

**Environment and Natural Resources Trust Fund  
2020 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 107-B**

Mobile Water Treatment Demonstration System for Sulfate Reduction

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**Category:** B. Water Resources

**Sub-Category:**

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**Total Project Budget: \$** 838,401

**Proposed Project Time Period for the Funding Requested:** June 30, 2022 (2 yrs)

**Summary:**

A flexible, mobile treatment system will be developed to demonstrate chemical and biological technologies to remove sulfate from waste streams to below 10 ppm at municipal and industrial sites.

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**Name:** Lucinda Johnson

**Sponsoring Organization:** U of MN - Duluth

**Job Title:** Dr.

**Department:** Natural Resources Research Institute

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Duluth MN 55811

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**Web Address:** <https://www.nrri.umn.edu/administration/faculty-staff/lucinda-johnson>

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**Location:**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

This depicts the impacts of sulfate on ecosystems, the successful biological and chemical lab-scale treatments developed, and the proposed trailer-based system for sulfate removal technologies.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity	_____ Readiness	_____ Leverage	_____ TOTAL _____%



## PROJECT TITLE: Mobile Water Treatment Demonstration System for Sulfate Reduction

### I. PROJECT STATEMENT

Minnesota is globally unique in its need for a portfolio of viable approaches to reduce wastewater sulfate concentrations significantly below drinking water standards (250ppm) in wild rice regions. One technology, reverse osmosis, can reduce concentrations to 10ppm or lower, but at operating costs that provide significant financial challenges to municipalities, citizens and industry, and also produce significant waste sludge disposal issues. **We propose to build a flexible, mobile demonstration system to scale up and demonstrate two treatment processes in the field – at municipal wastewater treatment facilities and industrial sites.**

The Natural Resources Research Institute (NRRI), with 2016 Minnesota Legislative investment and in collaboration with colleagues from across the University of Minnesota system, has successfully demonstrated two sulfate reduction technologies in laboratory. A chemical system successfully reduces 50-200 ppm sulfate to less than 10 ppm – a scenario associated with many municipal water treatment facilities in Minnesota. This system will likely be able to utilize existing treatment infrastructure in this application. A second, biological system successfully reduced concentrations of 800-1500 ppm to 100-200 ppm – a scenario associated with some industrial waste streams.

The goal of this project is to build a trailer-based demonstration system to scale up and demonstrate these two processes at municipal water treatment facilities and industrial sites. The design will be flexible to accommodate/add other developing water treatment technologies that address other water challenges in Minnesota such as excess phosphorus and nitrogen.

Demonstration in real-world applications, in collaboration with partners and stakeholders, will reduce risk, establish confidence and provide a broader portfolio of viable approaches to address the different ranges of sulfate concentration present in Minnesota waters. The NRRI mobile water treatment demonstration system is a tool to accelerate demonstration, commercialization and deployment of emerging technologies associated with Minnesota water quality efforts around the state.

### II. PROJECT ACTIVITIES AND OUTCOMES

#### Activity 1 Title: Construct trailer based mobile treatment system

**Description:** Based on a system design developed by NRRI in 2019, we will construct a trailer-based mobile treatment system capable of supporting two treatment technologies. This mobile system will support a chemical precipitation system capable of reducing sulfate concentrations from ~100 ppm to < 10 ppm; a biological reactor can reduce concentrations of 800-1500 ppm to 100-200 ppm. The mobile treatment system will have real-time monitoring laboratory to evaluate their performance and operation. Test operation will be conducted at NRRI with synthetic or wastewater collected from facilities prior to the deployment. A collaboration plan and agreement with project partners for on-site deployment will be completed in this activity.

**ENRTF BUDGET: \$538,278**

Outcome	Completion Date
1. Construct mobile treatment system	12/31/2020



**Environment and Natural Resources Trust Fund (ENRTF)**  
**2020 Main Proposal Template**

2. <i>Run test operation of the treatment system at NRRI</i>	6/30/2021
3. <i>Finalize collaboration plan and agreement with project partner for on-site deployment</i>	6/30/2021

**Activity 2 Title: Deploy and demonstrate two sulfate treatment technologies on site**

**Description:** The mobile treatment system will be deployed at two municipal wastewater treatment plants and two industrial sites (e.g. paper and pulp mill or mine water) to test and refine the chemical treatment system and the biological reactor system on site. Each run will be conducted for a duration of 1-3 months at least two seasons (summer and cold season). The performance of treatment system will be evaluated through water chemistry, operational parameters, and waste management.

