Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-374

Proposal Title: Plasma System for PFAS Remediation: Integration and Validation

Project Manager Information

Name: Shaobo Deng

Organization: U of MN - Southern Research and Outreach Center

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Project Basic Information

Project Summary: Develop and validate a commercially viable 60 gph plasma system and pre-post treatment that can be scaled upward to eradicate PFAS from common water sources, resulting in CaF2 and H2O.

ENRTF Funds Requested: $862,000

Proposed Project Completion: June 30, 2028

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?

In the Future

Narrative

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

Per- and poly-fluoroalkyl substances (PFAS)-Forever Chemicals- pose a threat to Minnesota's health. At relatively low concentrations, PFAS can lead to serious health conditions such as kidney and testicular cancers, liver damage, immunotoxicity, neurotoxicity, and endocrine dysfunction. Studies indicate similar PFAS-related health problems for companion pets and wildlife and are highly toxic to fish (Break et al., 2023; Hamad et al., 2024).

Removing PFAS from the Minnesota water supply is a priority issue facing the government and industry, and current technologies do not destroy these chemicals. Municipalities throughout Minnesota are working to identify a permanent solution to their PFAS problems. As of April 2024, at least 22 cities in the state were out of compliance with EPA rules. Ryan Stempski, director of public works for Hastings, states that installing sequestering technology will cost the city $68.9 million—Money which the city does not have (MPR news April 11, 2024). Further, the waste from sequestration still needs to be appropriately disposed of, leading to additional costs and uncertainty for long-term storage options. The University of Minnesota and Plasma Blue have developed a low-cost, on-site system and may be able to offer a low-cost solution that actually destroys PFAS.

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.

In April 2024, the EPA released regulations concerning enforcement levels for drinking water. These regulations, along with the grave health and ecological impacts of PFAS, make developing commercially viable destruction technologies and systems an urgent priority. To complicate matters, PFAS does not decompose naturally and is therefore present in the environment. Furthermore, these molecules are still necessary for specific critical applications, resulting in both legacy contamination and new emissions to address. The liquid-phase plasma reactor at the core of the proposed system for PFAS destruction was developed at the University of Minnesota Southern Research and Outreach Center, verified, and scaled up to 10 gph with a 99% or greater efficacy rate under LCCMR Project 2022-265.

The next logical step is to further scale up the reactor throughput and develop a commercially viable treatment system capable of meeting a 4 ppt PFAS standard. Necessary system components that will need to be designed, tested, optimized, and integrated into the system include 1) an optimized pre-treatment PFAS concentrating module, 2) an optimized post-treatment CaF2 precipitation module removal of residuals from water s, and 3) an optimized argon gas collector. The scalable prototype commercial system will then be integrated, validated, and demonstrated.

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 specific outcomes of this project are to further scale the liquid-phase plasma reactor for PFAS destruction to a 60 gph flow-through treatment of a filtered side stream with concentrated PFAS, optimize operating parameters, and verify its efficacy. Additionally, pre-and post-treatment modules will be designed, optimized, verified, and integrated into a PFAS water treatment system. This system will serve as a real-world PFAS water treatment setting, capable of effectively destroying PFAS at low cost from the city, well, and gray water to meet the anticipated EPA and MDH standard of 4 ppt.

Activities and Milestones

Activity 1: Study and verify the efficacy of pre-and post-treatment integrated with the plasma reactor over a range of PFAS contamination levels

Activity Budget: $211,400

Activity Description:
The pre-treatment concentration of PFAS, through air flotation or filtration, and the post-treatment using a CaF2 precipitator to remove fluorine ions will be investigated and evaluated on a lab scale. Five PFAS concentrations, ranging from low to high, will be prepared in the lab to simulate expected levels in bottled water, city water, well water, gray water, and industrial wastewater. Tests will determine the optimal operating parameters for PFAS treatment at each level of contamination on a benchtop scale. These parameters will include system configuration, treatment time, energy consumption, the necessity of introducing a gas (air, argon, or other) into the flow stream, the number of passes through the system to achieve the desired standard, operating cost estimates, and water quality analysis.

