Environment and Natural Resources Trust Fund

M.L. 2026 Draft Work Plan

General Information

ID Number: 2026-447

Staff Lead: Lisa Bigaouette

Date this document submitted to LCCMR: October 23, 2025

Project Title: Cheap Portable Sensor to Detect PFAS in Water

Project Budget: $357,000

Project Manager Information

Name: Tianhong Cui

Organization: U of MN - College of Science and Engineering

Office Telephone: (612) 626-1636

Email: cuixx006@umn.edu

Web Address: https://cse.umn.edu/

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 propose to develop a cheap, accurate, and ease-to-use sensor for detection of PFAS in water. It can be used for natural water monitoring and drinking water detection of PFAS.

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

PFAS are human-made chemicals found in many industrial and consumer products because they repel water and oil. However, these chemicals do not break down easily and build up in the environment, especially in water sources. Over time, this can harm ecosystems and pose serious health risks to people. Exposure to PFAS has been linked to problems such as developmental and reproductive issues, thyroid disorders, weakened immune function, and liver damage. PFAS contamination in drinking water and natural water bodies is a growing concern. Detecting these chemicals currently requires laboratory tests like liquid chromatography-mass spectrometry (LC-MS), which are highly accurate but expensive, slow, and require specialized equipment. This makes regular testing difficult, especially in areas with limited resources or where quick results are needed. This proposal aims to develop an affordable, portable sensor for rapid PFAS detection. This new tool will allow on-site testing, reducing the need for costly lab analysis and speeding up contamination assessments. By making PFAS detection more accessible and efficient, this innovation will improve environmental monitoring and help protect public health by enabling faster responses to pollution.

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.

We plan to develop an affordable, portable sensor that can quickly detect PFAS in water. The sensor will use laser-induced graphene (LIG) and molecularly imprinted polymers (MIPs). LIG creates a conductive and porous surface that improves sensitivity, while MIPs help the sensor accurately recognize PFAS molecules. This design will allow real-time, on-site testing without the need for expensive laboratory equipment. Funding will support two main efforts. First, we will design, build, and test the sensor in the laboratory, ensuring it is sensitive, accurate, and easy to use. This step will focus on improving how LIG and MIPs work together and on testing the sensor with controlled PFAS samples. Second, we will connect the sensor to a portable electrochemical testing kit and conduct field tests in Minnesota lakes and rivers. These real-world trials will help us identify and address any performance issues, ensuring the sensor is ready for practical use in environmental monitoring.

We have established proof of concept for this design in our laboratory using a low-cost, highly sensitive, and selective LIG-MIP sensor for perfluorooctanoic acid (PFOA), as demonstrated in the results provided on the Attachments page as a supplemental file.

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?

This project will help protect Minnesota's water by making PFAS detection more affordable and portable. With easier access to testing, contamination can be identified and addressed more quickly, reducing long-term environmental harm. The project will help safeguard aquatic ecosystems, protect wildlife from PFAS exposure, and ensure cleaner water for public use. Data from Minnesota's lakes and rivers will support informed policy decisions and cleanup efforts. This sensor provides a practical and scalable way to expand PFAS monitoring, improving the state's ability to manage and reduce contamination effectively.

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

Activities and Milestones

Activity 1: Design, fabricate, and test an affordable, accurate, and easy-to-use sensor for detecting PFAS in water in a laboratory setting

Activity Budget: $178,000

Activity Description:
The first activity of the project focuses on designing, fabricating, and testing a highly sensitive sensor based on laser-induced graphene (LIG) for PFAS detection in the lab. This phase begins by optimizing the fabrication process for LIG electrodes, adjusting factors including laser power, scan speed, and electrode shape to improve conductivity, stability, and surface area for better electrochemical sensing. The electrodes' structures and electrical properties will be analyzed to ensure strong performance. Next, molecularly imprinted polymers (MIPs) will be created for different PFAS compounds. This involves using electropolymerization, where monomers form selective binding sites around PFAS molecules. The process will be tuned by adjusting factors including monomer-to-template ratio, polymerization time, and cycle number to enhance selectivity. Finally, the sensor's performance will be tested in the lab by measuring its ability to detect various PFAS compounds, developing calibration curves, and evaluating response time, stability, and repeatability. These results will help refine the sensor before moving on to real-world field testing.

