Final Abstract

Final Report Approved on September 4, 2025

M.L. 2021 Project Abstract

For the Period Ending June 30, 2025

Project Title: Forest Health: Development and Demonstration of Biochar Opportunities

Project Manager: Eric Singsaas

Affiliation: U of MN - Duluth - NRRI

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Website: https://www.nrri.umn.edu/

Funding Source:

Fiscal Year:

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 19

Appropriation Amount: $340,000

Amount Spent: $340,000

Amount Remaining: -

Sound bite of Project Outcomes and Results

NRRI's new mid-scale rotary kiln advances Minnesota biochar research, enabling cost-effective sample production for carbon capture, stormwater cleanup, and industrial decarbonization. This investment boosts NRRI's ability to tailor and test biochars, helping realize the state's climate and environmental goals through innovative use of local biomass resources.

Overall Project Outcome and Results

The primary goal of this project was to fund the acquisition, installation, and commissioning of a mid-scale rotary kiln to advance the Natural Resources Research Institute's (NRRI) biochar program. NRRI is engaged in research and development focused on leveraging Minnesota's biomass resources to address the state's forest management, climate, and environmental objectives. The program sought to formulate application-specific biochars from biomass residuals for uses including carbon sequestration, water filtration, and industrial decarbonization. While NRRI previously had the capacity to produce biochar at both bench and pilot scales, a gap existed for producing mid-scale quantities (tens to hundreds of pounds) in a cost-effective manner. A comprehensive needs assessment and engineering study guided the selection process, followed by a competitive procurement managed through the University of Minnesota. Upon

awarding the contract, the team developed and implemented detailed planning, installation, and safety documentation. After successful commissioning, the new kiln produced biochar from oat hulls, which demonstrated effectiveness in removing metals, orthophosphate, and dissolved organic carbon from simulated stormwater compared to other biochars. As a result, NRRI now possesses enhanced capabilities to produce and evaluate biochar, enabling further research in applications that support forest health and other statewide goals, such as decarbonizing steel and metals production, stormwater treatment, roadside bioswales, and other climate-aligned initiatives.

Project Results Use and Dissemination

This project funded the procurement and installation of equipment to be used in future research and development programs. As a result, most publications and public disclosures related to this project will occur after its completion. Researchers utilizing this equipment will acknowledge LCCMR funding with the written statement: “Funding for the rotary kiln used in this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR).” Additionally, we have affixed the ENRTF logo to the equipment to ensure researchers, students, and clients are aware of the funding source.

Environment and Natural Resources Trust Fund

M.L. 2021 Approved Final Report

General Information

Date: September 15, 2025

ID Number: 2021-463

Staff Lead: Mike Campana

Project Title: Forest Health: Development and Demonstration of Biochar Opportunities

Project Budget: $340,000

Project Manager Information

Name: Eric Singsaas

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Project Reporting

Final Report Approved: September 4, 2025

Reporting Status: Project Completed

Date of Last Action: September 4, 2025

Project Completion: May 31, 2025

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 19

Appropriation Language: (a) The following amounts, totaling $840,000, are transferred to the Board of Regents of the University of Minnesota for academic and applied research through the MnDRIVE program at the Natural Resources Research Institute to develop and demonstrate technologies that enhance the long-term health and management of Minnesota's forest resources, extend the viability of incumbent forest-based industries, and accelerate emerging industry opportunities. Of this amount, $500,000 is for extending the demonstrated forest management assessment tool to statewide application:

(1) the unencumbered amount, estimated to be $250,000, in Laws 2017, chapter 96, section 2, subdivision 7, paragraph (e), Geotargeted Distributed Clean Energy Initiative;

(2) the unencumbered amount, estimated to be $20,000, in Laws 2017, chapter 96, section 2, subdivision 8, paragraph (g), Minnesota Bee and Beneficial Species Habitat Restoration;

(3) the unencumbered amount, estimated to be $350,000, in Laws 2018, chapter 214, article 4, section 2, subdivision 9, paragraph (e), Swedish Immigrant Regional Trail Segment within Interstate State Park; and

(4) the unencumbered amount, estimated to be $220,000, in Laws 2019, First Special Session chapter 4, article 2, section 2, subdivision 5, paragraph (a), Expanding Camp Sunrise Environmental Program.

