Environment and Natural Resources Trust Fund

M.L. 2026 Draft Work Plan

General Information

ID Number: 2026-203

Staff Lead: Lisa Bigaouette

Date this document submitted to LCCMR: December 1, 2025

Project Title: Assessment of Microplastic Pollution in Minnesota Karst Aquifers

Project Budget: $458,000

Project Manager Information

Name: Boya Xiong

Organization: U of MN - College of Science and Engineering

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Project Reporting

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2029

Final Report Due Date: August 14, 2029

Legal Information

Legal Citation:

Appropriation Language:

Appropriation End Date: June 30, 2029

Narrative

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.

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.

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?

Region(s): SE

When will the work impact occur?

During the Project and In the Future

Activities and Milestones

Activity 1: Quantify microplastics in shallow karst aquifers

Activity Budget: $373,200

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), cave streams, and outlets (springs) from multiple locations will be investigated 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 perform sampling and analysis of identified locations during a variety of flow conditions. with a focus on determining 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. By selecting sampling locations near agriculture, roads, and septic systems, we will investigate how land use can impact the quantity and type of microplastics in karst aquifers. 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 and fluorescent microscopy, and micro-Raman spectroscopy.

Activity Milestones:

Description	Approximate Completion Date
Complete first field campaign to collect samples for analysis, process and analyze samples for microplastics	September 30, 2027
Complete second field campaign to collect samples for analysis, process and analyze samples for microplastics	December 31, 2027
Complete third field campaign to collect samples for analysis, process and analyze samples for microplastics	December 31, 2028
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: $64,800

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	September 30, 2027
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, manuscript 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, size, shape, and type of microplastics in surface water, sediment, and groundwater, and the sources of the microplastics, to conduct a probabilistic-based ecological risk assessment of microplastic pollution in the karst ecosystem. We will leverage an existing probabilistic-based ecological risk assessment framework for microplastics and quantify the ecological risk characterization ratio. In addition, we will perform an illustrative screening risk assessment of microplastic pollution to assess 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 humans). 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	December 31, 2026
Example screening assessment illustrated with unit microplastic concentrations	August 31, 2027
Test application of the screening assessment using selected field data	December 31, 2027
Refined framework for screening assessment of human and ecological risks	December 31, 2028
Report preparation. manuscript preparation, including risk assessment of microplastic to karst ecosystems	June 30, 2029
Propose drinking water guidelines around microplastic pollution in karst region with MPCA	June 30, 2029
Archive project data in an open access repository.	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Boya Xiong, Ph.D.	University of Minnesota	PI, supervising and leading the entire project.	Yes
Margaret MacDonell, Ph.D.	Argonne National Laboratory	Department Head, Radiological, Chemical, and Environmental Risk Analysis, Environmental Science Division	No
Benjamin Maas	DNR	collaborator on identifying sampling sites and mentoring postdoc to create the initial sampling protocol and efforts.	No
Rondedrick Sinville	Metropolitan State University	Co-PI responsible for anion analysis of all water samples and supervising students.	Yes

Dissemination

Describe your plans for dissemination, presentation, documentation, or sharing of data, results, samples, physical collections, and other products and how they will follow ENRTF Acknowledgement Requirements and Guidelines.
For each of the activities, results will be disseminated by peer-reviewed publications in archival journals. Data will also be archived in the open-access data repository for the University of Minnesota. In both cases, this will make information from the project widely accessible to Minnesotans and other interested parties who are working on the environmental impacts of microplastics in surface water and groundwater. Results from the project will also be presented at scientific conferences, including local/regional conferences. We will also communicate key findings to scientists in the Minnesota Pollution Control Agency directly. PI Xiong has established regular communication with personnel from the Water Quality Standards Unit of the Minnesota Pollution Control Agency (MPCA). They are the only personnel at the state level who are actively involved in sampling and measuring the scope of microplastic contamination in Minnesota's water and are involved in developing regulatory guidelines from their data. They will unofficially support the technical aspects of this project and leverage the data generated from this project for risk assessment and to develop guidelines for drinking water in the karst region. In the last year of this project, the team will share our findings with MPCA and help develop drinking water guidelines around microplastic pollution. Lastly, the Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and presentations.

