Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-312

Proposal Title: Optimal Sampling Design for Tracking Impairments in Streams

Project Manager Information

Name: Kun Zhang

Organization: U of MN - Duluth

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Project Basic Information

Project Summary: Because agencies have limited resources and capacity to monitor streams at adequate resolution to assess stream health, we will use advanced computational approaches to develop and evaluate optimal sampling designs.

ENRTF Funds Requested: $329,000

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.

Transport of legacy and emerging contaminants to receiving waterbodies, particularly in urbanized and agriculturally impacted watersheds, present a serious challenge to Minnesota communities. Comprehensive water quality monitoring data are essential to inform stormwater management decisions and watershed management strategies. However, state and regional agencies often face resource and capacity constraints that make it challenging to collect data at the necessary spatial and temporal resolution. Instead of relying solely on extensive field measurements, innovative computational algorithms, such as data-driven sparse-sensing (DSS), offer a promising solution. By mining existing datasets, these approaches can optimize both sampling locations and timing, enabling efficient stream monitoring programs at significantly lower costs (i.e., fewer sampling sites, events, and associated analytical costs) while still providing the adequate monitoring data needed for the management of our treasured lakes and streams. Additionally, the integration of volunteer-collected water quality data can help increase spatial and temporal resolution at minimal costs while also building a cohort of individuals with a deeper understanding and appreciation of what it takes to manage the state's natural resources.

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.

To help protect Minnesota's streams with lower monitoring costs, we will mine historical data using advanced computational frameworks to find the most representative locations and times to take samples. We will first compile historical datasets (discharge, conductivity, turbidity, and temperature) across Minnesota from the Watershed Pollutant Load Monitoring Network (WPLMN) database and identify the prioritized streams for sampling. Based on the results, we will identify 3 prototyped streams (1 urbanized, 1 agricultural, and 1 forested) for sampling. We will identify the specific times to take samples in each stream by investigating the historical data. Then we will sample these 3 streams at the calculated optimal times in 2027 and 2028 for chloride, sediments, nitrogen, and phosphorus to evaluate the accuracy of annual load calculations based on the optimal (reduced) sampling design versus traditional approaches. Volunteer water quality monitors will be outfitted with sampling kits and trained to routinely monitor bacteria, chloride, sediments, temperature, and conductivity in these streams. Data collected by these citizen scientists will be integrated with the professionally collected data to assess the benefit of incorporating citizen science programs. Finally, we will meet with partners to turn our findings into a water quality monitoring recommendation report.

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?

Our proposed study will identify the prioritized streams to sample across Minnesota that serve as representative streams for different regions or land cover types. We will also identify the optimal sampling timing for collecting essential contaminant data in selective urbanized, agricultural, and forested streams and validate them through field campaigns with professional and citizen scientists. This information is needed by agencies and municipalities to develop efficient stream monitoring and sampling plans, minimizing efforts and costs while supporting habitat protection and watershed management. Furthermore, a corps of community scientists become local experts, enhancing information sharing and potential behavior changes in communities.

Activities and Milestones

Activity 1: Identify Representative Streams Statewide and Develop Optimal Sampling Design for Prototyped Streams

Activity Budget: $106,947

Activity Description:
We will synthesize historical high frequency sensor data (15-minute observations of stream discharge, temperature, turbidity, and conductivity) in streams across Minnesota using the MPCA's Watershed Pollutant Load Monitoring Network (WPLMN) database and the 40 year Metropolitan Council stream monitoring dataset. We will utilize the dataset as our training dataset to identify the most representative watersheds for sampling using the DSS framework described above. Using these results, we will work with our partners to obtain historical data from 3 prototyped streams (1 urbanized, 1 agricultural, and 1 forested) to identify the optimal sampling times to monitor streams using the same approach as previously described.

