



# Environment and Natural Resources Trust Fund

2025 Request for Proposal

## General Information

**Proposal ID:** 2025-246

**Proposal Title:** Aerial Investigation of Stormwater Ponds' Water Quality Impacts

## Project Manager Information

**Name:** John Gulliver

**Organization:** U of MN - St. Anthony Falls Laboratory

**Office Telephone:** (651) 636-4166

**Email:** gulli003@umn.edu

## Project Basic Information

**Project Summary:** We propose analyzing Minnesota urban stormwater ponds using AI tools and satellite imagery to remotely assess water quality conditions of individual ponds and their potential impact on downstream surface waters.

**ENRTF Funds Requested:** \$426,000

**Proposed Project Completion:** June 30, 2028

**LCCMR Funding Category:** Methods to Protect or Restore 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.**

We propose to identify the stormwater ponds with water quality problems that export noxious and greenhouse gases and undesired dissolved chemicals to receiving waters. We have been studying stormwater ponds since 2016, first discovering that many were stratified at as little of 1 foot of depth, as opposed to being well-mixed water bodies as previously assumed. Stratified stormwater ponds are different than lakes, in that they are well sheltered by trees and banks surrounding a small pond area, and have floating plants and a large sediment oxygen demand due to the material that has settled to the bottom of the pond. These stratified ponds therefore tend to have a bottom layer with low dissolved oxygen concentrations that create conditions that can release noxious and greenhouse gases to the atmosphere and export dissolved chemicals released from the pond sediments to downstream receiving waters. This discovery changed the assumption that stormwater ponds were a minimal maintenance stormwater treatment technology. Our research has indicated that there are problematic stormwater ponds that meet these conditions across Minnesota, and we are currently investigating methods to identify these problematic ponds and develop means to remediate the undesired dissolved chemical releases in order to protect downstream waterbodies.

### **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.**

Our field studies identified factors that are associated with impairment of pond water quality benefits leading to poor water quality, export of noxious and greenhouse gases and release of undesired dissolved compounds to receiving waters. Our studies provide robust predictors of anoxia in ponds, which is associated with release of dissolved chemicals from sediments and greenhouse gas production. We propose to locate at-risk ponds to identify management solutions and help prioritize their management. Current high-resolution imagery from the Planet.com satellites (available at the University of Minnesota) have a pixel resolution of 2.7 to 100 ft<sup>2</sup>, sufficient to document the character of the stormwater ponds, with areas of 10,000 to 80,000 ft<sup>2</sup>. The satellite imagery provides a measure of chlorophyll concentration that is directly related to primary productivity and performance of the ponds. We have also discovered that stormwater ponds which contain a large quantity of emergent or floating plants, like duckweed (*Lemna*) and water meal (*Wolfia*), tend to be stratified with low dissolved oxygen in the bottom layer of the pond, a primary indicator allowing identification of ponds that municipalities should consider for further study and potential remediation of bottom release of noxious gases

### **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?**

There are estimated to be over 30,000 urban stormwater ponds in Minnesota. The realization that many of these ponds require substantial additional maintenance has been a surprise for most cities, counties, commercial enterprises and watershed districts. Many do not have the budget to assess all ponds individually, so this project will provide information on which ponds potentially need maintenance and which ones do not, bringing together recent research from field studies into a tool that can be used to scale up findings toward prioritization of management of degraded ponds by cities.

## Activities and Milestones

### Activity 1: Develop satellite imagery analysis methodology for stormwater ponds

**Activity Budget:** \$102,930

**Activity Description:**

We will develop AI tools that leverage the activities of Dr. Ebtehaj under LCCMR-2024-037 for lakes to determine the floating plant coverage, emergent plant coverage and other water quality indicators of stormwater ponds. New and emerging AI tools, namely deep neural networks, will help us to characterize the level of productivity and concentration of floating plants and emergent plants on the ponds through modern supervised classification approaches. Our prior and current stormwater pond analyses will be used as a ground-truthing dataset to compare the results of the satellite imagery analysis methodology.

**Activity Milestones:**

Description	Approximate Completion Date
Adapt AI tools to Stormwater Pond analysis	June 30, 2026

### Activity 2: Apply developed satellite imagery analysis methodology to urban stormwater ponds

**Activity Budget:** \$245,537

**Activity Description:**

We will apply the developed satellite imagery analysis methodology to a dataset containing the 16,467 municipally owned MS4 ponds in the State of Minnesota. First, we will work with municipalities to create a location database for managed ponds in all interested MS4 cities. Then we will apply the satellite imagery analysis methodology, using recently developed research results, for estimating key water quality parameters for each MS4 pond to correlate its individual potential to release noxious gasses and export undesirable dissolved compounds downstream. Using the results, we will develop an inventory of ponds which the methodology indicates have acceptable water quality and those that may need further study for potential maintenance or remediation activities. We will then develop an inventory of ponds which the study indicates have acceptable water quality and those that may be in need of maintenance. Finally, we will analyze the data and methodology results to develop metrics and relationships that can help future stormwater pond owners to better monitor their stormwater assets, focus their operations and maintenance budgets on the most problematic ponds, and plan ahead for when major maintenance or remediation efforts may be necessary.

