



Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-320

Proposal Title: Minnesota Microbes for Enhanced Biodegradation of Microplastics

Project Manager Information

Name: Brett Barney

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

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Project Basic Information

Project Summary: We are investigating the potential of natural microbes indigenous to Minnesota to biodegrade conventional plastics in the environment as a means for cleaning contaminated waters and soils across the state.

ENRTF Funds Requested: \$608,000

Proposed Project Completion: June 30, 2030

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.

Microplastics are small particles found in personal hygiene products or the result of the physical degradation process of larger plastics in our environment that results from exposure to sunlight and weathering. These are often invisible to the naked eye, but become apparent under a microscope based on collection techniques with small precision screens. Microplastics have permeated into the food chain and also concentrate environmental pollutants. Recent reports citing high levels of microplastics in the Great Lakes confirmed concerns that the accumulation of microplastics in the environment is not only an issue facing the Pacific Ocean, where this topic has been highlighted as a key element of the Great Pacific Garbage Patch. Indeed, microplastics have infiltrated many standing bodies of water throughout the world and across the state of Minnesota. Plastic waste within the environment contributes to the illness and deaths of countless fish, amphibians, marine mammals and bird species, and also diminishes the pristine nature of our public waters which are a valuable aspect of recreation in Minnesota and the general health of Minnesotans. This unanticipated and detrimental result of our wide-scale adoption of plastics over the past century is an issue that will face generations to come.

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.

Conventional plastics are widely thought to be non-biodegradable. Recent reports have identified microbes capable of degrading common plastics such as those found in beverage bottles (PETE). These studies were important because they identified specific microbes that slowly degrade a common plastic, shattering the misconception that all petroleum-derived commodity plastics are non-biodegradable. Significantly less progress has been made in relation to polyethylene (HDPE or LDPE) and polypropylene used to store everything from milk to household chemicals and detergent. Our prior LCCMR projects have identified various microbes found throughout Minnesota that degrade chemicals like polyethylene, laying the framework to develop approaches to treat contaminated waters and soils across the state. These projects demonstrated that microbial communities are better at degrading complex chemicals like plastics, but also identified specific microbes that have emerged to be primary biodegraders of these plastics. Understanding the mechanisms used by these microbes will lead to the development of new and improved methods to increase rates of degradation. Coupled with efforts to make the public more aware of the emerging issue of microplastics that have proliferated into our environment and food systems, we aim to develop approaches to enhance the biodegradation of microplastics using native Minnesota microbes.

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 project will study mechanisms used by specific microbes to biodegrade plastics like polyethylene. Using the techniques developed in our prior funded work, we will also identify microbes capable of degrading additional plastics, including several proposed next-generation biodegradable plastics. This aspect is important to determine if these materials really perform as promised. We will further investigate methods to enhance the rates of biodegradation and use these microbes to treat contaminated environments to increase plastic biodegradation in a manner that is safe and effective. Finally, we will continue our educational component to educate students across the state of Minnesota.

Activities and Milestones

Activity 1: Evaluate the Mechanisms used by Specific Microbes to Biodegrade Polyethylene

Activity Budget: \$324,000

Activity Description:

Our prior LCCMR projects successfully identified a variety of microbes native to Minnesota that degrade polyethylene over the course of several weeks or months, enabling more detailed studies to understand how these microbes accomplish this very difficult task. Now that these microbes have been identified, we are developing complex genetic methods to identify the genes, biochemical pathways and enzymes that take part in the biodegradation of polyethylene plastics. Equipped with this information, we will identify additional microbes that share similar genes and characteristics to develop enhanced microbial communities to further improve the rates of biodegradation. These microbes can be applied to a range of treatment options, from seed inoculum to large-scale treatment of plastic wastes, to recycling chemicals and energy production. These studies would establish the foundations for each of these potential outcomes. Modern genetic approaches have already been successfully applied to several of these microbes, and using next-generation sequencing, genetic and biochemical characterization techniques, we have begun to identify the features of these microbes that may provide a long-term solution to an important segment of our microplastics problem. Specific enzymes will be characterized and these results shared with the scientific community.

