Problem Statement: (why is this project necessary and relevant to ITRC’s purpose & mission?)

Mineral-influenced water (MIW) is a major environmental problem in mining districts throughout the U.S. and around the world. Water quality impacts vary from elevated suspended solids to acidic mine drainage. Elevated suspended solids generally occur through erosion of mine waste, causing increased turbidity and potential aquatic impacts following deposition. Acid mine waters are produced in mined rock masses or mining/milling waste piles containing sulfide minerals with insufficient neutralizing capacity. Oxidation of these sulfide minerals produces acid and releases metals into solution. These problems can persist for tens to hundreds of years. Over 10,000 miles of receiving waters in the United States are affected by MIW. MIW is difficult to treat cost-effectively to levels protective of human health and the environment.

A biochemical reactor (BCR) generically implies a system that cultivates microorganisms that transform contaminants or produce chemicals that can be used for remediation or treatment. The most commonly used BCRs for treating MIW are operated anaerobically, i.e. in the absence of oxygen, require a carbon source and sulfate and are often called sulfate-reducing bioreactors (SRBRs). The microbial process of sulfate reduction produces sulfide and bicarbonate. A number of target metals (e.g., cadmium, copper, nickel, lead, and zinc) in MIW will precipitate as metal sulfides at pH values above 5.0. The bicarbonate promotes an increase in pH and will promote the removal of some metals as carbonates (e.g., Iron (II) Carbonate (FeCO3) and Zinc Carbonate (ZnCO3)) under the appropriate conditions (e.g., specific pH and carbonate concentration). Additionally, reduct oxygen metal and metalloids (e.g., arsenic, chromium, selenium, and uranium) that are oxidized to their higher valence. The technology has been applied at mining sites but additional work is continuing to fully evaluate metrics important during deployment.

Thus, BCRs may be applicable to a broad range of metal and metalloids found in MIW. If space is not a limitation, then BCRs can be designed to address a wide range of flows, acidity and metal loading. BCRs are attractive since they can be built with local materials and often can be designed to operate without any external inputs of energy or material and require minimal maintenance. As a result, BCRs can be built to provide passive treatment and may be particularly suitable for remote and abandoned sites.

During the development of the problem-based technology and regulatory guidance for mining- waste treatment technology selection, the ITRC Mining Waste Team collected some case studies leading and additional case studies and use new data and research from the U.S. EPA, U.S. Department of the Interior, Colorado School of Mines and the ITRC Industry Affiliates Program (IAP) members to evaluate the following:

- The microbial and chemical processes occurring in BCRs,
- A detailed comparison of the different types of BCRs,
- The parameters and concentrations that can be treated,
- Required site characteristics,
- Flow and chemical loading requirements,
- Treatment life,
- Costs,
- How long will treatment last and when will the substrate media need to be replaced or replenished,
- Where and how is the substrate media from the BCR disposed?

Proposed Scope to Address Problem: (what is the approach for this project?)

The ITRC Mining Waste Team will build from the existing case studies and literature research included in the existing BCR Technology Overview. The team will conduct a critical review of existing and additional case studies and use new data and research from the U.S. EPA, U.S. Department of the Interior, Colorado School of Mines and the ITRC Industry Affiliates Program (IAP) members to evaluate the following:

- The microbial and chemical processes occurring in BCRs,
- A detailed comparison of the different types of BCRs,
- The parameters and concentrations that can be treated,
- Required site characteristics,
- Flow and chemical loading requirements,
- Treatment life,
- Costs,
- How is a BCR appropriate for a given site and how is this determined?
- What are the BCR design requirements and what are the constraints?
- What modifications are needed for treatment during winter months?
- How are fluctuating flows and water quality managed?
- What are the requirements to prevent the system flow from short circuiting?
- How can systems be designed to reduce or minimize maintenance?
- How can treatment be optimized or improved?
- What modifications are needed for treatment during winter months?
- How long will treatment last and when will the substrate media need to be replaced or replenished?
- Where and how is the substrate media from the BCR disposed?

