

West Virginia Water Research Institute





West Virginia Water Research Institute

Greetings from the WV Water Research Institute,

Water is one of West Virginia's most precious resources. It is essential for life and our economic prosperity, yet so many of the activities that keep our economy alive, and growing, also threaten our water resources. Energy generation, mineral extraction, agricultural production and other industrial activities all impact our water, making it increasingly necessary to find new ways to protect and restore this vital commodity as our economic activity accelerates. For over 40 years, the West Virginia Water Research Institute (WVWRI) has been leading the important work of addressing these issues and is the go-to organization for solving West Virginia's water-related problems.

While much of the work we do is focused on exploring and implementing technologies to improve and protect the quality of our State's water resources, we are also dedicated to expanding the understanding of threats and opportunities related to this critically important resource. We strive to bring together a diverse cross section of stakeholders to participate in water-related research throughout West Virginia. We encourage a constructive and respectful dialog about the future of our lakes, rivers and streams as well as our groundwater supplies.

Today, the WVWRI continues to grow its established programs and develop new initiatives to address emerging problems affecting the State's environmental and economic health. With continued financial support from our State and Federal partners, and with the expertise of our staff and collaborating researchers, the WVWRI will continue to work for real improvements to West Virginia's water resources.

Sincerely,

A handwritten signature in blue ink, appearing to read 'P. Ziemkiewicz'.

Paul Ziemkiewicz, Director

A Program of the National Research Center
for Coal and Energy

Phone: 304 293-2867
Fax: 304 293-7822

PO Box 6064
Morgantown, WV 26506-6064



Water Research for West Virginia: A Team Approach

Under Federal legislation, Water Resources Research Institutes, or Centers, have been established in each of the 50 states, the District of Columbia, Puerto Rico, the U.S. Virgin Islands and Guam. In 1967, the United States Geological Survey established the West Virginia Water Research Institute (WVWRI) to conduct research related to water issues in the State. Today, the WVWRI develops state water research priorities with oversight and guidance from the West Virginia Advisory Committee for Water Research, a committee represented by members of Federal and

State agencies, academia and industry. Our programs and projects develop strong, multi-disciplinary research teams through collaboration with West Virginia University colleges and divisions, higher education institutions across the country and industry professionals. This team approach offers the best expertise available to address West Virginia water issues and allows the WVWRI to perform research in a number of areas at any given time. More information on WVWRI programs, research, projects, initiatives and publications can be found at www.wvwri.com.



West Virginia Water Research Institute Staff

The West Virginia Water Research Institute is dedicated to the preservation and restoration of the natural environment through research and outreach with industry, government agencies, academia, and the public. The Institute, in existence since 1967, is the premier water research center in West Virginia and, within selected fields, an international leader.

National Mine Land Reclamation Center

The National Mine Land Reclamation Center (NMLRC) housed within the West Virginia Water Research Institute has become an internationally-recognized leader in the area of acid mine drainage (AMD) treatment. Coal mine reclamation restores value to land and water affected by current and historic mining operations. The NMLRC works to improve methods for protecting streams from mine pollution and develops ways to establish productive uses of mined lands. Working with state and federal agencies, citizen watershed organizations and the coal industry, the NMLRC has pioneered large-scale watershed reclamation strategies that connect regulatory programs with voluntary remediation.

Technologies developed by the NMLRC now used by industry and regulatory agencies include:

- Alkaline amendment,
- Quantitative AMD prediction method,
- Pneumatic and slurry placement of alkaline coal ash in underground mines,
- Selective spoil handling,
- Re-mining,
- Passive AMD treatment systems for watershed restoration, and
- Watershed-based approach to modeling and restoration planning.



*Brady Gutta
WVWRI Project Manager*

Mine of the Future

In a collaborative effort between WVWRI, the WVU Departments of Civil & Environmental Engineering, and Geology & Geography, this multi-disciplinary group addresses research and development into the broad area of mine safety by targeting the following tasks: safety and health technologies in mountain top mining, mine impoundment safety inspection and verification, and addressing risk from mining blowouts, breakout, and flooding.

The *Mine of the Future* project meets the needs of an ever-changing coal industry by researching ways to improve the health and safety of mountain top mining by exploring alternative mining methods for mountain top reserves that will minimize miners' exposure to hazardous site conditions. Researchers are also developing a technology that will provide mine impoundment inspectors and regulatory agencies with improved field inspection methodologies for dam inspections. A rugged computer based tool is being developed that will provide a more efficient way to inspect dams and impoundments, thus increasing the safety of the work environment near these structures. The project also seeks to predict and map potential flooded mine breakout locations on a priority-based scale. These discharges are a widespread and lurking hazard not only to worker safety, but also to property and surface water quality. This research will lower the risk of unwanted mine flooding through the use of GIS mapping.

A Collaborative Approach to Mine Drainage Treatment

Roaring Creek

Roaring Creek is a 15 square mile tributary of the Tygart Valley River in Randolph County, West Virginia. Historic mining has impacted the water quality with high iron content and low pH.

The NMLRC, West Virginia Department of Environmental Protection (WVDEP) and the Mountaineer Chapter of Trout Unlimited have implemented a sampling plan to identify major sources of AMD while developing conceptual passive treatment systems and Best Management Practices.

