Environment and Natural Resources Trust Fund
2019 Request for Proposals (RFP)

Project Title: **ENRTF ID: 108-BH**

Shallow Waters: Road Salt Impairment and Mitigation Potential

Category: H. Proposals seeking $200,000 or less in funding

Sub-Category: B. Water Resources

Total Project Budget: $ 196,720

Proposed Project Time Period for the Funding Requested: June 30, 2021 (2 yrs)

Summary:

We will determine the extent of road salt accumulation and its impairment of dissolved oxygen in Minnesota's numerous shallow waters, and evaluate pond features that could impact chloride mitigation.

Name: Benjamin Janke

Sponsoring Organization: U of MN

Title: Research Associate

Department: St. Anthony Falls Laboratory

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Web Address

Location

Region: Statewide, Metro

County Name: Statewide

City / Township:

Alternate Text for Visual:

Illustration of data collection activities in winter and summer, illustration of accumulated salt causing low oxygen in ponds, and map showing areas with potential for high salt.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%
____ If under $200,000, waive presentation?			

PROJECT TITLE: Shallow Waters: Road Salt Impairment and Mitigation Potential

I. PROJECT STATEMENT

This work proposed by the **University of Minnesota** will address a major gap in understanding the **extent of road salt pollution in the state's numerous (40,000+) shallow lakes, ponds, and wetlands**, which are under-studied yet widely used to pre-treat stormwater flowing into lakes and streams. Road salt accumulating in these waters has direct and indirect **harmful effects on aquatic life**, and may be **detrimental to the function of many ponds and wetlands** being used for stormwater management. The goals of our project are to:

1) Assess **road salt (chloride) accumulation and related oxygen depletion** through field data collection over an annual period within numerous small water bodies located near and connected to roadways;
2) Determine the **impact of accumulated chloride on critical functions of ponds** (dissolved oxygen dynamics, stormwater and chloride residence time);
3) Determine the **influence of pond or watershed characteristics** on susceptibility of ponds to accumulate chloride and become impaired for key functions;
4) Develop a **tool to predict chloride levels in shallow waters**, which would help identify salt-sensitive water bodies without intensive monitoring, and **evaluate pond design factors** (outlet structures, depth, or sheltering) that allow predictable timing of chloride export to downstream waters, which would **contribute to development of alternative chloride mitigation strategies**.

Chloride pollution in shallow waters is a potentially widespread problem in Minnesota, endangering aquatic life and drinking water. The Minnesota Pollution Control Agency's initial chloride assessment focused mainly on larger lakes and streams in the Twin Cities metro; unknown is the extent of pollution in the state's many ponds and wetlands. Recent work by the University of Minnesota showed that chloride in winter runoff, which is heavier than fresh water, accumulates in the bottom of shallow roadside ponds. While these ponds are designed to hold water and are assumed to be well-aerated due to mixing by action of wind or inflows, the study showed that salt remained throughout the summer in 50% of sampled ponds (6 of 12), preventing mixing of inflows and leading to oxygen depletion (anoxia) at bottom of the ponds. Chloride toxicity and anoxia are harmful to insects, amphibians, and turtles with life stages at the bottom of shallow waters, and can impair pond function for removal of contaminants by causing the release of phosphorus and heavy metals from sediments.

This two-year project would benefit on-going and future efforts to manage and mitigate the impacts of road salt to aquatic life and water resources across the state, through a rapid assessment of the currently unknown extent of road salt pollution within and from small water bodies, and by preliminary evaluation of alternative pond designs to promote or reduce chloride retention. The project will also provide foundational data for future studies of road salt's impacts on aquatic life and contaminant transport in shallow waters.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: *Determine the extent of chloride pollution and oxygen depletion in shallow waters*

Over one year, we will collect repeated water (chloride) samples and water chemistry measurements from road-connected shallow water bodies in a range of land uses. From these data we will quantify the accumulation, persistence and flushing of chloride, stratification, and oxygen depletion (anoxia) in shallow waters over the season, and relate these patterns to climate, hydrology, pond, or watershed characteristics (e.g., size, road density, sheltering, outlet structure) using statistical methods. MPCA will assist in site selection.

