Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 044-B**

Wetland Contribution to Methylmercury Pollution of Surface Waters

Category: B. Water Resources

Total Project Budget: $ 567,604

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

Create design guidelines for agricultural wetlands to optimize nitrate removal while reducing potential toxic methylmercury production, and develop a tool to assess methylmercury pollution risk in Minnesota lakes and streams.

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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:

Mercury enters a treatment wetland in runoff or from the atmosphere, microbes in the wetland remove nitrate by conversion to nitrogen gas, other microbes under conditions of resulting low nitrate may turn mercury into methylmercury, a toxic and bioavailable form of mercury that is taken up by fish.

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

PROJECT TITLE: *Wetland Contribution to Methylmercury Pollution of Surface Waters*

I. PROJECT STATEMENT

In Minnesota's agricultural watersheds, management practices are sought to improve water quality through reduction of water, sediment, and nitrate in runoff. **Restored wetlands may effectively reduce nitrate pollution to surface waters in Minnesota's agricultural regions, yet there remain concerns regarding their potential to promote bioavailable mercury pollution (methylmercury), which may be influenced by seasonally shifting nitrate levels present in these systems.** In this work, we propose to:

(1) Identify factors that influence the trade-off of nitrate removal and methylmercury formation in agricultural treatment wetlands, resulting in design guidelines for wetland construction;

(2) Produce a tool to forecast potential for methylmercury pollution in Minnesota lakes and rivers from commonly available water quality and land cover (spatial) data.

Conditions that enable the conversion of mercury to methylmercury in northern wetlands may also be present in treatment wetlands in southern MN: low oxygen, high organic matter, high sulfate, and fluctuating water levels. The effect of nitrate on methylation is less clear, but its abundance in agricultural systems makes it a concern for wetland design. Toxic methylmercury can accumulate in fish and wildlife, eventually posing serious health risks to humans that consume fish. Considerable state resources have been invested in assessing mercury pollution and identifying environmental factors causing high levels of mercury in fish, yet the **results have not yet been put into a framework capable of predicting risk for mercury methylation under changing conditions of water quality management (e.g. nitrate reduction) or land use change (e.g. wetland restoration).**

Our work would result in a set of design guidelines for wetland construction to improve water quality by optimizing nitrate removal and reducing methylmercury production, as well as a tool, published online as a map, that could predict the potential for methylmercury pollution in Minnesota lakes and rivers as a function of water chemistry, hydrology, land use, and wetland cover**.** We will assemble existing data for mercury and relevant environmental, water, land use, and wetland factors; supplement these data with collection of new water quality data from ~200 water bodies across the state; intensively monitor nine existing agricultural treatment wetlands in southern Minnesota; and facilitate two workshops with local stakeholders (e.g., farmers, county SWCD, DNR, MDA) to ensure our wetland design recommendations address their concerns.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Assess statewide potential for methylmercury pollution in lakes and streams **Budget: $**235,018

Consolidate existing data from state and local agencies for mercury/methylmercury in water and fish, water quality, hydrology, and land cover, including wetland cover from DNR's recent mapping efforts; use assembled data and results of previous studies to quantify relationships between mercury and common water quality and watershed characteristics and develop a tool to evaluate risk for toxic methylmercury formation in state waters; collect additional water quality data from 200 water bodies to develop and validate tool.

Outcome	Completion Date
1. Consolidated dataset of mercury/methylmercury and relevant land and water factors	*Fall 2019*
2. Tool, published as a map, of MN lakes and streams showing potential for methylmercury pollution due to factors associated with water chemistry, land/wetland cover & hydrology	*Fall 2020*
3. Sampling of 200 lakes and streams to develop and to evaluate tool's accuracy	*Fall 2020*

Activity 2: Determine wetland designs to optimize nitrate removal and reduce mercury **Budget: $**251,411

Identify wetland design factors (e.g., size, storage capacity, vegetation) that affect nitrate removal and methylmercury production, through intensive monitoring of nitrate, mercury, and relevant parameters identified in Activity 1 (e.g. sulfate, dissolved carbon), across seasons and flow conditions, in 9 existing flow-through treatment wetlands in southern Minnesota; sampling of biota to study accumulation of mercury in food webs;

develop wetland construction guidelines to maximize nitrate removal and minimize mercury methylation.

