Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-310

Proposal Title: Microwave Assisted Pyrolysis for Environmental Prion Remediation

Project Manager Information

Name: Stuart Lichtenberg

Organization: U of MN - College of Veterinary Medicine

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Project Basic Information

Project Summary: This project aims to develop and demonstrate and a novel soil decontamination technology by integrating biochar application and microwave-assisted pyrolysis for remediating prions and other persistent pollutants in soil.

ENRTF Funds Requested: $799,000

Proposed Project Completion: June 30, 2029

LCCMR Funding 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?

During the Project and In the Future

Narrative

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

Prions—misfolded proteins which cause transmissible spongiform encephalopathies (TSEs)—are an emerging environmental pollutant, sharing many features with conventional organic contaminants, while being remarkably distinctive. Prions are particularly challenging problem due to their long-term infectivity, strong affinity for soils, and extraordinary resistance to degradation. As a result of the continued spread of chronic wasting disease, the TSE of deer, environmental prion contamination is an ever-growing threat. At the same time, other common persistent organic pollutants (POPs), such as per- and poly-fluoroalkyl substances (PFAS), legacy pesticides, and polychlorinated biphenyls (PCBs) also continue to be long-term environmental hazards, posing threats to effective natural resource utilization and land management. Several techniques for remediating these contaminants have been developed, which generally fall into two categories: in-situ and ex-situ. In-situ methods, like phytoremediation and bioremediation, treat the soil without excavation, offering cost savings and fewer environmental impacts. However, they often suffer from long treatment times and uneven effectiveness. Ex-situ methods, while faster and more controllable, are often hindered by high costs due to excavation, transportation, and energy consumption. Integrating in-situ and ex-situ approaches into a rapid, controllable, and cost-effective soil decontamination strategy provides a promising solution for both conventional organic pollutants and prions alike.

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 propose a novel soil remediation technology integrating biochar application and microwave-assisted pyrolysis, termed as BAMAP, for highly efficient decontamination of organic pollutants in soil. Biochar, a renewable and low-cost material readily produced from biomass pyrolysis, offers excellent adsorption capability of a wide range of organic pollutants. In a typical remediation process, biochar is applied to contaminated soil, which adsorbs and immobilizes free prions and other contaminants. Microwave irradiation is then used to selectively heat the biochar, itself a strong microwave absorber, destroying the adsorbed contaminants while regenerating the biochar for reuse. By harnessing biochar's adsorption capacity, avoiding the need to heat bulk soil, and implementing highly efficient microwave heating, BAMAP offers superior performance in terms of efficacy, speed, and energy cost compared to conventional methods. The project will begin with lab-scale process development to (1) optimize biochar properties and soil application conditions for pollutant adsorption, (2) assess prion decontamination and contaminant degradation, and (3) refine microwave system parameters for effective pollutant destruction. A mobile microwave treatment system will then be developed for field testing at typical contaminated sites in Minnesota. Finally, techno-economic and environmental analyses will assess the scalability and cost-effectiveness of BAMAP as a viable soil remediation solution.

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?

We aim to protect and enhance Minnesota soil resources by developing an innovative soil remediation technology that outperforms conventional methods and can address emerging concerns. This project will determine the extent to which biochar can adsorb prions and other contaminants under a variety of conditions, along with optimization of BAMAP as a soil decontamination method. The ultimate product will be a mobile continuous feed BAMAP system, used for identification of critical specifications, process improvements, and field testing. Lastly, technoeconomic analysis of the entire process will be performed for assessment of the feasibility of full-scale applications and commercialization.

Activities and Milestones

Activity 1: Process development for biochar application and microwave-assisted pyrolysis (BAMAP) for destruction of prions and other organic pollutants in soil

Activity Budget: $175,647

Activity Description:
This activity aims to integrate biochar and microwave-assisted pyrolysis (MAP) into a unified strategy to remediate soil contaminated with prions and other persistent organic pollutants. We will optimize biochar production by fine-tuning feedstock type and pyrolysis conditions to enhance physicochemical properties (surface area, porosity, functional groups) for effective adsorption of pollutants. Building on our expertise in MAP systems, we will design a lab-scale MAP reactor to destroy adsorbed pollutants in biochar and soil. By optimizing power input, temperature, and residence time, we aim to achieve efficient destruction of prions and other contaminants while minimizing energy costs. Comprehensive analytical techniques (GC-MS and LC-MS) will monitor pollutant degradation. For the assessment of prion decontamination, we will employ two detection technologies in tandem: the real-time quaking induced conversion assay and the protein misfolding cyclic amplification assay. Unspiked and CWD prion-spiked soil pre- and post-BAMAP treatment will be extracted and subjected to PMCA analysis. PMCA products will be analyzed by Western blot and by serial RT-QuIC to quantify prions present before and after treatment. We will assess the reusability of regenerated biochar through adsorption tests. Biochar will also be subject to PMCA/RT-QuIC analysis to identify any cross-contamination that may have resulted during biochar

