

## **Applied Research in State Mineral and Water Resources; \$2.0M appropriation request**

### **Critical Research for Minnesota**

Minnesota's mineral and water resources are valuable, precious and interconnected; advancements in how we both use and preserve these resources is critical to the future economy of our state.

### **Two Applied Research Projects**

NRRI is requesting continuing Legislative support for two strategic, applied research and demonstration projects intended to deliver new opportunities for Minnesota.

#### **PROJECT 1**

#### **Demonstration of Three Sulfate Reduction Technology Applications (\$600K)**

**FOCUS:** Sulfate contamination of Minnesota's water bodies, whether natural or manmade is a challenge across the state. Demonstration of low-cost methods are needed to offer alternative treatments.

- small, municipal water treatment facilities (100-200ppm) cannot meet current standards cost-effectively
- alternative approaches to address legacy (1000-2000ppm) and operating (>2000ppm) industrial sites are also needed
- physical & biological technologies and combinations thereof have been developed for piloting in mobile demonstration units

#### **BENEFITS:** *This research will*

- ✓ demonstrate emerging technology applications to address municipal and industrial challenges
- ✓ pilot scale operations will provide relevant performance and economic data
- ✓ build upon partnerships with state agencies and municipalities

#### **FUNDING DISTRIBUTION:**

1. Design/build/commission mobile biological treatment unit (\$150K)
2. Multisite deployment; data collection and analysis (\$400K)
3. Partner outreach (\$50K)

**Over >**

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## PROJECT 2

### Minnesota's Future iron Resources, Next-Generation Technologies and New Iron Products(\$1.4M)

**FOCUS:** Minnesota's higher quality ores are becoming depleted, but abundant lower quality ores remain – what is the Iron of the Future?

- future use of Minnesota's iron resources will require development of new technologies and higher value iron products coupled with continual evaluation of social, environmental and economic considerations
- this work will build on past investment in UMN's former Mines Experimental Station and the work of E.W. Davis that made today's taconite industry possible
- Minnesota must *begin* to invest today to have an iron industry in the future

**BENEFITS:** *This research will*

- ✓ characterize Minnesota's remaining iron and related mineral resources
- ✓ outline technology gaps and novel process development opportunities
- ✓ incorporate life cycle thinking to address sustainable development goals associated with impact reductions in carbon and other emissions, water utilization and energy consumption

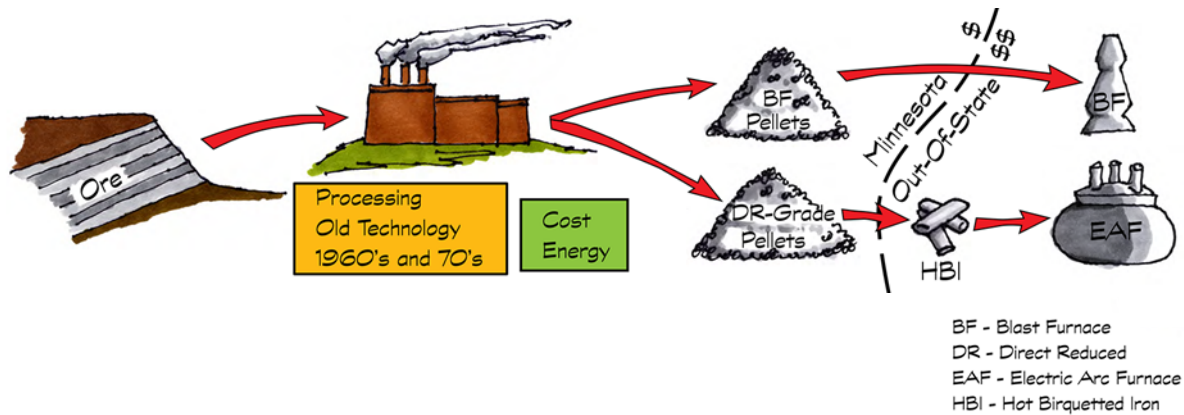
### FUNDING DISTRIBUTION:

1. Identify and characterize Minnesota's remaining iron resources (\$600K)
  - initiate long-term, geological, geochemical and geometallurgical studies
  - collaborate with industry, agency & public stakeholders
2. Initiate comprehensive process development research program (\$600K)
3. Develop & test approaches to ensure modern, sustainable iron mining and iron products in Minnesota (\$200K)
  - target emerging high-value iron products

# Minnesota's Iron *of the* Future

Minnesota iron resources are changing. We have to innovate and adapt by expanding our portfolio of Iron products and keeping value in the state.

