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Journal of the American Society of Mining and Reclamation

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

Contributions to JASMR

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

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

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

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

Policy or Review Papers: Submission of papers dealing with regulatory and procedural issues is welcomed. These papers emphasize changing approaches to the science and technology of landscape revitalization.

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

Paper Submission to JASMR

Manuscripts are submitted electronically to Dr. Richard Barnhisel at asmr@twc.com.

Style Guide for Authors: Manuscript preparation guide is available at: http://www.asmr.us/Publications/Journal/Manuscript%20Guidelines%20Journal.pdf or use https://www.agronomy.org/publications/style

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RESEARCH PAPER

NATIVE MYCORRHIZAL FUNGI REPLACE INTRODUCED FUNGAL SPECIES ON VIRGINIA PINE AND AMERICAN CHESTNUT PLANTED ON RECLAIMED MINE SITES OF OHIO[1]

Shiv Hiremath[2], Kirsten Lehtoma, and Jenise M. Bauman

Abstract. Plant-microbe community dynamics influence the natural succession of plant species where pioneer vegetation facilitates the establishment of a distantly related, later successional plant species. This has been observed in the case of restoration of the American chestnut (*Castanea dentata*) on abandoned mine land where Virginia pine (*Pinus virginiana*) facilitated the establishment of chestnut seedlings. This was apparently due to the natural mycorrhizal networks of pine, which aided the survival and growth of chestnut seedlings. In this study, we assessed the survival and propensity of introduced mycorrhizal fungi on Virginia pine to colonize pure American and backcrossed American chestnut. Seedlings were planted in Perry State Forest located in southeastern Ohio. This area was mined for coal in the 1950s and had very little reclamation done aside from experimental tree plantings. The selected site, with little topsoil or organic matter, was characterized by high concentrations of Al, high soil temperatures, and a pH of 3.6. Virginia pine seedlings were inoculated using ectomycorrhizal (ECM) cultures of *Amanita rubescens*, *Laccaria laccata*, and *Pisolithus tinctorius* via liquid media. After three months, roots were tested for the presence of mycorrhizae. They were then transplanted and grown for two years in the greenhouse. After verifying mycorrhizal colonization, 600 pines were out planted in May of 2005. Chestnut seedlings (100 one-year-old seedlings) inoculated with *P. tinctorius* by the Ohio state tree nursery had been planted by other researchers at the same time. After eight growing seasons, pines and chestnuts were measured and sampled for ECM colonization. Growth measurements showed that pines and hybrid chestnuts had significantly more aboveground biomass compared to pure American chestnut (P = 0.01). Eleven fungal species were detected using DNA sequencing. With the exception of *Amanita*, the inoculum that were out planted with both chestnut and Virginia pine were replaced after 8 field seasons by fungi native to the site. More fungal species were sampled from the Virginia pines than from chestnut roots, which contributed to the significant differences in ECM fungal community composition between the two species (P = 0.005).

Additional Key Words: root colonization of fungi, chestnut restoration, American chestnut.

[1.] Paper was presented at the 2013 National Meeting of the American Society of Mining and Reclamation, Laramie, WY ***Reclamation Across Industries,*** June 1-6, 2013, and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Hiremath-OH.pdf

SURVIVAL AND GROWTH OF ASPEN AND SERVICEBERRY PLANTED ON RECLAIMED SURFACE MINED LAND WITH LANDSCAPE FABRIC AND IRRIGATION[1]

R.C. Musselman[2], W.D. Shepperd, F.W. Smith, and L.A. Asherin

Abstract: Difficulty in re-establishing native vegetation on surface mined lands in the semi-arid western U.S. prompted this study to determine the effectiveness of landscape fabric and supplemental irrigation on survival and growth of the woody perennials aspen (*Populus tremuloides* Michx.) and serviceberry (*Amelanchier alnifolia* (Nutt.) Nutt. ex M. Roem.) at a high elevation reclaimed surface coal mine site in Colorado. The study compared growth and survival of container-grown aspen and serviceberry planted with or without landscape fabric for control of competing vegetation, and with or without biweekly supplemental irrigation during the first growing season. Response after three years indicated that the landscape fabric was particularly crucial in survival and growth of aspen on sites with heavy competing vegetative cover. Serviceberry plants grew better with landscape fabric but the fabric did not increase survival. Supplemental irrigation provided only limited advantage compared to the landscape fabric. Photosynthesis and pre-dawn moisture stress measurements on the aspen indicated that they were more stressed without landscape fabric. Soil moisture was higher under the landscape fabric.

