Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-178

Proposal Title: Biochar Applications for Stormwater Pond Management and Remediation

Project Manager Information

Name: Lea Pollack

Organization: U of MN - College of Biological Sciences

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Project Basic Information

Project Summary: Researching how novel applications of biochar amendments in stormwater ponds can be used to maximize pollution remediation while minimizing negative effects on freshwater communities.

ENRTF Funds Requested: $641,000

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?

Region(s): Metro

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.

Pollution poses a significant threat to lakes and groundwater across Minnesota. Stormwater ponds offer a cost-effective solution to protect water resources from pollutants. Stormwater ponds retain runoff to mitigate flooding while also reducing pollution impacts by capturing contaminants before they move farther downstream to lakes and rivers. Critically, we have little knowledge of how well stormwater ponds trap emerging contaminants of concern, especially those released from tire-wear particles. By binding contaminants via microscopic pores, biochar presents an exciting opportunity to enhance pollutant mitigation, particularly for heavy metals and tire chemicals. While extensively recommended for soil remediation and runoff filtration, the direct application of biochar remains largely unexplored in wetlands and freshwater ecosystems. Stormwater ponds represent an untapped frontier for biochar application, potentially supercharging their pollution remediation capabilities. However, before implementing biochar in these systems, rigorous testing is needed to identify the most effective implementation methods. Moreover, since stormwater ponds provide important habitat for aquatic life, it is essential to confirm management practices produce no adverse effects on ecological functions or wildlife. By strategically integrating biochar into stormwater pond management, these functional infrastructure elements can serve as robust ecological assets that support biodiversity and water quality improvements across the state.

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 testing biochar applications for pollution remediation directly within urban and highway stormwater ponds. Our research will comprehensively measure both contaminant remediation effectiveness and impacts on ecosystem health and functioning. We will examine biochar's proven capacity to retain heavy metals and its potential to capture emerging tire-related contaminants (e.g., 6PPD-Q, 1,3-DPG, HMMM) that are highly toxic to fish and have been detected at elevated concentrations in Minnesota's stormwater ponds. First, we will test designs for use in stormwater ponds developed to minimize the loss of biochar through natural weathering patterns (i.e., storm events that would slowly pulverize the application material) and maximize efficiency of applications. To strengthen our findings, we will complement these field-based studies with controlled experimental pond mesocosms. These enclosures are designed to mimic natural environments in which natural conditions, like salinity from road salts and oxygen levels, can be directly manipulated and studied. These experiments will provide insights into the environmental and geochemical impacts of biochar applications across known variation within these ecosystems. We will share our data directly with managers and agencies (e.g., City of Minneapolis, MPCA, BWSR) that provide recommendations for both stormwater pond management and biochar applications.

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?

By improving remediation of pollutants in stormwater systems, this project will reduce contaminant loading into downstream lakes, rivers, and wetlands, preserving water quality and ecosystem health. Our research will unlock the untapped potential of biochar applications directly within stormwater ponds, leveraging a growing resource that Minnesota is increasingly producing from wood waste. This approach offers dual environmental benefits: pollutant remediation and carbon sequestration, aligning with the state's climate and conservation goals. The proposed study has transformative potential to influence both stormwater management practices and biochar application guidelines statewide.

Activities and Milestones

Activity 1: Application of biochar amendments within stormwater ponds: case studies

Activity Budget: $219,000

Activity Description:
The goals of activity 1 are to design and test biochar amendment strategies within stormwater ponds that could improve their capacity to mitigate pollution. A central challenge is how best to place and replace biochar within freshwater ecosystems. Considerations include a containment strategy that prevents biochar fragment release, allows water to penetrate materials, and facilitates removal. As part of this project, we will host two workshops with the Minnesota Design Center to (1) work through design constraints and (2) develop 3-4 designs to be piloted using City of Minneapolis biochar from woody feedstock. Designs to compare include biochar enclosed within a floating plastic sleeve versus a sand-biochar filter embedded within the sediment. In collaboration with the City of Minneapolis, we will implement designs simultaneously within four representative ponds. We will measure the rate of degradation of the intervention (e.g., how quickly it falls apart) and uptake of pollutants (e.g., heavy metals, tire-wear chemicals) in the biochar over a year (i.e., 1, 6, and 12 months).

First, this activity will allow us to determine robust designs for in-pond biochar application. Second, this activity will allow us to determine whether these amendments can effectively trap contaminants under real-world conditions.

