Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-500

Proposal Title: Biosolids PFAS Management: Evaluating Risks, Costs, and Benefits

Project Manager Information

Name: Alison Ling

Organization: University of St. Thomas

Office Telephone: (651) 962-7749

Email: aling@stthomas.edu

Project Basic Information

Project Summary: This project integrates PFAS risk modeling and economic analysis to evaluate alternative biosolids management strategies to land application and identify cost-effective opportunities to protect Minnesota's soil, agricultural and freshwater resources.

ENRTF Funds Requested: $193,000

Proposed Project Completion: December 31, 2029

LCCMR Funding Category: Small Projects (G)
Secondary Category: Land (F)

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?
In the Future

Narrative

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

Land application of biosolids has raised concerns that the practice may introduce PFAS into agricultural soils, crops, and potentially surface waters in Minnesota. Policymakers nationwide are debating whether restricting or eliminating biosolids land application would meaningfully reduce environmental risks, and what the consequences would be for wastewater management and nutrient recycling.

Because 20% of Minnesota biosolids are applied to agricultural land, understanding how PFAS may move into crops, soils, or downstream freshwater systems is critical for protecting Minnesota's natural resources. Minnesota is already a leader in PFAS monitoring in wastewater and soils, and is enacting statewide biosolids sampling to better understand PFAS levels and distributions. At the same time, emerging research highlights the substantial costs associated with PFAS treatment. Removing or destroying PFAS from wastewater systems can dramatically increase treatment costs for municipalities and ratepayers, underscoring the need to evaluate environmental benefits alongside economic impacts.

Existing PFAS monitoring data and cost analyses remain fragmented across agencies and studies, leaving policymakers without an integrated framework to evaluate environmental risk reduction relative to the economic consequences of biosolids management decisions. This project addresses that gap by integrating Minnesota's existing datasets with risk-based modeling and economic analysis to support evidence-based biosolids management

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.

This project will develop an integrated analysis of PFAS risks, costs, and management options associated with biosolids land application in Minnesota. While the state has invested heavily in PFAS monitoring across wastewater, biosolids, and soils, these datasets remain largely unintegrated and have not been evaluated in a single framework that compares environmental risks with the economic consequences of management decisions.

The project addresses this gap through three coordinated activities. First, existing PFAS monitoring datasets from state agencies and research partners—including biosolids monitoring, wastewater data, and emerging statewide soil datasets—will be compiled and curated for integrated analysis. Engagement with wastewater utilities, agricultural landowners, and state agencies will help identify realistic management scenarios and key decision needs.

Second, the project will model PFAS transport, human exposure, and health risk pathways associated with biosolids land application, with emphasis on crop uptake and potential freshwater impacts. These analyses will be paired with economic evaluation of alternative biosolids management strategies.

Finally, results will be integrated into a decision-support framework and synthesized in a resource management report that quantifies environmental risks, management costs, and tradeoffs across scenarios. These tools will support evidence-based biosolids management decisions that protect Minnesota's soil and freshwater resources.

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?

Project outcomes will provide Minnesota decision-makers with an integrated assessment of PFAS risks, economic costs, and environmental tradeoffs associated with biosolids land application and alternative management strategies. Deliverables include a decision-focused report for LCCMR, state agencies, and utilities summarizing how management scenarios influence PFAS risks to soils, crops, and freshwater resources. The project will also produce a curated statewide PFAS dataset and a scenario-based, decision-support model for evaluating biosolids management strategies and identifying cost-effective options that reduce environmental risks. These tools will support evidence-based policies

that protect Minnesota's soil and water resources while maintaining sustainable wastewater and nutrient management practices.

Activities and Milestones

Activity 1: Data Collection, Curation, and Stakeholder Engagement

Activity Budget: $40,000

Activity Description:
In Activity 1, our project team will compile and curate existing datasets needed to evaluate PFAS risks, costs, and benefits associated with biosolids land application in Minnesota. This activity will be led by Dr. Ali Ling (University of St. Thomas) with support from Dr. Jon Petali (Battelle) for stakeholder engagement and subsequent mode development.

The team will gather and review available PFAS datasets from Minnesota agencies and research programs, including annual biosolids reports, more recent biosolids PFAS monitoring, wastewater influent and effluent data, and anticipated statewide soil datasets.

Stakeholder engagement will ensure the analysis approach addresses questions relevant to real-world practices in Minnesota. The project team will coordinate an initial listening session with each of the following stakeholder groups to identify priority concerns and decision needs: i) state agencies, including MPCA, MDH, and MDA, ii) wastewater utilities, and iii) landowners and agricultural users. A follow-up session with each group will present the proposed study approach for further alignment with stakeholder questions, concerns, and realistic scenarios.

Outputs include a curated statewide PFAS dataset and a set of stakeholder-informed biosolids management scenarios that will serve as inputs to the integrated modeling and decision-support framework developed in Activity 2.