Lambert Run

Water draining from inactive deep mines along Lambert Run, a tributary of the West Fork River in Harrison County, has seriously compromised the water quality of the stream. A partnership exists between the WVDEP's Division of Water and Waste Management, U.S. Office of Surface Mining (OSM), NMLRC, and the Guardians of the West Fork to assess, design and install passive treatment systems to treat the mine drainage. As of early 2011, four systems have been successfully installed and design work has begun on two additional sites.

Cheat River

The Cheat River in West Virginia has a history of being polluted by acid mine drainage. Through partnerships with NMLRC, WVDEP, Friends of the Cheat, OSM, and the mining industry, the water quality of the Cheat River has dramatically improved. In fact, Cheat Lake, fed by the Cheat River, is now one of the top warm water fisheries in the state.



Selenium Research

Selenium is a naturally occurring element in aquatic ecosystems. In high concentrations it can pose an environmental and human health risk. In addition to background levels, activities such as mining, sewage discharge, erosion, atmospheric deposition and other processes are thought to add selenium to water bodies. Selenium leached from coal tailings is a challenge for mining operations in southern West Virginia. WVWRI initiated studies in 2008 to help better understand and find solutions to this problem.

Selenium Leaching Kinetics and In-Situ control

Once selenium is oxidized to a selenate ion, removal is extremely difficult and expensive. Lab studies are attempting to understand the potential to control selenium at the source through special handling and treatment of selenium-rich rock.

Because selenite is known to bind to ferrihydrite, a humidity cell leaching study has been initiated to confirm selenite as the initial, mobile selenium species during weathering and to determine the effectiveness of ferrihydrite as a potential sorbent.

Identifying Sources and Effects of Selenium in the Mud River Basin

Researchers are studying the sources of selenium in the Mud River and the Mud River Reservoir, how much accumulates in aquatic organisms and the extent to which selenium remains biologically available. The study also looks at whether or not aquatic organisms are affected by selenium, and if so, at what concentrations.

Northern West Virginia Brownfields Assistance Center (NBAC)



This abandoned glass factory in Moundsville, West Virginia is illustrative of brownfields sites found in communities throughout the state.

Many small communities in rural West Virginia do not have the staff or technical expertise to undertake brownfields redevelopment projects on their own. In an effort to reclaim the potential economic and social value of brownfields, such as abandoned industrial lands, the West Virginia State Legislature created the Northern and Southern Brownfields Assistance Centers in 2005. The Centers work with the West Virginia Department of Environmental Protection to help communities plan and implement brownfield redevelopment projects.

The Northern West Virginia Brownfields Assistance Center (NBAC), housed at WVVRI, serves the State's northern 33 counties by providing communities with technical assistance, regulatory understanding, help with site assessments, planning, funding and risk management and site marketing. The Northern Center promotes environmental and public health protection by facilitating the innovative clean-up and redevelopment of brownfield sites.

What is a Brownfield?

A site, or portion of a piece of property, that has actual or perceived contamination and an active potential for redevelopment or reuse.

FOCUS WV Brownfields Program

The Foundation for Overcoming Challenges and Utilizing Strengths (FOCUS) WV Brownfields Program was started in 2008 through the support of the Claude Worthington Benedum Foundation. The program provides community groups and local governments with start-up funding to help identify and overcome barriers in brownfield redevelopment projects. Through 2010, the FOCUS WV Brownfields Program had provided over \$268,000 in funding to 32 communities. These communities generated an additional \$2.2 million in funding and in-kind support to help turn brownfields into community assets.



Officials from the City of Parkersburg accept a FOCUS WV check from NBAC Director, Patrick Kirby, for the Little Kanawha Riverfront Project.

Sustainable Energy Parks

The WVWRI received a Training, Research, and Technical Assistance Grant from the U.S. Environmental Protection Agency to construct a framework for developing Sustainable Energy Park opportunities on mine scarred land in Appalachia. Citizens of Appalachia have historically borne the human health and environmental costs of extracting the region's natural resources without receiving equitable return to repair the scars left from coal mining.

This project provides a catalyst to foster a companion sustainable energy industry to coal in Appalachia. The result will be an environmentally and economically sustainable reuse of brownfields. Sustainable Energy Parks have the potential to generate local economic growth, decrease greenhouse gases through carbon sequestration and promote renewable energy technologies by using mine scarred land for wind generation, switchgrass production and solar energy capture. The project will create a replicable model for communities nationwide to apply to mine scarred lands.

Switchgrass production on mine scarred lands in West Virginia is a good choice for biofuels production because of proximity to major markets, abundant water supplies for ethanol processing, abundant rainfall and a long, warm growing season.

