hence, a simple strategy to improve the precision of commonly used estimators is to spread the sample well over the study area, called spatially balanced sampling.

For study regions with simple boundaries, the spatial spread can be achieved using a systematic pattern covering the study area, such as a randomly placed grid or lattice. However, grid structures become less effective for complex study regions and arbitrary sample sizes. This article describes a spatial sampling design alternative to grid-based methods called Balanced Acceptance Sampling (BAS, Robertson et al. 2013, 2017). BAS is simple to implement and far more flexible than grid-based methods.

![](_page_62_Figure_7.jpeg)

![](_page_62_Figure_8.jpeg)

Figure 1: (Left) A simple random sample (SRS) of n = 50 points from the unit square. (Right) A spatially balanced sample of n = 50 BASpoints. For a spatially balanced sample, the area of each Voronoi polygon (the set of nearest neighbors to each sample point, shown in red) should be similar in size. The SRS sample clumps points and BAS is well-spread.

![](_page_63_Picture_0.jpeg)

Figure 2: (Left) An aerial photo of the Jonah Infill natural gas field in Wyoming, United States. (Right) BAS sample locations on one well pad, where the first 30 locations on the interim reclamation area and the reference area are taken. The sample is well-spread over both areas (image taken from Curran et al. 2019).

BAS uses the two-dimensional Halton sequence, a quasirandom number sequence, to spread sample locations evenly over the unit square (see Figure 1). The Halton sequence is deterministic, but BAS randomizes its starting point to give a probability sample. Loosely speaking, BAS is the Halton sequence skipping a random number of points in the first dimension and a random number of points in the second dimension. BAS has similar properties to a randomly placed regular grid, including evenly spread points, but unlike a grid, points can be added incrementally with no clumping of points. This makes BAS particularly useful for sampling natural resources because the sample size is easily adjusted to meet the researcher's needs.

- 1. BAS generates n sample locations using the following approach.
- 2. Scale and translate the study area to fit the unit square.
- 3. Generate a random-start Halton sequence in the unit square, with the first point from the sequence in the study area.

Take the first n points from the sequence that fall within the study region (see Figure 2).

Grid-based methods replace step 2 with a grid or systematic pattern of points, and step 3 takes all the grid points within the study region or a random sample of them. BAS replaces the grid with a random-start Halton sequence and takes the first n points within the study region. The sample size is easily increased or decreased (taking more or fewer points from the sequence) without compromising spatial spread. This isn't necessarily the case for grid-based methods.

BAS has been used successfully in environmental monitoring programs in several countries, including abandoned mine

land sites and oil and natural gas well pad reclamation programs in Wyoming (Curran et al. 2019; see Figure 2). The main advantages of BAS over other approaches include being conceptually simple, computationally efficient, able to adjust sample size and point density, and able to draw spatially balanced master samples (van Dam-Bates et al. 2018). The flexibility to adjust sample size dynamically is immensely popular with field practitioners because nontarget or inaccessible sites can be replaced with well-spread replacement locations. This feature does not eliminate the non-response or the bias of inference but allows researchers to achieve the maximum sample size their budget permits. Several packages are available in the R programming language to draw BAS samples, including SDraw, MBHdesign and the soon-to-be-released uc511 sampling package.

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![](_page_64_Picture_6.jpeg)

![](_page_64_Picture_7.jpeg)

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![](_page_67_Picture_2.jpeg)