

**Environment and Natural Resources Trust Fund
2016 Request for Proposals (RFP)**

Project Title:

ENRTF ID: 073-B

Removal of Nitrates from Minnesota Waters

Category: B. Water Resources

Total Project Budget: \$ 198,256

Proposed Project Time Period for the Funding Requested: 2 years, July 2016 to June 2018

Summary:

We will develop, demonstrate, and disseminate a simple, effective and inexpensive technology to remove nitrates from drinking water, a major problem in Minnesota today.

Name: Lawrence Wackett

Sponsoring Organization: U of MN

Address: BioTechnology Institute, 1479 Gortner Avenue

St. Paul MN 55108

Telephone Number: (612) 625-3785

Email wacke003@umn.edu

Web Address

Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Map shows nitrate impacted waters all over state; technological solution is shown pictorially

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



PROJECT TITLE: Removal of Nitrates from Minnesota Waters

I. PROJECT STATEMENT

We will develop, demonstrate, and disseminate a simple, effective, and inexpensive technology to remove nitrates from drinking water, a major problem in Minnesota today. Minnesotans from all parts of the state are suffering from nitrates in their water. Seventy-five percent of Minnesotans get their water from wells, and 105 water systems in Minnesota were found with nitrate at or above maximum contaminant levels, according to a State Health Department report released in May 2015. The cost of treating these nitrate problems with current technology is estimated to be \$3500 per household, a huge burden for Minnesotans. Nitrate in water was linked to fourteen deaths in Minnesota in the 1940's and the National Cancer Institute is studying a link between nitrates and non-Hodgkin's lymphoma. Something must be done. Recent technology developed at the University by the PI and co-PI has demonstrated the efficacy of using a biocatalyst sponge (a biosponge) to remove and destroy unwanted chemicals in water. The technology is clean and safe. It has to this point not been applied to nitrates, but it has been used effectively with numerous other chemicals that are otherwise difficult or expensive to remove from water. In this project, we will conduct the necessary research to adapt and transfer the technology to be useful for nitrates, then optimize it to make it better and cheaper, and finally test it with nitrate-contaminated waters from around the state of Minnesota. Near the end of the project period, we will hold a conference hosted by the Institute on the Environment with many invited stakeholders from around the state and the focus will be squarely on solutions for the nitrate problem in Minnesota. The conference will serve to disseminate our findings and help arrive at the best practices for implementation in the state. Materials and information will be made available to all state agencies. Currently, there are many responses to this problem under discussion by both scientists and the legislature but some of the steps envisioned will take years to implement, and even longer to significantly impact nitrate levels. This project, if funded by the ENRTF, will develop, educate, and foster all best practices for treating nitrate contamination in Minnesota waters and can help institute a long-term, sustainable solution.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Producing biocatalyst

Budget: \$ 40,000

We will use University facilities at the BioTechnology Institute to efficiently and inexpensively produce the bio-component used for the biosponge that will remove nitrate from water. This activity will be conducted by the project manager.

Outcome	Completion Date
1. Produce bio-component of the biosponge material	November 1, 2016

Activity 2: Making biosponge material for testing

Budget: \$ 109,500

The project lab and field director will make sponge material suitable for adsorbing and destroying nitrate. Dr. Aukema will also take the bio-component and incorporate that into the sponge material.

Outcome	Completion Date
1. Produce biosponge materials and show it works on nitrates	January 1, 2017
2. Optimize the biosponge to work under conditions relevant to use at Minnesota sites	January 1, 2018

Activity 3: Testing efficacy of product with Minnesota waters

Budget: \$ 48,756

We will work with our contacts in the Minnesota Department of Health, Department of Agriculture, and the MPCA, to identify, obtain, and test actual nitrate contaminated waters. Note that we have experience in conducting environmental cleanups approved by state agencies and the U.S. EPA and so we understand the complications that can arise in moving from the laboratory to the field.



Environment and Natural Resources Trust Fund (ENRTF)

2016 Main Proposal

Project Title: Removal of Nitrates in Minnesota Waters

Outcome	Completion Date
1. Show biosponge greatly lowers nitrates in impacted waters from sites around the state	June 30, 2018

Activity 4: Disseminating findings and informing stakeholders

Budget: \$ 0

We will organize and host a conference in the Institute on the Environment. The conference participants will include political leaders, people from relevant state agencies, concerned citizens, and the private sector. We will disseminate our findings from the project. We will also discuss the major state sites that are most impacted by nitrates and the best means for deploying the biosponge, and any other technology that can help solve the problem. It is understood that nitrate contamination of waters has been a long-term problem in Minnesota and other agricultural states and so we seek to implement a long-lasting, sustainable solution.

