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

Project Title: **ENRTF ID: 067-B**

Reducing Municipal Sulfate Discharges to Wild Rice Waters

Category: B. Water Resources

Total Project Budget: $ 244,181

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

Summary:

A new wild rice sulfate standard might require cities to reduce sulfate discharges. Engineered treatment is expensive. This project would create a tool for cities to examine alternative techniques.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

The graphic shows a preliminary map of wild rice waters, which are mainly in the northern half of the state, especially the NE. Two photos of wastewater treatment plants illustrate the diversity of ways water is treated among cities, meaning that each city is somewhat unique. The pie graph illustrates a sulfate balance for the City of Phoenix, based on the PIs previous research.

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

PROJECT TITLE: Reducing municipal sulfate discharges to wild rice waters

I. PROJECT STATEMENT

The Minnesota Pollution Control Agency is in the process of developing a "wild rice" sulfate standard. If this is enacted, it is likely that some municipal dischargers will need to reduce their loading of sulfate into designated wild rice waters. In a recent editorial (March 4, 2015) to the Minneapolis Star and Tribune, 11 mayors of northern Minnesota cities express grave concern over the potential costs (*Lower sulfates? The cost is just too high)*. If cities discharging to wild rice waters relied entirely on engineering technologies (such as reverse osmosis) to remove sulfate from wastewater, costs may indeed be quite high.
The proposed project would investigate three alternative approaches for meeting the sulfate standard that may be much cheaper: (1) **source switching** of water supplies (switching to water supplies with lower sulfate levels); (2) **sulfate source reduction** (reducing inputs of sulfate to water systems) and **wastewater reuse** (using treated wastewater for irrigation, thereby preventing discharge to surface waters). Source switching would work only if there is a readily alternative water source that a city could use. For example, this might work if a city drilled a deeper well to obtain lower-sulfate water. Source reduction is attractive because municipal water systems gain 10-190 mg/L sulfate (based on a literature review by the PI), meaning that there is ample opportunity for reducing sulfate inputs. Finally, many cities, particularly small cities, could reuse (recycle) their wastewater for irrigation of crops, parks, or golf courses. Though not frequently done in Minnesota, nearly all wastewater in cities of the southwestern U.S. is reused.

The proposed study would examine the sulfate balances of water systems for 25 cities located upstream of designated Wild Rice Waters, to determine how much sulfate is entering each water supply from various sources, including source water, urine, garbage disposal wastes, detergents, water treatment chemicals, and industrial chemicals. These data would be used to develop a sulfate mass balance tool that other cities could use. The study would also examine the potential for reusing treated wastewater for irrigation of various crops, resulting in export of sulfur in crops. The costs of various sulfate control measures would be evaluated. The proposed study would complement MPCA's study of sulfate removal by conventional engineering approaches (e.g., reverse osmosis). The proposed study would provide much-needed, unbiased information regarding the impact of a new wild rice sulfate standard on cities. If a new standard is enacted, outcomes, including a sulfate calculator tool, would to enable cities to examine non-treatment alternatives to find the cheapest approach to meet the standard.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Determine study sites (municipal discharges)* **Budget: $53,819**

Twenty five municipal water/wastewater systems that discharge effluent to wild rice waters will be selected as case studies for detailed analysis. They will be selected to represent a range of conditions, including location, volume of discharge, extent of industrialization, type of source water (groundwater vs. surface water) and quality of source water, and potential for effluent reuse. We will also ask public works directors in candidate cities if they are willing to collaborate. This is essential, because we will need to obtain operational data for their water and wastewater systems. The final case study list will be selected in collaboration with LCCMR and MPCA staff.

Outcome	Completion Date
1. Short report describing the approach for selection of the final case study cities and a map of their locations.	*December 2016*

Activity 2: *Collection of data from cities; development of sulfate model.* **Budget: $130,840**

We will visit each city to interview public works departments, collect data on the use of water and wastewater treatment chemicals, the magnitude and type of industrial discharges, and the actual concentrations of sulfate at key points. The potential for using treated wastewater in each city will be estimated based on proximity of using it for irrigation and the cost of doing so.