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.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Dr. Boya Xiong/principal investigator		Principal Investigator; Leading and supervising the project. Responsible for microplastic sampling and analysis, and analysis of organic compounds, postdoc and grad student advising, , publication, and outreach			36.6%	0.06		$53,693
Undergraduate student (UMN)		Students will assist with sampling and microplastic analysis			0%	0.12		$11,939
Postdoc		This researcher will lead sampling and perform the analysis of microplastics and organic contaminants, publication			26.1%	0.75		$180,887
Graduate student research assistant		Students will work on sampling and microplastic analysis			24.2%	0.5		$63,744
							Sub Total	**$310,263**
Contracts and Services								
Lab services	Internal services or fees (uncommon)	Characterization facility Raman spectroscopy and AFTR-FTIR at UMN Minneapolis campus and cation analysis on the St Paul campus				0		$49,261
North Dakota State University, Prof. Syeed Islanker	Service Contract	Prof. Islanker's group will perform pyGCMS analysis of the purified microplastic samples.		X		0		$5,000
Metro State University	Subaward	Supporting one co-PI Rondedrick Sinville's salary ($20,129) and undergraduate students ($10,697), and lab supplies ($4,800) In charge of analyzing anion concentration, mentoring undergraduate student, and publication.				0		$35,626
							Sub Total	**$89,887**

Equipment, Tools, and Supplies								
	Tools and Supplies	Laboratory and field work supplies for the collection of water samples, microplastic analysis, and organic analysis (no single item will exceed $5,000)	These supplies will be used to complete analyses of microplastics, organic pollutants, and cations.					$27,500
	Tools and Supplies	mass spectrometry instrument supply and maintainence cost Laboratory and field work supplies for the collection of water samples, microplastic analysis, and organic analysis (no single item will exceed $5,000)	For analyzing organic compounds in samples					$15,000
							Sub Total	**$42,500**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Cost to cover 6 field campaigns to collect samples for microplastic analyses. Each trip is 280 miles round trip. Budgeted for two people on each trip. Meals for six field campaigns, meals include lunch and dinner for two people. There will not be any overnight stays for this project as the field sites are in southeastern Minnesota	Up to six field campaigns each year and 18 total. these field campaigns will be used to collect all samples that will be analyzed. Monies for food for two people to support sample collection.					$4,850
							Sub Total	**$4,850**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	One travel of project PI to outside MN conference (e.g. Association of Environmental Engineering and Science Professors (AEESP) Research and Education Conference or The Society of Environmental Toxicology and Chemistry annual conference))	To give formal presentation on project findings and identify further collaboration and secure federal funding	X				$2,500
							Sub Total	**$2,500**

Printing and Publication								
	Publication	One publication in scientific. peer-reviewed journal	To share results with the scientific community and the general public					$8,000
							Sub Total	**$8,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$458,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - North Dakota State University, Prof. Syeed Islanker	Service Contract	Prof. Islanker's group will perform pyGCMS analysis of the purified microplastic samples.	This has to be done out of state because there is no running pyGC-MS instrument in Minnesota that is readily available for use via collaboration. There is one instrument, but it is not easily accessible.
Travel Outside Minnesota	Conference Registration Miles/Meals/Lodging	One travel of project PI to outside MN conference (e.g. Association of Environmental Engineering and Science Professors (AEESP) Research and Education Conference or The Society of Environmental Toxicology and Chemistry annual conference))	To give a formal presentation on project findings and identify further collaboration, and secure federal funding. Such collaboration could lead to more advanced risk assessment for microplastic pollution in Minnesota.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	No funds required	Dr. MacDonell will support work on activity 3. No monies will be required for this work.	Secured	-
In-Kind	No funds required	Dr. Benjamine Maas will train the postdoc for the sampling protocol and provide access to sampling locations through his connections.	Secured	-
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $458,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 272150e9-27f.docx

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
2025-11-12 Letter from Metro State approving change to UMN as lead institution	9063c795-b99.pdf
UMN SPA letter	53f23819-451.pdf
SPA_UMN letter	52c5ba60-b2d.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

Some minor reductions in the money requested to cover the laboratory services and to the amount requested to cover costs associated with hiring a post doc. were made. The reduction in laboratory services came from a reduction in the number of samples that will be analyzed. Because there are fewer samples that will need to be prepared, run, and then analyzed, the funds needed for a post doc were also reduced accordingly.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

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 project:

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

Yes, I understand