Activity Milestones:

Description	Approximate Completion Date
Design, fabrication, and evaluation of PFAS sensors and discussion with Minnesota agencies (MPCA & MDH)	June 30, 2027
Design, synthesis, and evaluation of molecularly imprinted polymers for various PFAS with conference presentations	June 30, 2028
Characterization, evaluation, and optimization of portable PFAS sensors in lab, published peer-reviewed papers	June 30, 2029

Activity 2: Integration of the sensor with a portable electrochemical measurement kit, followed by field testing, refinement, and optimization in real-world conditions

Activity Budget: $179,000

Activity Description:
The second activity focuses on integrating the PFAS sensor with a portable electrochemical measurement kit for real-world use. This step ensures the sensor is practical for field deployment and works effectively in different water environments. First, the sensor will be connected to a portable electrochemical workstation, allowing for on-site PFAS detection. Its performance will be tested with real water samples from Minnesota lakes and rivers, optimizing it for different environmental conditions. A standardized detection process will be developed to ensure accurate and consistent results across various water sources. Next, field tests will be conducted using the portable detection kit, incorporating wireless data transmission for real-time monitoring. These tests will assess sensor stability, response time, and accuracy in natural settings, guiding improvements for better reliability and durability. Finally, we will analyze the collected data and collaborate with environmental agencies and policymakers in Minnesota. The findings will provide insights into PFAS contamination trends, helping to refine monitoring strategies and strengthen the sensor's role in long-term environmental protection and policy decisions.

Activity Milestones:

Description	Approximate Completion Date
Integrated PFAS sensing systems, launched online measurement kit, and established standard protocol	June 30, 2027

Completed field test results, technical report, conference presentations, launched project website	June 30, 2028
Data analysis and system evaluation of PFAS sensors with stakeholders, culminating in peer-reviewed publications	June 30, 2029

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.
Project results will be shared through peer-reviewed open-access publications, conference presentations, and direct communication with Minnesota agencies such as the MPCA and MDH. Data, calibration curves, and fabrication protocols will be made available in public repositories to ensure reproducibility and long-term accessibility. We will engage with environmental managers, municipal water utilities, and industry partners to demonstrate the technology and explore adoption for PFAS monitoring. Public outreach will include talks, infographics, and social media to communicate the work's environmental benefits in an accessible manner. All publications, presentations, and outreach materials will include the Environment and Natural Resources Trust Fund logo and attribution language per ENRTF guidelines. Physical prototypes and datasets will be archived at the University of Minnesota for at least five years to ensure their continued availability.

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 will develop portable field and laboratory testing kits for PFAS detection in water, with patents filed to support commercialization. Findings will be shared through publications, conferences, and collaborations with industry and environmental agencies to encourage adoption. The University of Minnesota and Cui's lab will continue supporting development through the NSF Regional Innovation Engine, which has an initial $15 million investment over two years and potential for up to $145 million over eight years. This water technology initiative will drive further advancements, optimization, and real-world deployment.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Tianhong Cui		Principal Investigator			26.79%	0.24		$89,299
Graduate Research Assistant		Research Assistant			43.01%	1.5		$186,769
							Sub Total	**$276,068**
Contracts and Services								
Scientific Services - University Of Minnesota Nano Center and the Characterization Facility	Internal services or fees (uncommon)	Scientific Service at the University of Minnesota's Minnesota Nano Center and the Characterization facility. Fabrication and characterization costs of the PFAS detectors in central facilities				0		$37,500
							Sub Total	**$37,500**
Equipment, Tools, and Supplies								
	Tools and Supplies	Silicon wafers, polymer substrates, graphene, chemicals, and components for testing set-up	Materials and supplies for various items required to fabricate and characterize the PFAS sensor					$29,932
							Sub Total	**$29,932**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**

Travel In Minnesota								
	Miles/ Meals/ Lodging	We plan two multi-day U.S. trips per year within Minnesota for two staff (500 miles each trip), reimbursed at $0.655/mile, with meals at $75 per person per day and lodging at $200 per room per night.	Sampling and field tests in Minnesota waters					$13,500
							Sub Total	**$13,500**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$357,000**

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				
In-Kind	Unrecovered F&A calculated at 54% MTDC	Support of ME Facilities where research will be conducted.	Secured	$169,212
			Non State Sub Total	**$169,212**
			Funds Total	**$169,212**

Total Project Cost: $526,212

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 621eaf3b-7ad.pdf

Alternate Text for Visual Component

Comparision of the current and proposed technologies...

Supplemental Attachments

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

Title	File
Proposal Submission Authorization Letter	f2a9512c-e50.pdf
Proof of Concept	bfce61cb-af2.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

No changes were made compared to the final proposal, except for updating the budget to move “Scientific Services” to the Services and Subawards subtab as an Internal Service, revising milestones to explicitly include outputs such as publications and reports, and adding quantity details for Travel in MN (trips, miles, people, and rate).

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?

Yes

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

Yes

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

No

Does your project include original, hypothesis-driven research?

No

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 project:

Josh Gates <gates191@umn.edu>

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