**Activity Milestones:**

Description	Approximate Completion Date
Contact municipalities to locate the stormwater ponds with names given to each pond	June 30, 2026
Apply AI methodology to estimating the water quality parameters of each pond	September 30, 2027
Develop metrics and relations that can help future stormwater pond managers	November 30, 2027
Develop an inventory of ponds according to their water quality	June 30, 2028

### Activity 3: Provide an online web tool to make the finding available to stakeholders and citizens

**Activity Budget:** \$77,533

**Activity Description:**

To bring the results to the stakeholders, we we will develop a GIS web server tool that can be used to identify Minnesota stormwater ponds and provide the information on pond water quality, gas release, and export of dissolved chemicals

determined from the satellite information in this project. We will use many currently operated technical assistance paths to provide this information to the stakeholders, stormwater practitioners and the general public, including: Stormwater Updates; an email newsletter that is circulated among over 1600 practitioners, mostly in Minnesota, the MPCA stormwater mailing list, circulated to over 5000 stormwater professionals in Minnesota, and the Minnesota Cities Stormwater Coalition.

**Activity Milestones:**

Description	Approximate Completion Date
1. Develop GIS web server for urban stormwater ponds	September 30, 2027
2. Circulate address of web server and describe its use	June 30, 2028

## Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Dr. Jacques Finlay	University of Minnesota-St. Anthony Falls Laboratory	Dr. Finlay will be involved in all aspects of the project, but will take a greater role in identifying ponds and ground-truthing AI results from our previous research.	Yes
Dr. Ardeshir Ebtehaj	University of Minnesota-St. Anthony Falls Laboratory	Dr. Ardeshir will provide his expertise in satellite imagery and the AI program that will process much of the imagery data.	Yes
Katy Thompson	Minnesota Cities Stormwater Coalition	Informing coalition members of project results	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 provide valuable information on stormwater ponds maintenance and best practices to Minnesota municipalities and other MS4 permit holders, such as the Minnesota Department of Transportation, cities and counties in the state of Minnesota, and watershed organizations across Minnesota. The web-based GIS tool will help assess their stormwater ponds and assist their maintenance efforts. In addition, results will be published in a peer-reviewed journal (UofM funding). Possible follow-on effort is performing similar analyses of agricultural ponds, funded by the Minnesota Department of Agriculture, and analysis of commercial stormwater ponds, funded by the commercial entities.

## 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 is continuing research into the future because it is his avocation. 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. He has led 108 research projects, most recently on the impacts of stratification in stormwater ponds and the associated export of pollutants, 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 - St. Anthony Falls Laboratory

**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
<b>Personnel</b>								
John Gulliver		PI and project manager; will be in charge of overall project management and tasks required to complete activities, co-supervision of one post-doctoral associate, one research associate and two undergraduate assistants.			7.7%	0.12		\$39,815
Jacques Finlay		Co-PI, co-supervision of one post-doctoral associate, one research associate and two undergraduate assistants.			37.1%	0.12		\$31,288
Ardeshir Ebtehaj		Co-PI, will develop and advise on the implementation of the AI pond assessment tool. Will supervise one post-doctoral associate.			37.1%	0.12		\$29,958
Research Associate		Will work with the post-doctoral associate and the undergraduates to make sure that the ground-truthing is properly applied.			37.1%	0.36		\$32,505
Undergraduate Research Assistants		Will implement of the AI pond assessment tool and apply the ground-truthing data to the results of the tool.			0%	2.01		\$64,945
Post-Doctoral Associate		Will work on the development of the AI tool, the application of the tool to stormwater ponds, and the development of the GIS based web server.			25.1%	2.25		\$168,720
Research Staff		Will work on developing the web-based GIS tool and help with AI technology.			33.5%	0.6		\$53,658
							<b>Sub Total</b>	<b>\$420,889</b>
<b>Contracts and Services</b>								
							<b>Sub Total</b>	-
<b>Equipment, Tools, and Supplies</b>								
	Tools and Supplies	Laptop computer and accessories for undergraduates and the Post-Doc Associate	Supplies to facilitate working with PlanetScope, the AI program and the GIS web site.					\$3,851
							<b>Sub Total</b>	<b>\$3,851</b>

<b>Capital Expenditures</b>								
							<b>Sub Total</b>	-
<b>Acquisitions and Stewardship</b>								
							<b>Sub Total</b>	-
<b>Travel In Minnesota</b>								
	Conference Registration Miles/ Meals/ Lodging	Registration and Travel for 2 to the MN Water Resources Conference	This will be to disseminate information found, as well as to gather new ideas					\$1,260
							<b>Sub Total</b>	<b>\$1,260</b>
<b>Travel Outside Minnesota</b>								
							<b>Sub Total</b>	-
<b>Printing and Publication</b>								
							<b>Sub Total</b>	-
<b>Other Expenses</b>								
							<b>Sub Total</b>	-
							<b>Grand Total</b>	<b>\$426,000</b>



Classified Staff or Generally Ineligible Expenses

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

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

**Total Project Cost: \$426,000**

**This amount accurately reflects total project cost?**

Yes

## Attachments

### Required Attachments

#### *Visual Component*

File: [80590858-ab8.pdf](#)

#### *Alternate Text for Visual Component*

Two ponds with floating plants and text describing main points of project...

### Supplemental Attachments

#### *Capital Project Questionnaire, Budget Supplements, Support Letter, Photos, Media, Other*

Title	File
Letter of Support, Regents of the University of Minnesota	<a href="#">74cb42af-f22.pdf</a>
Letter from Minnesota Cities Stormwater Coalition	<a href="#">b8c974bc-a6f.pdf</a>

## Administrative Use

**Does your project include restoration or acquisition of land rights?**

No

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

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?**

No

**Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing \$10,000 or more or large-scale stream or wetland restoration?**

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 as "the provision of care, treatment, education, training, instruction, or recreation to children")?**

No

**Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:**

Jacques Finlay, Ardeshir Ebtehaj, Angela Botch, Jon Lee all from the University of Minnesota