Additional Key Words: Amelanchier alnifolia, competition, Populus tremuloides, revegetation, soil moisture

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[1] This study was presented at the 2009 National Meeting of the American Society of Mining and Reclamation, Billings, MT. *Revitalizing the Environment: Proven Solutions and Innovative Approaches* May 30 – June 5, 2009 and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Musselman-CO.pdf

IMPACT OF SEED EXPOSURE TO PLANT MATERIAL ON PLANT GROWTH AND DEVELOPMENT ON REMEDIATED ARID LANDS[1]

Conrad W. Nelson, Adrian Unc, Kevin Lombard, Mary Lucero, Steven Perkins[2]

Abstract. Remediation of land following surface mining requires the re-establishment of critical soil, plant, and microbial interactions on which the long-term sustainability of the site hinges. Current surface mine remediation practices may utilize topsoil with or without shredded plant material to overlay spoil. We evaluated whether the presence of such plant material may affect initial plant fitness and thus plant establishment. Tests were carried out in a greenhouse under controlled, replicated conditions common during early stages of remediation. Responses to seed exposure to plant material were species dependent. Plant growth parameters were linked to properties associated with the seed hull and seed surface and to functions associated with shredded plant material added to topsoil. Confirming the nature of these properties, hypothesized as microbial in origin, will be important for understanding factors critical to reclamation and management of disturbed sites, where native biological functions have been suppressed or fragmented. In degraded arid environments, such functions may govern micro-scale interactions that influence macro-scale processes.

Additional Keywords: land remediation, surface mine, plant fitness, non-specific inoculation

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[1] Poster paper presented at the 2013 National Meeting of the American Society of Mining and Reclamation, Laramie, WY ***Reclamation Across Industries***, June 1–6, 2013 and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1, R.I. Barnhisel (Ed.), Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Nelson-NM.pdf

CHARACTERIZING THE UNSATURATED AND SATURATED HYDRAULIC PROPERTIES OF COAL COMBUSTION BY-PRODUCTS IN LANDFILLS OF NORTHWESTERN NEW MEXICO[1]

R.W. Webb[2], J.C. Stormont, M.C. Stone, and B.M. Thomson,

Abstract. Coal combustion byproducts (CCBs) disposed of in unlined landfills can affect the quality of adjacent water resources. In previous studies, CCBs have been found to leach toxic heavy metals such as arsenic, mercury, and lead into groundwater. CCBs include fly ash, bottom ash, and flue-gas desulfurization product (FGD gypsum). Within a landfill, CCBs may be present at different densities associated with depth, compacted primarily from the weight of above materials. This investigation focused on determination of the unsaturated and saturated hydraulic properties of fly ash and bottom ash as a function of density and thus a function of depth within a landfill. Ash samples from a power plant in northern New Mexico were collected for laboratory analysis. Compressibility curves were developed in order to determine what densities may be experienced at a range of pressures. Saturated hydraulic conductivity was determined using falling head tests for multiple densities of each material. Moisture characteristic curves were developed from hanging column tests, pressure plate tests, dew point potentiometer measurements, and relative humidity measurements. The moisture characteristic curves were also measured at a range of densities for each material. Results indicated that the fly ash saturated hydraulic conductivity varied as a function of density for the materials tested and the density could be reasonably predicted using an equation presented. Fly ash unsaturated properties also show trends with variations in density with the variability decreasing as density increases. Fly ash in a landfill can have estimated density, unsaturated and saturated hydraulic properties as a function of depth using the methods in this paper. Bottom ash showed similar trends in compressibility with less variability with respect to the fly ash. The unsaturated and saturated hydraulic properties show some trends, though with high amounts of variability. The density of bottom ash materials in a landfill may be reasonably estimated using methods proposed in this study while unsaturated and saturated hydraulic properties have greater uncertainty.

[1] Article submitted to the Journal of the American Society of Mining and Reclamation and was accepted for the online in Volume 3, No. 1. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Webb-NM.pdf

A COMBINATION OF ACID B EXTRA ™ AND BIOCHAR TO REDUCE METAL CONCENTRATIONS IN ACID MINE DRAINAGE[1]

C.D. Peltz[2], C. Zillich, and K.L. Brown

Abstract The Bureau of Land Management (BLM) Abandoned Mined Land Program has built and is operating the Eveline Mine Drainage Treatment Vault near Silverton, CO to investigate innovative passive treatment technologies for acid mine drainage (AMD) in high alpine environments. Column tests of several materials were conducted to determine treatment media to use in the vault. This case study examines the potential of combining Bauxsol™ Acid B Extra™ (an alumina refining by-product) with biochar, pea-gravel, and porous concrete to reduce AMD metal concentrations. The objective of the trial was to create a passive treatment system that (1) reduces metal concentrations in effluent waters, (2) reduces operational costs, (3) utilizes waste streams from industry, and (4) operates in cold weather climates with limited space for infrastructure. Results suggest that the combination of Acid B Extra™ and biochar achieved optimal near term results with >95% removal of Cd, Cu, Fe, Mn, and Zn, and >60% removal of Al, while not clogging the pilot test columns.