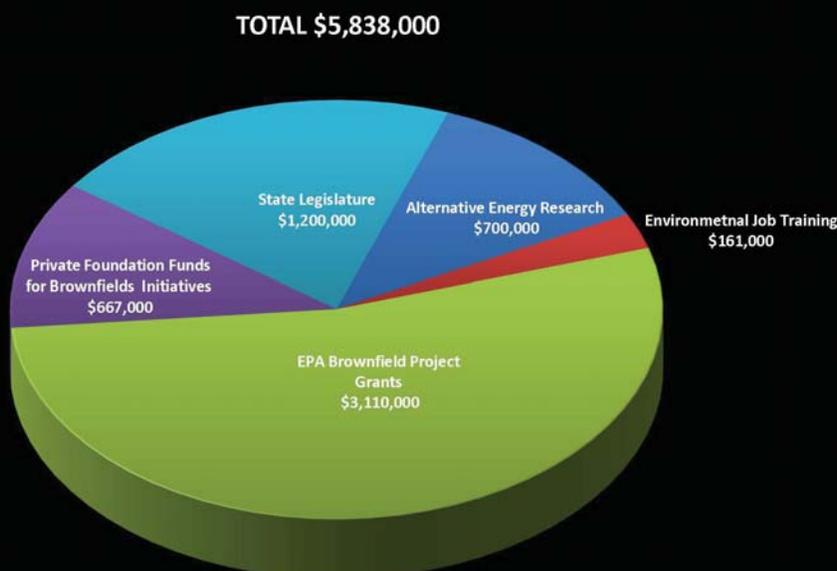


Land-Use Master Planning

The Northern West Virginia Brownfields Assistance Center has partnered with the West Virginia Division of Energy's Office of Coalfield Community Development to work with West Virginia counties across the state in the creation of their Land Use Master Plans.

A Land Use Master Plan (LUMP) is a tool that provides guidance and suggestions to County Development Authorities for alternate land use of transportation systems, highway development, and surface mine sites. These plans are used primarily to assist in the advancement of surface mined properties for community, economic, and energy development opportunities. A LUMP offers an interested property owner the opportunity to work with a surface mine operator to prepare post mine lands for a variety of potential profitable uses.

Sources of Northern West Virginia Brownfields Funding 2005-2010



Sources of Funding for the Northern West Virginia Brownfields Assistance Center 2005-2010

Water Resources Research Program

With funding from the U.S. Geological Survey's (USGS's) State Grant Program, the WVVRI recruits new water researchers and develops new programs to protect West Virginia's watersheds focusing on issues such as domestic & industrial water use and safety, supply and policy. Through conferences and workshops, the WVVRI works with state agencies, the public and industry to help define the policy and technical issues affecting West Virginia's water resources.



In 2010, the annual statewide Water Conference was held in Morgantown, WV, at the Waterfront Place Hotel. A record attendance of over 200 people attended the event with featured speakers including West Virginia Congressman Alan Mollohan, West Virginia University President James Clements, USGS's Chief Scientist for Hydrology, Jared Bales and others. Over 50 researchers in 20 sessions shared information about the work they are doing to understand, protect and restore our water resources.

WVVRI Organizes a TDS Working Group in Response to Fish Kill on Dunkard Creek

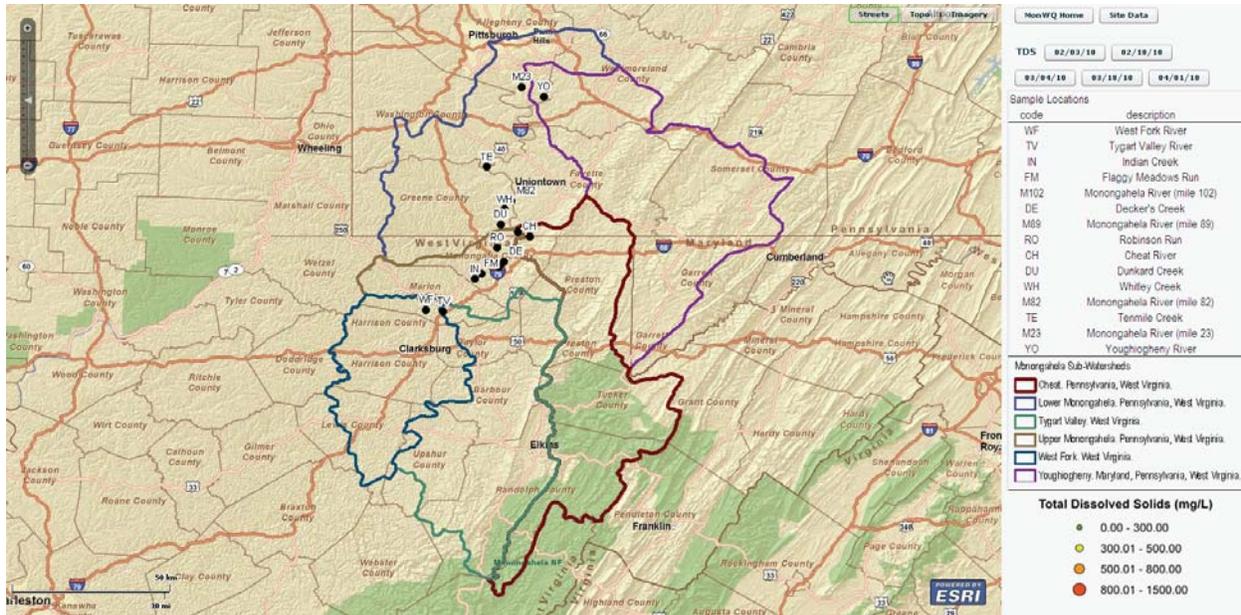
In September 2009, a fish kill on Dunkard Creek, West Virginia, a major tributary of the Monongahela River, was caused by a toxic Golden Algae bloom made possible by high concentrations of Total Dissolved Solids (TDS) in the stream. In response to this situation, the WVVRI organized a TDS Working Group consisting of seven coal companies operating in the area.

This group worked together to identify a way to manage mine discharges in order to keep TDS in the Monongahela River and its tributaries at acceptable levels. By controlling TDS through planned mine discharges, concentrations are maintained at levels that prevent conditions conducive to Golden Algae growth. Hence, this collaborative of industry and scientists is proactively reducing the risk of future fish kills.