Activity Milestones:

Description	Approximate Completion Date
Apply new genetic techniques to identify genes from multiple microbes involved in polyethylene biodegradation.	December 31, 2028
Characterize specific enzymes and pathways responsible for the biodegradation of polyethylene and publish results.	August 31, 2029
Construct optimized microbial communities that synergistically biodegrade polyethylene in a mutualistic manner.	December 31, 2029
Develop additional educational components to teach Minnesotans about microplastics and share through social media.	June 30, 2030

Activity 2: Evaluate Minnesota Microbes to Determine the Potential to Decompose Biodegradable Plastic Alternatives

Activity Budget: \$140,000

Activity Description:

Various companies and manufacturers promote biodegradable plastic alternatives including polylactic acid (PLA), polybutylene succinate (PBS), polybutylene adipate terephthalate (PBAT) and polycaprolactone (PCL) as biodegradable alternatives to current plastics. In many cases, these biodegradable alternatives do decompose, but require elevated temperatures that are only found in industrial composting operations. However, under typical environmental conditions, the biodegradation of these plastics may be much slower. As an effort to determine whether these polymers are actually better if they escape other potential waste management schemes, we will test these next-generation biodegradable plastics under typical environmental conditions using the same approaches we developed to study polymers such as polyethylene. These results will provide the citizens of Minnesota with an unbiased analysis of the biodegradation potential of emerging plastic alternatives to determine if these products actually perform as advertised. As a comparison, we will also investigate and compare these to natural bioplastics such as polyhydroxybutyrate (PHB) that are produced by certain microbes, and are beginning to show up in the marketplace as well.

Activity Milestones:

Description	Approximate Completion Date
Identify commercial sources of biodegradable plastics for unbiased natural environment studies.	December 31, 2027
Test six biodegradable plastics under nominal environmental conditions to compared and contrast potential to decompose.	December 31, 2028
Determine the key environmental microbes that are involved in the biodegradation of next-generation biodegradable plastics.	May 31, 2030

Activity 3: Develop Seed Stocks of Natural Communities to Treat Microplastic Contaminated Waters and Soils across Minnesota

Activity Budget: \$144,000

Activity Description:

Our prior studies of microbial communities and individual microbes have identified strains that degrade polyethylene both individually, but also together as part of a larger community. As a final effort to develop natural communities that can be used for broad treatment of microplastic contaminated waters, we will investigate the potential to recombine optimal strains back together to create specific communities that increase the rates of biodegradation. While some microbes are able to function well with others in a community (symbionts), certain microbes are antagonistic to one another, and may either dominate a community or become detrimental to other key microbes. We will create matrices of different microbes and test them over the course of several months to develop a variety of communities that can be applied for the treatment of contaminate environments. These studies will include detailed studies of the suitability for safe application of the microbes, and will include potential efforts to remove any pathogenic genes from these microbes to make them more suitable to broader application (if required).

Activity Milestones:

Description	Approximate Completion Date
Prepare matrices of various microbial community structures and test for several months to determine stability.	September 30, 2028
Analyze the genomes of key microbes to evaluate the safety and potential of field application.	March 31, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Bo Hu	University of Minnesota	co-PI	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.

We will share results from this research with the broader scientific community through publications in open access journals. Genome sequences for any strains sequenced as part of this project will be submitted to the National Center for Biotechnology Information. Strains will be made available to fellow scientists for research purposes or submitted to strain banks or culture collections for long-term storage. Our laboratory also maintains stocks of these strains in cryogenic storage and provides these to other entities upon reasonable request. Work from this research project will also be shared with students across the state through various outreach aspects that will be overseen by the Principal Investigators, Postdocs and Graduate Students. This outreach will include the development and maintenance of an expanded website related to this project, where we will share information related to the status of the project. We will also develop various short descriptive videos to showcase some of the work and accomplishments of the project, which will be shared through outlets such as YouTube and other social media outlets. The Environmental and Natural Resources Trust Fund will be acknowledged through attribution in the acknowledgements section of any peer reviewed research or acknowledged in any public presentations. The use of the trust fund logo will be used in any presentation or electronic media, publications and signage as detailed in the 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?

We are also seeking funds from additional federal funding sources including the Environmental Protection Agency, the National Science Foundation and the National Institutes for Health, though current funding from these agencies remains uncertain, and a lapse in funding could dramatically hinder our recent progress, which has been significant. The continuation of this funding is essential to the long-term success of this project. We are seeking to train a new generation of scientists and engineers who will work to tackle this problem that could take decades to fully address.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Minnesota Microbes for Enhanced Biodegradation of Microplastics	M.L. 2024, , Chp. 83, Art. , Sec. 2, Subd. 08g	\$524,000
Healthy Native Prairie Microbiomes for Cleaner Water	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04q	\$468,000

Project Manager and Organization Qualifications

Project Manager Name: Brett Barney

Job Title: Professor

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

Dr. Brett Barney (Project Manager) spent six years in the medical device manufacturing sector, before returning to complete a PhD in 2003. Following his PhD, he spent six years as a postdoctoral fellow and project manager. He has been a professor with the Department of Bioproducts and Biosystems Engineering and a member of the Biotechnology Institute at the University of Minnesota since 2009. He was the Director of the Microbial and Plant Genomics Institute from 2020 to 2022. The Bioproducts and Biosystems Engineering Department serves as a core department combining Environmental and Ecological Engineering, Agricultural Engineering, and Biological Engineering. The University of Minnesota provides a range of facilities and sufficient laboratory space to perform each of the activities described in this proposal.

