Environment and Natural Resources Trust Fund

2024 Request for Proposal

General Information

Proposal ID: 2024-255

Proposal Title: Road Salt Pollution of Surface Waters from Groundwater

Project Manager Information

Name: John Gulliver

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: We propose identifying hot spots of groundwater chloride pollution of surface waters due to excessive road salt use, which is a long term source increasing chloride impairment of surface waters.

Funds Requested: $689,000

Proposed Project Completion: June 30, 2027

LCCMR Funding Category: Methods to Protect, Restore, and Enhance Land, Water, and Habitat (F)

Project Location

What is the best scale for describing where your work will take place?

Statewide

What is the best scale to describe the area impacted by your work?

Statewide

When will the work impact occur?

During the Project and In the Future

Narrative

Describe the opportunity or problem your proposal seeks to address. Include any relevant background information.

Chloride-based road salts, placed onto roads and parking lots during winter, are plowed to the side and infiltrate to shallow groundwater. In fact, seventy eight percent of chloride from road salts enter shallow groundwater in the Twin Cities metropolitan area, with a similar percentage in other Minnesota urban areas. This project will investigate groundwater pollution of rivers and streams by chloride. It will identify the sources, assess the risk, determine hot spots, and thus provide tools to guide actions to improve the water quality of our lakes and streams. Most surface water regulations do not consider groundwater as a pollution source for surface water, but a 2020 court case in Hawaii, has changed that. The pollution of surface water by groundwater is therefore an important research topic. Chloride from road salt is a highly-mobile chemical that is not adsorbed by soil and passes through the groundwater into our lakes and streams. We have reached toxic levels of chloride in streams during summer and fall (see support letter from Shingle Creek Watershed Management Organization), indicating that shallow groundwater transport to surface waters is degrading the aquatic ecosystem in urban areas.

What is your proposed solution to the problem or opportunity discussed above? Introduce us to the work you are seeking funding to do. You will be asked to expand on this proposed solution in Activities & Milestones.

This proposal is about finding solutions to the chloride groundwater-to-surface water pollution caused by excessive use of road salt. Groundwater resources are affected in different degrees by chloride leached with recharge water. First, the amount of leaching depends on the type of soil at the ground surface. For instance, clays will leach less than sands. Second, the amount of groundwater discharging to surface waters varies depending on the aquifer conditions and the connection to the surface water. Third, aquifers are complex, multilayered geological features and deeper aquifers are less likely to be impacted by chloride than shallow aquifers. So the fraction of discharge to surface waters that occurs from the different aquifer layers will affect the amount of chloride that enters the surface waters with the discharging groundwater. The combination of all of these considerations requires research to determine where chloride groundwater pollution of surface water is more likely and less likely, so that it is possible to focus source reduction on the the potential hot spots within the State.

What are the specific project outcomes as they relate to the public purpose of protection, conservation, preservation, and enhancement of the state's natural resources?

Chloride from road salt is a powerful pollutant of our lakes and rivers, directly impacting aquatic species. This project will identify how groundwater exacerbates the chloride contamination of surface water; this source of surface water contamination is largely ignored for current surface water pollution management. The result will clarify the potential connections between groundwater and surface water, where this interaction is most likely to occur, allow us to suggest ways of minimizing this source of contamination to surface waters, and allow us to respond to the new legal regulation of groundwater resources that are substantially connected to surface waters.

Activities and Milestones

Activity 1: Project Management and Quality Assurance

Activity Budget: $38,000

Activity Description:

Project management will include initiating agreements, tracking deliverables, preparing invoices, and reporting to the LCCMR. Our team will develop a Technical Advisory Committee (TAC) which will meet every six months while the project team will meet internally every two weeks. The TAC will advise the project team on technical issues and concerns throughout the project. The TAC will be comprised of one to two representatives from state entities (e.g., Minnesota Pollution Control Agency (MPCA), Minnesota Department of Natural Resources (DNR) and one to two local public entities (cities or watershed districts).

A Quality Assurance Project Plan (QAPP) will be created before any field activity starts. The plan will list the sites to be investigated, the number of surface and groundwater sites, the type of data that will be needed, how often data are collected, maintenance protocols, how data will be managed, and lastly how data will be analyzed. The research team will develop the QAPP from an approved template for monitoring studies. We will use accessible river site and groundwater wells to sample for surface and groundwater. We will follow the general guidelines of prior groundwater sampling protocols and analyze the samples ourselves or identify a qualified local laboratory for the study.