## Minnesota's Iron Industry Today



## Challenges facing the Minnesota iron industry today:

1. **Resource:** Declining quality and reserves of the iron ore resource
2. **Economic:** Increased energy costs for production
3. **Limited Portfolio:** Single low-margin product which accesses only 30% of the steel industry overall
4. **Regulatory:** Increasingly stringent water quality and air emission standards

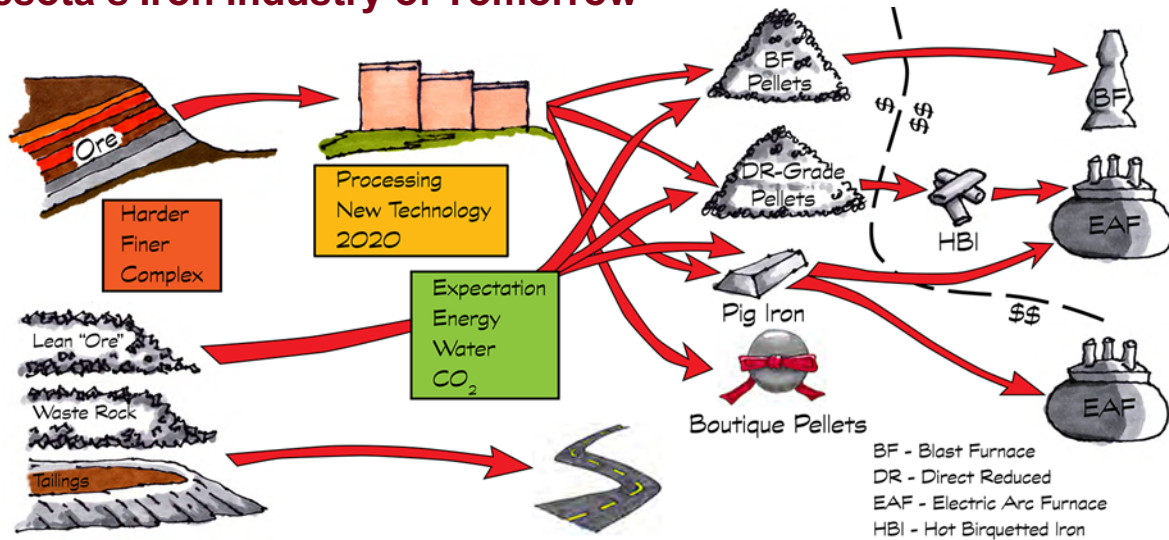
## Goals and Impacts for Minnesota's Next Gen Iron Industry:

- **Jobs:** Job development for today and tomorrow
- **Profits:** High-value products developed in state
- **Economic Development:** A high-tech portfolio of iron products
- **Sustainability:** Potential for a carbon-neutral iron industry in Minnesota

# Minnesota's **Iron** *of the* **Future**

# NRRI Solution

# Minnesota's Iron Industry of Tomorrow



**Imagine Minnesota as a carbon neutral leader in the global iron industry.  
We have the resources. NRRI can help make it happen.**

### Ongoing Work:

- Reduce energy and water use
- Reduce emissions
- Increase energy, water, and resource efficiencies

## What is success?

- MN Iron Industry jobs
- MN Iron Industry profits
- Diversified Iron product portfolio

## Future work:

- Developing a high-tech, high-value iron industry
- Diversifying the iron product portfolio
- Participating in a robust iron-based industry
- Accessing lean ore and waste resources

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# Minnesota Water Quality Sulfate Remediation Technologies

**Sulfate remediation is critical to water quality in Minnesota.  
NRRI is addressing sulfate in three critical areas:**

## NRRI Sulfate Remediation Technologies

1. Municipal mobile unit treatment system 50-200 PPM
2. Mineland Treatment system 200-500 PPM
3. Industrial Treatment system 500+ PPM



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# Minnesota Water Quality

# Sulfate Remediation Technologies

## Municipal Treatment Mobile Unit

**Problem:** Minnesota's standard for sulfate concentrations in wild rice waters is significantly lower than drinking water standards. Meeting the 10 parts per million goal is very expensive using reverse osmosis.

**Research Solution:** An inexpensive barium sulfate precipitation process was developed and scaled up to a mobile demonstration system for testing in two Minnesota communities.

**Status:** NRRI is performing indoor trials to optimize the process, reduce potential risks and demonstrate efficacy. Two wastewater treatment plants have agreed to field pilot tests.

## Minelands Treatment

**Problem:** A municipal drinking water supply that uses mine pit water is threatened by high levels of sulfate. A cost-effective treatment system is needed to address this problem.

**Research Solution:** New, patented technology introduces a path forward to develop a peat-based media that removes sulfate from industrial and mining impacted waters.

**Status:** Preliminary testing shows sulfate concentrations can be reduced to as low as 10 parts per million a two-stage process: biofiltration and electrochemical treatment to be followed by the chemical precipitation.



## Industrial Treatment

**Problem:** While it can occur naturally, elevated sulfate in freshwater systems often comes from industrial waste streams or agricultural runoff. Removal of sulfate from waste streams is a burden to many industries and municipalities.

**Research Solution:** Two bioreactor systems have been evaluated for scalability and industrial/community use. The goal is to significantly reduce sulfate treatment costs and improve water quality.

**Status:** A biological treatment with iron-based immobilization has been designed and successfully tested in phase one demonstration scale. Industry partners are engaged.