ENRTF BUDGET: $78,446

Outcome	Completion Date
1. Identify approximately 50 shallow water bodies for sampling and monitoring	*Oct 2019*
2. Quantify chloride concentration, anoxia, and timing of salt flushing from shallow waters	*Jan 2021*
3. Relate patterns of salt pollution and anoxia to weather, pond, and watershed factors	*June 2021*

Activity 2: *Assess the effect of chloride on the function of shallow aquatic environments and stormwater ponds*
Potential effects of chloride accumulation in ponds (reduced mixing, oxygen depletion, and delayed flushing of chloride to downstream waters), and the influence of weather and of pond design (physical) features on these processes, will be investigated through continuous monitoring of water chemistry in a sub-set of 5 water bodies (concurrent with Activity 1). We will use data analysis and a water quality model to describe and interpret mixing processes within ponds and evaluate pond designs.

ENRTF BUDGET: $72,359

Outcome	Completion Date
1. Quantify the influence of chloride on mixing and oxygen dynamics within water bodies	*Jan 2021*
2. Identify pond designs or features, and threshold chloride levels in water bodies, that can prevent anoxia and disruption of hydrologic function of ponds and wetlands	*June 2021*

Activity 3: *Produce a tool for identifying high-chloride ponds and wetlands*
Using the analyses from Activities 1 and 2, a predictive tool will be developed to assess potential chloride pollution and oxygen depletion in shallow waters, and potential downstream impacts, as a function of critical weather, water body, or watershed characteristics. We will use existing chloride data from MPCA to strengthen analyses and test the tool. The tool and its foundational analyses will be provided to agencies and the public.

ENRTF BUDGET: $45,915

Outcome	Completion Date
1. Develop and test a tool to predict chloride pollution and anoxia in shallow lakes, wetlands, and ponds, and potential for impacts to downstream waters	*June 2021*

III. PROJECT PARTNERS:

A. Partners receiving ENRTF funding

Name	Title	Affiliation	Role

B. Partners NOT receiving ENRTF funding

Name	Title	Affiliation	Role
Brooke Asleson	**Sustainability/Outreach**	**MPCA**	**Study Site Selection**
John Gulliver	**Professor**	**Univ. of Minnesota**	**Advisory**

IV. LONG-TERM- IMPLEMENTATION AND FUNDING:
Mitigation of chloride pollution is an issue of critical importance to water quality in Minnesota. This project will complement MPCA's efforts to assess chloride pollution statewide by helping fill a substantial knowledge gap on the extent of pollution within small, shallow water bodies. Given the prevalence of ponds and wetlands for treating stormwater runoff, a need exists to develop and implement alternative chloride management practices, such as the changes in pond design (tree sheltering, outlet structure, depth/area ratios, etc.) to be investigated by this project. Finally, project results concerning the effect of chloride on oxygen depletion in shallow aquatic environments will provide valuable foundational data for future studies of chloride impacts to aquatic life, and of chloride-related contaminant release from stormwater treatment ponds and wetlands. We will also a make use of large and under-utilized water quality dataset from the MPCA (valued at several million dollars).

