Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-280

Proposal Title: Uncovering Drivers of Fecal Contamination in Minnesota's Waters

Project Manager Information

Name: Satoshi Ishii

Organization: U of MN - College of Biological Sciences

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Project Basic Information

Project Summary: This project will identify the sources and influencing factors of fecal contamination in Minnesota's surface waters and provide a decision support tool for water managers.

ENRTF Funds Requested: $500,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Water (B)

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.

Over half of Minnesota's rivers, lakes, and streams have been identified as "impaired," and fecal bacteria is one of the largest causes of impairment. Fecal bacteria are chosen to indicate the contamination of water with feces, but they provide only a partial picture of the risk posed to human, animal, and environmental health. Further investigation is required to identify the likely source of contamination for risk mitigation. Prioritization for risk mitigation is complicated by a lack of knowledge about what pathogens, and at what concentrations, were introduced into a waterbody by fecal contamination. This includes the identification of emerging threats, such as highly pathogenic avian influenza (HPAI), not currently tested for in natural waters. HPAI and other waterborne pathogens can be deposited by infected wildlife or livestock directly and through runoff. Many of these pathogens, including HPAI, can survive for months in water, particularly at cold temperatures. They can subsequently spread to humans, livestock, and wildlife, compromising public and animal health and perpetuating local cycles of transmission. Characterizing pathogens infecting fecally-contaminated waters and identifying factors that influence pathogen presence, concentration, and source, would enable water quality managers to more rapidly and efficiently identify and prioritize waters for risk mitigation.

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 overall objective is to identify sources of high-risk fecal contamination and factors that increase the likelihood of contamination. We will profile pathogen assortment, load, and persistence; source of contamination; impact of significant precipitation events; and waterbody characteristics. To provide actionable information for water managers, we will develop a geostatistical model of fecal contamination risk and create a visual dashboard. We will attain our objective through the following activities:

Activity 1: Quantify the enteric pathogen load in Minnesota's rivers, streams, and lakes during normal and extreme precipitation conditions, determine the associated host source of fecal contamination, and identify factors associated with elevated pathogen load.

Activity 2: Determine the persistence of enteric pathogens identified and determine the waterbody characteristics, water quality measures, and sources of contamination that can influence bacterial persistence.

Activity 3: Create and validate a model of fecal contamination in the Upper Mississippi and Minnesota River Basins and develop a dashboard that can be used by water managers to anticipate contamination and prioritize areas for risk mitigation.

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?

The specific project outcomes are (1) the levels of pathogens and their sources in Minnesota's watersheds, (2) the factors influencing the persistence of pathogens, (3) a pathogen predictive model, and (4) a fecal contamination dashboard for water managers. The information obtained in this project will be available to water managers through a dashboard to identify (i) when and where water testing efforts should be intensified due to an elevated threat of high-risk contamination and (ii) if contamination is detected, which scenarios to prioritize for risk mitigation.

Activities and Milestones

Activity 1: Quantify enteric pathogen load and determine the source of contamination

Activity Budget: $183,000

Activity Description:
The objective of this activity is to measure the levels of fecally transmitted pathogens in Minnesota's waters and determine what type of host was likely responsible for the fecal contamination.

Task 1: Enhance microbial source tracking assay with emerging pathogens of concern
We have developed and validated a high-throughput microbial source tracking and pathogen detection (HT-MST) tool that can measure the levels of 37 pathogens. We will add emerging pathogens of concern to local water managers, including HPAI.
Deliverable 1: Updated HT-MST tool

Task 2: Test Minnesota waters for pathogens and associated source species
We will sample 10 fecally impaired waterbodies in each of the Upper Mississippi and Minnesota River Basins 6 times per year (3 high-flow, 3 low-flow) during Years 1-2. Using HT-MST, we will identify pathogens, quantify pathogen load, and detect genetic markers indicating pathogen hosts/sources. General water quality will also be measured.
Deliverable 2: Summary of pathogens, pathogen load, and sources

