

# **Environment and Natural Resources Trust Fund**

# 2026 Request for Proposal

# **General Information**

Proposal ID: 2026-203

Proposal Title: Assessment of Microplastic Pollution in Karst Aquifers

# **Project Manager Information**

Name: Benjamin Maas Organization: Minnesota State Colleges and Universities - Metropolitan State University Office Telephone: (651) 793-1456 Email: benjamin.maas@metrostate.edu

# **Project Basic Information**

**Project Summary:** We will determine the nature and extent of microplastic pollution in shallow karst aquifers, identify potential sources, and assess human and ecosystem health implications to inform mitigation and prevention strategies.

ENRTF Funds Requested: \$472,000

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? Region(s): SE
- What is the best scale to describe the area impacted by your work? Statewide
- When will the work impact occur? During the Project

# Narrative

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

About 80,000 people in southern Minnesota rely on private wells supplied by karst aquifers for their drinking water. These aquifers also support trout streams and associated tourism, ecosystem services, and agricultural activities. However, karst aquifers are especially susceptible to anthropogenic pollution in surface water due to the presence of sinkholes, thin soil coverage, and lack of natural filtration. Microplastics are emerging and prevalent pollutants associated with agricultural practices, tire wear, biosolids, and wastewaters/septic systems. Microplastics pose potential threats to human and ecological health not only due to their own effects but also as a carrier transporting co-located chemical pollutants and pathogens that sorb to their surfaces. The unique nature of karst hydrogeology makes it vulnerable to microplastic pollution, leading to an increased risk of human exposure to microplastics via impacted drinking water. However, we do not know the extent of microplastic pollution, how it is transported, or its potential accumulation in the sediment or groundwater of Minnesota's karst aquifers. Additionally, we do not know how microplastics are impacting karst ecosystems, which are essential to maintaining biodiversity. Therefore, it is critical to assess microplastic pollution in Minnesota's karst aquifers and springs.

# 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.

Because microplastics are prevalent in the environment, they are likely present in karst-supplied drinking water sources and the karst ecosystem in southeastern Minnesota. Understanding the nature and extent, potential sources, and associated risks of these pollutants is critical to informing mitigation measures. Our objectives are to determine the quantity, type, transport, and possible sources of microplastics in southeastern Minnesota's karstic region, including in karst aquifers, springs and supported streams. These data will allow us to not only determine the nature of microplastic pollution but also whether microplastics are entering and moving through the karst aquifers of Minnesota. We will also assess seasonal effects on the levels and extent of microplastic pollution under various precipitation conditions. Furthermore, we will quantify the levels of indicator inorganic pollutants and agrochemicals to identify whether microplastics may be coming from wastewaters/septic systems, agriculture, road runoff, and/or other sources. The collected information will be used to determine potential impacts of microplastics on southeastern Minnesota's fragile karst ecosystem that represents a biodiversity hotspot. This information will also be used to assess potential health implications and provide recommendations for better managing these aquifers to protect the drinking water resources and critical habitats they support.

# 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 project will enhance our understanding of the nature and extent, sources, and transport of microplastics in the shallow karst aquifers of southeastern Minnesota. This information is critically important to understanding implications for the public health of rural Minnesotans, trout streams, and ecosystems supported by karst springs. Furthermore, knowing how microplastics enter and move through karst aquifers will enable better management of vulnerable drinking water resources and could result in best practices to limit microplastic pollution from entering karst aquifers.

