Environment and Natural Resources Trust Fund

M.L. 2023 Draft Work Plan

General Information

ID Number: 2023-177

Staff Lead: Corrie Layfield

Date this document submitted to LCCMR: February 9, 2023

Project Title: Quantifying Environmental Benefits of Peatland Restoration in Minnesota

Project Budget: $754,000

Project Manager Information

Name: Christian Lenhart

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Project Reporting

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2026

Final Report Due Date: August 14, 2026

Legal Information

Legal Citation:

Appropriation Language:

Appropriation End Date: June 30, 2026

Narrative

Project Summary: We will quantify the capacity of restored peatlands to store and accumulate atmospheric carbon and their capacity to prevent release of accumulated mercury into streams, rivers and lakes.

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

Over 6 million acres (~12%) of Minnesota is peatlands, many of which were drained using thousands of miles of ditches in the early 20th century. These ditches, now commonly abandoned but still draining the peatlands, contribute to degradation of this unique ecosystem and lead to the release of large amounts of greenhouse gases to the atmosphere and mercury into streams. The greenhouse gases contribute to global climate change, and the mercury threatens the health and livelihoods of Minnesotans. There is potential for restoration of hundreds of thousands of acres of peatlands degraded by these ditches, and while some peatland restoration is already underway, we do not know the net water and air quality benefits of such restorations. This information is critical for developing science-based restoration policies and guidelines (e.g., The Nature Conservancy's Peatland Playbook). However, some policy-relevant scientific uncertainties must be addressed prior to expanding into large-scale restoration. Specifically, we need to determine the likely net environmental benefits of these restoration efforts on both greenhouse gases and mercury export to develop practical responses based on sound science. The proposed effort would provide information needed by state agencies and tribal partners to make informed management decisions.

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 will fill the knowledge gap relating to comprehensive impacts of peatland ditch restoration on air and water quality using a three-pronged approach. First, by synthesixing existing literature from other regions we will provide a foundation for decision-making based on current science. Second, by performing field research, we will determine likely effects of peatland restoration on net greenhouse gas fluxes and stream water mercury. The field research will be located in the Sax-Zim area in peatlands that were restored about 10 years ago (Sax-Zim Bog) and at the EIP restoration site< 2 years ago at the time the research starts, paired with nearby unrestored sites. This will allow us to determine short- and longer-term benefits of restoration. We will use tower- and chamber-based methods to measure the movement of carbon dioxide, methane, and mercury into and out of peatlands. We will sample water in streams draining peatlands to assess the effect of ditching on mercury export. Third we'll develop models to scale-up the field results. The three investigations will be synthesized into management and policy guidance and peer-reviewed publications,. Partner organizations can use this to assess the net benefit of peatland restoration and prioritize projects for maximum benefit.

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?

There is little data from Minnesota on the net carbon benefits of peatland restoration. This study will synthesize scientific literature and existing data sources, detailing peatland drainage and restoration impacts, and management and policy options, enabling state agencies to make science-based decisions to prioritize peatland restoration for air (carbon dioxide and methane), climate, and water quality (mercury). Specifically, we will synthesize the policy-relevant scientific literature and perform field studies on restoration impacts on net emissions of greenhouse gases, and net export of mercury into stream water. Results and policy options will be shared in reports, peer-reviewed publications, and stakeholder meetings.

Project Location

What is the best scale for describing where your work will take place?

Region(s): NE, NW,

What is the best scale to describe the area impacted by your work?

Region(s): NE, NW,

When will the work impact occur?