Activity Milestones:

Description	Approximate Completion Date
Kick Off Meeting - Team Meets for Project Updates and Coordination	July 31, 2027
Initial compilation of Minnesota PFAS datasets	September 30, 2027
Initial stakeholder listening sessions (3 session)	December 31, 2027
Finalize curation of Minnesota PFAS datasets	March 31, 2028
Stakeholder review meeting confirming modeling scenarios (3 sessions)	June 30, 2028

Activity 2: Integrated Risk and Economic Analysis of Biosolids Practices

Activity Budget: $87,000

Activity Description:
Activity 2 is the core analytical component of the project, integrating datasets from Activity 1 with PFAS risk modeling and economic analysis to develop a decision-support framework for evaluating biosolids management strategies in Minnesota.

Using curated statewide PFAS datasets and stakeholder-defined scenarios, the team will evaluate PFAS exposure pathways associated with biosolids land application and estimate risks to agricultural soils, crops, and freshwater resources. This work will be led by Dr. Jon Petali (Battelle) based on his expertise in PFAS transport, exposure, and human health risk assessment.

The project will also estimate economic costs associated with alternative biosolids management strategies under scenarios such as continued land application, landfilling, thermal treatment, hybrid approaches, and other stakeholder-identified options based on Dr. Ling's expertise, available cost data, and interactions with vendors and existing facilities.

Integration of the risk and economic analyses into the decision-support framework will benefit from the expertise of Dr. Rashkova (University of St. Thomas) in operations research and optimization methods. Scenario and sensitivity analyses will identify cost-effective strategies that meet environmental risk thresholds while supporting sustainable wastewater and nutrient management.

Outputs include statewide estimates of PFAS risk and cost outcomes and a decision-support model for Minnesota agencies.

Activity Milestones:

Description	Approximate Completion Date
PFAS exposure and costs model – Scenario identification & development	March 31, 2028
PFAS exposure and costs model – Scenario finalization	June 30, 2028
Integrated model/framework set-up and calibration	September 30, 2028
Integrated model/framework finalization	December 31, 2028
Complete sensitivity and uncertainty analysis	December 31, 2028

Activity 3: Reporting and Dissemination

Activity Budget: $66,000

Activity Description:
Activity 3 will synthesize the results from Activity 2 into resource management tools and communication products that support biosolids management decisions in Minnesota. The project team will translate the integrated risk, cost, and decision-support analyses into outputs designed for use by state agencies, municipalities, and other stakeholders responsible for managing biosolids and protecting Minnesota's natural resources.

The primary deliverable will be a resource management report summarizing modeled PFAS risks, economic costs, and environmental tradeoffs associated with alternative biosolids management strategies. The report will highlight how different management scenarios affect PFAS risks to agricultural soils, crops, and freshwater systems and will summarize key drivers influencing those outcomes.

Activity 3 will also deliver the curated statewide PFAS dataset assembled in Activity 1 and the scenario-based decision-support model developed in Activity 2. These tools will allow Minnesota agencies and stakeholders to evaluate biosolids management strategies using Minnesota-specific data and to assess how policy or management changes may influence environmental risks and costs.

Stakeholder engagement will continue through workshops to review results and communicate findings in formats useful to practitioners. Results will also be shared through professional conferences, peer-reviewed publications, and undergraduate training opportunities.

Activity Milestones:

Description	Approximate Completion Date
Initial conference presentations to solicit feedback on report	November 30, 2028
Draft report and affiliated publications	March 31, 2029
Stakeholder workshops for feedback on draft deliverables	March 31, 2029
Final report, dataset, and scenario model publication	June 30, 2029
Final conference report-outs and peer-reviewed publications finalized	December 31, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Jonathan Petali	Battelle	Risk and Stakeholder Engagement Lead	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.
The primary deliverable will be a publicly available report, with associated data set and decision-making framework. We further plan to publish three peer-reviewed publications, one outlining the viable scenarios established through stakeholder interaction in Activity 1, one detailing risk and cost estimates for these scenarios as developed in Activity 2, and one detailing the decision-making framework model developed in Activity 2.

Two initial rounds of stakeholder meetings detailed in Activity 1 will be conducted to collect stakeholder needs, limitations, and concerns regarding biosolids management and solicit feedback on model scenarios for existing and viable future biosolids management. Separate stakeholder meetings will target i) state agencies, including MPCA, MDH, and MDA, ii) wastewater utilities, and iii) landowners and agricultural users Results from the three main project focus areas will be shared with Minnesota stakeholders as in-person, follow-up workshops after the main work has been completed.. This event will provide guidance on how to use the tools developed to inform decision-making around biosolids management in Minensota. We also plan to share outcomes more broadly within the state at the Minnesota Wastewater Operators Association and MPCA Wastewater Operators Conferences in 2028 and 2029. Additionally, we plan to host a virtual workshop with out-of-state regional biosolids management organizations to share context and applicability of developed framework in other regions.

All communications will acknowledge the Environment and Natural Resources Trust Fund per ENRTF Acknowledgement Guidelines.