Using water quality data made available by the WVVRI's Monongahela River Water Study, assimilative capacity of Dunkard Creek was determined. Since January 2010, the strategic management of pumped mine discharges has resulted in concentrations of TDS on Dunkard Creek well below those during the fish kill, despite low river flow conditions. This voluntary process uses a cooperative approach to protect the Monongahela River watershed and in resource rich states like West Virginia and Pennsylvania illustrates how we can achieve better results working together to resolve problems. The West Virginia Division of Natural Resources (DNR) reports that fish and aquatic life are returning to the stream at a rate exceeding the DNR's expectations.

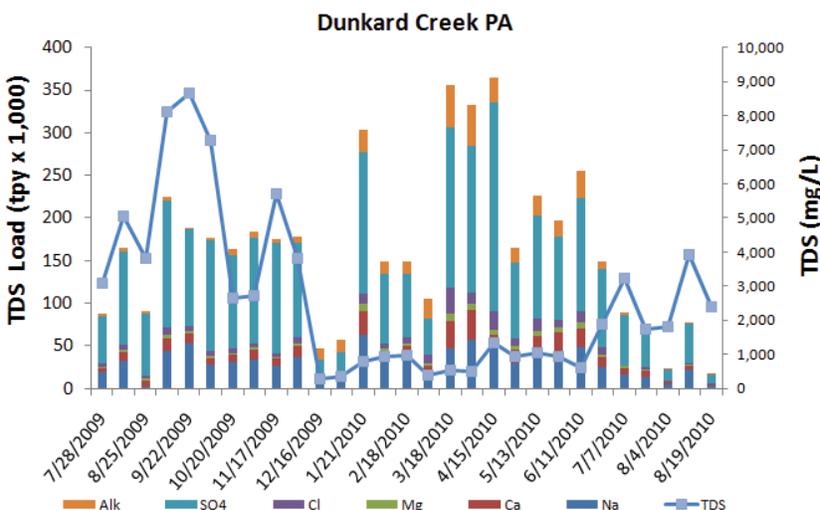
Monongahela River Water Quality Study

The WVWRI has undertaken a comprehensive water quality monitoring and reporting project for the Monongahela River basin. Bi-weekly samples are collected and analyzed with the water quality data and results organized and presented via a website utilizing a Geographic Information System map and database.



Water quality monitoring began in the Monongahela River basin in July of 2009. Sixteen tributary and mainstem stations are being sampled bi-weekly. Water quality analysis includes 19 field and lab determined parameters.

A website (www.MonWQ.net) provides easy to understand visualizations of the water quality in the Monongahela River basin. Geographic Information System (GIS) mapping also provides users of the site with the ability to see the Monongahela River basin and specific sampling locations. Many users of the Monongahela River such as recreationists, anglers and industry, as well as policy makers and regulators benefit from having accurate and current information about water quality conditions.



For more information, or to view the map and sampling results, visit: www.MonWQ.net

The Monongahela River Water Quality Study is being funded by the WVWRI and the U.S. Geological Survey.

Coal Slurry Waste Underground Injection Assessment

In February 2007, the West Virginia Legislature mandated a comprehensive environmental study of the injection of coal preparation plant slurry into underground mines.

Through an agreement between West Virginia University (WVU) and the West Virginia Bureau for Public Health, WVU researchers have evaluated existing environmental and human health data concerning coal slurry injection and produced a “risk-assessment” document similar to those produced by the Agency for Toxic Substances and Disease Registry (ATSDR). In order to produce this document, WVU researchers have gathered publicly accessible data, interviewed experts and obtained information from local, state, and federal authorities, as well as from experts in interested nonprofit foundations, research institutions, and industries.

The goals of the project were to answer the questions:

- What are the known health hazards of the components of coal slurry?
- What data exists about human community health hazards from exposure to coal slurries contaminating water, soil or air?
- What is known about effects of coal slurry injection on surface water and aquatic ecosystems?
- How do the known or suspected hazards of injection compare to other means of dealing with slurry from coal operations?

To view findings of the study, log onto <http://www.coalslurry.net>

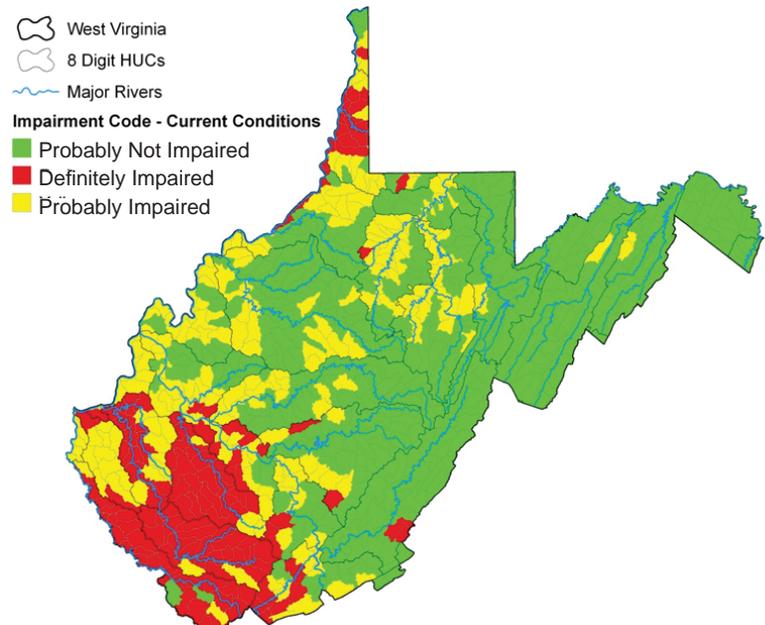
A Hierarchical Alternative Futures Modeling System to Support Decisions for the Mountaintop Removal – Valley Fill Mining Region of West Virginia

This research is quantifying links between mining, wildlife habitat, water quality, and aquatic communities and identifying associated mining thresholds that produce ecological impairment downstream. The data is being built into a geographic information system (GIS) based alternative futures modeling system that can be used to reach scientifically based management decisions concerning efficient mining.