(b) The amounts transferred under this subdivision are available until June 30, 2023.

M.L. 2022, Chp. 94, Sec. 2, Subd. 19 Carryforward; Extenstions, (b) The availability of the transfers for the following projects is extended to June 30, 2024: (8) Laws of 2021 First Special Session, chapter 6, article 6, section 2, subdivision 19, paragraph (a), clauses (1) through (4), Forest Health Research, Development and Demonstration

Appropriation End Date: June 30, 2024

Narrative

Project Summary: This project is an expansion of the work began under LCCMR 2019 Forest and Bioeconomy Research. NRRI is requesting continuing Legislative support for two strategic applied research and demonstration projects

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

Minnesota's forest products industries, sawtimber, paper, pulp and engineered wood products, contributed $9.8 billion in forest product shipments and $3.4 billion in direct value to Minnesota's economy in 2019 (Bergstrand 2019). Declining demand for forest products, a changing climate and new opportunities like carbon markets will require forest managers to think differently about how they manage forest lands and forest products industry about the potential products they can produce.

This equipment will support ongoing research programs, such as a project to develop materials to treat stormwater contaminants; develop a portable field demonstration unit to demonstrate stormwater best management practices; and field scale testing of biochar materials for stormwater treatment along the Mississippi river. The current state-of-the-art research in these areas is done by purchasing commercial biochars and evaluating their performance by trial and error. Instead, incorporating the ability to make and test custom biochars will enable researchers to engineer biochars that are fit for purpose to each situation, leading to more effective engineered stormwater treatment technologies.

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 have identified the field of functional biocarbon materials as a major research opportunity to add value from Minnesota's forest and agricultural resources. Functional biocarbon materials include biochar, which is used as a soil amendment in agricultural, horticulture, and forestry, but also includes many other functional materials such as sorbents for water and air purification, composite fillers, and battery components. This current project will enhance this program by adding a needed piece of equipment capable of processing biomass at higher temperatures and assist with process scale-up. This mid-scale kiln will also provide valuable information on the transition from the laboratory bench scale (grams) to the pilot scale (tons) production rates while also being able to produce sufficient quantities of functional biocarbon materials to demonstrate their utility in water treatment and other materials applications. We will develop design criteria, solicit bids for the equipment and then purchase and install it.

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?

This project will provide a foundation for new types of products made from Minnesota's natural resources, which have a high fixed carbon content to store atmospheric carbon dioxide in soils or are used in environmentally relevant industries, such as in soil and water remediation and energy systems. This equipment will be used by NRRI and University of Minnesota researchers to support the R&D needed to deploy these materials with the help of industry, agency, and NGO partnerships.

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

Activities and Milestones

Activity 1: Forest Health: Development and Demonstration of Biochar Opportunities

Activity Budget: $340,000

Activity Description:

This current project will enhance this program by adding a needed piece of equipment capable of processing biomass at higher temperatures and assist with process scale-up. This mid-scale kiln will also provide valuable information on the transition from the laboratory bench scale (grams) to the pilot scale (tons) production rates while also being able to produce sufficient quantities of functional biocarbon materials to demonstrate their utility in water treatment and other materials applications. We will develop design criteria, solicit bids for the equipment and then purchase and install it. These funds will also allow us to develop safety and quality management documents and test the equipment with preliminary run data by producing sample materials for some small project from Minnesota resources. Once installed and qualified, we will produce and evaluate sample sorbent materials to support ongoing research into developing fit-for-purpose materials to treat stormwater for metal and organic contaminants with additional funding by MN Drive, the Minnesota Coastal Wetland Program, and the Mississippi Watershed Management Organization.

