



Environment and Natural Resources Trust Fund (ENRTF) M.L. 2016 Work Plan

Date of Report: January 25, 2016

Date of Next Status Update Report: January 1, 2017

Date of Work Plan Approval:

Project Completion Date: June 30, 2018

Does this submission include an amendment request? No

PROJECT TITLE: Developing Biosponge Technology for Removal of Nitrates from Minnesota Waters

Project Manager: Lawrence Wackett

Organization: University of Minnesota

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Location: State of Minnesota

Total ENRTF Project Budget:

ENRTF Appropriation: \$198,000

Amount Spent: \$0

Balance: \$198,000

Legal Citation: M.L. 2016, Chp. xx, Sec. xx, Subd. xx

Appropriation Language:

I. PROJECT TITLE: Developing Biosponge Technology for Removal of Nitrates from Minnesota Waters

II. 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.

III. OVERALL PROJECT STATUS UPDATES:

Project Status as of: January 1, 2017

Project Status as of: June 30, 2017

Project Status as of: January 1, 2018

Overall Project Outcomes and Results:

IV. PROJECT ACTIVITIES AND OUTCOMES:

ACTIVITY 1: Producing biosponge component material

Description:

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 will require growing cells in fermenters in the Biotechnology Resource Center at the University of Minnesota. The amount and quality of the material will be tested continuously. Assays will be developed to measure the growth and activity of the biological material to be used for the biosponge. The biosponge production will be later in the product, this is only the production of the initial biological material that will be used for the subsequent aspects of the project. These activities will be conducted by and under supervision of the project manager.

Summary Budget Information for Activity 1:

ENRTF Budget: \$ 40,000
Amount Spent: \$ 0
Balance: \$ 40,000

Outcome	Completion Date
1. <i>Initial work with Biotechnology Resource Center - First material production run</i>	September 1, 2016
2. <i>Second material production run</i>	October 1, 2016
3. <i>Testing and measurement of production material by project manager</i>	November 1, 2016

Activity Status as of: January 1, 2017

Activity Status as of: June 30, 2017

Activity Status as of: January 1, 2018

Final Report Summary:

ACTIVITY 2: Making biosponge material for testing

Description:

The project lab and field director will make sponge material suitable for adsorbing and destroying nitrate. This material consists of silica precursors and particles that constitute the main structural materials that comprise the sponge. This material is porous and so it allows water to permeate the material and contact the biocatalyst that will degrade and remove nitrate. Dr. Aukema will 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

Summary Budget Information for Activity 2:

ENRTF Budget: \$ 109,500
Amount Spent: \$ 0
Balance: \$ 109,500

Activity Status as of: January 1, 2017

Activity Status as of: June 30, 2017

Activity Status as of: January 1, 2018

Final Report Summary:

ACTIVITY 3: Testing efficacy of product with Minnesota waters

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. We also have contacts in the field near Northfield, MN and plan to explore the use of nitrate mitigation in a field setting using the first derivative

production of the nitrate biosponge. We will explore the best places for field mitigation, which might be at tile drain sites, or edge of field. We will use assays developed for nitrate to conduct the experiments. The field project will be presided over by the project manager, Dr. Kelly Aukema.

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

Summary Budget Information for Activity 3:

ENRTF Budget: \$ 48,756
Amount Spent: \$ 0
Balance: \$ 48,756

Activity Status as of: January 1, 2017

Activity Status as of: June 30, 2017

Activity Status as of: January 1, 2018

Final Report Summary:

V. DISSEMINATION:

Description: Conference at end of project, participation in other conferences, invited lectures, and peer-reviewed scientific

It is expected that the technology developed under this project will be broadly useful. In this context, it is anticipated that research publications will result that will disseminate the findings to the scientific community so that many can use and implement the results here. In addition, if there is patentable material, invention disclosures will be filed with the Office of Technology Commercialization at the University of Minnesota. They will decide if the results should be filed for patents. Patents publish but they also retain rights for the University and the State of Minnesota. At the conclusion of the project, we will organize and host a conference at 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 help devise and implement long-lasting, sustainable solutions.

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

Status as of: January 1, 2017

Status as of: June 30, 2017

Status as of: January 1, 2018

Final Report Summary:

VI. PROJECT BUDGET SUMMARY:

A. ENRTF Budget Overview:

Budget Category	\$ Amount	Overview Explanation
Personnel:	\$ 126,000	1 project manager, Dr. Kelly Aukema, at 100% FTE for two years (\$126,256). Dr. Aukema is a highly experienced lab and project manager with a Ph.D. from the University of Wisconsin and research management experience at the University of British Columbia.
Professional/Technical/Service Contracts:	\$40,000	University facilities at the BioTechnology Institute will be used and there is a fee for the facility and the materials used to produce the biological material (\$30,000). There will also be fees for the use of the Characterization Facility at the University of Minnesota (\$10,000).
Equipment/Tools/Supplies:	\$30,000	Funds are for producing nitrate-reducing materials for field testing, in addition to routine lab supplies are budgeted. These include silica encapsulation materials, solvents, buffers, chemicals, flasks, pipetters, glassware (\$30,000)
Travel Expenses in MN:	\$2000	Funds are requested to travel to state sites for acquiring water samples, and testing our materials in actual field environments.
TOTAL ENRTF BUDGET:	\$198,000	

