Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-078

Proposal Title: Utilizing Wood Waste and Biochar for Mineland Reclamation

Project Manager Information

Name: Matthew Aro

Organization: U of MN - Duluth - NRRI

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Project Basic Information

Project Summary: We propose to reduce greenhouse gas emissions and expand markets for Minnesota wood waste by developing guidelines for utilizing wood waste and biochar as topsoil amendments for mineland reclamation.

ENRTF Funds Requested: $371,000

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?

Region(s): NE

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.

The federal Surface Mining Control and Reclamation Act of 1977 and the Minnesota Mineland Reclamation Act of 1969 require that mining land reclamation practices restore land to its pre-mining condition. However, despite nearly 130,000 acres of mine-disturbed land on the Iron Range, less than 5% has been reclaimed. To fulfill this requirement, salvaging and redistributing topsoil alone is unlikely to restore the land to its original state unless additional organic matter is added. Woody biochar and wood waste, such as that derived from trees infested by the emerald ash borer (EAB), are potential candidates for mineland reclamation since their nutrient content supports topsoil formation. The project team has prior experience working with biochar and wood waste in stormwater treatment projects, observing that these materials enhance soil structure, improve water retention and infiltration, adsorb pollutants, and promote plant growth. Based on this experience, we propose to assess current applications of ash- and balsam fir-based biochar and wood waste in mineland reclamation and explore new soil mixtures that incorporate these materials. The goal is to create detailed guidelines for effectively using biochar and wood waste in mineland reclamation efforts, while upcycling the waste wood to reduce greenhouse gas (GHG) emissions.

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 would identify and collect waste ash and balsam fir wood and heat-treat a portion of it into thermally modified wood and biochar—a stable, carbon-sequestering material produced via partial combustion in limited oxygen. We will utilize previously developed protocols to manufacture both the biochar and thermally modified wood. These newly produced materials, along with raw wood waste and soil, will be characterized and tested individually and in various combinations to determine the optimal soil composition for effective mineland reclamation. Additionally, the team will survey existing reclamation sites where wood waste has been applied as topsoil to evaluate its impact on plant growth, soil erosion, and drainage water quality.

The survey results from existing sites, along with the new engineered soil mixes developed from our tests, will result in guidelines for wood waste applications in mineland reclamation that can help utilize the increasing volumes of wood waste generated by urban expansion, emerald ash borer (EAB) and spruce budworm infestations, hazardous fuel reduction projects in Minnesota forests, and storm-related tree removal. Finally, we will share project outcomes with stakeholders through meetings, conferences, an educational video, and webinars to ensure broad dissemination and engagement to catalyze real-world application of project results.

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?

Project results can be applied statewide, regardless of an area's economic or health status, thus benefiting not only economically privileged communities. If successful, this research will: (1) provide a comprehensive understanding of how wood waste and biochar can be effectively utilized as soil amendments for mineland reclamation to retain water, remove pollutants, and support plant growth; (2) preserve the environment by reducing runoff and erosion from land surfaces to surrounding water bodies; (3) reduce disposal of wood waste and mitigate climate change by utilizing biochar; (4) and generate best practices for using wood waste as soil amendments in mineland reclamation.

Activities and Milestones

Activity 1: Monitor existing applications of woody biochar and wood waste in land reclamation

Activity Budget: $73,429

Activity Description:
The objective of this Activity is to explore the potential performance of wood waste and biochar in land reclamation by identifying and documenting the sites where these materials have already been utilized. Since biochar applications in land reclamation are relatively new, this activity will primarily focus on land reclamation sites that have utilized wood waste. First, we will collect data from these sites, including information on soil health monitoring, plant growth, and pollutant reduction. We will then compile a comprehensive performance report to provide valuable insights into the effectiveness of using woody biochar or wood waste for mineland reclamation, as well as the long-term aging effect. The outcome of this Activity will be new knowledge that is critical for designing more efficient and sustainable land reclamation strategies that incorporate woody materials, enabling future projects to benefit from proven, cost-effective solutions for soil degradation and pollution.