Activity Milestones:

Description	Approximate Completion Date
1. Invitations for TAC accepted	September 30, 2024
2. QAPP completed	September 30, 2024

Activity 2: Groundwater Monitoring Studies

Activity Budget: $300,000

Activity Description:

We propose studying up to three areas with different connectivity between surface and groundwater. We will use available groundwater atlases and work closely with state hydrogeologists to identify the study areas. The monitoring sites will be selected in consultation with our TAC and the availability of prior groundwater models. The groundwater sites will be: 1) downgradient from pollutant sources, 2) upgradient from surface water sites, and 3) accessible. The surface water sites will be: 1) downgradient from groundwater sites, 2) accessible from river or bridge, and 3) safe to sample.

Each site will have up to three monitoring wells and a surface water station. The aquifer material will be characterized for particle size. We will use a combination of automated sensors and monthly sampling for water quality over two years. Conductivity and water depth will be measured to provide a continuous record. Monthly grab samples will be collected from the wells and river and, in combination with continuous data, used to calibrate and verify the groundwater pollutant transport model. Samples will be analyzed for chloride and oxygen and hydrogen isotopes.

Activity Milestones:

Description	Approximate Completion Date
1. Study sites selected	October 31, 2024
2. Well drilling complete	November 30, 2024
3. Sampling completed (year 1)	November 30, 2025
4. Sampling completed (year 2)	June 30, 2026
5. Summary report on data collection	January 31, 2027

Activity 3: Modeling and Analysis of Groundwater Pollution of Surface Waters

Activity Budget: $351,000

Activity Description:
Numerical models that quantify the groundwater pollution of surface waters will be developed for the selected field sites. Existing data sets will be collected and compiled, and data gaps will be identified which will guide field data collections. Several locations in the southeast karst region, and the north-central sandplains region are currently under detailed study supported by LCCMR, MDH, and the Anishinaabe Agriculture Institute. The research sites at these locations are good candidates for the proposed research. Groundwater flow models either have been or are currently being developed and calibrated for these sites. A surface water model component will be coupled to these groundwater flow models to provide integrated models that quantify the flow connectivity between surface water and groundwater. These integrated models will be used to simulate transport of chloride from road salt in the groundwater and to quantify the groundwater contribution of chloride pollution of surface waters.

Activity Milestones:

Description	Approximate Completion Date
1. Data compilation and identification of data gaps	December 31, 2024
2. Develop and implement surface water - groundwater integrated flow model	December 31, 2025
3. Develop and implement surface water - groundwater integrated chloride transport model	June 30, 2026
4. Identify road salt hot spots in Minnesota with integrated chloride transport model	April 30, 2027

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Nigel Pickering	Geosyntec Consultants	Nigel Pickering will be a Co-PI for this project and the Project Manager for all the Geosyntec tasks. He will manage the overall field project (activity 2), schedule, and budget. He will help pick suitable groundwater monitoring sites, prepare the collected water quality data and interact with the modeling team.	Yes
David Richardson	Geosyntec Consultants	David Richardson will be a Co-PI and Senior Engineer for this project. He will help pick suitable groundwater monitoring sites, oversee the well drilling and groundwater monitoring, and analyze the collected water quality data.	Yes
Dr. Peter T. Weiss	Valparaiso University	Peter Weiss is a Visiting Professor at the St. Anthony Falls Laboratory, University of Minnesota, every summer. He will be involved in Activities 2 and 3, Field studies and application of these results in the computational model.	Yes
Brooke Asleson	Minnesota Pollution Control Agency	Brooke Asleson will advise on field sites and modeling efforts; collaboration and communication between the research community and state and local government units to improve understanding and outreach; and outreach to practitioners and the local community.	No

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

The proposed project will find hot spots of chloride pollution stemming from groundwater flow into surface waters. Follow-on research on mitigating these hot spots will require additional funding. Aside from the LCCMR, there are many potential in-state sources that can fund the mitigation of groundwater to surface water chloride pollution, such as the Minnesota Department of Transportation, the Local Road Research board, the Minnesota Stormwater Research Council and the Minnesota Pollution Control Agency.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Reduce Chlorides in Minnesota Waters by Evaluating Road-Salt Alternatives and Pavement Innovations	M.L. 2018, Chp. 214, Art. 4, Sec. 2, Subd. 04c	$400,000

Project Manager and Organization Qualifications

Project Manager Name: John Gulliver

Job Title: Professor Emeritus

Provide description of the project manager's qualifications to manage the proposed project.