Activity Milestones:

Description	Approximate Completion Date
Characterize biochar's physicochemical properties and study their influence on pollutant adsorption	October 31, 2026
Establish protocols for analyzing treatment products to detect and quantify POPs	October 31, 2026
Establish protocols for analyzing treatment products to detect and quantify prions (PMCA and RT-QuIC)	November 30, 2026
Design and optimize a lab-scale MAP system for pollutant destruction tests	December 31, 2026
Study the impact of soil conditions on prion and pollutant adsorption in Minnesota soil samples	April 30, 2027
Optimize key process variables to achieve efficient decontamination and minimize energy costs	May 31, 2027
Evaluate biochar reusability through follow-up tests	October 31, 2027

Activity 2: Development of a pilot-scale microwave-assisted pyrolysis system for field tests and techno-economic analysis

Activity Budget: $623,353

Activity Description:
Following laboratory-scale experiments and optimization, we will design a mobile, continuous conveyor-belt BAMAP system for field testing and demonstration. Biochar and contaminated topsoil will pass through the microwave cavity on a conveyor belt, where contaminants will be decomposed. This system will enable the continuous treatment of large sample sizes under realistic conditions, while maintaining the efficiency observed in lab-scale trials. Key elements—such as microwave cavity geometry, power distribution, temperature control, and material flow—will be optimized using simulations during the scale-up process to ensure uniform temperature distribution and effective contaminant destruction. Field tests, including biochar application and microwave decontamination, will be conducted either at contaminated sites (i.e. depopulated cervid farms, industrial sites) or in a controlled demonstration-scale lab setting. Critical data on mass and energy balances, operational costs, and decontamination efficiency will be collected, followed by a comprehensive techno-economic analysis to assess the feasibility of application of the BAMAP technology at full scale. Additionally, emissions—including CO_2 and potential byproducts related to fluorine and chlorine—will be closely

monitored to ensure environmental safety and facilitate an environmental analysis. Prion contamination will be assessed both before and after treatment using the mobile system, using the same methods described

Activity Milestones:

Description	Approximate Completion Date
Identify field testing sites and start biochar application field testing	August 31, 2027
Design a pilot-scale microwave-assisted pyrolysis system for soil decontamination	October 31, 2027
Build pilot-scale system and conduct preliminary evaluation of its performance	March 31, 2028
Field tests of microwave decontamination and gather mass/energy balances and decontamination data	October 31, 2028
Techno-economic analysis and environmental analysis	March 31, 2029
Final Report on this project with manuscript publication	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Roger Ruan	University of Minnesota - Department of Bioproducts and Biosystems Engineering	Co-PI	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?

Collaboration with industry partners will be pivotal in overcoming engineering challenges, securing financial backing, and ultimately, commercialization. Numerous federal agencies have expressed interest in high-throughput prion decontamination technologies, including the Environmental Protection Agency (EPA), the United States Department of Agriculture (USDA), and the United States Geological Survey (USGS). Funding opportunities from these agencies can be used for further scale-up and can also be used to identify and test new applications for the system.

Project Manager and Organization Qualifications

Project Manager Name: Stuart Lichtenberg

Job Title: Researcher 6

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

Dr. Lichtenberg holds a bachelor's degree in Agricultural Biotechnology and a doctorate in Integrated Plant and Soil Sciences, both from the University of Kentucky. Dr. Lichtenberg is an environmental toxicologist by training and has a particular interest in novel and highly persistent environmental contaminants. Since 2021, he has operated a research program focused upon the environmental implications of prion diseases, first at the University of Wisconsin and now at the University of Minnesota within the Minnesota Center for Prion Research and Outreach. He is the co-author of numerous manuscripts in the field and is frequently approached by state regulatory and expert panels for his knowledge in this area. Ongoing research areas include prion uptake in plants, prion detection and long-term persistence in soils, and prion strain differentiation using novel amplification assays. Specific to this project, remediation of prion contamination is a major thrust within his laboratory, with several ongoing projects investigating chemical, controlled burn, and conventional incineration as means of prion removal. Dr. Lichtenberg's personnel currently consist of two career research scientists, a graduate student, and a postdoctoral scholar. Physical resources available to Dr. Lichtenberg include a fully equipped molecular biology laboratory, and real-time quaking induced conversion specific resources.