V. TIME LINE REQUIREMENTS: Project will commence July 1, 2019 and conclude June 30, 2021.

2019 Proposal Budget Spreadsheet

Project Title: Shallow Waters: Road Salt Impairment and Mitigation Potential

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

BUDGET ITEM (See "Guidance on Allowable Expenses")	**AMOUNT**
Personnel:	$ 147,582
Dr. Benjamin Janke, Research Associate (PI); Project Manager, field data collection and analysis, tool development; [50% FTE, Year 1 and 2] 75% salary & 25% benefits, $81,860	
Dr. Jacques Finlay, Professor (co-PI); Data analysis; [2% FTE, Year 1 & 2] 75% salary & 25% benefits, $14,956	
Dr. William Herb, Research Associate; Water quality modeling in ponds; [25% FTE, Year 2] 75% salary & 25% benefits, $25,861	
Junior Scientist, St. Anthony Falls Laboratory / Dept. of Ecology; sample filtering and prep, probe maintenance, construction of field equipment; [10% FTE, Year 1 & 2] 79% salary & 21% benefits, $12,766	
Undergraduate Students; support of field and lab activities; 100% salary & $0 benefits, $12,139	
Professional/Technical/Service Contracts:	$ 23,685
University of Minnesota - Research Analytical Laboratory (St. Paul, MN): analysis of 660 water samples (12 per site, n=45 sites + 24 per monitoring site, n=5 sites) for Chloride ($17.50/sample + setup costs), analyzing half of those samples (n=330) for cations (Sodium, Magnesium, Calcium; $22.50/sample) to confirm road salt; $19,185	
University of Minnesota - Department of Soil, Water, and Climate (St. Paul, MN): analysis of 300 water samples (6 per site; n = 50 sites) for oxygen isotope of water to detect groundwater ($15/sample); $4,500	
Equipment/Tools/Supplies:	$ 23,848
Instrumentation for continuous monitoring of water chemistry at 5 shallow water sites (per site: 3 conductivity probes, 2 temperature probes, 1 dissolved oxygen probe, 1 water level logger, and mounting hardware or buoys); $19,600	
Water quality probes (1x 5-m DO probe, 2x 5-m conductivity probe) for a Hach WQ40D portable meter, to record vertical profiles of temperature, conductivity (chloride), and dissolved oxygen at field sites during repeated surveys; probes supplement existing meters to provide instruments for 2 field teams; $1,448	
Fiberglass filters (45mm GF/F) for 660 samples (1 filter ea.); 7 boxes (100 filters ea.) @ $400/box; $2,800	
Travel: mileage for travel to survey and monitoring sites (est. 3000 miles), per University policy and rate	$ 1,605
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 196,720

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

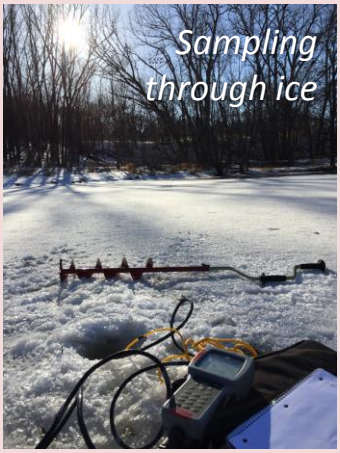
SOURCE OF FUNDS	**AMOUNT**	**Status**
Other Non-State $ To Be Applied To Project During Project Period:	n/a	
Other State $ To Be Applied To Project During Project Period:	n/a	
In-kind Services To Be Applied To Project During Project Period: Unrecovered UMN overhead (54% MTDC)	$ 94,863	*Secured*
Past and Current ENRTF Appropriation: "Impacts of Adding Salt to Our Lakes, Rivers, and Groundwater" PI's: J. Gulliver and S. Heger. 2016.	$ 497,000	*Unspent*
Other Funding History: Stormwater Research Priorities and Pond Maintenance, Objective 3: Phosphorus Release from Ponds [grant from MPCA]; PI's: J. Gulliver and J. Finlay. Concludes June 30, 2018	$ 250,000	*Secured*
Study of Deicing Salt Accumulation and Transport Through a Watershed [Local Roads Research Board, #INV 965]; PI: W. Herb. Concluded Dec 31, 2017	$ 164,043	*Secured*

Shallow Waters: Road Salt Impairment and Mitigation Potential

- *40,000+ shallow lakes, wetlands, and ponds in Minnesota*
- *Those near roadways accumulate and store road salt through summer*