Outcome	Completion Date
1. Identify environmental factors that enhance mercury methylation, its accumulation in food webs, and export from flow-through nitrate-treatment wetlands in southern MN	*Fall 2020*
2. Design guidelines for treatment wetland construction to remove nitrate without causing excessive methylmercury formation	*Spring 2021*

Activity 3: Collaboration and communication with stakeholders **Budget:** $81,175

Organize two workshops with local stakeholders in southern Minnesota to discuss trade-offs for using wetland restoration to improve water quality in agricultural landscapes. Dissemination will include publication of results in journals and white papers, sharing results with agencies and practitioners at the MN Water Resources Conference, and online publishing of main deliverables: (1) map of methylmercury pollution potential in state waters, and (2) Design Guidelines for Treatment Wetland Construction to remove nitrate and reduce mercury methylation.

Outcome	Completion Date
1. Website for distribution of project reports, pollution map, and wetland design guide	*Spring 2021*
2. Share findings with watershed management organizations and other stakeholders through MN Water Resources Conference	*Fall 2020*
3. Two workshops with local stakeholders on water quality tradeoffs of treatment wetlands	*Spring 2021*

III. PROJECT STRATEGY

A. Project Team/Partners

• **Ben Janke** (Project Manager; Research Associate, UMN) is an expert in watershed hydrology and nutrient transport, and is responsible for project coordination, logistical and data support (Activity 1-3).
• **Claire Griffin** (Collaborator; Post-doctoral Researcher, UMN) has expertise in lake and stream water quality and organic matter cycling, which is relevant to mercury methylation. (Activity 1,3).
• **Amy Hansen** (Collaborator; Research Associate, UMN) has extensive experience studying nitrate processing in MN agricultural wetlands. She will work on nitrate removal-mercury methylation tradeoffs (Activity 2,3).
• **Christy Dolph** (Collaborator; Post-doctoral Researcher, UMN) is an expert in river and stream health, and will collect biological samples in the field to assess methylmercury accumulation in food webs (Activity 2,3).

Project partners not receiving funds:

• **Bruce Monson** (Collaborator, MPCA) has studied mercury in Midwestern lakes and rivers since the 1990s.
• *Jacques Finlay* (Collaborator, UMN) studies the influence of water management practices on water quality, including environmental controls on nitrogen and phosphorous loading, mercury bioavailability.
• **Jeff Jeremiason** (Collaborator, Gustavus Adolphus College) is an environmental chemist and expert in mercury cycling, and will provide project input and perform mercury analyses on all collected samples.

B. Project Impact and Long-Term Strategy

Wetlands provide critical ecosystem services in agricultural watersheds through water storage and nitrate removal, and the project's outcomes will ensure that expanded use of treatment wetlands to provide these benefits will minimize unintended mercury pollution of lakes and streams. The methylmercury pollution potential map will give managers a tool to assess likelihood of mercury pollution of water or fish in response to projected changes in land use, wetland cover, or water quality management. Mercury is an expensive analysis that also takes years to accumulate in fish, and this tool could guide MPCA monitoring and management efforts, using only routinely collected data (e.g., dissolved organic carbon, nitrate, and discharge).

C. Timeline Requirements

This project requires three years (July 2018 – June 2021) for successful completion of all activities, including two full spring-summer-fall seasons for wetland monitoring (2019,2020), and lake/stream sampling.