Activity Milestones:

Description	Approximate Completion Date
Milestone 1: Equipment specification for competitive bid	November 30, 2021
Milestone 2: Equipment purchase decision	April 30, 2022
Milestone 3: Equipment installation	September 30, 2022
Milestone 4: Safety and Quality Documentation	December 31, 2022
Milestone 5: Materials Production and Evaluation for Stormwater Programs	June 30, 2023

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 communicate with industry and academic partners through technical presentations, marketing materials, and mass media to advertise the availability of this equipment for collaborative research. All public-facing research dissemination for projects using this equipment, including scientific publications, presentations, and technical reports, will acknowledge the ENRTF contribution to the equipment.

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 will continue to use this equipment for both discovery science and material R&D programs as well as industry support. These programs will be funded by federal and state grants, industry sponsored research, and service contract work.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount	$ Amount Spent	$ Amount Remaining
Personnel										
John Du Plissis		Du Plissis will serve as principal investigator and be responsible for general project management and reporting.			25.09%	0.1		$12,946	-	-
Eric Singsaas		Singsaas will serve as project manager and coordinate equipment selection, purchase, installation, and manage the safety and quality management of research.			25.09%	0.1		$17,723	-	-
Timothy Hagen		Chemical Engineer/Agglomeration Specialist			25.09%	0.02		$2,501	-	-
Matthew Young		Research Engineer			22.3%	0.02		$1,557	-	-
Cally Hunt		Biomass Process Engineer			22.3%	0.02		$1,496	-	-
Brian Barry		Chemistry & Materials Science Program Leader			25.09%	0.3		$20,994	-	-
Sergiy Yemets		Senior Research Scientist			25.09%	0.3		$14,476	-	-
Oksana Kolomitsyna		Senior Research Scientist, Organic Chemistry			25.09%	0.3		$11,413	-	-
TBD Post Doc		Postdoc to work on development of sorption materials development.			17.28%	0.2		$12,271	-	-
Matthew Mlinar		Mlinar will provide project management support and serve as a part of the project management team for this grant			25.09%	0.1		$13,091	-	-
							Sub Total	**$108,468**	**$108,468**	**-**
Contracts and Services										
Anderson Engineering; New Prague, MN	Professional or Technical Service Contract	Electrical safety inspection and remediation to meet National Electrical Code (NEC) certification for safe kiln operation.		X		0.01		$1,195	$1,195	-
							Sub Total	**$1,195**	**$1,195**	**-**

Equipment, Tools, and Supplies										
	Tools and Supplies	Laboratory supplies - biochar analysis	Chemicals, gases, and other reagents needed to operate biochar analytical equipment.					$3,150	$3,150	-
	Tools and Supplies	Chemistry Lab Consumables	General supplies for laboratory analyses and performance testing of biochars.					$349	$349	-
	Tools and Supplies	Safety equipment for kiln	Installation of this equipment will require safety equipment to protect users against fire and burning hazards while handling equipment, including fire suppression personal protective equipment, and physical barriers.	X				$5,944	$5,944	-
							Sub Total	**$9,443**	**$9,443**	**-**
Capital Expenditures										
		The requested equipment is a mid-scale indirectly heated kiln	The requested equipment is a mid-scale indirectly heated kiln with add-on equipment for pilot-scale production of carbonized materials from Minnesota-based forest biomass. This is necessary to produce sufficient quantities of these materials under controlled conditions to develop new value-added materials from woody biomass for markets such as water treatment. air filtration, energy storage, and minerals processing. As	X				$220,894	$220,894	-