Additional Key Words: acid mine drainage, passive treatment, Eveline Mine, biochar, porous concrete, pea-gravel, Acid B Extra™, Silverton CO, Bureau of Land Management.

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[1] Oral paper was presented at the 2013 National Meeting of the American Society of Mining and Reclamation, Laramie, WY ***Reclamation Across Industries***, June 1-6, 2013 and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Peltz-CO.pdf

TREE GROWTH ON RIPPED, COMPACTED, AND SLIGHTLY COMPACTED GRAY SANDSTONE TOPSOIL SUBSTITUTE ON A SURFACE COAL MINE IN WEST VIRGINIA[1]

Lindsay Wilson-Kokes and Jeff Skousen[2]

Abstract: Steep topography and thin native soils characterize the coal mining regions of southern West Virginia. State and federal regulations require replacement of native topsoil during reclamation for re-establishment of a vegetative cover. Due to hazards and expense associated with collecting this thin layer of soil before mining, regulators have allowed mine operators to use substitute topsoil materials, including weathered (brown) and unweathered (gray) geologic materials for growth media. For pasture and hayland post-mining land uses, substitute materials provide suitable physical and chemical properties for establishment and growth of forages with fertilization and liming. When reforestation is the post-mining land use, regulations in West Virginia require a 1.2 m layer of native topsoil and brown weathered sandstone, but unweathered materials may be used if native topsoil quantities are insufficient. This study examined tree growth on areas where brown and gray sandstone materials were applied to the surface as growth media at the Samples Mine in West Virginia. In a study already published at this site, we found significant differences in tree growth on brown and gray sandstone plots. For this study, we selected two additional gray sandstone plots for comparison to the original brown and gray plots. The two original sites were brown sandstone compacted and gray sandstone compacted, and we added nearby plots of gray sandstone slightly compacted and gray sandstone compacted and then ripped. Average pH ranged from 7.3 to 7.9 on the gray plots compared to 5.4 on the brown plot. Tree growth on brown sandstone was more than triple that of tree growth on all of the gray sandstone plots. Mean tree volume index on the brown compacted plot was 3108 cm^3 while mean tree volume index was significantly lower on the gray compacted plot (909 cm^3), the gray slightly compacted plot (407 cm^3), and the gray ripped plot (885 cm^3). Eight years after reclamation, the gray sandstone plots, whether slightly compacted, compacted, or ripped, showed poor tree growth compared to brown sandstone. Gray sandstone has proven to be an inferior topsoil substitute for reforestation on this site.

Additional Key Words: unweathered gray sandstone, tree volume index, reclamation, reforestation, weathered brown sandstone

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1. Paper to be presented at the 2014 National Meeting of the American Society of Mining and Reclamation, Oklahoma City OK, June 14–19, 2014 and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1, R.I. Barnhisel (Ed.), Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Skousen-WV-1.pdf

ESTABLISHMENT AND GROWTH OF SWITCHGRASS AND OTHER BIOMASS CROPS ON SURFACE MINES[1]

Jeff Skousen, Carol Brown, Thomas Griggs, and Shana Byrd[2]

Abstract: Biomass crops are being grown on agricultural and marginal lands to provide feedstock for co-firing in power plants and conversion to transportation fuels. Switchgrass (*Panicum virgatum* L.), Miscanthus (*Miscanthus x giganteus)*, and giant cane (*Arundo donax* L.) are three biofuel feedstocks that have been planted on reclaimed surface-mined land to determine their establishment and potential for biomass production. This study documents the establishment and dry matter (DM) yield of these biomass crops on several mined sites in West Virginia. The Alton site has all three species planted, and DM yield after the fourth growing season averaged 5,200 kg ha^{-1} for switchgrass (Kanlow and Bomaster varieties) and 9,000 kg ha^{-1} for two varieties of Miscanthus. Giant cane had less than 1,000 kg ha^{-1}. Cave-In-Rock switchgrass was planted on 8 ha at the MeadWestvaco (MWV), WV, site and at The Wilds, OH, site in 2013. After the first growing season, switchgrass production was 752 kg ha^{-1} at MWV and 1,045 kg ha^{-1} at The Wilds site. Miscanthus was also planted on these two latter sites, and biomass production after one year was 200 and 600 kg ha^{-1}, respectively. These biomass averages at The Wilds and MWV were lower than averages produced at Alton after the first growing season. At the Coal Mac site, an average of 10,000 kg ha^{-1} of Arundo was produced after the third growing season. As demonstrated in these and other studies, two to three years are required for these bioenergy plants to establish and expand to produce suitable amounts of biomass.

