



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-386

Proposal Title: Minnesota PFAS Destruction Verification Framework

Project Manager Information

Name: Abdenmour Abbas

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

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Project Basic Information

Project Summary: Many PFAS removal technologies rely on vendor-defined testing protocols. This project will develop a standardized destruction verification protocol to confirm mineralization, fluorine mass balance, ecological relevance, and regulatory confidence.

ENRTF Funds Requested: \$300,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Small Projects (G)

Secondary 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?

In the Future

Narrative

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

As Minnesota and the whole world confront PFAS contamination, our state has invested heavily in PFAS capture and destruction technologies. Most common capture methods, like granular activated carbon, ion exchange, reverse osmosis, and foam fractionation, concentrate PFAS into smaller but highly contaminated residual streams. The unresolved question is what happens to these residuals. Many technology vendors now claim PFAS destruction capabilities, but these claims often rely on limited analyte lists, excluding short-chain and ultrashort PFAS, which are more mobile and biologically active. Evaluations commonly overlook precursor conversion, fail to demonstrate air–water–solid mass balance closure, and rarely characterize fluorinated byproducts or downstream disposal. As a result, the overall effectiveness and safety of these technologies cannot be independently verified. Clear, reproducible criteria are necessary to determine whether emerging “destruction” technologies truly mineralize PFAS, merely transform them into other persistent or mobile compounds, or create unintended downstream environmental impacts. Establishing a standardized, state-defined PFAS destruction verification framework, independent of vendor-developed testing protocols and industry-generated claims, is therefore critical. While many proposals seek to optimize reactors, none establish the scientific standard by which destruction claims must be judged. This project fills that structural gap by creating the verification infrastructure governing future deployment.

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 and validate a standardized Minnesota PFAS Destruction Verification Protocol defining measurable criteria for confirming true PFAS mineralization and ecological risk reduction across relevant environmental matrices. This protocol will be applicable to real environmental matrices, including wastewater concentrates (ion exchange regenerant, RO brine), landfill leachate concentrates, and biosolids extracts. The innovation is not a new treatment device, but a defensible, reproducible, regulator-ready performance standard applicable to any destruction technologies.

Typical engineering demonstrations report percent removal of a limited PFAS list. This framework requires fluorine mass balance accounting and confirmation of inorganic fluoride formation to distinguish mineralization from transformation. Core elements include:

- Matrix-specific validation using real Minnesota wastewater concentrates, landfill leachate concentrate, and biosolids extracts
- Expanded target PFAS panel and Total Oxidizable Precursor (TOP) assessment
- Extractable organic fluorine and inorganic fluoride quantification
- Air and byproduct screening for volatile fluorinated compounds
- Quantitative classification of outcomes: mineralization, transformation, incomplete treatment

Destruction will require $\geq 90\%$ fluorine mass balance closure and documented fluoride formation to qualify as mineralization. This prevents deployment based solely on disappearance of regulated analytes.

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 outcome will be a regulatory-ready framework enabling agencies and utilities to evaluate destruction claims based on fluorine mass balance, precursor transformation, and ecological relevance and impact. The deliverable is a verification system enabling Minnesota to evaluate any destruction technologies with scientific rigor, independent of industry-generated benchmarks.

By project completion, Minnesota will have:

- A validated, matrix-tested destruction verification protocol

- A demonstrated fluorine mass balance methodology for complex waste streams
- Defined mineralization criteria thresholds
- Guidance for evaluating vendor destruction claims
- A framework ready for incorporation into procurement and permitting processes

Activities and Milestones

Activity 1: Environmental Matrix Characterization and Verification Protocol Development

Activity Budget: \$134,048

Activity Description:

Representative Minnesota matrices (IX regenerant, RO brine, landfill leachate concentrate, biosolids extracts) will be collected and characterized for expanded PFAS targets, precursors (TOP), extractable organic fluorine, inorganic fluoride, and baseline mobility indicators. The objective is to establish the analytical foundation and standardized workflow needed to evaluate PFAS destruction claims in environmental waste streams. We will characterize ≥ 12 matrix samples from ≥ 4 Minnesota facilities and establish baseline fluorine mass balance. Sampling will be coordinated with wastewater utilities, landfill operators, and biosolids managers to represent Minnesota treatment conditions. A standardized testing workflow will be developed including sample preparation, analytical requirements, fluorine mass balance calculations, byproduct screening, and reporting templates. Controlled trials using two representative destruction technologies will demonstrate protocol application and test whether the framework distinguishes mineralization from transformation. Outputs include the analytical workflow and draft Minnesota PFAS Destruction Verification Protocol (Version 1.0). Additional work will evaluate analytical reproducibility, sensitivity, operational range and detection limits across matrices to ensure the protocol functions reliably in complex waste streams. This step will refine quality assurance criteria and confirm that the framework can consistently distinguish true mineralization from partial transformation across representative Minnesota treatment residuals.