			part of the capital equipment, building modifications will be necessary.							
							Sub Total	**$220,894**	**$220,894**	**-**
Acquisitions and Stewardship										
							Sub Total	**-**	**-**	**-**
Travel In Minnesota										
							Sub Total	**-**	**-**	**-**
Travel Outside Minnesota										
							Sub Total	**-**	**-**	**-**
Printing and Publication										
							Sub Total	**-**	**-**	**-**
Other Expenses										
							Sub Total	**-**	**-**	**-**
							Grand Total	**$340,000**	**$340,000**	**-**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Contracts and Services - Anderson Engineering; New Prague, MN	Professional or Technical Service Contract	Electrical safety inspection and remediation to meet National Electrical Code (NEC) certification for safe kiln operation.	The equipment will require wiring of dedicated 240V electrical circuits into the process development area, tying into the existing electrical panels.
Capital Expenditures		The requested equipment is a mid-scale indirectly heated kiln	This equipment will enhance the capabilities of NRRI to engage in collaborative research with academia, industry, and agencies to develop and demonstrate new materials from Minnesota resources. **Additional Explanation :** The objective of this project is to obtain and install equipment that will be used to support research on this topic into the future.
Equipment, Tools, and Supplies		Safety equipment for kiln	This cost is necessary for the safety of personnel using this equipment.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount	$ Amount Spent	$ Amount Remaining
State						
Cash	NRRI Funding Resource Board	Ventilation and Power Modifications	Secured	$30,000	-	$30,000
Cash	NRRI Internal Funding Review Board	Commissioning and Trial Runs	Secured	$10,000	-	$10,000
			State Sub Total	**$40,000**	**-**	**$40,000**
Non-State						
			Non State Sub Total	**-**	**-**	**-**
			Funds Total	**$40,000**	**-**	**$40,000**

Attachments

Required Attachments

Visual Component

File: 340c36f4-963.pdf

Alternate Text for Visual Component

The graphic describes the goal, opportunities benefits of biochar opportunities...

Supplemental Attachments

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

Title	File
Background Check	83814f65-cf0.pdf
Institutional Letter	0c0a6f90-902.pdf
Kiln Commissioning Timeline	4245a254-d43.pdf
Kiln Picture 1	e452977b-cea.jpe
Kiln Picture 2	d6084b85-330.jpe
Kiln Picture 3	961657da-60a.jpe
Kiln Picture 4	8b9cee6a-61e.jpe

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

N/A

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

Yes

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?

No

Does the organization have a fiscal agent for this project?

Yes, Sponsored Projects Administration

Work Plan Amendments

Amendment ID	Request Type	Changes made on the following pages	Explanation & justification for Amendment Request (word limit 75)	Date Submitted	Approved	Date of LCCMR Action
1	Completion Date	Previous Completion Date: 06/30/2023 New Completion Date: 06/30/2024	We are requesting an extension because University purchasing sent out two Request for Proposals (RFPs) for the specified equipment and received no competitive bids that fit the project timeline and budget, causing a delay in our initial project timeline. We have gone back to modify equipment specifications to fit the allocated budget.	May 23, 2023	Yes	May 24, 2023
2	Amendment Request	• Budget • Other • Budget - Professional / Technical Contracts • Budget - Other • Activities and Milestones • Budget - Personnel • Budget - Capital, Equipment, Tools, and Supplies • Budget - Non-ENRTF Funds Contributed • Attachments	We requested a rebudget to accomodate the change in equipment delivery date. More work was completed on the front end to design, and plan for the equipment, increasing salaries and safety equipment. We reduced and away from categories that supported laboratory experiments, shipping, lab services, and supplies. We also reduced the capital equipment by $4106 to reflect actual equipment costs. We will use internal funds to support experimental runs, lab supplies, shipping, and analyses.	January 9, 2025	Yes	January 13, 2025
3	Completion Date	Previous Completion Date: 06/30/2024 New Completion Date: 05/31/2025	Delays in manufacturing and delivery of the main piece of equipment (tube furnace) until September 2024 have pushed back completion of the project. We will receive the equipment and schedule commissioning with the vendor's representative before completing the experimental plan.	September 17, 2024	Yes	January 13, 2025

Status Update Reporting

Final Status Update July 15, 2025

Date Submitted: July 2, 2025

Date Approved: August 26, 2025

Overall Update
The biochar kiln has been installed and is now operational. Following its startup and commissioning, we produced biochar samples from oat hulls obtained from General Mills at three different temperatures. We then tested these samples for their ability to adsorb both organic and inorganic pollutants.

Additionally, we placed a sticker featuring the ENRTF logo on the kiln to remind future users of the funding provided for this project. I have also reminded all researchers involved that any projects utilizing this kiln should acknowledge the role the ENRTF played in financing its acquisition and commissioning.

This marks the completion of the work plan for this project.