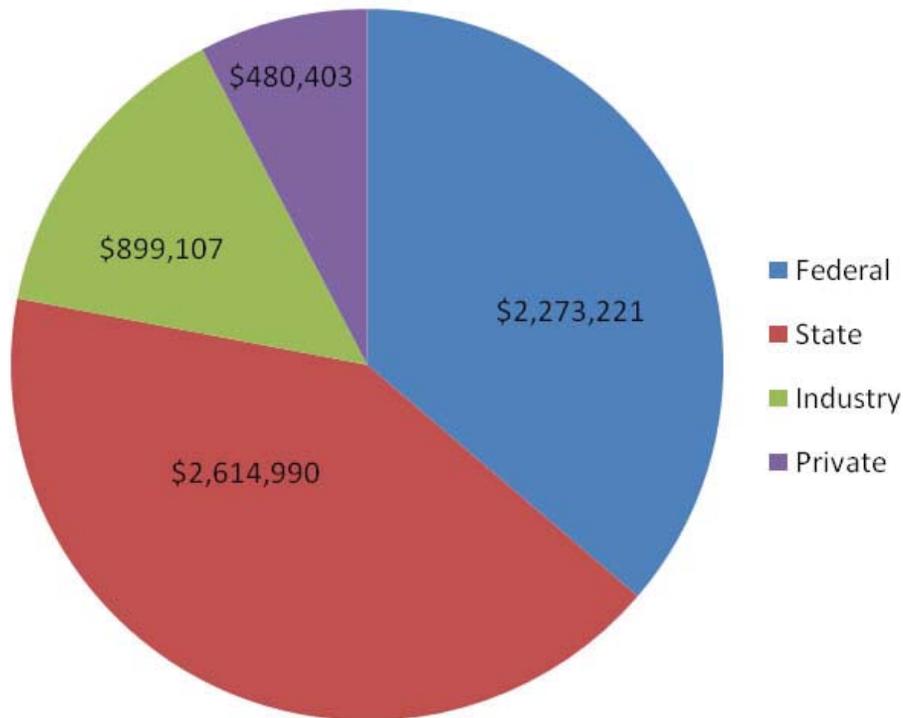
Initiated in 2010, this project is part of an integrated effort to develop technical tools to improve the reliability of mine permitting decisions in the central Appalachians, especially as they relate to regional and watershed scale impacts from mining. Project objectives are to:

1. Conduct a statewide landscape characterization which includes both an updated land-use/cover classification and terrain-derived landforms using appropriate remote sensing techniques and imagery,
2. Construct and validate a GIS-based watershed model that uses information on mining, coal geology, land cover, and other land use activities to predict instream conditions in coalfield watersheds, and

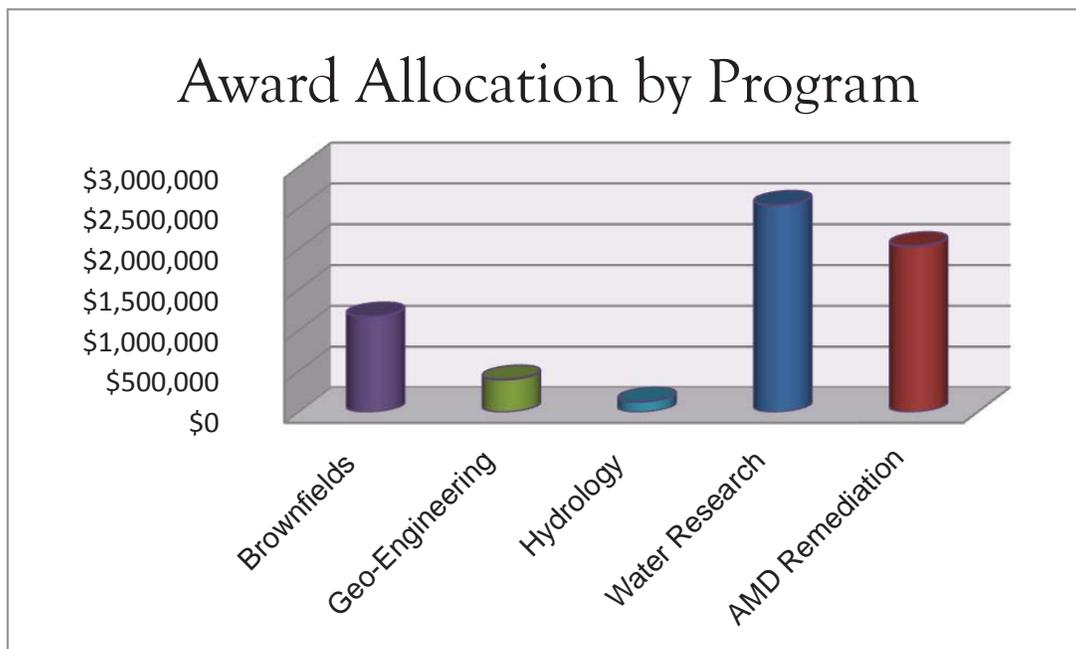
3. Conduct alternative futures analyses capable of projecting changes in aquatic and terrestrial ecosystem conditions under a range of mine development scenarios.