During the Project

Activities and Milestones

Activity 1: Determination of likely impacts of peatland restoration on climate and water quality based on current scientific literature

Activity Budget: $54,000

Activity Description:
Although there are studies of drainage effects on greenhouse gases and mercury in peatlands and water, none is focused on effects of restoration in Minnesota, and there is no comprehensive policy-relevant synthesis on the effects of peatland drainage and restoration on greenhouse gases (carbon dioxide, methane) and streamwater mercury in our region. To guide policy and management decisions for Minnesota we need data based on local studies. The impact of restoration activities is highly dependent on climate, vegetation, land use history and peat properties. We will carry out a thorough synthesis of existing studies from similar ecosystems to determine the likely impact of restoration of Minnesota peatlands on air and water quality. This literature synthesis will identify key areas of agreement and uncertainties in impacts of drainage and restoration on greenhouse gases and water quality. A report summarizing these findings will be developed in partnersip with TNC and state agency partners, made public, and presented to stakeholders (state agencies, legislators, NGOs, environmental investment organizations, tribes, the public) in public meetings.

Activity Milestones:

Description	Approximate Completion Date
Literature review and report on peatland drainage and restoration on greenhouse gases and climate	December 31, 2023
Presentation of results at stakeholder meetings (TNC peat network or other group)	March 31, 2024
Peer-reviewed publication submitted on the above findings	December 31, 2024

Activity 2: Field and modeling assessments of restoration impacts on climate (greenhouse gases, energy balance)

Activity Budget: $516,000

Activity Description:
Peatland restoration generally leads to positive climate impacts by sequestering carbon from the atmosphere, but there is insufficient evidence from our region, causing uncertainty in planning and prioritizing projects. To determine these benefits, we will measure carbon dioxide and methane fluxes, and energy exchange with the atmosphere, at two pairs of disturbed and restored (rewetted) sites at different times after restoration using state-of-the-art methods (high towers to measure gases above the ground surface and small chambers for spot, on-the-ground measurements). This approach will allow us to determine the sequence of benefits and impacts over the course of time. Peatland restoration will likely decrease carbon dioxide emissions, however there is uncertainty about the implications for net methane flux. Some studies suggest there could be short-term increases in methane emissions. Tower-based methods (called eddy covariance) will quantify the net transfer of gases between the peatlands and the atmosphere, whereas chamber-based methods will determine hotspots of gas flux. This information will inform best management practices for restoration, for example, by identifying plant communities that have the greatest impact on air quality, prioritizing specific types of ditched peatlands for restoration, and/or determining water table elevations and dynamics that provide the most net benefits.

Activity Milestones:

Description	Approximate Completion Date
Site selection, reconnaissance data collection and preliminary data collection	November 30, 2023

Literature review and synthesis of relevant research and existing data sources at research sites	December 31, 2023
Annual presentation to TNC peatland network, BWSR and/or USFS	December 31, 2023
Complete flux monitoring at site 1, (Sax Zim Bog), restored >10 years, ditched and natural	October 31, 2024
First iteration of model for coupled moisture and heat flow, and carbon transport in peat	December 31, 2024
2md Annual presentation to TNC peatland network, BWSR and/or USFS	December 31, 2024
Complete flux monitoring at site 2, (EIP site) recently restored, ditched and natural	October 31, 2025
Calibrate COUP model and apply coupled model to evaluation of future conditions	December 31, 2025
Prepare draft (s) of journal article(s)	April 30, 2026
Collect any additional data needed to complete field and modeling work	May 31, 2026

Activity 3: Field and modeling assessments of the impact of peatland restoration on mercury export

Activity Budget: $184,000

Activity Description:

Methylmercury is a major threat to water quality. It is mobilized by drainage ditches from peatlands, bioaccumulates in fish and wildlife, and causes a serious threat to human health and local economies. Restoration-mediated changes in water table and plant communities can alter the amount of methylmercury mobilized into streams, and the amount of mercury volatilized back to the atmosphere. We will work with the Minnesota Pollution Control Agency to fill gaps in our understanding of the factors that regulate methylmercury mobilization in drainage ditches, and test restoration approaches that minimize that transport from peatlands. To do this, we will monitor the fluxes of total mercury and methylmercury from pristine, ditched, and restored sites associated with Activity 2. This will include both emissions of mercury to the atmosphere using gas sampling from towers, and sampling of mercury fluxes in streams from each of these three types of sites. Streams will be sampled at biweekly intervals during the ice-free season at these sites. Gases will be sampled via monthly campaigns at the different sites.