Activity Milestones:

Description	Approximate Completion Date
Compile performance report on existing land reclamation sites using wood waste or woody biochar	December 31, 2026
Finish monitoring these existing land reclamation sites	December 31, 2028

Activity 2: Obtain materials for direct use and the production of biochar and thermally modified wood

Activity Budget: $69,246

Activity Description:
The objective of this Activity is to secure all materials needed for the project. First, we will secure up to 500 lbs each of waste ash wood chips from the City of Duluth and waste balsam fir wood chips from Hedstrom Lumber in Grand Marais, MN (see Letters of Support). The chips will be collected in drums or totes, as appropriate. During the material collection, more relevant site information will be collected, if necessary. Once received, the moisture content of the chips will be determined using standard ASTM procedures. We will then manufacture biochar from a portion of the waste ash and balsam fir chips at up to two treatment intensities (e.g., low temperature/high temperature) at the NRRI Biomass Conversion Laboratory by leveraging established procedures and equipment. The biochars' surface, structure, and stability will then be characterized. We will also manufacture thermally modified wood from the waste ash and balsam fir chips at a moderate treatment intensity at the NRRI by leveraging established procedures and equipment. The outcome of this Activity will be successful manufacturing of biochar and thermally modified wood from the waste ash and balsam fir, which will be used for completion of Activity 3.

Activity Milestones:

Description	Approximate Completion Date
Secure up to 500 lbs of both waste ash and balsam fir waste wood chips	December 31, 2026
Manufacture biochar and thermally modified wood from the waste ash and balsam fir wood	July 31, 2027
Characterize biochar	December 31, 2027

Activity 3: Conduct laboratory tests on the new engineered soil mixes for mineland reclamation

Activity Budget: $179,036

Activity Description:
The objective of this Activity is to gain a full understanding of the chemical and physical properties and performance of new engineered soil mixes containing waste ash and balsam fir wood waste, and thermally modified wood and biochar manufactured from this waste. First, we will characterize the waste ash and balsam fir wood chips by leveraging pertinent methods developed in previous research completed by the project team, followed by creation of engineered soil mixes composed of wood chips, biochar, thermally modified wood, and natural soil at different mixing ratios. Second, the soil mixes will be tested to assess key land reclamation performance parameters, including infiltration, erosion resistance, water quality, and vegetation growth. This work will also include assessing the wood chip decomposition rates within each mixture as biochar can potentially enhance the wood composting process. Through laboratory-scale batch tests and greenhouse studies, the outcome of this Activity will be a thorough evaluation of the performance of the engineered soil mixes for mineland reclamation, including water infiltration capacity, pollutant (metals, phosphorus, and nitrogen) removal, and plant growth.

Activity Milestones:

Description	Approximate Completion Date
Characterize the waste ash and balsam fir wood chips	December 31, 2027
Create engineered soil mixes composed of waste wood, biochar, thermally modified wood, and natural soil	December 31, 2027
Evaluate the performance of the engineered soil mixes for mineland reclamation efficacy	December 31, 2028

Activity 4: Evaluate and maximize project impact by disseminating results and benefits to public and private stakeholders

Activity Budget: $49,289

Activity Description:
The objective of this Activity is to maximize project impact by developing comprehensive guidelines for the use of wood waste in mineland reclamation. First, we will determine potential consumption of wood waste statewide for land reclamation based on composition and performance of the highest-performing engineered soil mixes. Using life cycle assessment, we will then determine avoided GHG emissions and global warming potential (GWP) of the highest performing engineered soil mixes compared to traditional engineered soil mixes. To further maximize impact, the NRRI, UMD, and project partners will share project results and benefits with public and private stakeholders via: (1) webinars presented to National Forest Supervisors, the Minnesota Forest Industries (MFI), public and private land managers, and state foresters across Minnesota; (2) web/electronic media and technical reports delivered through the NRRI and UMD websites, newsletters, and social media; (3) news releases (potential outlets include Duluth/Minneapolis and National media); (4) an educational video; (5) a conference presentation; and (6) and one peer-reviewed journal article. The outcome of this Activity is promotion of the project's ability to enhance climate resilience; reduce wildfire risks; improve forest health; and catalyze potential future waste wood-based markets, innovations, and investments in Minnesota.

Activity Milestones:

Description	Approximate Completion Date
Determine potential consumption of wood waste statewide	June 30, 2029
Determine avoided GHG emissions and global warming potential (GWP) of the highest performing soil mixes	June 30, 2029
Submit Final Report	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Clark Christenson	City of Duluth	Clark will donate waste ash wood chips from emerald ash borer (EAB) restoration projects, which will be converted into biochar at the NRRI.	No
Jeff Johanns	Hedstrom Lumber	Jeff will donate waste balsam fir wood chips, which will be converted into biochar at the NRRI.	No
Kevin Jacobsen	Story North Productions	Kevin will lead production of the educational video for widely disseminating project results.	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?