Explanation of Use of Classified Staff: NA

Explanation of Capital Expenditures Greater Than \$5,000: NA

Number of Full-time Equivalents (FTE) Directly Funded with this ENRTF Appropriation: 2

Number of Full-time Equivalents (FTE) Estimated to Be Funded through Contracts with this ENRTF Appropriation: NA

B. Other Funds:

Source of Funds	\$ Amount Proposed	\$ Amount Spent	Use of Other Funds
State			
Institute on the Environment funds	\$30,000	\$	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.
In-kind services to be applied during project period	\$15,000		Faculty salary time paid by the University of Minnesota that the PI will devote to the project over the summer months.
In-kind services to be applied during project period	\$20,000		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.
TOTAL OTHER FUNDS:	\$ 65,000	\$	

VII. PROJECT STRATEGY:

A. Project Partners:

BioTechnology Institute
Institute on the Environment

B. Project Impact and Long-term Strategy:

Nitrate contamination of water is a Minnesota problem but also it is a national issue. The development of technology for cheaply and efficiently removing nitrate will have major impact on our state and country.

The existing technology platform uses non-growing, actively-metabolizing bacteria that are encapsulated in a cheap, safe, extended life-time, silica-based hybrid gel. The silica material is robust and retains the bacteria within, yet it is highly porous to water and chemicals.

There is an opportunity for developing patentable material on this project and this bring an additional impact to the project.

The long-term strategy is to develop an easy to use and inexpensive treatment material for removing nitrate from waters. This material could be used in wells, municipal water systems and for treating runoff from fields.

C. Funding History:

Funding Source and Use of Funds	Funding Timeframe	\$ Amount
National Science Foundation funds from the federal government were used to develop some of the key background for this platform technology to be applied here to nitrates	September 1, 2012- August 31, 2015	\$601,000

VIII. FEE TITLE ACQUISITION/CONSERVATION EASEMENT/RESTORATION REQUIREMENTS:

A. Parcel List: N/A

B. Acquisition/Restoration Information: N/A

IX. VISUAL COMPONENT or MAP(S):

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)

X. RESEARCH ADDENDUM: N/A – Project contains confidential information and and has been confidentially peer-reviewed following the protocol designated by LCCMR staff.

XI. REPORTING REQUIREMENTS:

Periodic work plan status update reports will be submitted no later than January 1, 2017, June 30, 2017, and January 1, 2018. A final report and associated products will be submitted between June 30 and August 15, 2018.

**Environment and Natural Resources Trust Fund
M.L. 2016 Project Budget**



Project Title: Removal of Nitrates from Minnesota Waters

Legal Citation: M.L. 2016, Chp. xx, Sec. xx, Subd. Xx

Project Manager: Lawrence Wackett

Organization: University of Minnesota

M.L. 2016 ENRTF Appropriation: \$ 198,000

Project Length and Completion Date: 3 years, June 30, 2019

Date of Report: 1/25/2016

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Activity 1 Budget	Amount Spent	Activity 1 Balance	Activity 2 Budget	Amount Spent	Activity 2 Balance	Activity 3 Budget	Amount Spent	Activity 3 Balance	TOTAL BUDGET	TOTAL BALANCE
BUDGET ITEM	<i>Producing biosponge component material</i>		<i>Making biosponge material for testing</i>		<i>Testing efficacy of product in Minnesota</i>						
Personnel (Wages and Benefits)	\$30,000		\$30,000	\$49,500		\$49,500	\$46,500		\$46,500	\$126,000	\$126,000
<i>Kelly Aukema, Ph.D.: \$63,128 (salary 82% salary; 18% fringe)- 100% FTE for 2 years</i>											
Professional/Technical/Service Contracts											
<i>Biotechnology Resource Center, University of Minnesota: Fermentation for producing bacteria to be used in assay development and subsequent production of nitrate-removing materials; Characterization facility, University of Minnesota: Electron microscopy, hardness testing, water content testing, porosity testing</i>	\$8,000		\$8,000	\$32,000		\$32,000				\$40,000	\$40,000
Equipment/Tools/Supplies											
<i>Materials for assay development: Silica precursors, silica particles, solvents, catalysts, enzymes, chemicals for assays, test tubes, cuvettes, pipettes, pipette tips, screw cap vials, flasks, buffers, disposable gloves</i>	\$2,000		\$2,000	\$28,000		\$28,000				\$30,000	\$30,000
Travel expenses in Minnesota											
<i>Travel will be conducted to test biosponge technology in the field in Minnesota.</i>							\$2,000		\$2,000	\$2,000	\$2,000
COLUMN TOTAL	\$40,000	\$0	\$40,000	\$109,500	\$0	\$109,500	\$48,500	\$0	\$48,500	\$198,000	\$198,000