Activity Milestones:

Description	Approximate Completion Date
Workshops with Minnesota Design Center to create different designs for biochar applications	April 30, 2028
Create biochar applications models and test in the lab for fragment release and water penetration	August 31, 2028
Place winning designs into real-world ponds and monitor impacts before and after implementation	October 31, 2029
Prepare report for stormwater professionals.	June 30, 2030

Activity 2: Study how variation in pond chemistry impacts biochar's pollution remediation effectiveness

Activity Budget: $212,000

Activity Description:
The goal of activity 2 is to use experimental pond mesocosms to investigate how natural chemical variation impacts biochar's ability to capture contaminants. Stormwater ponds vary in chemistry due to environmental factors, including road salt inputs and stratification that leads to low oxygen levels. It is currently unknown how these variables might impact biochar's ability to capture and retain pollutants over the long term. This experiment will use twenty 22-gallon containers established with water, sediment, algae, and microbes from a local stormwater pond as well as an ecologically relevant amount of heavy metals and tire chemicals. The experimental design will comprise of four treatments with five replicates each: control, high salinity, low oxygen, and high salinity + low oxygen. To evaluate temporal effectiveness, mesocosm ponds will be assessed before biochar application (e.g., via a filter embedded into the sediment) and periodically over a year post application (i.e., 1, 3, 6, and 12 months). Measurements will include heavy metals and tire chemicals within water and sediments.

This activity will allow us to identify how biochar performs under common chemical environments. These insights will enable development of practices tailored to specific ponds, providing managers with evidence-based guidance for optimizing biochar applications.

Activity Milestones:

Description	Approximate Completion Date
Set up mesocosms ponds with varying treatments of salinity and oxygen	May 31, 2028
Collect samples at multiple time points over a year before and after biochar introduction	June 30, 2029
Assess water samples for heavy metal and tire chemical concentrations	December 31, 2029
Analyze data, write scientific manuscript, and prepare report for stormwater professionals.	June 30, 2030

Activity 3: Document how biochar impacts local ecosystem functioning

Activity Budget: $210,000

Activity Description:
The goal of activity 3 is to use the same experimental pond mesocosm setup (described in Activity 2) to simultaneously investigate the impact of biochar on ecosystem health and functioning of stormwater ponds. While research has shown that biochar can be an effective pollution remediation tool in freshwater, its impact on freshwater plants and wildlife is less clear. Will these amendments improve health and ecosystem functioning by limiting the impacts of pollutants or does it have unintended consequences? Measurements will include biochar mineralization products, water chemistry (e.g., pH, redox conditions, chlorine levels, nitrogen and phosphorus concentrations, organic pollutants), pond respiration rates, algal productivity, microbial community composition, and invertebrate assemblages. To evaluate temporal effectiveness, measurements will be assessed before biochar application and periodically over a year post application (i.e., 1, 3, 6, and 12 months).

This activity will provide a greater understanding of biochar's ecological impacts on stormwater ponds as complete ecosystems rather than merely pollution retention technologies. This dual focus ensures that remediation strategies effectively reduce contaminants while maintaining or enhancing overall pond ecosystem health and bioremediation functionality.

Activity Milestones:

Description	Approximate Completion Date
Measure ecological health and function of mesocosms at multiple time points over a year	June 30, 2029
Measure water chemistry and biochar mineralization products at multiple time points over a year	January 31, 2030
Analyze data, write scientific manuscript, and prepare report for stormwater professionals.	June 30, 2030

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Emilie Snell-Rood	University of Minnesota (Ecology, Evolution & Behavior)	Professor collaborating on project with expertise on ecotoxicology, tire-wear pollution, and biochar application development. Will provide guidance on biochar design, field protocols, and ecology. Dr. Snell-Rood will also support with lab space for sample storage, preparation, and analysis.	Yes
Jacques Finlay	University of Minnesota (Ecology, Evolution & Behavior)	Professor collaborating on project with expertise on stormwater pond management and freshwater ecology. Will provide guidance on experimental design, field protocols, and water quality analysis. Dr. Finlay's lab will support with field gear and needed laboratory infrastructure for research on pond ecology.	Yes
Cara Santelli	University of Minnesota (Earth and Environmental Sciences)	Professor collaborating on project with expertise on water chemistry and microbial geochemistry. Will provide guidance on experimental design and chemical analysis. Dr. Santelli's lab will also support with needed laboratory equipment and infrastructure to analyze microbial communities, heavy metal contamination, and water quality metrics.	Yes
William Arnold	University of Minnesota (Department of Civil, Environmental, and Geo-Engineering)	Professor collaborating on project with expertise on stormwater contamination and techniques to measure emerging contaminants of concern. Will provide guidance on experimental design and organic chemical analysis. Dr. Arnold's lab will support with needed equipment and protocols to measure tire chemicals.	Yes
James Doten	City of Minneapolis	Carbon Sequestration Program Manager for the City of Minneapolis, overseeing the city's first biochar facility. Will provide guidance on use and application of biochar. The project will be using the biochar produced by the City of Minneapolis's facility in the proposed field and laboratory based experiments.	No
Shahram Missaghi	City of Minneapolis	Water Resources Regulatory Coordinator for the City of Minneapolis Public Works, Surface Water and Sewers-Regulatory. Will provide guidance and feedback on application of biochar directly into stormwater ponds, including selection and accessing appropriate field sites.	No
Dan Shaw	Minnesota Board of Soil and Water Resources	Senior Ecologist for the Board of Soil and Water Resources (BWSR). Will provide guidance on use of biochar as well as potential incorporation for best use practices.	No