Organization: U of MN - College of Veterinary Medicine

Organization Description:

Established in 1947, the University of Minnesota College of Veterinary Medicine is Minnesota's only veterinary college. Fully accredited, the college has graduated nearly 4,000 veterinarians and hundreds of scientists. The college embraces the "One Health" concept, which aims to transform new knowledge into better health for animals, people, and the environment. The college also plays an important role in the health of the community by assuring food safety, conducting biomedical research, preventing zoonotic diseases, and enhancing our physical and psychological well-being through the care of companion animals and the protection of Minnesota's wildlife natural resources. Our focus is building a globally diverse and inclusive community to improve the health of animals, people, and the environment. This

will be accomplished by discovering and disseminating new knowledge and skills, educating current and future veterinarians and scientists, and providing innovative veterinary services.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Dr. Stuart Lichtenberg		Lead PI			26.8%	0.3		$36,160
Professor Roger Ruan		Co-PI			26.8%	0.24		$70,296
TBN Postdoctoral Scholar		Conduct experiments, design MAP devices, produce manuscripts			20.5%	1.5		$123,481
TBN Graduate Student		Conduct experiments, design MAP devices, analyze data, produce manuscripts			47%	0.75		$85,269
TBN Researcher 4		Conduct prion assays, analyze data, produce manuscripts			24.4%	0.75		$67,973
							Sub Total	**$383,179**
Contracts and Services								
University of Minnesota Biotechnology Resource Center	Internal services or fees (uncommon)	The Biotechnology Resource Center will synthesize the protein substrate necessary for conducting RT-QuIC assays.				-		$20,000
							Sub Total	**$20,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	General Laboratory Consumables (PPE, microcentrifuge tubes, pipette tips, chemicals)	General laboratory consumables are required for each aspect (MAP, RT-QuIC analysis, PMCA analysis) of the project. For the MAP component, $8,000 is requested each year. This funding will cover general consumables (laboratory plastics and chemicals) as well as costs and fees associated with analysis of the non-prion contaminants under investigation. For the RT-QuIC					$45,000

			component, $2,500 is requested each year. This will cover chemicals and disposable lab supplies associated with RT-QuIC analysis. For the PMCA component, $5,000 is requested each year. This will cover chemicals, disposable lab supplies, and PPE needed.					
	Equipment	Devices and Supplies for BAMAP process construction	Construction of the MAP processes will require components of varying purpose and construction. Funds are requested in Years 2 and 3 specifically for this purpose. These items will include, but not limited to, magnetrons, motors, fans, conveyors, temperature probes, and sensors. Additional funding is included to cover the cost of raw materials and fabrication as needed. Funding is also required for non-capital equipment in all years. This will cover small items used in the analysis of processed samples, such as pipettors, scales, and pH meters.					$334,000
							Sub Total	**$379,000**
Capital Expenditures								
		Cup Horn Sonicator for PMCA	Funds are requested for a QSonica Q700MPX microplate cup horn sonicator and chiller. This apparatus is used for the Protein Misfolding Cyclic Amplification (PMCA) assay, which will be used in tandem with RT-QuIC to confirm the efficacy of MAP for prion remediation.	X				$13,800
							Sub Total	**$13,800**
Acquisitions and Stewardship								

							Sub Total	**-**
Travel In Minnesota								
	Other	Expected 2-4 trips in year 3 of the project for field site testing	Travel to and from field site tests					$1,021
							Sub Total	**$1,021**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Open Access Publication Fees	In Year 3, we request $2,000 to offset publication costs associated with open-access publication of our results.					$2,000
							Sub Total	**$2,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$799,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Expenditures		Cup Horn Sonicator for PMCA	The PMCA apparatus is essential for the analysis described in the project. No other alternatives exist, and lack of this methodology will greatly weaken the reliability of our findings. **Additional Explanation :** The PMCA apparatus is expected to be used solely for CWD contaminated sample analysis for the duration of its useful life.

Non ENRTF Funds

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

Total Project Cost: $799,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 19372afc-d86.pdf

Alternate Text for Visual Component

A visual map of the work proposed in this grant. Contaminated materials are fed into a microwave pyrolysis process, decontaminated, and then analyzed for the presence of prions and other POPs....

Supplemental Attachments

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

Title	File
SPA Approval Letter	bfd41d92-3ea.pdf
UMN 2024 Audit	14f43c83-e21.pdf
UMN Secretary of State Good Standing Letter	cb1bb0f9-a37.pdf
UMN Tax Exemption Letter	1b739a09-faf.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:

N/A

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