Project findings can be applied to statewide land reclamation projects that require topsoil. Our guidelines will describe optimal waste wood, thermally modified wood, biochar, and natural soil mixing ratios to enhance civil and environmental engineering performance for mineland reclamation. Results will be shared with the public, regulatory agencies, industry, and design firms through conferences, meetings, and webinars. We will leverage recent research by Co-PIs Saftner and Cai in a similar stormwater treatment application that is being implemented through the use of a Design Guide, and we will use a similar approach to implement these new research findings into practice, statewide.

Project Manager and Organization Qualifications

Project Manager Name: Matthew Aro

Job Title: Research Program Manager

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

Matthew Aro is a Research Program Manager of Wood Products at the University of Minnesota Duluth Natural Resources Research Institute (NRRI). He has over 20 years of experience providing product, process, and business concept research and development services to entrepreneurs, organizations, and agencies associated with the wood products and natural resources sectors. His work fosters regional economic development for enterprises that impact the building material and industrial wood markets, and he has worked on a broad spectrum of applied research projects focused on wood- and natural fiber-based materials. He also regularly interacts and collaborates with public and private sector professionals and academicians in the wood products field. Previous work included a role as Co-PI on a MnDOT-funded project to evaluate the use of biochar-based engineered soil mixes for stormwater retention, pollution mitigation, and plant growth along Minnesota roadways. He is also currently PI and Co-PI and two projects evaluating the use of biochar as a functional performance additive in construction bricks and plasters. Project collaborators have included state agencies, the U.S. Department of Agriculture, the National Science Foundation, and the private sector (both in the U.S. and abroad). He also has experience conducting environmental life cycle and sustainability assessments of a range of new natural resource-based technologies. He has a B.S. degree in Broad Field Science from the University of Wisconsin-Superior, as well as M.S. degrees in Management of Technology and Natural Resources Science and Management, both from the University of Minnesota.

Organization: U of MN - Duluth - NRRI

Organization Description:

The Natural Resources Research Institute (NRRI) is part of the University of Minnesota research enterprise and employs over 130 scientists, engineers, and technicians in its mission to deliver integrated research solutions that value our resources, environment, and economy for a sustainable and resilient future. NRRI collaborates broadly across the

University system, the state, and the region to address the challenges of a natural resource-based economy.

By partnering with industry, business leaders, agency decision-makers and many others, NRRI researchers frame and deliver on real-world solutions. NRRI scientists have extensive experience in managing large, interdisciplinary projects, including the development of tools for environmental assessment and resource management. NRRI's role is as an impartial, science-based resource that develops and translates knowledge by characterizing and defining value-resource opportunities, minimizing waste and environmental impact, maximizing value from natural resource utilization, and maintaining/restoring ecosystem function.

Major outcomes from NRRI projects include informing environmental management and policy and assisting industry and communities in defining and maintaining the social license to operate in natural systems. NRRI also has established mechanisms for sharing outcomes through press releases, publications in peer-reviewed journals, technical reports, annual reports, periodicals, and through social media channels

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Matt Aro		PI: provide overall project leadership, coordinate project activities, determine avoided GHG emissions and global warming potential (GWP) of the engineered soil mixes, and prepare all reports.			26.8%	0.3		$34,855
Meijun Cai		Co-PI: train technician, evaluate the pollutant removal capacity and plant growth performance of the new engineered soil mixes by testing different compositions and mixing ratios through both laboratory experiments and field surveys, and assist with reporting.			26.8%	0.27		$35,672
David Saftner		Co-PI: physically characterize and test the raw materials, biochar, and engineered soil mixtures, and assist with reporting.			26.8%	0.15		$35,767
Brian Barry		Lead the biochar characterization work.			26.8%	0.02		$2,757
Victor Krause		Assist with securing and processing all wood materials.			26.8%	0.04		$4,105
Oksana Stratovych		Assist with biochar characterization work.			26.8%	0.02		$1,825
Daniel Wisniewski		Technician: Conduct lab leaching/adsorption testing, field visit and sample collection, sample processing and analysis.			24.4%	0.9		$55,346
Matt Young		Manufacture biochar.			24.4%	0.01		$1,105
Temp/Casual TBD		Assist with field visits and sample collection, sample processing, and analysis.			6.9%	0.01		$465
Graduate Student		Assist with physically characterizing and testing the raw materials, biochar, and engineered soil mixtures.			45.4%	0.88		$103,334
Undergraduate		Assist with field visits and sample collection, sample processing, and analysis.			0%	0.01		$317
							Sub Total	**$275,548**
Contracts and Services								
UMN and NRRI Labs	Internal services or	Sample measurement by external labs. UMN Research Analytical Laboratory provides metal analysis ($4,306), NRRI Analytical Laboratory				0		$9,000