Activity Milestones:

Description	Approximate Completion Date
Compile data from MPCA WPLMN and Metropolitan Council	October 31, 2026
Identify the prioritized watersheds across the state	February 28, 2027
Produce an optimal sampling design in the selected streams	March 31, 2027

Activity 2: Validate the Accuracy of Optimal Sampling Design through Field Trials

Activity Budget: $204,838

Activity Description:
To validate the accuracy of optimal sampling times obtained in Activity One, we will perform a two-year field sampling trial at three selected case study watersheds. We will collect 24 grab samples in total each year at each stream; 12 samples taken at the optimal times identified in Activity One and 12 samples taken monthly. The water samples will be analyzed for total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and chloride by NRRI. Additionally, we will work with a group of volunteering citizen scientists to collect water samples at the same location and analyze for chloride and E. coli as supplementary data. We will estimate their annual loads using data-driven algorithms (based on the samples taken at the optimal times) and using traditionally used tools (FLUX and LOADEST; based on the monthly samples) and compare them. We will compare annual loads based on different numbers of samples to explore the minimum required samples to obtain adequate annual load calculations. We will also compare the results of professionally collected samples with those augmented by citizen science data to determine the effectiveness of leveraging citizen science programs to improve water quality assessments.

Activity Milestones:

Description	Approximate Completion Date
Site visits to identify sampling locations	April 30, 2027
Collect and analyze water quality samples in Year 1	October 31, 2027
Collect and analyze water quality samples in Year 2	October 31, 2028
Nutrient load estimation and comparison	March 31, 2029

Activity 3: Develop Water Quality Sampling Recommendations with Partners and Practitioners

Activity Budget: $17,215

Activity Description:

We will use the findings of Activity One and Two to answer important management questions such as: which watersheds best represent the hydrologic and biogeochemical processes over the entire state and, thus, should be prioritized for monitoring and sampling?, when is the best time to collect water quality samples in urban, agricultural, and forested watersheds?, and what is the minimum number of samples required for accurate water quality load estimation? We will organize kick-off and wrap-up workshops with our partners at Minnesota Pollution Control Agency, Metropolitan Council, and practitioners specializing in water quality monitoring in the region. We will collect input from our partners about the existing sampling approaches in kick-off workshops prior to field trials. We will disseminate the findings of this project, discuss possible water quality sampling recommendations, and explore future funding models to support water quality monitoring and sampling in the state in the wrap-up workshops. To expand the project's reach, we will present findings at regional meetings, such as the St. Louis River Summit and the Water Resources Conference. Through project reporting and scientific publications, we will share our findings so that other state agencies and tribes may use them to guide their water quality sampling.

Activity Milestones:

Description	Approximate Completion Date
Host kick-off workshops and get advice from partners prior to field trials	March 31, 2027
Host wrap-up workshops to deliver project outputs, discuss possible sampling recommendations, and future funding models	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Christopher Filstrup	U of MN - Duluth - NRRI	Filstrup leads NRRI's Central Analytical Water Testing Lab and will be responsible for the analytical testing of water samples. He will be responsible for project administration and reporting, data analysis and interpretation, and stakeholder engagement.	Yes
Jerry Henneck	U of MN - Duluth - NRRI	Henneck is a senior research scientist specializing in field sampling and instrumentation. He will be responsible for leading field operations, instrument troubleshooting and maintenance, data management, and project reporting.	Yes
Tiffany Sprague	U of MN - Duluth - NRRI	Sprague works with a citizen scientist group in Duluth. Sprague will be responsible for leading and coordinating citizen science volunteers, data management and integration, and project reporting.	Yes
Eva Hendrickson	U of MN - Duluth - NRRI	Hendrickson is a researcher at the NRRI's Central Analytical Lab. She will be responsible for sample collection and field work.	Yes
Elena Ceballos	U of MN - Duluth - NRRI	Ceballos is an Aquatic Scientist at the NRRI's Central Analytical Lab. She will be responsible for sample collection and field work.	Yes
Sam Paske	Metropolitan Council	Paske and the Metropolitan Council are operating 20 long-term, automated stream and tributary monitoring stations in the metro area; the Metropolitan Council will provide historical data in urban streams to the project team and provide feedback on transferring the findings of this project into management decisions.	No
Tom Estabrooks	MPCA	Estabrooks and MPCA will provide feedback on transferring the findings of this project into management decisions.	No
Andy Kasun	South St Louis SWCD	Kasun and South St. Louis Soil & Water Conservation District will provide feedback on transferring the findings of this project into management decisions.	No
Amit Kumar	U of MN - Duluth	Kumar is a postdoctoral research associate at the Civil Engineering department of UMD, specializing in applying data-driven and machine learning models for hydrologic prediction. He will assist with the data-driven modeling to identify optimal sampling design.	Yes
Zihang Ding	U of MN - Duluth	Ding is a graduate student at the Civil Engineering department of UMD. He will assist with the data-driven modeling to identify optimal sampling design and pollutant load estimation.	Yes
Julie O'Leary	W.J. McCabe Chapter of Izaak Walton League	O'Leary and the McCabe Chapter IWLA sponsors several citizen monitoring programs in their communities; McCabe Chapter IWLA will help engage with volunteers and provide guidance for citizens and students interested in stream monitoring.	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?