Targeted Users: (who will use products generated by this project?)

Primary users for BCRs will be practitioners and consultants and state and federal regulators responsible for the remediation of MIW at abandoned or active mining sites. Responsible parties for MIW include the commercial mining industry, the U.S. Department of the Interior including the Bureau of Land Management and the U.S. Forest Service, EPA Superfund through Fund-lead response actions, U.S. Department of Defense, U.S. Department of Energy, and state mined land and water-resource programs. Universities such as the Colorado School of Mines, Pennsylvania State University, the University of Georgia, and the University of Nevada, Reno are currently interested and conducting research on the biochemical treatment of MIW.

According to the ITRC SE needs assessment:

- Five states have noted that mining-related problems are a number-one (#1) state priority. These are Missouri, Oklahoma, West Virginia, Wyoming, Alaska, California, and Colorado.
- Four states have noted that mining-related problems are a number-two (#2) state priority. These are Colorado, Georgia, Missouri, and Wyoming.
- Three states have noted that mining-related problems are a number-three (#3) state priority. These include Colorado, Maine, Utah, California, and Idaho.
- Two states have noted that mining-related problems are a number-four (#4) state priority. These include Arizona and Pennsylvania.

Please refer to the Mining Specific Needs assessment at http://www.itrcweb.org/mining.asp for further information.

During preparation of the Mine Waste Issues in the United States: A White Paper and the guidance, the ITRC Mining Waste Team state members identified Acid Mine Drainage (AMD), which is included in MIW, as a priority. These states include:

- Alaska
- California
- Colorado
- Idaho
- Maine
- Minnesota
- Missouri
- Oklahoma
- Pennsylvania
- Utah
- Vermont

Proposal Contacts:

Paul Eger, Minnesota Department of Natural Resources
500 Lafayette Rd, St. Paul, MN 55155
Tel 651-259-5384
E-mail a.paul.eger@state.mn.us

Cherri Baysinger, Missouri Department of Health and Senior Services
930 Wildwood, P.O. Box 570, Jefferson City, MO 65109
Tel 573-751-6102
E-mail cherri.baysinger@dshs.mo.gov

2011 ITRC PROJECT PROPOSAL:
Biochemical Reactors to Treat Metals in Mining-Influenced Water
Summary of Deliverables: (primary project product(s))

A Technology Overview of Biochemical Reactors has been completed by the ITRC Mining Waste Team and can be found on http://www.itrcweb.org/teamresources_56.asp. The Mining Waste Team will use the information, case studies and literature referenced in the Technology Overview of Biochemical Reactors, plus additional information that becomes available, to prepare a Technical and Regulatory Guidance for the application of BCRs to treat metal-contaminated water. This will be accompanied by the required Internet Based Training. This is the final product development phase in the ITRC Project Lifecycle. This will be followed by implementation. All products will follow the guidance provided in the ITRC Framework for Developing a Quality ITRC Technical and Regulatory Guidance Document.

Proposed Personnel:

Potential Team Membership/Needs

Co-Team Leader: Cherri Baysinger, Missouri

Cherri is the Chief of the Bureau of Environmental Epidemiology, Missouri Department of Health and Senior Services. She has worked for Missouri Department of Health and Senior Services or Missouri Department of Natural Resources for 19 years. Ms. Baysinger has a B.A. in Biology and an M.S. in Forestry, Fisheries, and Wildlife, both from the University of Missouri-Columbia. Cherri has been the Co-team Leader of the ITRC Mining Waste Team since 2007 and the team received the Team of the Year award in 2009.

Co-Team Leader: Paul Eger, Minnesota

Paul is a principal engineer for the Minnesota Department of Natural Resources, Division of Lands and Minerals, where for over 30 years he has worked with environmental issues related to mining. Much of his work has focused on the development of successful passive systems to control and prevent mine drainage problems. He has also been a leader in the development of cost-effective and environmentally safe remediation using waste products, including biosolids and dredged material. Paul was a member and internet instructor for the ITRC Wetlands Team, was a co-team leader and instructor for the ITRC Mitigation Wetlands Team and has been co-team leader of the ITRC Mining Waste Team since it began in 2007.