	fees (uncommon)	provides N & P measurement ($3,432), and UMN Laboratory provides soil characterization ($1,200).						
NRRI	Internal services or fees (uncommon)	Cost to produce four types of biochar at the NRRI's Biomass Conversion Laboratory. We will produce biochar from ash and balsam fir wood at two treatment intensities each, for a total of approximately 200 lbs of biochar.				0		$39,105
NRRI	Internal services or fees (uncommon)	NRRI wood thermal modification autoclave use fee for thermally modifying four kiln loads of balsam fir and ash wood chips in Y1 (4 * $1,099 = $4,396) and one load in Y2 ($1,099). Total of $5,495.				0		$5,495
Story North Productions	Service Contract	Development of educational video by Kevin Jacobsen (Story North Productions) in Y3. The video will be used for sharing project results and impacts with public and private stakeholders.				0		$7,500
							Sub Total	**$61,100**
Equipment, Tools, and Supplies								
	Tools and Supplies	Filtration membrane (2,000 pieces, $180/100 x 20 = $3,600), AAS graphite tube ($350/tube, 100 samples/tube, 1000 samples in total, $3,500), IC columns (replace once for two columns, $2,500), other supplies (bottles, gloves, vials, pipette tips, glassware, etc., $5,000).	Lab and field supplies required for project.					$15,056
							Sub Total	**$15,056**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Land reclamation site field visit, assume 10 sites, 2 times per year and two years, each time visit three sites = 16 visits, assume 70 miles each way, 140	Field visits and sample drops.					$4,162

		miles * $0.70/mile * 20 = $1,960. $654/year. Visit to collect wood waste and byproduct, 3 visits, 150 miles each way, 300 miles * $0.70/mile * 3 = $1,000 in each project year. ($3,000 total for project). Drive to drop samples off for analysis at external laboratory, $100 in Y2.						
	Conference Registration Miles/ Meals/ Lodging	Travel for two people in Y3 to a national/regional conference in Minnesota to present results (location TBD; rates below are based on Minneapolis): $1000 conference registration 3 nights in a hotel at $148/night = $444 Per diem: day 1 ($69) + day 2 ($92) + day 3 ($92) + day 4 ($69) = $322 300 miles round trip via car * $0.70/mile = $210 (assuming both people travel together) Total: $1,766/person * 2 people = $3,532 + $210 (mileage) = $3,742.	Conference travel to present results.					$3,742
							Sub Total	**$7,904**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	Page charges for publishing results in a peer-reviewed journal (in Y3).	Publishing results in a peer-reviewed journal.					$2,212
							Sub Total	**$2,212**
Other Expenses								
		ADP/Computer Services	Life cycle assessment (LCA) software virtual server fee; fee is for hosting LCA software on a UMD virtual server and includes server hosting, maintenance, and security. Software is used to calculate GHG emissions and global warming potential (GWP) of the new engineered soil mixes. $230/month for each month of the project.					$8,280
		General Operating Services	NRRI greenhouse use fee for plant growth studies ($150/month x 4					$900

			months = $600). Sample shipping to UMN laboratory, $300.					
							Sub Total	**$9,180**
							Grand Total	**$371,000**

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	UMN unrecovered indirect costs are calculated at the UMN federally negotiated rate for research of 54% modified total direct costs	Indirect costs are those costs incurred for common or joint objectives that cannot be readily identified with a specific sponsored program or institutional activity. Examples include utilities, building maintenance, clerical salaries, and general supplies. (https://research.umn.edu/units/oca/fa-costs/direct-indirect-costs)	Secured	$142,036
			Non State Sub Total	**$142,036**
			Funds Total	**$142,036**

Total Project Cost: $513,036

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 8c23a1bb-cdb.pdf

Alternate Text for Visual Component

The graphic describes that we will convert waste and balsam fir wood into biochar and thermally modified wood, and test the ability of engineered soil mixes containing the biochar and thermally modified wood to resist erosion, remove pollutants, and support plant growth on old mining lands that need reclamation....

Supplemental Attachments

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

Title	File
University of Minnesota Authorization Letter	478ed71e-b9b.pdf
MnDOT report from the project team demonstrating competence in the proposed research area	ccea7212-33b.pdf
City of Minneapolis Letter of Support	7b6bcd6e-02a.pdf
Hedstrom Lumber Letter of Support and Contribution of Materials	bff2895e-b2a.pdf
City of Duluth Letter of Support and Contribution of Materials	7a57b3a3-9f7.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?

Yes

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration (UMD)

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:

Lita Lind, University of Minnesota, Sponsored Projects Administration

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