2018 Detailed Project Budget

Project Title: Wetland Contribution to Methylmercury Pollution of Surface Waters

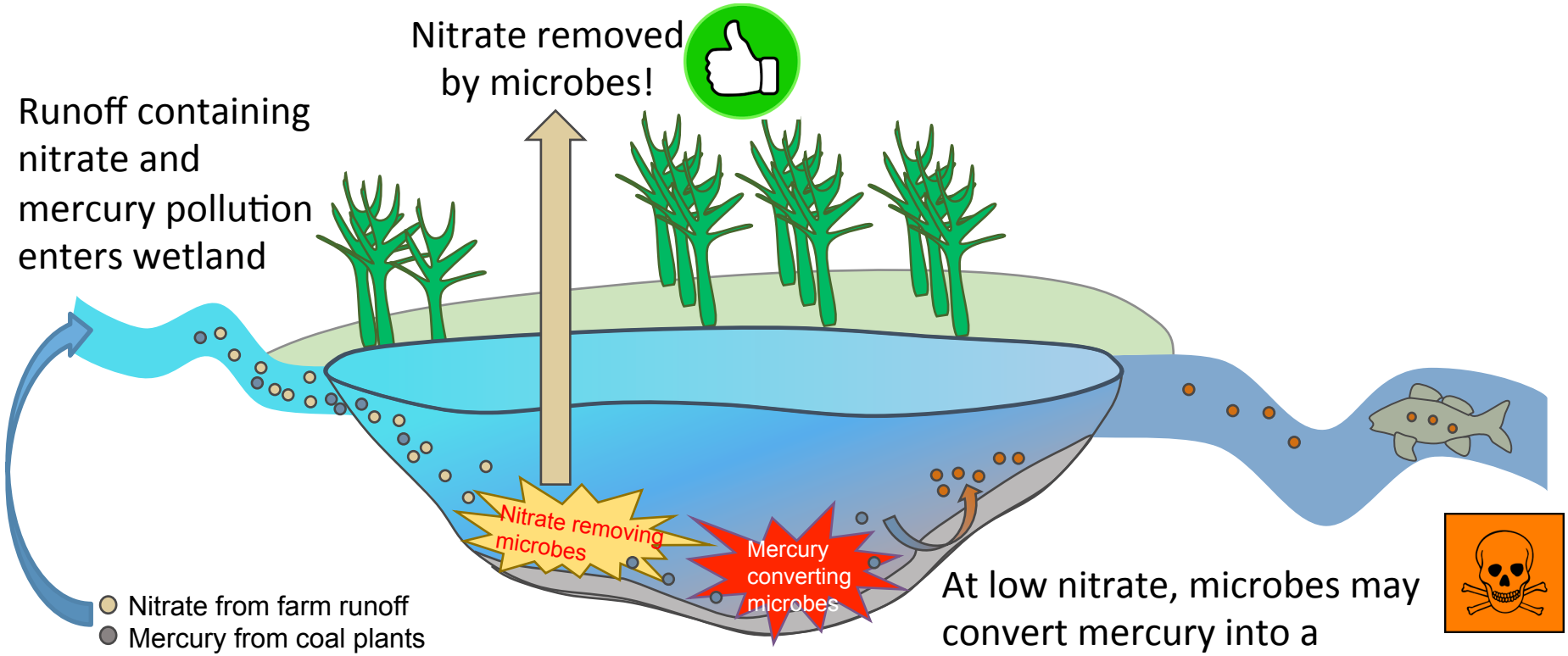
IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM *(See "Guidance on Allowable Expenses", p. 13)*	**AMOUNT**
PERSONNEL:	$ 429,419
Personnel: Ben Janke, Research Associate (PI); Project Manager, data collection and analysis, tool development; [25% FTE] 75% salary & 25% benefits, $60,507	
Personnel: Amy Hansen, Research Associate (Co-PI); data collection and study design for investigating nitrate removal - mercury methylation in wetlands; [25% FTE] 75% salary & 25% benefits, $75,908	
Personnel: Claire Griffin, Post-doctoral Researcher (Co-PI); spatial/remote sensing data acqusition, lake/stream sampling, data analysis, tool development; [50% FTE yrs 1-2, 25% FTE yr 3], 79% salary & 21% benefits, $90,856	
Personnel: Christy Dolph, Post-doctoral Researcher (Co-PI); study design and biological (insect) data collection in wetlands, data analysis; [25% FTE] 79% salary & 21% benefits, $45,428	
Personnel: Michelle Rorer, lab manager; conduct/supervise analysis of water samples in lab in Ecology, Evolution and Behavior Dept. at UMN [23% FTE yrs 1-2, 12% yr 3] 79% salary & 21% benefits, $41,380	
Personnel: Lab Technician, St. Anthony Falls Lab; construction of equipment and general support for field sampling and monitoring activities [33% FTE] 79% salary & 21% benefits, $51,049	
Personnel: Undergraduate Students; support of field and lab activities; 100% salary & $0 benefits, $64,291	
Professional/Technical/Service Contracts: All analyses of mercury (total mercury and methylmercury) will be analyzed at Gustavus Adolphus College in St. Peter, MN in the laboratory of Jeff Jeremiason, Associate Professor in Chemistry and Environmental Studies. 400 water samples + 100 bug tissue samples will be analyzed at a cost of $180 per sample.	$ 90,000
Equipment/Tools/Supplies: Onset Dissolved Oxygen Probes w/replacement caps (4@$1340 ea.) and Onset Vented Level Loggers (6 @ $550 ea.) for installation in wetlands; fiberglass filters (3000 @ $1 ea.); sample bottles (3000 @ $1 ea.); reagents, consumables & machine time for analysis of 400 water samples in the lab at the Ecology, Evolution and Behavior Dept. at UMN for parameters including several forms of nitrogen, phosphorus, carbon, and organic matter ($12,525)	$ 27,185
Travel: Field sites for water sample collection across MN, and field work in wetlands in southern MN ($8,000); Cost for 4 people to attend the MN Water Resources Conference ($1,000)	$ 9,000
Additional Budget Items: Publication fees for open-access journal papers ($2,000); Two Outreach workshops (2 @$5,000 ea., for cost of printed materials, venue rental, facilitators)	$ 12,000
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	**$ 567,604**