The proposed team includes some of the leading U.S. researchers, consultants, federal agencies and states in this area and the resulting guidance will draw upon their experiences and skills. The team will include numerous regulators from a variety of states and from the federal government who bring varying regulatory perspectives on this topic that are essential to incorporate in any characterization technical regulatory document.

States interested in participating in this project and why.

- Alaska
- Colorado
- Maine
- Minnesota
- Missouri
- Montana
- Nevada
- Pennsylvania
- Utah
- Vermont

All have reported to have serious MIW problems resulting from active or historic mining practices. Many of these sources of MIW are continuous and require economical methods of water treatment to protect human health and restore stream and watersheds to an ecologically healthy condition. Since these states are often responsible for long-term operation and maintenance costs, they are particularly interested in the feasibility of using innovative passive systems like BCRs.

Other organizations that have expressed interest in participating as team members for this project are:

Federal Agencies:

- U.S. EPA Office of Research and Development (ORD), National Risk Management Research Laboratory (NRMRL), Cincinnati, Ohio
- U.S. EPA Office of Solid Waste and Emergency Response (OSWER), Office of Superfund Remediation and Technology Innovation (OSRTI)
- U.S. EPA Regions 8 and 9

The U.S. EPA has and continues to conduct research on BCRs in conjunction with practitioners and various universities (e.g., Colorado School of Mines, University of Oklahoma). There are a number of large Superfund sites throughout the United States (e.g., Bunker Hill, Tar Creek, Standard Mine, etc.) that result from historic mining and where BCRs have been installed.

- The U.S. Department of the Interior

The U.S. Department of the Interior administers 253 million acres of land in the U.S. Much of this land is in the western U.S. There are thousands of abandoned mines on or adjacent to Bureau of Land Management (BLM) land that is impacting surface and groundwater. The BLM Abandoned Mine Lands program is charged to enhance public safety and improve water quality by reducing or eliminating effects of past hard rock mining in the western United States. Currently their inventory includes over 12,000 mining sites; 80% of these still require attention.

- U.S. Fish And Wildlife Service

The U.S. Fish and Wildlife Service has responsibility to maintain a healthy environment for aquatic species on and near superfund sites. This agency has a critical interest to see that surface waters are restored to healthy conditions and that can support a functional aquatic ecosystem.

- U.S. Department of Defense (including the Air Force Center for Engineering and the Environment (AFCEE), the Navy, the Strategic Environmental Research and Development Program (SERDP))

- U.S. Department of Energy

- Center for Protection of Sustainable Technologies (CPTS) La Paz Bolivia

Christian Romero of CPTS has been an active member of the ITRC Mining Team since it began and has been a significant contributor and author of the current web based Tech-Reg. CPTS is funded by USAID and the Denmark Embassy. CPTS has a signed agreement with “Universidad Mayor de San Andres” – UMSA (Mayor Saint Andrews University – MSUA) and includes German cooperation through Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) in order to conduct research on bioreactor technologies, including high altitude and low temperature operation.

IAP companies (Environmental Consultants and Industry)

- Arcadis
- JRMW Bioremediation, LLC
- ERN
- Kleinfelder
- Western Research Institute
- BP Corporation
- Freeport McMoRan
- Shaw Environmental
- DOE
- Northwind, Inc.
- Goiter and Associates

Academia

- Colorado School of Mines
- Pennsylvania State University
- University of Georgia
- University of Nebraska

The team provides a forum in which academics can bring their research and network with practitioners from both the private and public sectors.

- The skill mix of team members includes but is not limited to: hydrogeology and water chemistry, environmental, civil, and bioengineering, treatment system design, site characterization, regulatory issues, geology, chemistry, and bioremediation.

- For sectors of team members required, this will be the same as the existing ITRC Mining Waste Team which was well represented in all sectors.

Proposed In-Kind/Direct Project Funding

At this time, in-kind or direct project funding has not been identified.