Task 3: Test Minnesota waters following heavy precipitation
We will do supplemental HT-MST testing at the sites from Task 2 within 24 hours following heavy precipitation, defined as rainfall in an area's top 10%.
Deliverable 3: Better understanding of the effects of precipitation on pathogens

Activity Milestones:

Description	Approximate Completion Date
HT-MST tool updated with emerging pathogens	December 31, 2026
Summary of pathogens, pathogen load, and sources	June 30, 2028
Summary of the effects of precipitation on pathogens	December 31, 2028

Activity 2: Determine the persistence of major or emerging zoonotic enteric pathogens in water

Activity Budget: $180,000

Activity Description:
The objective of this activity is to characterize persistent pathogens in Minnesota's waters.

Task 1: Sequence the genomes of major pathogens detected multiple times
For any major or emerging pathogen (e.g. Campylobacter, Salmonella, pathogenic E. coli, Cryptosporidium, HPAI) detected multiple times within a basin, we will obtain isolated cultures for whole genome sequencing. By identifying the genomes of pathogens, we will be able to detect risk-associated factors (e.g., toxin and antibiotic resistance genes), identify the genotypes, and analyze how these genotype populations change over time. Identical isolates observed over multiple sampling times will be considered persistent.
Deliverable 1: Genetic profiles of species multiple times and persistent strains within them

Task 2: Identify risk factors for persistent strains

In most cases, persistent pathogens indicate an ongoing source of contamination, which should be mitigated to protect human, animal, and environmental health. We will identify waterbody characteristics, water quality measures, and sources of contamination associated with persistent vs. non-persistent pathogens. We will identify risk factor similarities and differences across species.

Deliverable 2: Summary of the presence and risk factors of persistent pathogens

Activity Milestones:

Description	Approximate Completion Date
Persistent pathogens identified	June 30, 2029
Summary of the presence and risk factors of persistent pathogens	June 30, 2029

Activity 3: Predict pathogen presence and load across the Upper Mississippi and Minnesota River Basins

Activity Budget: $137,000

Activity Description:
This activity aims to provide a tool for water managers to predict pathogen load in all impaired waters in the Upper Mississippi and Minnesota River Basins.

Task 1: Develop a pathogen-predictive model
Using all samples collected in Activity 1, we will model pathogen load as a function of factors known to affect fecal contamination: water flow, precipitation, temperature, vegetation type, land use, soil type, and landscape. We will use a geostatistical mixed-effect model, which will allow us to predict pathogen load at sites beyond those measured in Activity 1.
Deliverable 1: Predicted pathogen load across both basins

Task 2: Validate the predictive model
We will internally validate our model using 10-fold cross-validation, which makes optimal use of the data. If performance is low, we will re-derive the model employing an AI-based algorithm.
Deliverable 2: Performance assessment of the final model

Task 3: Create a dashboard for water managers
We will summarize our predictions in a series of maps on a fecal contamination dashboard. Working with water managers, we will determine which information is most useful to present and how best to present it in order to inform recommendations for testing and risk mitigation.
Deliverable 3: Fecal contamination dashboard

Activity Milestones:

Description	Approximate Completion Date
Model predictions obtained	December 31, 2028
Pathogen-predictive model validated	March 31, 2029
Fecal contamination dashboard for water managers	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Gillian Tarr	University of Minnesota	Co-Investigator	Yes
Caitlin Ward	University of Minnesota	Co-Investigator	Yes

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?
This project's immediate product is a dashboard, which will be designed to support the decisions of Minnesota water managers on how and where to improve water quality. We will apply the same/similar approach to other watersheds in MN in collaboration with local water managers. We will further seek state and federal funds (e.g., MPCA, EPA) to expand our microbial source tracking and pathogen detection research to improve surface water quality and mitigate health risks.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Advanced Biofilter for N2O Removal	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 07d	$325,000

Project Manager and Organization Qualifications

Project Manager Name: Satoshi Ishii

Job Title: Associate Professor

Provide description of the project manager's qualifications to manage the proposed project.
Satoshi Ishii is an Associate Professor at the BioTechnology Institute (BTI) and the Department of Soil, Water, and Climate (SWC) at the University of Minnesota. Dr. Ishii's research focuses on environmental microbiology and biotechnology, including water quality and public health microbiology. He has over 20 years of experience working on microbial source tracking and pathogen detection. Dr. Ishii has managed multiple projects related to the proposed subject, some of which were done in collaboration with the Minnesota Pollution Control Agency and local watershed management organizations.