# Activities and Milestones

# Activity 1: Quantify microplastics in shallow karst aquifers

Activity Budget: \$377,800

#### **Activity Description:**

The goal of Activity 1 is to determine the quantity and type of microplastics present in karst aquifers in southeastern Minnesota. To obtain these data, multiple field investigations, or field campaigns, will be completed in the Minnesota Cave Preserve. Springsheds with known inlets (sinkholes) and outlets (springs) will be investigated during a variety of flow conditions to understand whether sinkholes are the main entrance of microplastics from the surface and whether caves are sinks for microplastics where they can accumulate. We will also determine whether storm events (high flow conditions) can mobilize accumulated microplastics through karst aquifers, thus increasing their chances of being present in nearby wells used as drinking water sources. We will also investigate how land use can impact the quantity and type of microplastics in karst aquifers by sampling sinkholes near agriculture, roads, forests, and septic systems. Samples from groundwater, surface water, and sediment will be processed and analyzed to determine the type and quantity of microplastics with different size fractions, using pyrolysis gas chromatography mass spectrometry, optical microscopy, and infrared spectroscopy.

#### **Activity Milestones:**

Description	Approximate
	Completion Date
Complete first field campaign to collect samples for analysis, process and analyze samples for	December 31, 2026
microplastics	
Complete second field campaign to collect samples for analysis, process and analyze samples for	December 31, 2027
microplastics	
Complete third field campaign to collect samples for analysis, process and analyze samples for	December 31, 2028
microplastics	
Report preparation, including impacts of precipitation and land use on microplastic	June 30, 2029

# Activity 2: Using anthropogenic pollution to identify the sources of microplastic pollution in shallow karst aquifers

Activity Budget: \$74,200

#### **Activity Description:**

The goal of Activity 2 is to investigate the potential sources of microplastics in karst aquifers of southeastern Minnesota. These aquifers are known to contain other pollutants (including chloride, caffeine, nitrate and agrochemicals) from a multitude of anthropogenic activities, which negatively impact the public health of rural Minnesotans, trout streams, and ecosystems supported by karst springs. For example, in 2023, the US EPA advised the state of Minnesota to decrease nitrate concentrations (resulting from agricultural practices) in the impaired karst aquifers of southeastern Minnesota. We will analyze samples collected from each of the springsheds and karst-supported streams for these known inorganic and organic pollutants to help identify sources of microplastic pollution. Specifically, chemicals that were found to effectively identify sources from agriculture, septic tanks, and road salts from a previous LCCMR grant and other studies will be quantified. Agrochemicals known to be present in shallow karst aquifers will also be determined, to further help identify specifically agriculture-related pollution sources. Inorganic chemicals (e.g., chloride and nitrate) will be quantified using ion chromatography, and organic chemicals (e.g., agrochemicals, caffeine, and laundry fluorescent whitening agent) will be determined using liquid chromatography-mass spectrometry.

#### **Activity Milestones:**

Description	Approximate Completion Date
Analyze pollutant source data, a subset of samples collected during first field campaign, activity 1	December 31, 2026
Analyze pollutant source data, a subset of samples collected during second field campaign, activity 1	December 31, 2027
Analyze pollutant source data, a subset of samples collected during third field campaign, activity 1	December 31, 2028
Report preparation, including pollutant source identification of microplastic pollution	June 30, 2029

## Activity 3: Risk assessment of microplastic pollution to karst ecosystems

#### Activity Budget: \$20,000

#### **Activity Description:**

The goal of Activity 3 is to examine potential human and ecological risk implications of microplastics in the karst system of southeastern Minnesota. This activity will leverage the information developed during Activities 1 and 2 regarding the quantity and type of microplastics in surface water, sediment, and groundwater, and the sources of the microplastic, to conduct an illustrative screening risk assessment of microplastic pollution in the karst ecosystem and drinking water wells. Using the concentration, size, and type of microplastics found in the karst aquifers, we will leverage an existing human and ecological risk assessment framework for microplastics and quantify the ecological risk index and human health risks (cancer and noncancer endpoints) as screening risk indicators. We will estimate exposure factors based on the measured microplastic concentrations and route of exposure (e.g., ingestion and dermal uptake by macro vertebrate and human). The screening risk assessment will consider the persistence, bioaccumulation, and toxicity indicators based on literature data, as available.