Activity Milestones:

Description	Approximate Completion Date
Design and test bench top module for PFAS separation and concentration	December 31, 2026
Design and test bench top module of CaF2 precipitator to remove F ions.	June 30, 2027
Develop operating parameters for different PFAS concentrations	December 31, 2027

Activity 2: PFAS removal system scale-up to 60 gph throughput and validation of efficacy

Activity Budget: $593,000

Activity Description:
The scale-up from a PFAS destruction benchtop system, including a concentration module, plasma unit, and CaF2 precipitator, to one that will handle a 60 gph flow-through capacity will be completed. A suitably sized concentration and CaF2 precipitator will be incorporated into the PFAS plasma system. The scaled-up PFAS treatment system will be tested with 3 PFAS concentrations in the lab. Operating parameters will include reactor configuration, treatment time, energy use, need for including a gas (air, argon, or other) in the reactor flow stream, number of passes through the reactor to achieve the desired 4 ppt standards, operating cost estimates, and water quality analysis. The argon gas recapture modules will be fitted to the system.

Activity Milestones:

Description	Approximate Completion Date
Scale up to 60 gph, add concentration module and CaF2 precipitator of appropriate scale	December 31, 2027
Develop operating parameters for 3 PFAS contamination levels	March 31, 2028
Add argon gas recapture modules if use argon	March 31, 2028

Activity 3: Test and validate the efficacy of the 60 gph system for city water, well water, and gray water applications.

Activity Budget: $57,600

Activity Description:
City water, well water, and gray water will be sourced from five locations each. Water from each source will be analyzed for PFAS concentration, dissolved elemental constituents, and the composition and size of particulate matter.

Laboratory tests will determine the optimal operating parameters for each source. Water sourced from one location representing each of the three sources will be used to develop system operating parameters and validate the efficacy of the large-scale liquid plasma PFAS destruction system. Tests will confirm the optimal operating parameters for each source. If additional pre- or post-treatment modules are necessary, they will be incorporated into the system.

Activity Milestones:

Description	Approximate Completion Date
Locate sources and acquire sufficient quantities of water and analyze	March 31, 2028
Test and validate the system for tap water, well water and gray water	June 30, 2028
Demonstrate the PFAS destruction system to potential users	June 30, 2028

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Tom Slunecka	Plasma Blue LLC	Plasma Blue will be responsible for the design and construction of large-scale plasma units, pro-PFAS concentration treatment, and post-mineralization precipitation equipment. Additionally, they will work to identify real-world PFAS-contaminated water sources (ideally from municipalities or capped landfills) for testing and demonstrate the integrated filtration/reactor/precipitator system.	Yes

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 aims to optimize, scale up, and integrate the plasma reactor into a system for PFAS destruction and the recovery of valuable chemicals. The resulting 60 gph system will be real-world demonstrable and scalable. At any point during the research and development process, interested governments or NGOs could begin working on incorporating a commercial-scale unit into their specific context. Essentially, the results of this work will attract investors for technology implementation and deployment.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Innovative Technology for PFAS Destruction in Drinking Water	M.L. 2022, , Chp. 94, Art. , Sec. 2, Subd. 04k	$445,000

Project Manager and Organization Qualifications

Project Manager Name: Shaobo Deng

Job Title: Researcher 6

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

Shaobo Deng is a researcher at the Southern Research and Outreach Center, University of Minnesota, leading the development of plasma technology for agriculture, food processing, waste treatment, and renewable energy production. He designs and scales up processes from concept to lab and pilot scales, conducting experiments for process optimization and validation. Mr. Deng is the inventor of liquid-phase plasma discharge technology and oversees the environmental engineering and renewable energy research lab at the SROC. He was the Project Manager for the LCCMR project "Innovative Technology for PFAS Destruction in Drinking Water" and the project "Clean Water and Renewable Energy from Beet Processing Wastewater and Manure." Additionally, he served as the principal investigator of MSR&PC projects focused on developing liquid phase plasma technology for biodiesel production and water treatment.