WVWRI Funding Snapshot



As 2011 begins, the West Virginia Water Research Institute has 35 active projects with a total project value of \$6,267,721.



2010 funds are divided up between the various programs at the WV Water Research Institute. The Brownfields Assistance Center currently manages \$1,170,763; Geo-Engineering \$339,154; Hydrology Research Center \$127,737; Water Resources Research, \$2,538,244 and the National Minelands Reclamation Center (AMD Remediation) \$2,031,823.

WVWRI Partners

Thank You to our many partners in academia, industry, citizens organizations and Federal and State agencies who help make our many accomplishments possible.

Major Federal and State WVWRI Sponsors:

- WV Department of Health & Human Resources
- WV Department of Environmental Protection
- US Environmental Protection Agency
- WV Division of Energy
- Claude Worthington Benedum Foundation
- US Department of Defense
- US Geological Survey
- U.S. Department of Interior; Office of Surface Mining
- U.S. Army Corps of Engineers
- WV Department of Commerce Office of Coalfield Community Development
- US Department of Energy/METC
- WV Department of Natural Resources

Other Partners

- Friends of Deckers Creek
- Coal Heritage Highway Authority
- Triad Engineering
- Center for Disease Control/NIOSH
- Coal Industry
- City of Wheeling
- City of Parkersburg
- Potesta & Associates
- City of Clarksburg
- City of Shinnston
- Thrasher Engineering
- Upper Guyandotte Watershed Association
- City of Fairmont
- Central Appalachia Empowerment Zone of WV
- Morris Creek Watershed Association
- City of Morgantown
- Region 9 Planning and Development Council
- Rowlesburg Revitalization Committee
- Webster County Economic Development Authority
- Marion Region Development Council
- Shepherdstown Public Library
- Wheeling Jesuit University
- Brooke Hancock Regional Planning and Development Council
- Friends of Cheat
- Upper Monongahela River Association
- Wes-Mon-Ty Resource Conservation & Development
- Trout Unlimited
- Marshall University
- WV Water Gaging Council
- City of Ranson
- Guardians of the West Fork
- Mon Rail Trail Conservancy
- Arthurdale Heritage, Inc.
- Buckhannon River Watershed Association
- Paint Creek Watershed Association
- Alpha Engineering
- Belomar Regional Council
- City of Moundsville

Partnerships with Other West Virginia University Colleges

- Civil and Environmental Engineering
- Chemistry
- Geology
- Wildlife & Fisheries
- Forestry
- Plant & Soil Science
- Office of Sustainability
- Landscape Architecture
- Extension Service
- College of Law

Principal Investigator	College	Department	Contact Information
Peter Butler	Davis College of Agriculture, Natural Resources & Design	Landscape Architecture	Peter.Butler@mail.wvu.edu 304 293-5462
Joseph J. Donovan	Eberly College of Arts and Sciences	Geology and Geography	Joe.Donovan@mail.wvu.edu 304 293-2867 x 5463
Mark Fullen	Extension Service	Safety and Health	M.Fullen@mail.wvu.edu 304 293-3200
Lian-Shin Lin	College of Engineering & Mineral Resources	Civil & Environmental Engineering	Lianshin.Lin@mail.wvu.edu 304 293-9935
Pat Mazik	Davis College of Agriculture, Natural Resources & Design	Forestry	Pat.Mazik@mail.wvu.edu 304 293-2941 x 2431
Joyce McConnell	College of Law	Dean's Office	Joyce.McConnell@mail.wvu.edu 304 293-2867 x 5463
Louis M. McDonald, Jr.	Davis College of Agriculture, Natural Resources & Design	Plant & Soil Science	LMMcDonald@mail.wvu.edu 304 293-6023
Todd Petty	Davis College of Agriculture, Natural Resources & Design	Wildlife & Fisheries	Todd.Petty@mail.wvu.edu 304 293-2278
John Quaranta	College of Engineering and Mineral Resources	Civil & Environmental Engineering	JDQuaranta@mail.wvu.edu 304 293-9942
Jeffrey G. Skousen	Davis College of Agriculture, Natural Resources & Design	Plant & Soil Science	Jeff.Skousen@mail.wvu.edu 304 293-6256
Clement Soloman	Office of Sustainability	Sustainability	Clement.Soloman@mail.wvu.edu 304 293-6256
Dorothy Vesper	Eberly College of Arts and Sciences	Geology and Geography	Dorothy.Vesper@mail.wvu.edu 304 293-9816
Charles B. Yuill	Davis College of Agriculture, Natural Resources & Design	Landscape Architecture	Charlie.Yuill@mail.wvu.edu 304 293-2141

WVWRI Technical Staff



**Paul Ziemkiewicz, Ph.D.,
Director**
Responsible for the overall strategic
direction of the WVWRI
(304) 293-2867 x 5441
Paul.Ziemkiewicz@mail.wvu.edu

Areas of Expertise:

- Research and development
- Mine reclamation & acid mine drainage remediation
- Mine discharge, water chemistry, quality and treatment
- Gas well development impacts on water resources
- Sustainable energy, biofuels, switchgrass
- Soils, geology, range ecology
- Coal combustion byproducts and reuse



**Tamara Vandivort, M.S.,
Assistant Director**
Responsible for administration
and fiscal oversight of WVWRI's
programs and projects
(304) 293-2867 x 5448
Tamara.Vandivort@mail.wvu.edu

Areas of Expertise:

- Project management
- Environmental geology and water quality
- Stakeholder collaboration & community initiatives
- Human resources

**Jennifer Hause, M.S.,
Program Coordinator**

Civil Engineer responsible for
project management
(304) 293-2867 x 5457
Jennifer.Hause@mail.wvu.edu



Areas of Expertise:

- Industrial wastewater treatment
- Urban and residential sewage treatment
- Sewer design
- Project management



**Patrick Kirby, M.A.,
Program Coordinator**
Director of the Northern West Virginia
Brownfields Assistance Center
(304) 293-2867 x 5459
Patrick.Kirby@mail.wvu.edu

Areas of Expertise:

- Community economic revitalization
- Brownfields redevelopment
- Site assessments & environmental risk analysis
- Hazardous material remediation

**Brady Gutta, B.S.,
Project Manager**

Geologist responsible for project
management
(304) 293-2867 x 5445
Brady.Gutta@mail.wvu.edu



Areas of Expertise:

- Geology, water quality & acid mine drainage
- Design and construction of passive treatment systems
- Implementation of biofuels on mined lands
- Watershed association & permit application assistance



**Lucas Elser, B.A.,
Project Manager**
Serves as manager of small community
revitalization projects
(304) 293-2867 x 5447
Luke.Elser@mail.wvu.edu

Areas of Expertise:

- Small community assistance
- Brownfields remediation
- Economic revitalization

**Ben Mack, M.S.,
Research Associate**

Manages field studies and
water quality data collection
(304) 293-2867 x 5433
Ben.Mack@mail.wvu.edu



Areas of Expertise:

- Soil structure
- Acid mine drainage remediation
- Watershed association assistance & planning
- Field sampling methodology and data analysis



**David W. Saville, M.S.,
Outreach Coordinator**
Communications liaison with media
and stakeholder groups
(304) 293-2867 x 5458
Dave.Saville@mail.wvu.edu

Areas of Expertise:

- Publications
- Conferences and Events
- Websites
- Community Outreach

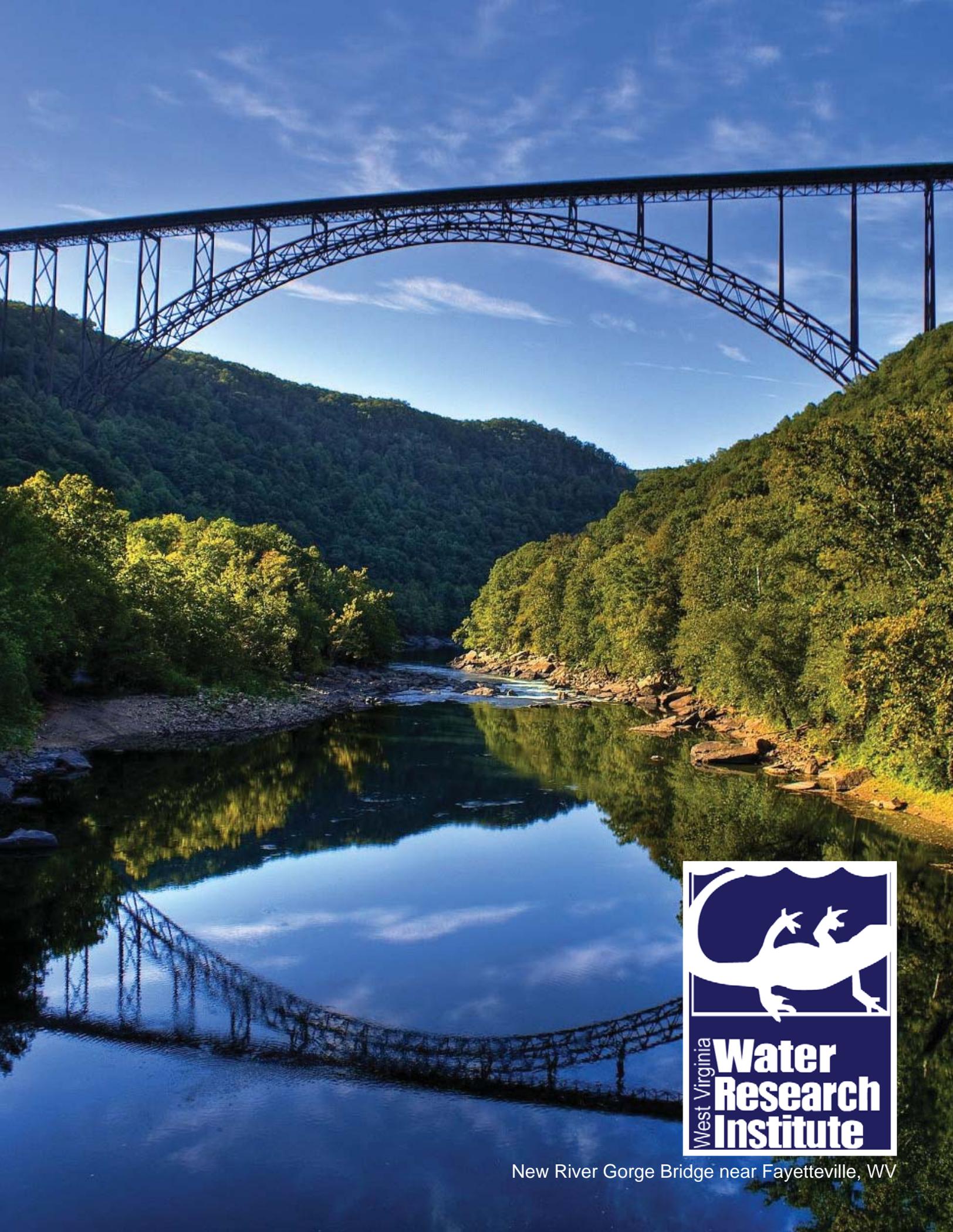
**Melissa O'Neal,
Environmental Technician**