#### **Activity Milestones:**

Description	Approximate Completion Date
Conceptual framework for screening assessment of human and ecological risks of microplastics in karstic aquifer	August 31, 2026
Example screening assessment illustrated with unit microplastic concentrations	December 31, 2026
Test application of the screening assessment using selected field data	August 31, 2027
Refined framework for screening assessment of human and ecological risks	December 31, 2027
Report preparation. including risk assessment of microplastic to karst ecosystems	June 30, 2028

# **Project Partners and Collaborators**

Name	Organization	Role	Receiving Funds
Boya Xiong, Ph.D.	University of Minnesota	Assistant Professor, Department of Civil, Environmental, and Geo-Engineering	Yes
Margaret MacDonell, Ph.D.	Argonne National Laboratory	Department Head, Radiological, Chemical, and Environmental Risk Analysis, Environmental Science Division	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?

For the first time, the scope of microplastic pollution in shallow karst aquifers in southeastern Minnesota will be determined and a preliminary screening assessment of potential risks to the karst ecosystem and drinking water resources will be developed. Data will be used to better inform future monitoring and management of groundwater resources and springs in the karstic region, help shape best management practices, and inform to what extent drinking water resources might be impacted by microplastic pollution. Results will be communicated to stakeholders, including the MPCA, MDH, and MNDNR, and others, by presentations, local and regional conferences, and peer-reviewed publications.

# Project Manager and Organization Qualifications

#### Project Manager Name: Benjamin Maas

#### Job Title: Assistant Professor

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

Professor Maas is a hydrogeochemist whose research focuses on the carbonate geochemistry of karst aquifers and carbonate springs. Maas is an assistant professor in the Department of Natural Sciences at Metropolitan State University in St. Paul, Minnesota. Prior to joining Metropolitan State University, Maas was a hydrologist in South Dakota doing stormwater modeling for a consulting company, and an Associate Professor at Buena Vista University, in Storm Lake, Iowa. Maas received his Ph.D. in Geology from Louisiana State University (2015), his master's degree from Illinois State University in Hydrogeology (2010), and his bachelor's degrees from the University of Minnesota in Geology and in Geophysics (2008). Maas has research experience in carbonate springs in karstic systems, including studying anthropogenic influences on spring water quality and geochemical modeling of saline springs. Maas has studied karst systems for more than 10 years, including karst systems in southeast Minnesota. Maas has published multiple manuscripts on the topic of karst geochemistry and anthropogenic pollution in karst.

Maas has taught a variety of Earth science related courses to undergraduate students, which include Hydrology, Environmental Chemistry, Earth Surface Processes, Introduction to Soils, and Introduction to GIS, among others. Maas is passionate about raising the public awareness of karst landscapes and improving the quality of our water resources.

Organization: Minnesota State Colleges and Universities - Metropolitan State University

#### **Organization Description:**

Established in 1971, Metro State serves more than 8,000 students in our metropolitan area locations as we approach our fifty-fifth anniversary.

Metro State is a fully accredited, comprehensive university and a member of the Minnesota State higher education

system. CollegeNet's 2024 Social Mobility Index, measuring colleges' and universities' success in elevating students from low income strata into the middle class by five years after graduation, ranks us thirty-first in the nation and first in the Midwest region.

With more than 60 undergraduate programs and more than 20 graduate programs, including our unique individualized studies programs where students design their own bachelor's or master's programs, Metro State offers in-demand degrees to help you get where you want to go!

# Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineli	% Bene	# FTE	Class ified	\$ Amount
				gible	fits		Staff?	
Personnel								
Benjamin Maas		Co-PI and Project Manager			14.9%	0.69		\$44,654
Undergraduate student		Multiple students at metro state will assist with this project			0%	0.36		\$10,697
							Sub Total	\$55,351
Contracts and Services								
Boya Xiong	Subaward	Dr. Xiong is an associate professor at the University of Minnesota and will be Co PI and will focus on Activity 1				0.18		\$39,112
Post Doctoral Associate	Subaward	This person will perform sampling procedures				2.24		\$180,599
Margaret MacDonell	Subaward	Dr. MacDonell will support work on activity 3				0.06		-
Graduate student	Subaward	Support work processing data				0.5		\$61,150
Undergraduate student	Subaward	Undergraduate student at the University of Minnesota				0.36		\$11,939
							Sub Total	\$292,800
Equipment, Tools, and Supplies								
	Equipment	Laboratory Supplies	Laboratory supplies for microplastic processing and detection using microscopy					\$22,000
	Tools and Supplies	Lab Services for Sample Analysis (pygcms, IC, and cations)	These services will allow for samples to be analyzed for organic and inorganic pollutants, for the pollution source identification					\$60,000
	Tools and Supplies	MS instrument maintenance and time	These funds will be used to ensure that equipment is properly maintained					\$15,000

	Equipment	Laboratory and field work supplies for the collection	These supplies will be used to			\$6,000
		of water samples and IC work	complete analyses of water for			
			inorganic pollutants			
					Sub	\$103,000
					Total	
Capital						
Expenditures						
					Sub	-
					Total	
Acquisitions						
and						
Stewardshin						
Stewardship					Sub	_
					Total	-
Travel In					Total	
Minnosoto						
winnesota	Othor	Cost to sover 6 field compaigns to collect complex	Lin to six field compaigns each year	+ + + -	_	¢2 975
	Other	for microplastic analyses. Each trip is 280 miles	op to six field campaigns each year			25,675
		round trip. Budgeted for two people on each trip	will be used to collect all samples that			
		round trip. Budgeted for two people on each trip.	will be applying			
	Canfananaa		Will be allalyzed.			6074
	Conference	Weals for six field campaigns, meals include lunch	Monies for food for two people to			\$974
	Registration	and dinner for two people	support sample collection			
	Ivilies/ Ivieals/					
	Lodging					4
					Sub	\$4,849
					Total	
Travel Outside						
Minnesota						
	Conference	1 trip per year for two years of the grant. two	Two people in two of the years of the			\$8,000
	Registration	people each year will go to a conference to present	grant will attend a conference.			
	Miles/ Meals/	work related to the project.				
	Lodging					
					Sub	\$8,000
					Total	
Printing and						
Publication						
	Publication	One publication in scientific. peer-reviewed journal	To share results with the scientific			\$8,000
			community and the general public			
					Sub	\$8,000
					Total	
Other						
Expenses						

			Sub	-
			Total	
			Grand	\$472,000
			Total	

# 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: \$472,000

This amount accurately reflects total project cost?

Yes

# Attachments

## **Required Attachments**

*Visual Component* File: <u>272150e9-27f.docx</u>

#### Alternate Text for Visual Component

Southeast Minnesota karst lands, with a link included to the Minnesota Cave Preserve's website...

#### Supplemental Attachments

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

Title	File
Qualifications of Activity Leaders	<u>48da818d-c6b.docx</u>
Metro State University - Ben Maas - Scope of Work	292ddb18-eac.docx
Metro State University - Ben Maas - LCCMR Budget Justification	9afda806-a3f.docx
Total Budget - Metro State University & U of MN	ba9521d9-ad9.xlsx
U of MN - Boya Xiong - Scope of Work	<u>312238e6-595.docx</u>
U of MN - Boya Xiong - LCCMR Budget Justification	ac58c97c-e40.docx
U of MN budget portion	5c29edb8-48d.xlsx
U of MN Letter of Support	db98ae4a-737.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 Commissioner's Plan 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?

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:

From Metropolitan State University, Dean of the College of Science Kyle Swanson, Ph.D., From the University of Minnesota Boya Xiong, Ph.D., Assistant Professor, Department of Civil, Environmental, and Geo-Engineering, Enoch Pan, Finance Professional, and Christina Doherty, Senior Grants & Contracts Officer, and from Argonne National Laboratory, Margaret MacDonell, Ph.D., Department Head, Radiological, Chemical, and Environmental Risk Analysis, Environmental Science Division

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