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.*	n/a	*Indicate: Secured or Pending*
In-kind Services To Be Applied To Project During Project Period: Unrecovered UMN overhead (54% MTDC)	$ 306,506	*Secured*
Past and 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.*	n/a	Indicate: Unspent? Legally Obligated? Other?
Other Funding History: *Indicate funding secured but to be expended prior to July 1, 2018, for activities directly relevant to this specific funding request. State specific source(s) of funds and dollar amount.*	n/a	

Wetland Contribution to Methylmercury Pollution of Surface Waters



Project outcomes:

1. Minnesota mercury methylation risk forecasting map to identify high risk water bodies and direct monitoring and management.

2. Design guidelines for nitrate treatment wetlands to promote nitrate removal while preventing release of harmful levels of methylmercury.

Title: Wetland Contribution to Methylmercury Pollution of Surface Waters

Project Manager Qualifications and Organization Description

Dr. Benjamin Janke, Project Manager, is a Research Associate at the St. Anthony Falls Laboratory (Department of Civil, Environmental, and Geo-Engineering) at the University of Minnesota (UMN), where he has been appointed since 2014. From 2011 to 2014, he was a post-doctoral associate in the Department of Ecology, Evolution and Behavior at UMN after earning a PhD in Civil Engineering from UMN in 2011. His expertise includes understanding of biogeochemical processes, nutrient transport, and hydrology of human-impacted watersheds. He has considerable experience in field data collection; hydrologic, water quality and spatial data analysis; and synthesizing large data sets. Janke has managed and participated in several projects since 2011 that have involved both public and academic collaborators, including a 3-year study of road salt transport in urban watersheds, analyses of stormwater monitoring data for Twin Cities metro watershed districts, and a study of tree and lawn impacts on stormwater nutrient pollution. He is familiar with the diverse land and water conditions across Minnesota, and in southern Minnesota specifically, having contributed to monitoring and field sampling efforts of wetlands and ditches in the agriculturally developed Minnesota River watershed. He has supervised undergraduate students in field and laboratory settings, and collaborated with professors, fellow research staff, graduate students, city governments, and state and local agencies, including watershed and soil conservation districts. He has written several papers and reports, and given oral presentations to diverse audiences as part of scientific meetings, college lectures, outreach to citizens, and watershed district board meetings.

Institutional Information:

St. Anthony Falls Laboratory (SAFL), University of Minnesota

Some of the proposed work will be carried out at SAFL, an interdisciplinary research and teaching facility affiliated with the Department of Civil, Environmental, and Geo-engineering. Faculty, graduate students, and full-time research and support staff conduct research on a broad range of applied and fundamental science and engineering topics, focused on the environment, water, and energy. The lab houses state-of-the art experimental and laboratory facilities, computing and technological support, and has the capability to design and construct instrumentation for diverse field monitoring and measurement applications. Research and technical staff at SAFL will be able to provide support for field work in the proposed study, as well as guidance in installation of monitoring equipment, calibration of data loggers, etc.

Department of Ecology Evolution and Behavior (EEB), University of Minnesota

The proposed work will also be carried out through the EEB Department, primarily in the laboratory of Dr. Jacques Finlay. Dr. Finlay's lab has provided water quality analyses in many previous studies of lakes, streams, and wetlands across the state of Minnesota, including in particular the Minnesota River watershed over the past several years. Michelle Rorer, lab manager for Dr. Finlay, will oversee analyses of all non-mercury water samples for the project, using in-house equipment and standard EPA protocols. The lab will also provide logistical support and equipment used in field sampling. Undergraduate students involved in the project will likely be hired through this department as well.