Activity 1
The kiln has been delivered, installed, and commissioned, and all safety and Management of Change (MOC) documentation is complete. We conducted commissioning runs using finely ground wood chips and oat hulls from General Mills and resolved issues with airflow and feed rates.

Three samples of oat hull biochar were produced at 350°C, 500°C, and 700°C for evaluation as water treatment media. Batch sorption experiments showed that the highest temperature samples effectively removed metals (copper, lead, and zinc) from synthetic stormwater. All samples released some organic material during pyrolysis, likely due to gas deposition.

We will continue to improve product quality as we gain experience with the kiln. The project is now complete, and the kiln is ready for research initiatives.

Dissemination
No formal dissemination this period, but we made a sticker with the ENRTF logo and fixed it to the instrument. Future presentations and publications using this instrument will include the acknowledgement:
“Funding for the biochar kiln equipment used in this project was provided by the Minnesota Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Commission on Minnesota Resources (LCCMR)”

Additional Status Update Reporting

Additional Status Update August 14, 2024

Date Submitted: January 9, 2025

Date Approved: January 13, 2025

Overall Update
Nabertherm Inc. was chosen for their tube furnace due to its larger diameter and heat capacity, unlike the other supplier, which doesn't manufacture the specified equipment. The NRRI finance team submitted a purchase order for the Nabertherm rotary tube furnace for $156,000 on November 29, 2023. An additional order for accessories and spare parts for $49,742 followed in June 2024. However, the furnace shipped late on September 2, 2024, prompting adjustments to the inspection and installation plans.

Meanwhile, we continued developing grant proposals supported by this equipment, submitting requests to the University of Minnesota, the US Forest Service, and the US Department of Energy. We were awarded funding from the Forest Service and University projects, and we expect the instrument to aid these programs with biochar samples.

We have secured NRRI internal funds to complete the project after June 30. All work is expected to be finished by May 31, 2025, using internal NRRI funds. The attachment "Kiln Commissioning Plan" describes the plan and timeline.

Activity 1
We deviated from the original plan to have the equipment supplier build a custom system to our specifications. When the quotes for custom systems came in, they were substantially more than the budgeted amount. (over $1.2 million). We decided to order less customized equipment and parts to do the customization ourselves. This lowered the equipment costs, but we paid an engineer to design and order the parts needed to customize the furnace to our specifications. I thought this was more in line with LCCMR's guidelines because the engineer was employed in Minnesota while the custom equipment producers were outside Minnesota. By mid-June, the engineer completed the design work, which helped us buy the necessary equipment to customize the furnace to our specifications. We had planned to receive the equipment first and then have an engineer work on it. However, due to the shipping delays, we paid the engineer to do this customization work to get ~90% of the engineering work and parts ordering done by the end of the project period. That's why the change came so late in the project.

Dissemination
Oral Presentation: Singsaas E “Engineered Biocarbon Materials: Sector Coupling to Low-Carbon Industry and Infrastructure”, Forest and Bioeconomy Delegation Workshop, Business Finland, Helsinki, Finland. June 11, 2024.

For all work that uses this kiln, we will acknowledge ENRTF support with the following, "Kiln purchase for this project was made possible by a grant from the ENTRF". In addition, we will attach a sticker with the ENTRF logo to the kiln.

Status Update Reporting

Status Update June 1, 2024

Date Submitted: January 9, 2025

Date Approved: January 13, 2025

Overall Update
The kiln was ordered in December 2023 and was scheduled to arrive in February. As of this writing, shipping is imminent. We are working with the University Purchasing office to ensure that payment will be made fully before project completion. Our engineering team has designed and ordered additional equipment for gas handling and condenser gas collection (needed for complete mass and energy balance calculations from pyrolysis. Site preparation and planning are underway to prepare for its imminent arrival. In the meantime, scale-up experiments with smaller 0.75” and 4” kilns are in progress, informing scale-up to this 8” kiln.

Activity 1
The equipment was ordered in December 2023 and was scheduled to arrive by March. The manufacturer experienced some delays related to parts shortages, but we have arranged between them and university purchasing to ensure the encumbrance clears before June 30.