Project activities, including data collection, data analysis and interpretation, and tool development, will be completed during this project. Institutional funds will be used to fund products that are developed afterwards, such as publications or scientific presentations. Implementation of the research will be via professionals and agencies who will use the findings to make management decisions about stream monitoring and sampling. If new research directions are developed from LCCMR's investment in this project, partners will seek new funding from other grant opportunities.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded

Catch and Reveal: Discovering Unknown Fish Contamination Threats	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 04g	$246,000
Wildfire Impacts on Mercury Cycling in Wilderness Lakes	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 04i	$297,000

Project Manager and Organization Qualifications

Project Manager Name: Kun Zhang

Job Title: Assistant Professor

Provide description of the project manager's qualifications to manage the proposed project.
Zhang will be responsible for project management and administration, and has the scientific expertise and project management experience to successfully complete this research. Zhang directs UMD Civil Engineering's Data-Model Integration in Urban Hydrology group specializing in using data-driven and process-based models to solve contemporary issues in urban hydrology. He has studied hydrology and water quality issues in urban watersheds for ~ 7 years, including quantifying the water balances and optimizing the design of green stormwater infrastructure in urban watersheds. Zhang also specializes in working with large complex datasets from existing monitoring programs to generate new knowledge from publicly funded data. Zhang currently manages one federal and several UMD funded projects, including serving as PI on a $200K NSF-funded project investigating the interventions of sewer networks and soil profiles on water balances. Most related to this project, Zhang was previously awarded funding from the U.S. Army Engineer Research and Development Center (ERDC) to develop a data-driven model for water quality prediction; while this project applied a similar approach to predict stream water quality concentrations and loads, it only focused on nutrients and did not validate the model through field sampling. More importantly, it did not transfer the results into implementable sampling suggestions.

Organization: U of MN - Duluth

Organization Description:
Swenson College of Science and Engineering (SCSE) (PI Zhang) is the largest college in U of MN – Duluth and is the third largest college in the U of MN system. It is the home of the Large Lakes Observatory, Integrated Biosciences graduate program, Water Resources Science graduate program, and Advanced Materials Center. SCSE also has close affiliations with the Natural Resources Research Institute (NRRI) and the Minnesota Sea Grant program. SCSE's mission is to inspire the next generation of STEM professionals to solve complex problems. SCSE provides the students with a good opportunity to engage in active learning and conduct world-class research with faculty, the community, and regional partners. The Lake and Stream Ecosystem Ecology Lab (PI Filstrup) at NRRI has the necessary experience, equipment, and infrastructure to monitor Duluth streams and analyze water chemistry samples. The lab has been monitoring Duluth streams for 25 years and has a long-term dataset that can be analyzed for this project. The lab also includes the Central Analytical Laboratory, a state-certified water chemistry laboratory specializing in the detection of low level nutrients in low productivity aquatic ecosystems, that will be responsible for analyzing nutrient, suspended sediment, and chloride samples.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Kun Zhang		Zhang will serve as the project PI and will be responsible for project administration, modeling, data analysis and interpretation, project reporting and manuscript development, and outreach.			27%	0.12		$20,556
Christopher Filstrup		Filstrup will serve as the co-PI of this project. He will be responsible for project administration and reporting, data analysis and interpretation, and stakeholder engagement.			27%	0.24		$32,758
Jerry Henneck		Henneck will be responsible for leading field operations, instrument troubleshooting and maintenance, data management, and project reporting.			24.4%	0.24		$25,998
Tiffany Sprague		Sprague will be responsible for leading and coordinating citizen science volunteers, data management and integration, and project reporting.			27%	0.24		$24,886
Eva Hendrickson		Hendrickson will be responsible for sample collection and field work.			24.4%	0.39		$26,601
Undergraduate Research Assistant		TBD undergraduate research assistants will assist with field work.			0%	0.24		$11,403
GRA Zihang Ding		50% Masters GRA AY and summer Y1, plus 1 semester Y3 will work on the project in year 1 (from July 1, 2026 to June 30, 2027) and year 3 (from January to May 2029). The student will be responsible for synthesizing prior data and performing data-driven sparse sensing modeling for identifying the prioritized watersheds and the optimal sampling times in the selected streams (Objective 1), and estimating contaminant loads from the measurements (Objective 2).			47%	0.34		$78,555
Postdoctoral research associate Amit Kumar		Will work on the project in year 1 (from July 1, 2026 to June 30, 2027). He will assist the PI Zhang and the graduate student Ding in performing data-driven sparse sensing modeling for identifying the			21%	0.5		$38,405