Outcome	Completion Date
1. Database for sulfate balances in the case study cities	*December 2017*
2. For each case study city, an analysis of potential approaches for reducing sulfate levels in discharges by switching source water, reducing sulfate inputs to the municipal system, and reusing (recycling) wastewater for irrigation.	*December 2017*

Activity 3: Synthesis and reporting **Budget: $59,522**

Data from activity 2, together with data from the literature, will be used to develop a sulfate mass balance calculator tool for other cities to use. Costs of reducing sulfate inputs will be estimated, to the extent possible. The model will be used to evaluate the feasibility of either reducing sulfate inputs to municipal water systems and/or diverting effluent for reuse.

Outcome	Completion Date
1. An open-source, Excel-based sulfate model tool for municipalities.	*March 2018*
2. A report "Decreasing sulfate in municipal effluents through source reduction and wastewater reuse", intended to support cities faced with sulfate discharge limits.	*March 2018*
3. Five workshops with municipal water/wastewater systems operators, designed to enable them to use the sulfate model tool for their cities to develop low-technology approaches for reducing sulfate in their discharges.	*June 2018*

III. PROJECT STRATEGY

A. Project Team/Partners

This project will be led by Dr. Lawrence Baker, a Research Professor in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota.

MPCA will be an informal partner. Their wastewater permitting group will be mapping out the locations of municipal wastewater discharges in relation to wild rice waters and evaluating the economic and technical feasibility of engineered treatment methods (e.g., reverse osmosis) for reducing sulfate in discharges. The proposed LCCMR study would complement their work. We would work closely with Steve Weiss' Effluent Limit Group. Initially, they would share data (GIS files; effluent sulfate concentrations, etc.); we would then continue to meet regularly to share research findings, and we would contribute findings from the LCCMR study to the anticipated SONOR (Statement of Need and Reasonableness).

B. Project Impact and Long-Term Strategy

This is a one-time project, intended to provide knowledge to cities that may be confronted with reducing sulfate in their wastewater discharges to cities. For some cities, the approaches to be studied in this project – water source switching, sulfate source reduction, and effluent reuse – may be sufficient by themselves to meet sulfate discharge limits. The benefit is that these strategies are likely to be far less expensive that highly engineered approaches. Even where non-treatment strategies alone are not sufficient to meet effluent limits, employing these measures would, for many cities, reduce the cost of engineered treatment systems.

C. Timeline Requirements

This project would be completed in two years.

2016 Detailed Project Budget

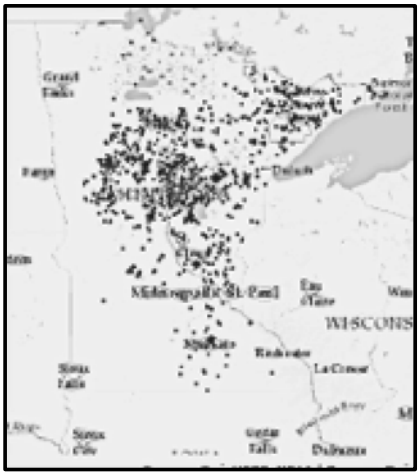
Project Title: Reducing municipal sulfate discharges to wild rice waters

IV. TOTAL ENRTF REQUEST BUDGET *2* **years**

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
Personnel:	$ -
Larry Baker, Project Manager (75% salary, 25% benefits), Research Professor, Self-supporting appointment. Four months salary for years 1 and 2. He will lead the project	$ 106,931
TBA, Graduate student (58% salary, 42% benefits) 50% time appointment for two years. The student will partiicpate in all site visits, be responsible for data analysis, and will write a thesis based on the project.	$ 88,350
Professional/Technical/Service Contracts:	$ -
Equipment/Tools/Supplies:	$ -
Supplies include sample bottles, GIS site licenses and other materials needed.	$ 10,000
Acquisition (Fee Title or Permanent Easements):	$ -
Travel:	$ -
Funds to travel to each of 25 case study cities, for the purpose of interviewing water and wastewater treatment plant operators and to collect samples from the water distribution systems. Travel includes car rental ($50/day * 2 days/trip * 25 trips + to miles/trip * 25 trips ($0.20/mi = $3,600, and per diem (2 days/trip * 25 * 2 people * $46/day - $4,600) for a total of $13,200, split between years 1 and 2.	$ 13,200
Conference registration for two attendees to present finds at Minnesota Water Resources Conference at the Rainy Lake Conference	$ 700
Additional Budget Items:	
Lab analysis of major ions (including sulfate) and cations (for interpretation of sulfate sources)	$ 25,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 244,181