Responsible for WRI data management
(304) 293-2867 x 5439
Melissa.O'Neal@mail.wvu.edu

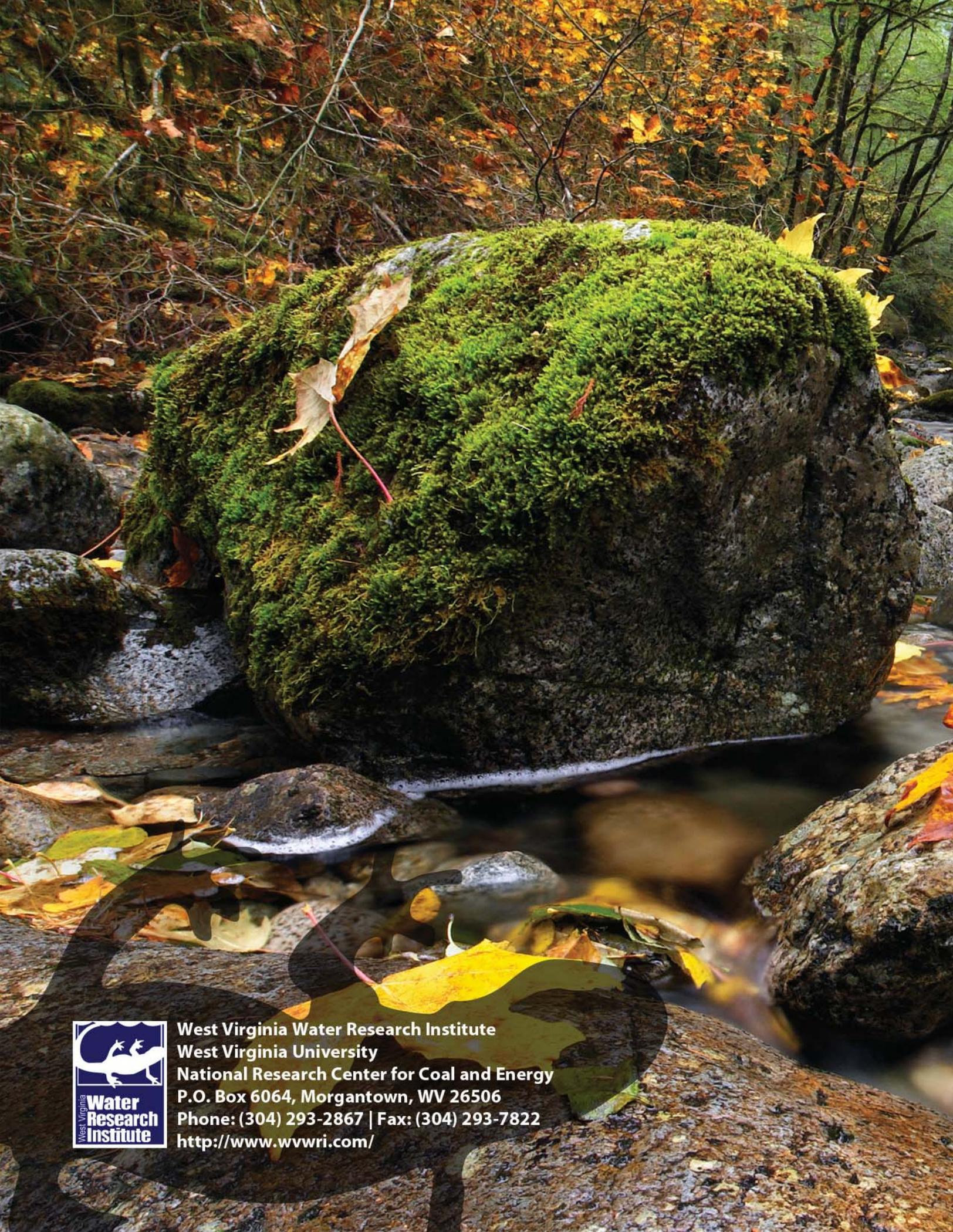


Areas of Expertise:

- Field sampling methodology
- Laboratory experimental procedures
- Water quality, chemistry, and analysis
- GIS & Web development



New River Gorge Bridge near Fayetteville, WV



West Virginia Water Research Institute
West Virginia University
National Research Center for Coal and Energy
P.O. Box 6064, Morgantown, WV 26506
Phone: (304) 293-2867 | Fax: (304) 293-7822
<http://www.wwwri.com/>