**ENRTF BUDGET: \$300,123**

<b>Outcome</b>	<b>Completion Date</b>
1. <i>Deploy mobile treatment system at two municipal treatment facilities</i>	4/30/2022
2. <i>Deploy mobile treatment system at two industrial facilities</i>	4/30/2022
3. <i>Refine the treatment system</i>	6/30/2022

**III. PROJECT PARTNERS AND COLLABORATORS:** Existing collaborators include: Dr. Chan Lan Chun (NRRI); Dr. Meijun Cai (NRRI); Dr. George Hudak (NRRI); Mr. Shashi Rao (NRRI); Dr. Lee Penn (UM-TC); Dr. Nate Johnson (UMD); and Dr. Adrian Hanson (UMD). Two unnamed wastewater treatment facilities and one industry are currently partnering with NRRI.

**IV. LONG-TERM IMPLEMENTATION AND FUNDING:**

Using a 2016 Minnesota Legislative investment the NRRI successfully demonstrated two sulfate reduction technologies. NRRI will provide bridge funding during 2019 – 2020 to refine these technologies and scale them from the lab bench to demonstration stage. NRRI will also provide funds for the system design and integration, in preparation for construction beginning in July 2020. We anticipate building partnerships with municipal treatment plant operators and industrial facilities to refine the treatment system once it is operational.

**Attachment A: Project Budget Spreadsheet**  
**Environment and Natural Resources Trust Fund**  
**M.L. 2020 Budget Spreadsheet**

**Legal Citation:**

**Project Manager:** Lucinda Johnson

**Project Title:** Mobile Water Treatment Demonstration System for Sulfate Reduction

**Organization:** Natural Resources Research Institute, University of Minnesota Duluth

**Project Budget:** \$838,401

**Project Length and Completion Date:** 2 years, July 1, 2020 - June 30, 2022

**Today's Date:** 04/10/2019



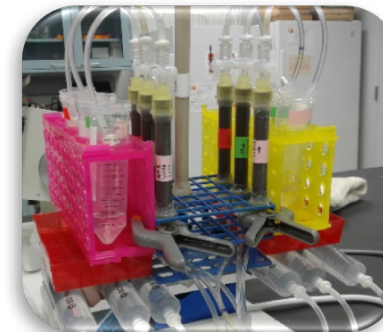
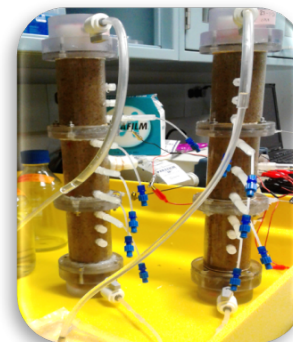
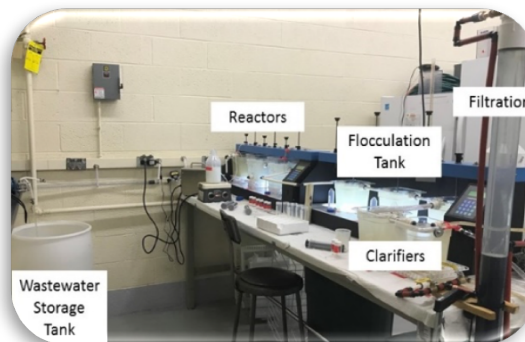
ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET		Budget	Amount Spent	Balance
BUDGET ITEM				
Personnel (Wages and Benefits)		\$ 473,751		\$ 473,751
Lucinda Johnson (PI, 2%, \$161,769/year, 36% fringe)				
George Hudak (Co-PI, 2%, \$128,355/year, 36% fringe)				
Meijun Cai (Environmental Engineer, 15%, \$66,992/year, 36% fringe)				
Shashi Rao (Metallurgical Engineer, 10%, \$84,000/year, 36% fringe)				
Chan Lan Chun (Environmental Engineer, 0.75 summer month each year, \$106,362/year, 36% fringe)				
Jerry Henneck (Water Quality Scientist, 25% first year, 50% second year, \$60,237/year, 29.5% fringe)				
Process Engineer (50%, \$70,000/year, 29.5% fringe)				
Adrian Hanson (Environmental Engineer, 0.5 summer month each year, \$127,589/year, 36% fringe)				
R. Lee Penn (Chemist and mineralogist, 0.5 summer month each year, \$134,032/year, 36% fringe)				
Nathan Johnson (Environmental Engineer, 0.5 summer month each year, \$91,878/year, 36% fringe)				
Postdoc (100%, \$55,000/year, 29.5% fringe)				
Undergraduate student (4%, \$24,960/year, 0% fringe)				
***Note that NRRI research staff salaries are largely sponsored by external (non-state) funding sources.				
Professional/Technical/Service Contracts				
Consulting with PRO company		\$ 5,950	\$ -	\$ 5,950
Equipment/Tools/Supplies				
Chemicals and lab supplies		\$ 37,000	\$ -	\$ 37,000
Materials for trailer based real time chemical analysis		\$ 27,000	\$ -	\$ 27,000
Materials for iron enhanced sulfide sequestrations		\$ 15,000	\$ -	\$ 15,000
Capital Expenditures Over \$5,000				
Chemostat for bioreactor		\$ 100,000	\$ -	\$ 100,000
Trailer and treatment platform		\$ 150,000	\$ -	\$ 150,000
Fee Title Acquisition				
		\$ -	\$ -	\$ -
Easement Acquisition				
		\$ -	\$ -	\$ -
Professional Services for Acquisition				
		\$ -	\$ -	\$ -
Printing				
		\$ -	\$ -	\$ -
Travel expenses in Minnesota				
Sample collection and field test		\$ 15,550	\$ -	\$ 15,550
Other				
External lab analysis		\$ 6,150	\$ -	\$ 6,150
DNA sequencing		\$ 8,000	\$ -	\$ 8,000
COLUMN TOTAL		\$ 838,401	\$ -	\$ 838,401
SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		\$ -	\$ -	\$ -
State:		\$ -	\$ -	\$ -
In kind: \$317,737 unrecovered 54% F&A on MTDC		\$ 317,737	\$ -	\$ 317,737
Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but	Budget	Spent	Balance
		\$ -	\$ -	\$ -