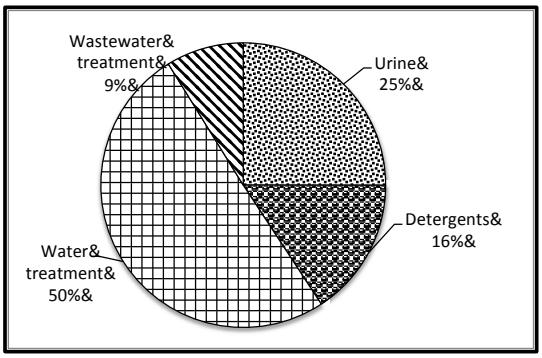
V. OTHER FUNDS *(This entire section must be filled out. Do not delete rows. Indicate "N/A" if row is not applicable.)*

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 approval.*	N/A	*Indicate: Secured or Pending*
Other State $ To Be Applied To Project During Project Period: *Indicate any additional state cash dollars (e.g., bonding, other grants) 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 approval.*	$ -	*Indicate: Secured or Pending*
In-kind Services To Be Applied To Project During Project Period: *Unrecovered F&A*	$ 108,535	
Funding History: *Indicate funding secured but to be expended prior to July 1, 2016, for activities directly relevant to this specific funding request, including past and current ENRTF funds. State specific source(s) of fund and dollar amount.*	$ -	
Remaining $ From Current ENRTF Appropriation: *Specify dollar amount and year of appropriation from any current ENRTF appropriation for any directly related project of the project manager or organization that remains unspent or not yet legally obligated at the time of proposal submission. Be as specific as possible. Indicate the status of the funds.*	$ -	*Indicate: Unspent? Legally Obligated? Other?*



Preliminary map of wild rice waters in Minnesota. From DNR.

Activity 2.
The **pie graph below** illustrates the sulfate balance for the City of Phoenix, Arizona developed by the PI. Similar sulfate balances would be developed for each case study city.



The problem: If enacted, a new wild rice sulfate standard may impact municipal wastewater dischargers. The gain in sulfate as water passes through a municipal water systems ranges from 10 mg/L to 190 mg/L (from the literature).

Activity 1. About 25 case study cities upstream of wild rice waters will be selected for analysis, to cover a range of conditions.

Below: Photos of a sewage lagoon and a secondary treatment plant, illustrating variations in wastewater management among cities. The lagoon (left) also reuses effluent to irrigate alfalfa.

Outcomes

- Report "*Decreasing sulfate in municipal effluents through source reduction and wastewater reuse.*
- Sulfate calculator tool for for other municipalitie.s
- Five workshops with public works staffs, to share findings.

SCHEMATIC OF PROPOSED ACTIVITIES

PROJECT MANAGER QUALIFICATIONS

The project would be led by Dr. Lawrence Baker, a Research Professor in the Department of Bioproducts and Biosystems Engineering at the University of Minnesota with more than 30 years of research experience. An environmental engineer by training, much of his research has dealt with a variety of problems associated with drinking water and wastewater management, including studies of water reuse, wetland treatment systems, taste and odor problems in water supplies, disinfection by-products, and salinity management. His recent work has focused on the flows of nitrogen, phosphorus, and organic wastes moving through cities, at scales from households to urban regions. He has authored more than 100 peer-reviewed articles, edited two books (most recently, *The Water Environment of Cities*), and is a member of the **Safe and Sustainable Water Subcommittee** of EPA's Board of Scientific Counselors.

Of particular relevance to the proposed study is his contribution of a major study of salt balances in six water utilities in California, Arizona, and Texas. The purpose of this study was to determine the impact of water softeners on the salinity of wastewater, which in these utilities was being reused for crop irrigation. In this study, we quantified various sources of salts entering municipal water supplies, include sulfate. The proposed LCCMR study would build upon this prior research.

A hallmark of his work is the development of **translational tools** to bring research findings into practical application. Some these tools include an adaptive management framework (used to reduce taste and odor problems in Phoenix's water supply), spreadsheet calculator tools (in a recent study of enhanced street sweeping and another on agricultural phosphorus balances), the development of design parameters (for wetland treatment systems), and the provision of readily accessible databases (several studies).

The study would be conducted in the Department of Bioproducts and Biosystems Engineering (BBE) at the University of Minnesota. Sample preparation would be done in the BBE lab and samples would be analyzed at the Soils Analysis Lab at the University of Minnesota. Vehicle rental would be done through the University of Minnesota Motor Pool.