Reasons for last-minute changes: The original budget plan was to have the equipment supplier build a custom system to our specifications. When the quotes for custom systems came in they were substantially more than the budgeted amount. (in excess of $1.2 million). We decided to order less customized equipment and parts to do the customization ourselves. This lowered the equipment costs but I paid an engineer to design and order the parts needed to customize the furnace to our specifications. I thought that this was more in line with LCCMR's guidelines as the engineer was employed in Minnesota while the custom equipment producers were outside of Minnesota. The engineering work and design were done in May and June to help us buy the necessary equipment to customize the furnace to our specifications. We had planned to receive the equipment first and then have an engineer work on it, but due to the shipping delays we paid the engineer to

Dissemination
Oral presentation: Singsaas E “Engineered Biocarbon Materials: Sector Coupling with Low-Carbon Infrastructure” Ernst & Young Low Carbon Consulting Group (online) May 21, 2024.

Oral presentation: Singsaas E “Woody Biomass Biochar as a Fossil Coke Substitute in Reducing Metal Oxides.” Semi-annual meeting for Materials Recovery Technology for Defense Supply Resiliency project, Worcester, MA, May 22, 2024.

Education: E Singsaas collaborated with UMD chemistry faculty member Jacob Wainmann on year 2 of the Course-Based Undergraduate Research Experiences (CUREs) project in freshman Chemistry. Chemistry students designed laboratory experiments on biochar adsorption of metal ions, performed tests on different biochar samples, and reported results on their semester-long projects.

All presentations and written reports for work involving this equipment will contain the following statement in the Acknowledgments: "The biochar production kiln was funded by a grant from the ENRTF XXX-YYY"

The kiln will be labeled with a visible sticker label with the LCCMR logo and the language "Equipment funded by ENRTF grant #XXXYYY"

Status Update Reporting

Status Update December 1, 2023

Date Submitted: February 9, 2024

Date Approved: February 12, 2024

Overall Update
We successfully executed a sealed bid process, selected a winning bid, and placed an equipment order. Equipment is scheduled to be delivered by April, and planning for site modifications, installation, and equipment qualification has begun. We continued to disseminate information on biochar applications and climate opportunities throughout the state with educational activities at UMD and engagement with Minnesota Forest Industries. We are also preparing to incorporate this equipment into research projects to assist Minnesota companies.

Activity 1
Working with the U of M Purchasing office, we issued a second Request for Proposals for equipment vendors in September. The RFP was open for three weeks and received bids from two vendors. We selected Nabertherm as a vendor, and a PO was issued in late November. The equipment is expected to arrive by April 2024. We have already ordered accessories for gas handling and sample collection and have begun space planning for the final equipment installation location. Final commissioning will happen by May 2024.

After commissioning, we will produce test quantities of biochar for two projects to validate the material performance and compare it with materials made on a smaller kiln. This will help ensure that process scale-up does not adversely impact biochar properties. The final two months of the project will be sufficient time for us to complete this validation step.

Dissemination
E Singsaas met with UMD chemistry faculty member Jacob Wainman and postdoctoral associate James Noble to plan for a second year of Course Undergraduate Research Experiences (CUREs) experiences for freshman Chemistry. Chemistry students. The program will be expanded to help students learn about biochar and its role in carbon sequestration and environmental remediation, learn about biochar production, and conduct experiments in biochar analysis.

E Singsaas hosted the quarterly meeting of Minnesota Forest Industries and led a tour of the biochar research and development labs for participants.

J Lovrien “Northland researchers look to Biochar as possible climate solution” Duluth News Tribune October 24, 2023. https://www.duluthnewstribune.com/news/local/northland-researchers-look-to-biochar-as-possible-climate-solution

Oral presentation: Singsaas E “Woody Biomass Biochar as a Fossil Coke Substitute in Reducing Metal Oxides.” Semi-annual meeting for Materials Recovery Technology for Defense Supply Resiliency project, Worcester, MA, November 16-17, 2023.