[1] Paper presented at the 2014 National Meeting of the American Society of Mining and Reclamation, Oklahoma City, OK, June 15 – 19, 2014 and accepted for the online Journal of The American Society of Mining and Reclamation, Volume 3, No. 1, R.I. Barnhisel (Ed.), Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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http://www.asmr.us/Publications/Journal/Vol 3 Issue 1/Skousen-WV-2.pdf

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Jenise M. Bauman is a professor at Miami University in Ohio and a research collaborator with the U.S. Forest Service. She earned her Ph.D. from Miami University, M.S. from West Virginia University, and B.S. at Eastern Kentucky University. Her research couples planting methods with molecular techniques to better understand seedling establishment in disturbed soils. Research foci include belowground interactions of beneficial fungi during restoration, impact of invasive species on plant-fungal mutualisms, and plant pathology within forest restoration.

Carol Brown, Research Assistant, West Virginia University

Kirstin Brown is a geologist with the Colorado Division of Reclamation, Mining and Safety, Inactive Mine Program. She has 12 years of experience in mine reclamation. Her work includes safeguarding abandoned mine sites to protect human safety, water quality projects and investigations, underground mine investigations and underground projects, three dimensional mapping, and coal mine fires.

Shana Byrd has been a natural resource educator and restoration practitioner for the past 13 years, specializing in conservation of prairies, wetlands and woodlands. As Director of the Restoration Ecology Program at the Wilds conservation center, she oversees habitat management and research on the 10,000 acre preserve, while promoting ecological awareness and personal action in conservation. In 2001, she received her Bachelor of Science degree in Environmental and Plant Biology with a specialization in Field Botany from Ohio University. She earned a Master of Arts in Zoology degree in the Global Field Program at Miami University with a focus on environmental stewardship and holds an Adjunct Faculty Appointment with the Department of Biology at Muskingum University.

Thomas C. Griggs is involved in forage and grassland management research and teaching as Assistant Professor of Agronomy at West Virginia University. His interests include plant-animal interactions in pastures, forage quality evaluation, pasture botanical composition, extended-season grazing to reduce hay-feeding costs, winter and early-season grazing impacts on pasture productivity, root responses to pasture management, bioenergy feedstock production and composition, and the broad range of ecosystem services that grassland agriculture provides. Tom grew up in Vermont and has also been active in forage and grassland management research, teaching, and Extension in Idaho, Utah, and Washington.

Shivanand Hiremath is a research molecular biologist in the "Genetics, Biological Control, and Management of Invasive Species" unit in Delaware, OH. His primary research focuses on understanding the molecular mechanisms mediating the formation and functioning of ectomycorrhizae. His work involves identification and utilization of suitable mycorrhizal fungi in restoration of the American chestnut and reforestation of reclaimed mined lands. He received his PhD from the National Chemical Laboratory, India, and a BSci in chemistry from the Karnatak University, India. He joined the Forest Service in 1988.

Dr. Kevin A. Lombard is an Assistant Professor of Horticulture with the New Mexico State University Plant and Environmental Sciences Department and New Mexico State University Agricultural Science Center at Farmington. He conducts research on specialty horticulture crop introductions for Northwest, New Mexico, the use of social media to conserve water in the urban landscape, and exploring the intersects of public health and horticulture as it pertains to diabetes and cancer risk reduction through the act of gardening. He is also affiliated with San Juan College, Farmington, NM, where he instructs horticulture practices in the urban environment. Previously, he received his PhD in Horticulture from New Mexico State University and his MSc and BSc in Horticulture from Texas Tech University.