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 directly provide our data to the City of Minneapolis on the ponds in which we test biochar applications methods. In addition, through our collaboration with BWSR and ongoing relationships with the Minnesota Pollution Control Agency (PI Finlay) and the Center for Watershed Protection, we will share our data with groups working on stormwater and biochar best practices recommendations. We will publish two scientific journal articles from this work. Moreover, the PIs on this project are part of a broader collaboration across universities, state and federal agencies, and non-profits within Minnesota through the NSF Minneapolis Saint Paul Long Term Ecological Research Program. This work will add to the larger data collection efforts to document pollution across Minnesota. Critically, researchers can continue to access this information for future work, including via open-source data sets. All products (i.e., datasets, papers, and presentations) from this research will acknowledge ENRTF funding according to requirements and 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?

Our commitment to translating research into practice includes direct data sharing with stormwater managers across the state, as well as the Minnesota Pollution Control Agency for incorporation in their Minnesota Stormwater Manual (which currently lacks information on biochar applications for tire chemicals). Additionally, we will provide our findings to the Center for Watershed Protection for incorporation into their Biochar in Stormwater Manual, ensuring broad accessibility for practitioners. To advance scientific understanding, we will publish two peer-reviewed papers in scientific journals accompanied by open-source data sets. This multi-faceted dissemination strategy ensures our research directly informs both policy and practice.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Documentation and Toxicity of Microplastics in Urban Ecosystems	M.L. 2025, First Special Session, Chp. 1, Art. 2, Sec. 2, Subd. 04j	$300,000

Project Manager and Organization Qualifications

Project Manager Name: Lea Pollack

Job Title: Research Associate

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

Dr. Lea Pollack is a researcher in the Ecology, Evolution, and Behavior Department at the University of Minnesota. Dr. Pollack is an expert on pollution and the ecology of stormwater ponds. She received her PhD in 2021, where her dissertation research focused on microplastic pollution impacts on wildlife. She then completed a National Science Foundation Postdoctoral Fellowship in Biology at Rice University. Currently, she is the principal investigator of a research program studying heavy metal and microplastic pollution across the stormwater network of the Twin Cities Metro. Thus she has a track record of managing large grants and coordinating between managers and multiple research laboratories. Moreover, because of her experience, she is particularly aware of the potential challenges involved in stormwater fieldwork for the proposed project. Lastly, she has established relationships with various stormwater management agencies and local governments across Minnesota because of her current research program.

Organization: U of MN - College of Biological Sciences

Organization Description:

Within the University of Minnesota College of Biological Sciences, this research will be embedded in the Minneapolis-St. Paul Metropolitan Area (MSP) Long-Term Ecological Research Program (mspurbanlter.umn.edu). Supported by a National Science Foundation investment in research infrastructure, the MSP LTER program investigates the effects of urban stressors on wildlife, freshwater systems, forests, and human communities. Through this program, all senior personnel are part of a larger collaborative effort between the University of Minnesota, University of Saint Thomas, USDA Forest Service, The Nature Conservancy, and The Water Bar. ENRTF support would enable the launch of new lines of inquiry within this established research platform. This organizational structure, together with regular engagement with relevant agencies, provides a robust foundation for effective implementation and long-term sustainability of the proposed work. In addition to research coordination, advanced infrastructure, and scientific expertise, the MSP Long-Term Ecological Research Program maintains dedicated capacity for education and outreach, including middle and high school programming delivered in partnership with the Bell Museum.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lea Pollack		Academic Research Associate. Project manager responsible for leading the project full time for 3 years.			36.6%	3		$320,000
Emilie Snell-Rood		Academic Faculty. Professor collaborating on project with strong expertise on pollution and biochar applications. Dr. Snell-Rood will provide guidance on experimental design, chemical analysis, calculations, writing, and developing guidelines for biochar professionals.			36.6%	0.04		$11,000
Cara Santelli		Academic Faculty. Professor collaborating on project with strong expertise on water and sediment chemistry. Dr. Santelli will provide guidance on experimental design, chemical analysis, calculations, and writing. She will also supervise one of the graduate student researchers on the team.			36.6%	0.04		$12,000
Jacques Finlay		Academic Faculty. Professor collaborating on project with strong expertise on stormwater pond pollution and ecology. Dr. Finlay will provide guidance on experimental design, field protocols, chemical analysis, calculations, writing, and developing guidelines for stormwater managers.			36.6%	0.04		$11,000
William Arnold		Academic Faculty. Professor collaborating on project with strong expertise on tire chemical pollution and chemistry. Dr. Arnold will provide guidance on experimental design, chemical analysis, and writing. He will also supervise one of the graduate student researchers on the team.			36.6%	0.04		$16,000
Graduate Student Researcher		Graduate student in Geosciences (Ethan Lynch) will assist with all experiments. In particular, the student will assist in collecting and analyzing heavy metal, microbial, and other chemical metrics from experimental ponds, processing and analyzing data, and writing formal papers.			24.2%	0.63		$81,000
Graduate Student Researcher		Graduate student in Engineering will assist with analysis of tire chemicals from both outdoor case studies and mesocosm experiments. The student			24.2%	0.76		$109,000

		will collaborate in processing and analyzing data, and writing formal papers.						
Undergraduate Research Assistant - Academic Year		Undergraduate student will assist in lab processing of samples collected throughout the year. Student will work 5 hours per week during the academic school year.			0%	0.27		$11,000
Undergraduate Research Assistant - Summer		Undergraduate student will assist in field work and lab work.			0%	0.75		$28,000
							Sub Total	**$599,000**
Contracts and Services								
Agilent	Service Contract	Maintenance service and repair for LC-MS/MS analytical equipment required for analysis of tire chemicals				0.2		$10,000
							Sub Total	**$10,000**
Equipment, Tools, and Supplies								
	Tools and Supplies	Lab supplies. Includes cartridges, standards, vials, solvents, filters for tire chemicals analysis - 150 samples ($5000), heavy metal analysis - 150 samples ($8000), and algal analysis - 100 samples ($4000). Includes plasticware and glassware containers for water sample collection and storage ($3000).	Supplies to support collection, storage, and analysis of water samples for tire chemicals in engineering lab, heavy metals in geosciences lab, and chlorophyl-a through fluorometric analysis in ecology lab.					$20,000
	Tools and Supplies	Lumber, buckets, hoses for mesocosms	Supplies for building and maintaining experimental pond mesocosms					$2,000
	Tools and Supplies	Biochar (~45 cubic yards)	For design testing, application in field case studies, and experimental pond mesocosms					$5,000
							Sub Total	**$27,000**
Capital Equipment								
							Sub Total	**-**

Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Instrument maintenance	Maintenance service and repair for ICP-MS analytical equipment required for heavy metal analysis					$5,000
							Sub Total	**$5,000**
							Grand Total	**$641,000**

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				
In-Kind	University of Minnesota	In-kind overhead for administrative and operational expenses that will support the proposed research.	Potential	$312,000
			Non State Sub Total	**$312,000**
			Funds Total	**$312,000**

Total Project Cost: $953,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 7a45921e-1e2.pdf

Alternate Text for Visual Component

Schematic showing how stormwater ponds protect fish and other aquatic wildlife by filtering and capturing pollutants out of runoff before it reaches local lakes and rivers. The proposed project will evaluate how biochar amendments can improve stormwater ponds' ability to capture contaminants and which amendment designs are most effective....

Supplemental Attachments

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

Title	File
Support Letter MN Board of Water and Soil Resources	f77eb72b-958.pdf
UMN SPA Letter of Approval	19e53ba2-7d6.pdf
Support Letter City of Minneapolis	a4210273-e44.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?

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?

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:

Emilie Snell-Rood (University of Minnesota), Jacques Finlay (University of Minnesota), Cara Santelli (University of Minnesota), William Arnold (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