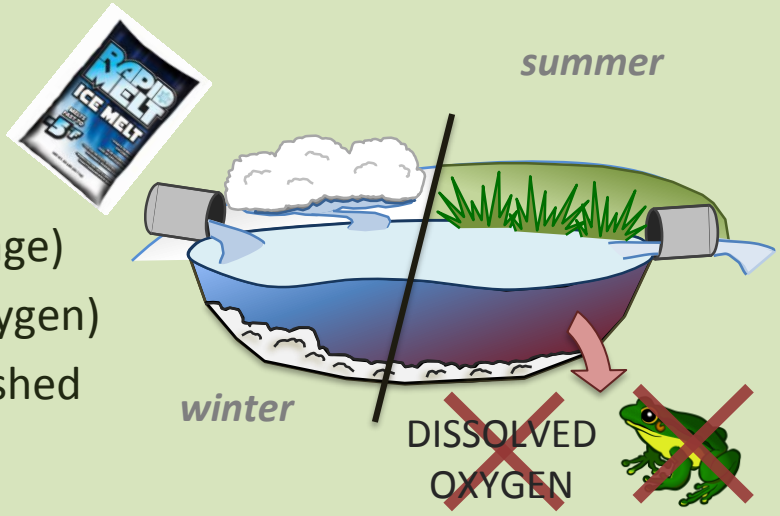
DATA COLLECTION

Measure the extent of **chloride accumulation** and **oxygen depletion** in shallow water bodies near roadways over an annual period



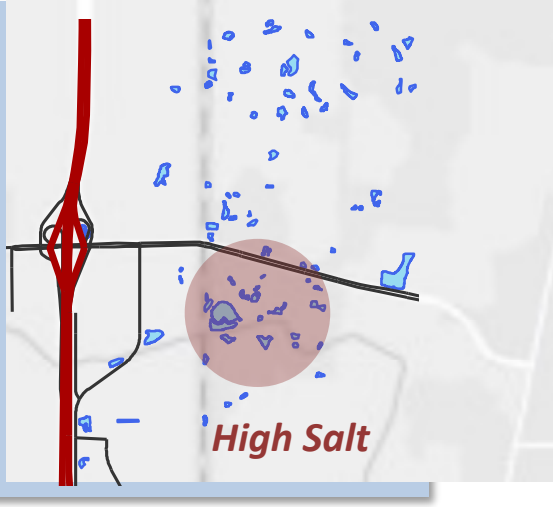
ANALYSIS

Determine **pond impairment** for **function** (runoff/salt storage) and **aquatic life** (dissolved oxygen) based on pond design, watershed features, and chloride levels



OUTCOMES

- **Tool to predict shallow waters with potentially high chloride**
- **Determine pond design features that affect chloride mitigation and dissolved oxygen**
- Provide input to future studies of chloride impacts on pond function and aquatic life



F. Project Manager Qualifications and Organization Description

Dr. Ben 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 urban biogeochemistry, nutrient and pollutant transport, and hydrology of human-impacted watersheds. He has several years' experience in field data collection in challenging conditions, including monitoring of road salt transport in snowmelt; 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, a project assessing phosphorus retention in stormwater detention ponds, 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 particular the urban setting of the Twin Cities metro. 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 published 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 quality, and energy. The lab houses state-of-the art experimental and laboratory facilities, computing and technological support, and has 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 on installation of monitoring equipment, calibration of data loggers, etc. SAFL collaborators include **Dr. William Herb** (Research Associate), who will contribute to water quality modeling in this project, and **Dr. John Gulliver** (Professor in Civil Engineering), who will provide input on road salt data collection and interpretation.

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 **co-PI Dr. Jacques Finlay** (Professor). Dr. Finlay's lab has provided critical water quality analyses in many previous studies of lakes, streams, ponds, and wetlands across the state of Minnesota. The lab will primarily handle the filtering, processing, and storage of water samples prior to analysis in neighboring labs, as well as providing logistical support and water quality equipment used in field sampling. Undergraduate students involved in the project will likely be hired through this department.