Organization: U of MN - College of Biological Sciences

Organization Description:
The University of Minnesota is the main research and graduate teaching institution in the state of Minnesota. The BioTechnology Institute provides advanced research, training, and university-industry interaction in biological process technology. In the Department of Soil, Water, and Climate, we seek to improve and protect the quality of soil, air, and water resources in natural and managed ecosystems, through research, teaching, and extension.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Satoshi Ishii		Lead and manage the project			27%	0.12		$28,118
Gillian Tarr		Advise/supervise researchers			27%	0.45		$90,378
Caitlin Ward		Advise/supervise researchers			27%	0.21		$41,404
1 Postdoctoral research associate		Perform experiments and data analysis			21%	3		$238,586
3 Undergraduate researchers		Collect water samples and analyze data			0%	1.17		$39,594
							Sub Total	**$438,080**
Contracts and Services								
							Sub Total	-
Equipment, Tools, and Supplies								
	Tools and Supplies	Chemicals for water quality analysis	Necessary to measure general water quality (nutrients, etc.)					$10,000
	Tools and Supplies	Chemicals and laboratory supplies for microbiological analysis	Necessary to quantify pathogens, grow bacteria, and sequence genomes (culture media, petri dishes, pipette tips, DNA extraction kits, sequencing reagents etc.)					$40,000
							Sub Total	**$50,000**
Capital Expenditures								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-

Travel In Minnesota								
	Miles/ Meals/ Lodging	A total of 38 trips (200 miles/trip x 38 = 7,600 miles) are planned at a rate of $0.70/mile.	Necessary to collect water samples					$5,320
	Conference Registration Miles/ Meals/ Lodging	Trips and registration fees to present our research results at a conference in MN ($300/person x 2 researchers)	To disseminate the results					$600
							Sub Total	**$5,920**
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Open access publication fee	Necessary to make our results publicly available					$6,000
							Sub Total	**$6,000**
Other Expenses								
							Sub Total	-
							Grand Total	**$500,000**

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				
In-Kind	University of Minnesota	The University of Minnesota is not allowed to charge the State of Minnesota its typical overhead rate of 54% of the total modified direct costs. We are listing our unrecoverable indirect cost as in-kind contribution.	Secured	$270,000
			State Sub Total	**$270,000**
Non-State				
-			**Non State Sub Total**	-
			Funds Total	**$270,000**

Total Project Cost: $770,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [ed4c5dc7-3a0.pdf](ed4c5dc7-3a0.pdf)

Alternate Text for Visual Component

We will create a dashboard based on the pathogen data collected in this project. The dashboard will present interactive maps displaying waters impaired due to fecal contamination and is designed to support the decisions of water managers on how and where to improve water quality....

Supplemental Attachments

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

Title	File
U of M Proposal Approval Letter	[4902623a-35d.pdf](4902623a-35d.pdf)

Administrative Use

Does your project include restoration or acquisition of land rights?

> No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

> Yes, I understand the UMN Policy on travel applies.

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?

> Yes, Sponsored Projects Administration

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:

Sponsored Projects Administration, University of Minnesota

Do you understand that a named service contract does not constitute a funder-designated subrecipient or approval of a sole-source contract? In other words, a service contract entity is only approved if it has been selected according to the contracting rules identified in state law and policy for organizations that receive ENRTF funds through direct appropriations, or in the DNR's reimbursement manual for non-state organizations. These rules may include competitive bidding and prevailing wage requirements

N/A