Dr. Mary E. Lucero retired from USDA-ARS in 2013, and is now adjunct faculty with the Department of Plant and Environmental Sciences and the Molecular Biology Program at New Mexico State University (NMSU). She is also the director of End-O-Fite Enterprises LLC, where she utilizes microbial technologies to build food security and restore health. A leader in detection and transfer of endophyte consortia *in vitro*, her current interests include understanding how microbes interact with living systems to influence health and nutrition, and communicating that knowledge to the public. Lucero received her PhD in Molecular Biology from NMSU, and carried out postdoctoral research in natural products chemistry at NMSU and at USDA-ARS. Lucero holds an MA in Curriculum and Instruction and a BS in Agricultural and Extension Education, both from NMSU in Las Cruces, NM, USA.

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Conrad W. Nelson is a graduate student at New Mexico State University in the Department of Plant and Environmental Sciences. His current research is focused on endophyte ecology and arid region mine site reclamation. Conrad is interested in landscape reclamation and remediation, endophytes, plant-soil relationships, range management, and alternative crop production. He received his BSc degree in Horticulture from New Mexico State University.

Steven R. Perkins is currently an Environmental Superintendent with BHP Billiton - New Mexico Coal where he works with a team responsible for managing environmental permitting and technical environmental programs at three mine sites. Steve received a B.S. in Biology from Brigham Young University, an M.S. in Rangeland Ecology and Management from Texas A&M University, and a Ph.D. in Range Science from New Mexico State University.

Mr. Christopher D. Peltz is a scientist at Research Services and is involved in mine reclamation research focusing on biochar applications for treating soils and mining affected waters. Mr. Peltz's research interests range from forest management to soil ecology and restoration. When not working at mine sites, Chris lives high in mountains of Silverton, Colorado with wife Elizabeth.

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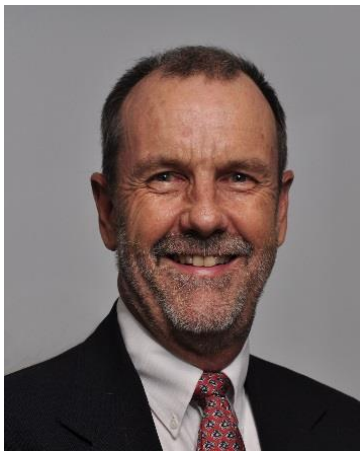
Frederick W. Smith, Professor, Colorado State University, Department of Forest and Rangeland Stewardship Photo unavailable

Jeff Skousen received his B.S. and M.S. from Brigham Young University and PhD from Texas A&M University. He is a professor of soil science and reclamation specialist at West Virginia University. He served as President of ASMR in 1991 and 2004, organized the 1990 and 2004 ASMR annual meetings, and edits the Society's Reclamation Matters magazine. He has published over 150 articles on reclamation and acid mine drainage, teaches a course in reclamation and has advised over 30 graduate students.

Dr. Mark Stone is an assistant professor in the Department of Civil Engineering at the University of New Mexico.Dr. Stone's research interests are in the area of ecological engineering including ecohydraulics, ecohydrology, watershed restoration, and ecological flows. He has been involved with dozens of field, laboratory, and computational research projects covering topics such as fish passage through dams and culverts, impacts of riparian vegetation on floodwaves, design guidance for stream restoration projects, climate change impacts, and water availability in developing countries.

Dr. John Stormont is a Professor in the Department of Civil Engineering at the University of New Mexico (UNM). Dr. Stormont has served as chair of the department since 2009. Dr. Stormont is actively working in the areas of saturated and unsaturated flow through soil and rock as well as pavement systems. His experience includes field and laboratory measurements of hydraulic properties and behavior, as well as numerical simulations of near-surface processes including evapotranspiration, infiltration, drainage, and erosion.



Bruce Thomson is a Research Professor and Regents Professor Emeritus in the Department of Civil Engineering at the University of New Mexico (UNM). Dr. Thomson was Director of UNM's Water Resources Program from 2006 to 2013. His areas of research include chemistry of inorganic contaminants, ground water contamination, and water resources management.

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Ryan Webb is currently a Ph.D. candidate at Colorado State University in the department of Civil and Environmental Engineering. His primary research interest there is the surface and sub-surface flow interactions of snowmelt. Ryan is working in bridging the gap between the soil sciences and snow hydrology. His experience includes field and laboratory work, numerical simulations of near-surface processes hydrologic processes, as well as water engineering in developing countries with organizations such as Engineers Without Borders.

Lindsay Wilson-Kokes photo and bio unavailable.

Cathleen Zillich is a hydrologist with the Tres Rios Field Office of the Bureau of Land Management. She has over 35 years with the Forest Service and BLM in water resources and watershed management. In the last ten years she has focused mainly on restoration of mines that impact human health and water quality, and restoration of mining-impacted wetlands.