Outcome	Completion Date
1. Disseminate information and move the best technology into practice in Minnesota	June 30, 2018

III. PROJECT STRATEGY

A. Project Team/Partners

The project manager is Distinguished McKnight Professor Lawrence Wackett (BioTechnology Institute) and the co-team leader is Professor Alptekin Aksan (Mechanical Engineering). Collectively, this team has 35 years experience in developing solutions to environmental chemical problems. Some of the technology developed has been commercialized, in one case by a Minnesota company. The project lab and field director is Dr. Kelly Aukema from the BioTechnology Institute at the University of Minnesota, a critical member of the team with more than ten years experience in solving difficult technical challenges. The team has not worked on nitrates specifically but has developed the core competency to make inexpensive biosponges that soak up and destroy problem chemicals. The BioTechnology Institute has a core production facility, originally funded by the Minnesota State Legislature, that translates University research into prototypes, and facilitates the transition from the University to the commercial sector. We need to develop the core technology with funds from the ENRTF and then the mechanisms are in place to move this technology out to the far reaches of Minnesota where it is needed. We also plan to partner with the Institute on the Environment to hold a conference discussing the nitrate problem with state agencies and other stakeholders, and disseminating the knowledge obtained from this project very broadly. This conference will be paid for with non-ENRTF funds that are already secured.

B. Project Impact and Long-Term Strategy

The project described here stems from our developing biosponge technology to adsorb and destroy other chemicals and our recognition that nitrate contamination is the biggest chemical threat to Minnesota waters. Moreover, we have developed the connections over the past twenty years to translate research into prototypes that industry can pick up on, and have helped Minnesota companies in this regard. Additionally, the Institute on the Environment is adept at bringing together stakeholders that can move knowledge to state agencies and others in the field who can implement new technologies. The development of the fundamental biosponge concept was funded Federally by the National Science Foundation, it will be translated here to deal with the nitrate problem using ENRTF funds, and funds will be leveraged with already-secured monies to disseminate information obtained by the project. We expect that commercial production of the biosponge for nitrates will be attractive to the private sector and the technology will be handed off to a Minnesota-based company, and become self-sustaining.

C. Timeline Requirements

This project will take 24 months to carry out as described above. Thereafter, it is expected that the products of the project to be handed off to state agencies and the private sector.

2016 Detailed Project Budget

Project Title: Removal of Nitrates from Minnesota Waters

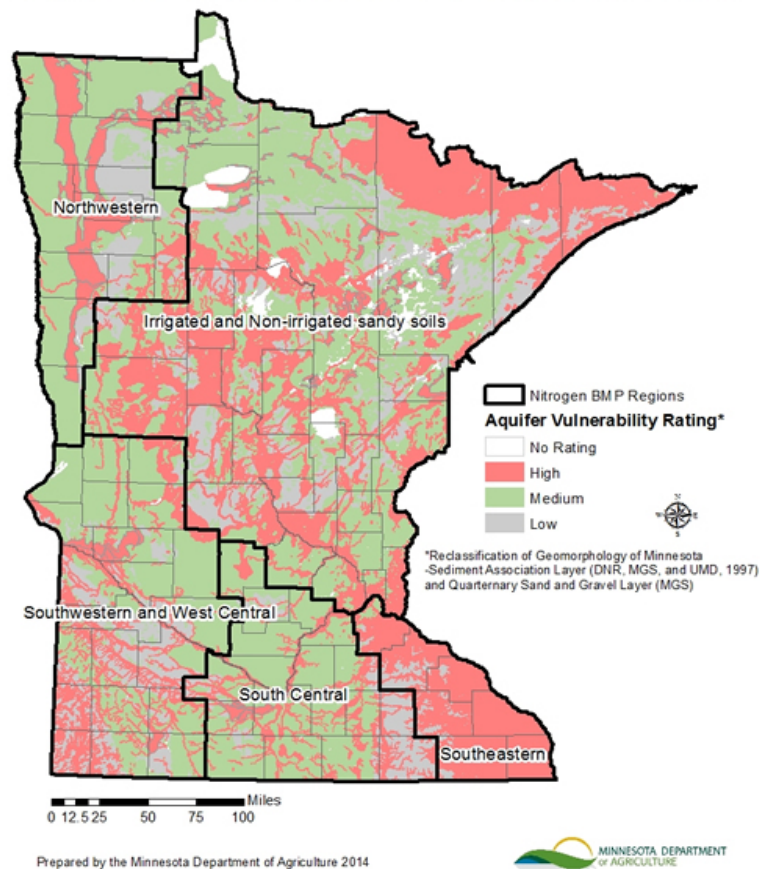
IV. TOTAL ENRTF REQUEST BUDGET: 2 years

BUDGET ITEM	AMOUNT
Personnel: Kelly Aukema, Project Manager and principle researcher, (82% salary, 18% benefits); 100% FTE for 2 years Funds are requested for two years of support for a scientist to direct the project, Dr. Kelly Aukema, who holds a Ph.D. degree in Molecular Sciences from the University of Wisconsin. Ms. Kasinkas is a crucial component of the project.	\$ 126,256
Contract services: Funds are requested for service provided by the University of Minnesota's BioTechnology Institute Pilot Plant to prepare the nitrate-reducing biocatalysts used in this proposed research.	\$ 40,000
Equipment/Tools/Supplies: Funds are for producing nitrate-reducing materials for field testing, in addition to routine lab supplies (chemicals, flasks, pipetters).	\$ 30,000
Acquisition (Fee Title or Permanent Easements): <i>In this column, indicate proposed number of acres and and name of organization or entity who will hold title.</i>	\$ -
Travel: Funds are requested to travel to state sites for acquiring water samples, and testing our materials in actual field environments.	\$ 2,000
Additional Budget Items:	N/A
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =	\$ 198,256