		prioritized watersheds and the optimal sampling times in the selected streams (Objective 1).						
Elena Ceballos		Ceballos will be responsible for sample collection and field work.			24.4%	0.39		$30,162
							Sub Total	**$289,324**
Contracts and Services								
Central Analytical Laboratory	Internal services or fees (uncommon)	We have budgeted funds for water chemistry analyses. Analytical rates are based on published Central Analytical Laboratory fees multiplied by the number of samples. Water quality analytical fees in each of Y1 & Y2. Y2 has 3% inflation added.				0		$11,664
NRRI	Internal services or fees (uncommon)	Multiparameter data sonde and field electronics use fees @ $25 per day. Estimated as 8 days x 3 streams = 24 in Y1; 24 days x 3 streams = 72 in Y2; 16 days x 3 streams = 48 in Y3.				-		$3,600
							Sub Total	**$15,264**
Equipment, Tools, and Supplies								
	Tools and Supplies	Field Supplies	Field supplies required to complete work in Years 1, 2.					$2,094
	Tools and Supplies	Citizen Scientist Supplies	Citizen Science volunteer test kits, including conductivity pen, chloride test strips, E. coli plates, writing materials, personal protective equipment, and carrying case. Costs estimated for 20 kits purchased in Year 1.					$8,128
							Sub Total	**$10,222**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**

Travel In Minnesota								
	Miles/ Meals/ Lodging	Estimated using published rates for mileage ($0.31) and vehicle rental fees ($35.83 full day, $17.92 half day). Year 1: (8 trips @ $35.83) + (8 trips @ $17.92) + (5200 miles @ $0.31) = $2042. Year 2: (24 trips @ $35.83) + (24 trips @ $17.92) + (15500 miles @ $0.31) = $6095. Year 3: (16 trips @ $35.83) + (16 trips @ $17.92) + (10300 miles @ $0.31) = $4053.	Travel required to conduct fieldwork near North Shore.					$12,190
							Sub Total	**$12,190**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Citizen Science participation support	Training stipends.					$2,000
							Sub Total	**$2,000**
							Grand Total	**$329,000**

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	UMN unrecovered indirect costs are calculated at the UMN federally negotiated rate for research of 54% modified total direct costs. MTDC excludes tuition remission and trainees stipends.	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$161,998
			Non State Sub Total	**$161,998**
			Funds Total	**$161,998**

Total Project Cost: $490,998

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: bae1c076-cd9.pdf

Alternate Text for Visual Component

Urban streams suffer from impairments such as nutrients, sediments, chloride, bacteria, and thermal impact due to stormwater runoff (top graphics). This study aims to develop a optimized method for sampling stream water quality from prior data (middle graphics), potentially enhancing stream health outcomes (bottom graphics)....

Supplemental Attachments

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

Title	File
UMD Authorization Letter	e616eb6e-92b.pdf
Letter of Support - McCabe Chapter IWLA	b08f7449-ef7.pdf
Letter of Support - SWCD	8fb6f62a-f5e.pdf
Letter of Support - Metropolitan Council	10869989-609.pdf
Letter of Support - MPCA	e94382c9-baf.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?

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?

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:

Michael Jacob, U of MN - Duluth; Brady Rivers, U of MN - Duluth

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