Tom Slunecka will serve as Co-Project Manager for this project. He has been the Chief Executive Officer of Minnesota Soybean since August 2012. During this time, he has overseen the creation of several new non-profit and for-profit entities, including Plasma Blue and the Soy Innovation Campus, as well as Ag Management Solutions, which focuses on providing services to agricultural associations and the businesses they manage. He currently serves as CEO of Plasma Blue LLC and is heavily involved in developing and commercializing liquid phase plasma technology. In this project, Tom will be responsible for coordinating efforts for Plasma Blue, ensuring that the necessary resources are in place, and supervising all activities.

Organization: U of MN - Southern Research and Outreach Center

Organization Description:
Southern Research and Outreach Center, located in Waseca, MN, is one of the ten University of Minnesota Research and Outreach Centers dedicated to conducting innovative basic and applied research for broad dissemination and education in areas such as agricultural and food production systems, renewable energy, and the environment. It provides extension services and research-based educational information to clientele regarding crop production, animal nutrition, horticulture, renewable energy, and waste treatment techniques. The center features a 1,500 sq ft laboratory for renewable energy, environmental engineering, and wastewater treatment research, equipped with all the necessary lab equipment and instruments for the proposed project. A lab-scale and a pilot-scale liquid phase plasma reactors have been built and have yielded promising results for PFAS destruction. The university also has analytical facilities available for a fee, such as the soil, water, and climate research analytical laboratory.

Plasma Blue, LLC is a biodiesel, chemical, and environmental process startup owned by the Minnesota Soybean Research & Promotion Council. It is based on liquid plasma technology licensed from the University of Minnesota, which is very efficient in destroying PFAS chemicals in the water. Plasma Blue's technology and engineering capabilities are well-suited for the commercialization of plasma PFAS technology.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Professional Researcher - FTE dependent on grant funding		Scientific Staff, system operation and data collection			36.6%	0.2		$19,111
Post doctoral researcher		Experiment design and conducting, samples testing, data analysis, project report and paper draft.			25.9%	2		$165,417
							Sub Total	**$184,528**
Contracts and Services								
Minnesota Vally Tsting Laboratory (MVTL)	Service Contract	Minnesota-certified PFAS, Water, and Environmental Testing Lab. Provides PFAS and other containment testing/analysis in water samples.				0		$56,000
Plasma Blue LLC	Subaward	Develop and fabricate large-scale plasma units, pro-PFAS concentration treatment, and post-mineralization and precipitation equipment. Work to identify real-world PFAS-contaminated water sources (ideally from municipalities or capped landfills) for testing and demonstrate the integrated filtration/reactor/precipitator system.				5		$558,500
							Sub Total	**$614,500**
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab Supplies: chemicals, reagents, pipettes, filters, personnel protection: gloves, masks, eyewear	to conduct experiments accurately and safely					$59,972
							Sub Total	**$59,972**
Capital Expenditures								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Trips to site and testing lab using vehicles, two people, and standard millage rate applies	Travel between waseca lab, demo-sites and analytical lab for collection and analysis of samples					$3,000
							Sub Total	**$3,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$862,000**

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				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $862,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 2d2d6ecc-abe.pdf

Alternate Text for Visual Component

1. PFAS Contamination at Minnesota Landfills – Minnesota Pollution Control Agency
2. Human health risks associated with PFAS
3. Plasma is a superior PFAS treatment technology
4. One scenario involving plasma PFAS treatment
5. Proposed Plasma PFAS Treatment System Train Process Schematic Diagram...

Supplemental Attachments

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

Title	File
Rock Leaf Water Support Letter	fcc82eca-719.pdf
Houston Engineering Support Letter	acb345b5-a08.pdf
MN Farmers Union Support Letter	5614d17a-ba0.pdf
Polk County Support Letter	1fde76b4-b8d.pdf
St. Louis County Support Letter	79879a11-c8b.pdf
Letter of approval to submit	b811861b-55c.pdf
Audit	96b3bc21-b49.pdf
Minnesota Soybean Support Letter	4e61847f-a80.pdf
Plasma Blue Support Letter	e3b54f7a-1f3.pdf
Plasma Blue Sub-award Budget	2f2f909d-54a.xlsx
Statement of Work for Sub-award to Plasma Blue LLC	eb765dcf-57b.docx

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?

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 proposal:

Tom Slunecka and Nathan Danielson, Plasma Blue LLC

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