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State \$ To Be Applied To Project During Project Period: Indicate any additional non-state cash dollars secured or applied for to be spent on the project during the funding period. For each individual sum, list out the source of the funds, the amount, and indicate whether the funds are secured or pending <i>approval</i> .	N/A	N/A
Other State \$ To Be Applied To Project During Project Period: MnDRIVE Initiative project funded by State of Minnesota through the University of Minnesota to Lawrence Wackett, PI for	\$ 40,000	<i>Secured</i>
Other State \$ To Be Applied To Project During Project Period: Funds are secured and held in the Institute on the Environment at the University of Minnesota to hold conferences, workshops and other working groups to explore solutions to water issues in Minnesota and beyond the region. Funds will be used to sponsor on meeting on nitrate in state waters and the best solutions to the problem. This will inform and guide or research and help educate people in the state on best-practice methods.	\$ 30,000	<i>Secured</i>
In-kind Services To Be Applied To Project During Project Period: Faculty salary time paid by the University of Minnesota that the PI will devote to the project over the summer months	\$ 15,000	<i>Secured</i>
In-kind Services To Be Applied To Project During Project Period: BioTechnology Institute Pilot Plant fee waiver. Since the PI is a member of the BioTechnology Institute, this project will have the entry fee waived for the use of the facilities to prepare nitrate-reducing biocatalysts to be used in this proposal. The project will only be charged for materials used in production and the hourly wages of the staff at the facility that they work on this specific project.	\$ 20,000	<i>Secured</i>
Funding History: \$600,001 - National Science Foundation - Federal funding from the National Science Foundation developed the core technology that forms the basis for this research. That funding was for nitrates and it has not yet been used for nitrates but this is a perfect application for using this technology and helping to solve a major state water problem.	\$ 600,001	<i>Spent</i>
Remaining \$ From Current ENRTF Appropriation:	N/A	N/A

Aquifer Vulnerability, Largely from Nitrates; Map, *Minnesota Department of Agriculture*



Solutions are controversial and expensive!

1. Remove agricultural land from production
2. Use reverse-osmosis water treatments – expensive, removes at most 80%
3. Use cheap biotechnological solution, >95% removal, to be developed here

Reverse osmosis system



Biosponge for chemicals in water
(For illustration: nitrate biosponge
to be developed in this project)



PROJECT MANAGER QUALIFICATIONS AND ORGANIZATION DESCRIPTION

PROJECT TEAM

Project Manager

Lawrence P. Wackett, Distinguished McKnight University Professor

BioTechnology Institute, University of Minnesota, St. Paul, MN

Lawrence Wackett is McKnight Distinguished Professor of Biotechnology with 27 years of experience in biological methods for chemical cleanup.

Project co-Team Manager

Alptekin Aksan, Associate Professor

Mechanical Engineering, University of Minnesota, Minneapolis, MN

Alptekin Aksan brings strong expertise in material science, engineering, and scale-up that will be critical for the success of this project.

Project Lab and Field Director

Kelly Aukema, Ph.D., BioTechnology Inst., University of MN

Education:

Ph.D. Biomolecular Chemistry; University of Wisconsin School of Medicine, 2003

B.S. Chemistry, *cum laude*; Butler University, Indianapolis, IN, 1996

Research Experience:

2010 - present Postdoctoral Researcher, University of Minnesota

2006 - 2010 Novo Nordisk, Canadian Hemophilia Society Postdoctoral Fellow

Dept of Chemistry, University of N. British Columbia

2003 – 2006 Department of Bacteriology, University of Wisconsin, Madison

Project Team Description

The project and co-project managers have a combined 35 years experience in chemical cleanup and engineering practices to implement solutions to real-world problems. They are also well-connected with Minnesota State agencies, Minnesota industry, and seek to see their research translated for the improvement of society. Dr. Kelly Aukema, the project lab and field director, will oversee the day-to-day operations of the project. Dr. Aukema has worked the last five years on developing innovative biological treatment technologies and is uniquely qualified to carry out this project.

ORGANIZATION DESCRIPTION

The University of Minnesota supports this research project with laboratory space, infrastructure, administrative support, and the facilities of the BioTechnology Institute and the Institute on the Environment. The University, under President Eric Kaler and research Vice President Brian Herman, are dedicated to promoting University research that directly benefits society, especially the state of Minnesota and its citizens. We expect that we will receive outstanding support throughout the University for all phases of this project.