Activity Milestones:

Description	Approximate Completion Date
Characterization of ≥ 12 matrix samples from ≥ 4 Minnesota facilities with baseline fluorine mass balance established	March 31, 2028
Completion of draft Minnesota PFAS Destruction Verification Protocol (Version 1.0)	June 30, 2028
Completion of ≥ 6 treated matrix experiments completed with documented mass balance and treatment classification	June 30, 2028

Activity 2: Protocol Validation and Environmental Relevance Assessment

Activity Budget: \$137,207

Activity Description:

This activity evaluates reproducibility and environmental relevance of the PFAS destruction verification framework. Additional environmental matrices will be analyzed using the protocol to assess robustness across waste streams. Replication will be performed on ≥ 6 independent matrices to determine whether fluorine mass balance closure can be consistently achieved within $\pm 15\%$ variance. Analytical results will be evaluated for reproducibility and sensitivity to matrix variability. Ecological flow collaborators will assess post-treatment environmental behavior by evaluating mobility potential, sediment partitioning, and estimated bioaccumulation indicators. These analyses link destruction classifications (mineralization, transformation, incomplete treatment) to modeled environmental transport and exposure pathways. Outputs include validated protocol performance metrics and environmental indicators connecting chemical verification results to potential ecological outcomes.

Results from these validation experiments will be used to refine protocol thresholds, confirm analytical detection limits across matrices, and identify conditions where mass balance uncertainty increases. Sensitivity analyses will evaluate how precursor conversion, short-chain PFAS formation, or volatile byproducts influence destruction classification. This will also inform recommended reporting formats to support consistent interpretation by regulators, utilities, and

technology evaluators statewide.

The final validated framework will include reproducibility benchmarks, recommended quality assurance criteria, and guidance for interpreting results when evaluating PFAS destruction technologies across diverse Minnesota waste streams.

Activity Milestones:

Description	Approximate Completion Date
Replication on ≥ 6 independent matrices demonstrating $\pm 15\%$ variance in mass balance closure	June 30, 2029
Quantitative linkage between destruction performance categories and modeled reduction in environmental mobility indicators	June 30, 2029

Activity 3: Protocol Refinement and Implementation Guidance for Minnesota

Activity Budget: \$28,745

Activity Description:

Results from Activities 1 and 2 will be integrated to finalize the Minnesota PFAS Destruction Verification Protocol. The objective is to produce a regulator-ready framework agencies and utilities can use to evaluate PFAS destruction technologies. Analytical workflows, fluorine mass balance thresholds, and treatment classification criteria will be refined using validation results. The Minnesota PFAS Destruction Verification Manual (Version 2.0) will provide standardized procedures for sample preparation, analytical measurements, mass balance calculations, byproduct screening, and reporting requirements. Recommended performance thresholds and reporting templates will support consistent evaluation of vendor destruction claims. Final outputs include the protocol manual, a public technical report, peer-reviewed publication(s), conference and seminar presentations, and a statewide dissemination workshop for Minnesota agencies, utilities, and environmental practitioners.

This activity will also develop implementation guidance describing how the protocol can be incorporated into state permitting, technology procurement, and performance verification programs. Case study summaries from the validation trials will illustrate application of the framework to real Minnesota waste streams and demonstrate interpretation of fluorine mass balance results. Guidance will also identify data requirements needed for agencies to independently verify vendor claims and ensure comparability across technologies. Implementation recommendations will support adoption by regulators utilities and future funded projects.

Activity Milestones:

Description	Approximate Completion Date
Completion of Minnesota PFAS Destruction Verification Manual (Version 2.0)	March 31, 2030
Publication of final guidance document and statewide dissemination workshop for agencies and utilities	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Bo Hu	University of Minnesota	Collaborator	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.

Dissemination, Communication, and Outreach

Project results will be disseminated through agency engagement, peer-reviewed publication, and practitioner outreach to ensure the framework is usable by regulators, utilities, and the scientific community.

Agency and Regulatory Dissemination:

Findings and analytical methods will be compiled into a Minnesota PFAS Destruction Verification Manual with standardized reporting templates and performance criteria. Interim and final briefings will be provided to the Minnesota Pollution Control Agency and the Minnesota Department of Natural Resources and shared with participating utilities to support potential integration into technology evaluation, procurement, and permitting processes.

Scientific Dissemination:

Methods and validation results will be submitted to peer-reviewed journals in environmental chemistry and water treatment (e.g., Environmental Science & Technology, Water Research). Publications will describe the fluorine mass balance methodology, matrix-specific verification approach, and protocol validation so the framework is transparent and reproducible.

Practitioner and Industry Outreach:

Results will be presented at conferences and technical meetings attended by utilities and environmental professionals, including the American Water Works Association and the Water Environment Federation. A final public workshop will present the protocol and findings to Minnesota stakeholders.