John Gulliver is a professor emeritus in the Department of Civil, Environmental and Geo- Engineering, performing his research at the St. Anthony Falls Laboratory. He has successfully managed 109 research projects, including 9 projects for the LCCMR. He is continuing research into the future because it is his advocation. Much of his research, in conjunction with other faculty, involves the development of new technology for stormwater treatment and assessment of field performance of stormwater treatment practices. His most recent research projects include the retention of metals by bioretention media, the infiltration rates of various stormwater treatment practices, the impact of various types of impervious areas on runoff, and the impact of climate change on stormwater infrastructure. He is a co-author of the book, Optimizing Stormwater Treatment Practices: A Handbook of Assessment and Maintenance, published by Springer.

Professor Gulliver is active in outreach to the community, including workshops, the monthly Stormwater Seminar Series and publication of the practitioner-oriented newsletter, Stormwater Updates.

Organization: U of MN - College of Science and Engineering

Organization Description:
The St. Anthony Falls Laboratory (SAFL), an interdisciplinary fluids research and educational facility of the College of Science and Engineering at the University of Minnesota. SAFLs research is focused at the intersection of fluid dynamics with major societal challenges in energy, environment and health. SAFL integrates experiments in the laboratory and field with advanced computational tools and theory to obtain innovative, science-based solutions to real-world fluid-flow problems. SAFL serves as a resource for departments across the Twin Cities campus, the statewide University system, and the broader research community. The connections and collaborations reach across the country and all over the world, and SAFL partners with local, state and federal agencies; private consulting firms; businesses of many kinds; technical associations; and other educational institutions to expand knowledge and solve problems.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
John Gulliver,		PI and project manager; will be in charge of overall project management and tasks required to complete activities			8.3%	0.12		$24,022
John Nieber		Co-PI, Supervision of one graduate research assistant who will be utilizing a large-scale groundwater flow model			36.8%	0.12		$21,220
Peter Kang		Co-PI, Supervision of one graduate research assistant who will be modeling detailed flow and transport of chloride			36.8%	0.12		$18,080
2 Graduate Research Assistants		One GRA will be modeling flow and transport around particles and the other GRA will be modeling flow and transport at a larger scale.			48%	3		$327,087
Undergraduate Research Assistants		Help in field monitoring			0%	0.6		$13,610
Civil Service/Ben Erickson-Shop staff		Help with field research			32%	0.24		$22,749
							Sub Total	**$426,768**
Contracts and Services								
Geosyntec Consultants	Sub award	Groundwater and surface water sampling and analysis and a portion of project management, including: Well installation (9), $49500, Water quality sondes (6), $19800, Instrument enclosures (3), $3300, Travel (4800 mi), $3036, WQ analyses (302 PO4/NO3/Cl), $24948, and Grain size analysis (9 samples), $19800.				1.14		$237,056
Dr. Peter T. Weiss	Professional or Technical Service Contract	Dr. Weiss will be involved in all portions of the project, from field monitoring to verification of groundwater flow modeling.				0.36		$21,882
							Sub Total	**$258,938**

Equipment, Tools, and Supplies								
							Sub Total	**-**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	2 people	Registration for the Minnesota Water Resources Conference					$550
	Miles/ Meals/ Lodging	49 trips of 100 miles at $0.56/mile	Travel to groundwater monitoring sites					$2,744
							Sub Total	**$3,294**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$689,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Attachments

Required Attachments

Visual Component

File: 75929f1f-60c.pdf

Alternate Text for Visual Component

Left-truck distributing salt brine. Middle truck plowing snow. Right-map of chloride impairments in the TCMA...

Optional Attachments

Support Letter, Photos, Media, Other

Title	File
Support from the Shingle Creek Water Management Organization	9249064f-a76.docx
Audited Financials - Geosyntec	4a934785-46d.pdf
Geosyntec Letter	5c5e75d7-53c.pdf
Dr. Peter Weiss Letter of Commitment	1cfef182-060.docx
1101653 LOC-Authorization from the U of M	9d53af87-26c.doc

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

No

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

N/A

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

N/A

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Does your project include the design, construction, or renovation of a building, trail, campground, or other capital asset costing $10,000 or more?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services, as defined in Minnesota Statutes section 299C.61 Subd.7?

No