Dr. Barney’s laboratory is focused on minimizing the environmental impacts associated with biofuels and agriculture, and finding innovative methods to remove plastic contaminants from water and soils. Dr. Barney has 30 years of experience in both basic and applied research in both academia and industry, including experience managing projects and laboratories in a range of settings. Previous research funding has come from the National Science Foundation (NSF), the United States Department of Agriculture (USDA), the United States Department of Energy (DOE), the Defense Advanced Research Projects Agency (DARPA), the Legislative-Citizen Commission on Minnesota Resources (LCCMR), Minnesota’s Discover, Research and Innovation Economy (MnDRIVE), the Forever Green Initiative and the Initiative for Renewable Energy and the Environment (IREE). He spent several years researching bioremediation of soil and waters contaminated with polyaromatic hydrocarbons (PAHs) and pentachlorophenol (PCP) in relation to Superfund sites in across the Western United State, and has been developing a research program to understand and characterize the biological degradation of various plastics in the environment for the past 10 years.

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								
Lead Principal Investigator/ 9 month appointment		Project design and management, two weeks of summer salary support per year.			36.6%	0.12		\$30,000
co-Principal Investigator, 9 month appointment		Project design and management, one week of summer salary support per year.			36.6%	0.06		\$15,000
Graduate Research Assistant		Research Assistant, Performing Laboratory Experiments and Data Analysis, supervised by the project manager, education			24.2%	1.5		\$188,000
Undergraduate Research Assistant		Research Assistants for Laboratory Experiment and Field Study Data Collection, supervised by the project manager and graduate student. Primarily summer research work for two students to learn about the research field.			0%	1.5		\$80,000
Postdoctoral Associate		Research Supervision, Performing Laboratory Experiments and Data Analysis, in collaboration with the Project Managers			25.7%	2		\$167,000
Research/Teaching Specialist/ funding dependent appointment		Project Support, Undergraduate Supervision, Performing Specific Analytical Procedures			36.6%	0.75		\$74,000
							Sub Total	\$554,000
Contracts and Services								
Various 3rd Party DNA Sequencing Services	Service Contract	As part of this project, we require some DNA sequencing services performed by a 3rd party external laboratory. This amounts to about \$4000 per year and is performed by reputable external laboratories.				0		\$12,000
							Sub Total	\$12,000
Equipment, Tools, and Supplies								

	Tools and Supplies	Non-Capitalized Lab Scientific or Field Supplies	Laboratory Supplies: General Laboratory Chemicals, Media, Reagents and Safety Materials for students and participants, including gloves (\$120 per month) and Kits for Performing Routine Molecular Biology (\$200 per kit), Analytical Reagents (\$300 per month), Liquid Nitrogen for Strain Storage (\$400 per year). Projections of laboratory supplies are based on long-standing historical costs associated with operations for similar projects.					\$36,000
							Sub Total	\$36,000
Capital Equipment								
							Sub Total	-
Acquisitions and Stewardship								
							Sub Total	-
Travel In Minnesota								
							Sub Total	-
Travel Outside Minnesota								
							Sub Total	-
Printing and Publication								
	Publication	Publications of two papers in Scientific and Engineering Journals	Many engineering journals have charges associated with publications, generally around \$3000 per journal. We plan to publish one manuscript before the end of 2028, and another before the end of 2030.					\$6,000
							Sub Total	\$6,000
Other Expenses								

							Sub Total	-
							Grand Total	\$608,000

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: \$608,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: [e04059dd-ac1.pdf](#)

Alternate Text for Visual Component

Graphic showing a high-resolution electron micrograph of Minnesota microbes degrading polyethylene along with laboratory samples illustrating culture growth. A brief list of the overall project aims is also included....

Supplemental Attachments

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

Title	File
Letter of Approval to Submit	9875df34-d48.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?

N/A

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:

Wendy Moylan, University of Minnesota

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