Status Update Reporting

Status Update June 1, 2023

Date Submitted: June 12, 2023

Date Approved: June 30, 2023

Overall Update

The previous failed round of equipment bids led us to reconsider the original specifications to fit the allotted time and budget better. Therefore, we revised our equipment guidelines to allow us to complete most of the desired scientific work with a lower-cost equipment option. We decided that we could complete the laboratory work with batch kilns instead of the continuous kiln we initially specified. Because the batch process is much more straightforward than a continuous kiln, there are substantial savings in equipment costs while still allowing researchers to produce the needed quantities of biochar. Considering these new constraints, we contacted vendors for equipment quotes and began evaluating the safety and space requirements to accommodate the batch kilns.

Activity 1

The engineering team reviewed the design criteria and again interviewed the researchers to revise the equipment parameters. This redesign aimed to determine the minimum viable design that allows researchers to complete their research while meeting cost and time constraints. Based on this input, we pivoted to batch processes instead of continuous processing. We have identified two vendors for batch processing units capable of producing the needed quantities of biochar for research and test quantities, and we designed a condenser system to handle anticipated gas production. We brought in an electrical engineer to evaluate the designs of the kilns and request upgrades to meet NEC and U of M electrical codes.

Dissemination

Education: E Singsaas collaborated with UMD chemistry faculty to develop Course Undergraduate Research Experiences (CUREs) in freshman Chemistry. Chemistry students designed laboratory experiments on biochar adsorption of metal ions, performed tests on different biochar samples, and reported results on their semester-long projects.

Oral presentation: Singsaas E “Biochar or Engineered Biocarbon Materials” Saint Louis County annual meeting. Cotton, MN, March 29, 2023.

Oral presentation: Singsaas E “Woody Biomass Biochar as a Fossil Coke Substitute in the Reduction of Metal Oxides.” Annual program meeting for Materials Recovery Technology for Defense Supply Resiliency, Worcester, MA, May 24-25, 2023.

Poster presentation: “Biochar and Engineered Biocarbon Materials.” Presented to attendees of the Association of Public Land Grant Universities Commission on Economic & Community Engagement. Duluth, MN, June 5, 2023.

Status Update Reporting

Status Update December 1, 2022

Date Submitted: November 30, 2022

Date Approved: December 13, 2022

Overall Update
The past six months were dedicated to soliciting vendor bids based on the selection criteria developed by the research team. The University of Minnesota's procurement office assisted the researchers with the closed bid process. After two rounds of bidding we were not able to make a final selection. This work will continue until we can meet both the technical and budget constraints.

Activity 1
The research and engineering team developed a Request for Proposals (RFP) based on the completed equipment design specification. The first RFP closed on June 30, 2022. There were two bidders, both over the budget cap. We met with interested companies and initiated a second RFP in August with a refined list of 25 desired equipment attributes and a closing date of August 30. Once again no equipment supplier was able to meet our cost requirement. There were two bidders, both over the budget cap. We interviewed both equipment suppliers to review their bids and asked them to adjust their equipment design so that their costs were lower. Both suppliers made the adjustments and their costs were still over budget. After reviewing the updated bids, one supplier was disqualified due to not meeting design criteria.

Dissemination
Oral presentation: Singsaas, E "Engineering functional biochar for specific applications." North American Biochar & Bioenergy Conference, Morgantown, West Virginia.August 8-11, 2022.

Status Update Reporting

Status Update June 1, 2022

Date Submitted: June 1, 2022

Date Approved: July 8, 2022

Overall Update
A committee of researchers met to define a list of relevant biomass needed to process and use case scenarios for each. This information guided equipment specification for activity 1.

Activity 1
We convened a biochar kiln technical teem to develop kiln specifications and a list of potential vendors. Kiln specifications were guided by what Minnesota-relevant biomass feedstocks were most important, range of process conditions, material handling capabilities, and utilities needed to operate the equipment. Consideration was given to ease of operation by research staff. This information was compiled into a University of Minnesota Request for Proposals (RFP) that was sent out to Vendors for sealed bids, following the University purchasing guidelines. The committee also provided preliminary data to the NRRI Management of Change Committee, which will evaluate equipment for environmental and safety considerations before a final purchase decision is made.

Dissemination
No dissemination this period.