**Sulfate containing wastewater from households and local industries**

**Excessive** loads of sulfate may impact ecosystem and public health.



## Successful lab-scale sulfate treatments



**A flexible, mobile demonstration system to scale up and demonstrate two sulfate treatment processes in the field.**

### Chemical Treatment

Municipal wastewater treatment (50-200 ppm of sulfate)

Treatment target:  
<10 ppm



Source: [www.indiamart.com/](http://www.indiamart.com/)

05/12/2019

### Biological Treatment

Industrial wastewater treatment (800-1500 ppm of sulfate)

Treatment target:  
100-200 ppm



ENRTF ID: 107-B

Source: [bioreactorsciences.com](http://bioreactorsciences.com)



## Environment and Natural Resources Trust Fund (ENRTF) 2020 Project Manager Qualifications and Organization Description

**PROJECT TITLE:** Mobile Water Treatment Demonstration System for Sulfate Reduction

**Dr. Lucinda Johnson, Natural Resources Research Institute (NRRI), University of Minnesota Duluth (UMD)**

### **Key Qualifications**

As the Water Initiative leader, Dr. Lucinda Johnson (NRRI-UMD Associate Director, a landscape and aquatic ecologist) directs a team of scientists involved in the development of sulfate reduction technologies. Four different sulfate treatment technologies are being tested at NRRI, two of which are amenable for deployment on a mobile platform. Johnson has led three previous LCCMR projects (2005; 2007; 2016) quantifying climate change impacts on aquatic resources in Minnesota. Johnson has considerable experience leading large projects, including a prior project to validate indicators of coastal ecosystem conditions (\$1.67M, funded by USEPA). The sulfate reduction team also includes two environmental engineers, a materials chemist, and several water quality specialists, including Johnson herself.

### **EDUCATION**

Ph.D., Zoology, Michigan State University, 1999

M.S., Environmental Science and Forestry, State University of New York, 1984

B.A., Duke University, 1976

### **Project Team:**

This team brings a very broad set of skills including research and work experience in engineering design and development of pilot demonstration system, chemical and biological expertise in sulfate removal. The assembled research team will consist of **Dr. George Hudak, Dr. Chan Lan Chun, Dr. Meijun Cai, Mr. Shashi Rao, Dr. Adrian Hanson, Dr. Lee Penn** and **Dr. Nathan Johnson**. **Dr. George Hudak** is the Director of the Minerals, Metallurgy & Mining at NRRI UMD, and is a geologist with experience in developing in-situ sulfate water treatment systems. **Dr. Chan Lan Chun** is an environmental engineer specified in biological treatment technology and environmental remediation. **Dr. Meijun Cai** is an environmental engineer having research experience focusing on water treatment by chemical methods. **Mr. Shashi Rao** is a metallurgical engineer and professional in engineering design. **Dr. Adrian Hanson** is a professor of environmental engineering from Civil Engineering Department. He has experience in constructing and running a pilot system for wastewater treatment plant. **Dr. Nathan Johnson** is an environmental engineer with expertise of sulfur chemistry in natural and built-in environment. **Dr. Lee Penn** is a chemist and mineralogist with expertise of the structure, properties, and reactivity of iron minerals and metal sulfides.

### **ORGANIZATION DESCRIPTION**

**The Natural Resources Research Institute** is a University of Minnesota Duluth applied research organization. NRRI's mission is to deliver research solutions to balance Minnesota's economy, resources and environment for resilient communities.