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?
Results from the three main project focus areas will be shared with stakeholders as in-person, follow-up workshops. We also plan to share outcomes more broadly within the state at the Minnesota Wastewater Operators Association and MPCA Wastewater Operators Conferences in 2028 and 2029. No additional work is directly planned, but follow-up work could be identified as part of final consultations with stakeholders both inside and outside Minnesota.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Breaking the PFAS Cycle with a Full-Scale Demonstration	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 04k	$1,481,000

Project Manager and Organization Qualifications

Project Manager Name: Alison Ling

Job Title: Assistant Professor

Provide description of the project manager's qualifications to manage the proposed project.
Ali Ling is an assistant professor in Civil Engineering at the University of St. Thomas, with practical and theoretical experience related to PFAS in biosolids and evaluating costs of alternative management scenarios. Ali's research program focuses on providing cost-benefit tools to support environmental decision making around emerging contaminants like per- and polyfluoroalkyl substances (PFAS). Recent publications and research work revolves around understanding costs (economic, environmental, and societal) and benefits of advanced treatment technologies in the water and wastewater sector. Ali was a primary author of the PFAS costs report by Barr Engineering and Hazen and Sawyer, published by the MPCA in 2023 under LCCMR grant 2020-04, which included modeling of costs to manage PFAS in biosolids, including considerations for regional biosolids management. She is involved in the current LCCMR grant 2024-257 supporting piloting of one specific PFAS management technologies for biosolids and other solid wastes and is a registered professional engineer in the state of Minnesota. Prior to joining St. Thomas, Ali spent nine years as a practicing environmental engineer, developing water and wastewater solutions for municipalities and companies in Minnesota and elsewhere.

Organization: University of St. Thomas

Organization Description:
The University of St. Thomas's mission is to educate students to be morally responsible leaders who think critically, act wisely, and work skillfully to advance the common good. Faculty members engage in research similarly to advance the common good.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Principal Investigator (Ali Ling)		Lead project, including coordinating other staff and supervising undergraduate researchers. Primary researcher on data curation, cost estimates and environmental impacts sections in Activity 1 and Activity 2, and on presentations in Activity 3			18%	0.3		$45,635
Modelling Lead (Iva Rashkova)		Lead development, calibration, and communication of desicion-support model to identify cost-effective options for biosolids management			12%	0.3		$45,586
Undergraduate Researcher		Two undergraduate researchers during Summers 2027 and 2028 to assist with a.) data curation efforts under Activity 1 and b.) environmental impacts modeling under Activity 2			8%	0.42		$13,844
							Sub Total	**$105,065**
Contracts and Services								
Battelle	Subaward	Battelle will lead stakeholder engagement and education sessions in Activity 1 and 3 and exposure and risk analysis part of Activity 2. Budget includes $60,292 for personnelv		X		0.2		$60,292
							Sub Total	**$60,292**
Equipment, Tools, and Supplies								
	Tools and Supplies	Life-Cycle Assessment Software (1-year subscription)	For environmental impacts modeling to feed into broader cost-risk model in Activity 2					$4,500
							Sub Total	**$4,500**
Capital Equipment								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Two trips out of Twin Cities, four conference registrations for Ali Ling	Attending MWOA and MPCA Wastewater Conferences in 2027 and 2028					$2,783
							Sub Total	**$2,783**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Open-access publication fees for three publications	Expected publications: introductory review of viable biosolids management strategies from Activity 1, detailed research article describing risk and cost estimates from Activity 2, detailed research article describing integrated cost-risk, decision-support model from Activity 2					$12,000
							Sub Total	**$12,000**
Other Expenses								
		Stakeholder In-Person Workshops	Site planning and limited refreshents for in-person stakeholder workshops in Activities 1 and 3					$8,360
							Sub Total	**$8,360**
							Grand Total	**$193,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Battelle	Subaward	Battelle will lead stakeholder engagement and education sessions in Activity 1 and 3 and exposure and risk analysis part of Activity 2. Budget includes $60,292 for personnelv	Fringe and benefits for Dr. Petali's rate will be released to the State if requested, under trade secret protection. Facilities and administrative (F&A) rate is based on Battelle federally negotiated F&A rate for this type of work and fringe benefit rates are consistent with federally negotiated rates.

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $193,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: abb27939-f62.pdf

Alternate Text for Visual Component

Figures shows a map of Minnesota data with a computer icon, then an arrow pointing to three groups of stakeholder icons to a map of scenarios. Bottom shows a balance between land applied biosolids and other options, with health, cost, and environmental icons, leading to a decision tree...

Financial Capacity

Title	File
UST Secretary of State Details	b549ba6d-ca8.pdf
UST Audit FY2025	47f38a2c-73d.pdf
UST Form 990	4d9fc388-ba7.pdf

Supplemental Attachments

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

Title	File
Battelle Subaward Scope/Budget Letter	411c3d5e-d86.pdf
UST Authorization Letter	2b8a8f18-ecc.pdf
City of St Cloud Support Letter	68b6e1d8-57a.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?

Yes, UST Sponsored Programs

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:

Iva Rashkova, University of St. Thomas; Jonathan Petali, Battelle;

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