A public technical report and project materials will be made available online. All communications will acknowledge support from the Environment and Natural Resources Trust Fund in accordance with ENRTF attribution 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?

Implementation of the Minnesota PFAS Destruction Verification Protocol is designed for direct adoption by state agencies including the MPCA and the Metropolitan Council, as well as federal partners such as the EPA. The framework provides a standardized methodology that agencies can incorporate into permitting, procurement, and technology evaluation processes when assessing PFAS destruction claims. Future implementation will not require creation of new funding streams; rather, existing resources currently allocated by these agencies to evaluate PFAS destruction technologies can be redirected to apply this independent verification protocol, ensuring consistent, scientifically defensible assessment of mineralization performance and environmental risk reduction.

Project Manager and Organization Qualifications

Project Manager Name: Abdenmour Abbas

Job Title: Associate Professor

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

The PI is an associate professor at the University of Minnesota with experience managing over \$5 million in state and federal grants, and has a deep expertise in PFAS detection and destruction as evidenced by previous scientific publications (<https://doi.org/10.1061/JOEEDU.EEENG-6957>). The PI has previously founded the first Minnesota startup that developed and commercialized a PFAS destruction technology, but is no longer involved with the company since 2023. The PI has a long experience managing a research team and complete research projects including projects funded by MITPPC through LCCMR.

Organization: U of MN - College of Food, Agricultural and Natural Resource Sciences

Organization Description:

In the College of Food, Agricultural and Natural Resources Sciences (CFANS) at the University of Minnesota, we look at the bigger picture. When we envision a better tomorrow, it includes disease-resistant crops, products that protect our health, lakes free from invasive species, and so much more. We use science to find answers to Minnesota and the world's grand challenges and solve tomorrow's problems. Almost 93 percent of students who earn CFANS undergraduate degrees find jobs in their career field or enter graduate school within six months of graduation.

The Department of Bioproducts and Biosystems Engineering, in CFANS, discovers and teaches solutions for the sustainable use of renewable resources and the enhancement of the environment. We discover innovative solutions to address challenges in the sustainable production and consumption of food, feed, fiber, materials, and chemicals by integrating engineering, science, technology, and management into all degree programs.

We have a public impact through community engagement and extension efforts. We develop and deliver high quality, regionally and nationally-recognized research-based programs to meet current and emerging needs of industry and communities. We also have a long-standing tradition of close partnerships with alumni, industry professionals, organizations, government agencies, donors and community members.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	\$ Amount
Personnel								
research faculty Abbas/9 month appointment seeking summer salary		Lead Investigator/ oversee all lab components and personnel			26%	0.3		\$41,595
research faculty Hu/9 month appointment seeking summer salary		Co-PI, working with PI on the PFAS analysis and protocol verification			26%	0.15		\$41,595
professional researcher - appointment dependent on project funds		conducting experiments, assisting both PI's			26%	2		\$159,303
							Sub Total	\$242,493
Contracts and Services								
Professor services	Service Contract	PFAS measurements at other research facilities outside of UMN.				0		\$13,862
U of M Lab Service	Internal services or fees (uncommon)	PFAS mass balance analysis, for instance, fluoride measurement.				0		\$20,300
							Sub Total	\$34,162
Equipment, Tools, and Supplies								

	Tools and Supplies	Chemical and lab supply includes sample containers (PFAS-free polypropylene and high-density polyethylene bottles), filtration materials, syringes, solid-phase extraction (SPE) cartridges, centrifuge tubes, and glassware used for sample preparation and concentration prior to chemical analysis. Additional materials such as pipette tips, vials compatible with liquid chromatography–mass spectrometry (LC-MS/MS), and solvent-resistant tubing will be required for handling and processing environmental samples. Some general supplies to maintain the lab such as paper tower and detergent are also included.	to work on the sample preparation and analysis.					\$20,300
							Sub Total	\$20,300
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
	Miles/ Meals/ Lodging	Five trips for one person for 50 miles distance and each trip is budgeted at \$203.	to take samples at different locations.					\$1,015
	Conference Registration Miles/ Meals/ Lodging	Two trips for one person, including mileage and registration fees	To disseminate the protocol and communicate with peers					\$2,030
							Sub Total	\$3,045
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								

							Sub Total	-
Other Expenses								
							Sub Total	-
							Grand Total	\$300,000

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: \$300,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [aedd6372-427.pdf](#)

Alternate Text for Visual Component

A diagram showing a standardized framework allowing Minnesota to verify whether PFAS destruction technologies truly mineralize PFAS or merely transform them into other persistent toxic compounds....

Supplemental Attachments

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

Title	File
Letter of Approval to Submit	b1b7abce-c8d.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?

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?

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 proposal:

Abdenmour Abbas

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