Activity Milestones:

Description	Approximate Completion Date
Monitoring of mercury export in water, site 1,; restored, unrestored and natural	October 31, 2024
Develop draft model of coupled water flow, heat transport and mercury transport in peat	December 31, 2024
Monitoring of mercury export in air, site 2,; restored, unrestored and natural	October 31, 2025
Calibrate model and apply coupled model to evaluation of future conditions	December 31, 2025
Draft journal article for submission to journal	May 31, 2026

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Randy Kolka	US Forest Service	Collaborator, oversee mercury water sampling effort. Dr. Kolka has decades of experience in studying peatland impacts on mercury cycling. As head of the Marcell Experimental Forest in Grand Rapids Minnesota, he is also an expert on Minnesota peatlands	Yes
Kristen Blann	The Nature Conservancy	Aquatic Ecologist for TNC. Dr. Blann will help translate the science into restoration plans, facilitate coordination with TNC and share results with the public.	No
Erik Lillekov	US Forest Service	Collaborator, oversee chamber-based flux work and related sampling. Dr. Lilleskov is a research ecologist with the USDA Forest Service who has extensive experience studying carbon cycling and microbial processes in peatlands of the upper Midwest and around the world.	Yes
Suzanne Rhees	BWSR	Partner, coordination on BWSR wetland bank restoration goals, stakeholder engagement. Ms. Rhees is Conservation Projects Coordinator at the Minnesota Board of Water and Soil Resources.	No
Dan Shaw	BSWR	Partner, coordination on BWSR wetland restoration methods and assessment, Dan is a wetland restoration specialist at the Minnesota Board of Water and Soil Resources.	No
Sarah Janssen	USGS	collaborator	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.
1.) Engagement with tribes (Red Lake Band of Ojibwe); engagement will involve collaboration on research methods and application of findings with tribal scientists. 2.) Chris Lenhart has a joint appointment with The Nature Conservancy and will communicate regularly with Kristen Blann and other TNC staff. Results of the LCCMR research will be shared, and we expect that the TNC will adopt some aspects into their peatland restoration planning. In addition, project researchers will present to the TNC International's peatland working group (proto-typing network) annually. 3.) The LCCMR-supported research will involve coordination with government agency staff, primarily Mn BWSR, Mn DNR and the US Forest Service. We have members from BWSR (S. Rhees and Dan Shaw) and the USFS (Randy Kolka, Erik Lilleskov) on the research team either contributing directly (USFS) or advising (BWSR). 4.) We will make presentations at professional and scientific conferences, including the Minnesota Water Resources Conference, the American Geophysical Union annual meeting, and the Society for Ecological Restoration. 5.) We expect to publish the research results in professional and scientific journals during the time period near the project end date or after the project. 6.) During the project we will organize one to two field trips to the Sax-Zim bog and other sites with project partners from 2024-26.
The Environment and Natural Resources Trust Fund will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, web pages, publications, signage, and other communications per the ENTRF Acknowledgment 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?
The results of the proposed project will be provided to stakeholders in publications and workshops, as described above. We are currently working closely with The Nature Conservancy on the assessment of restored peatlands. TNC will carry out long-term implementation of peatland restoration as part of their peatland restoration strategy for the state,

working with the relevant government agencies. Together these resources should provide a solid basis for decision-making as to the benefits of peatland restoration needed to guide management and policy. Funding for follow-on research will be sought from federal funding sources such as the NSF and DOE.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Techniques for Water Storage Estimates in Central Minnesota	M.L. 2017, Chp. 96, Sec. 2, Subd. 04h	$250,000
Setting Realistic Nitrate Reduction Goals in Southeast Minnesota	M.L. 2019, First Special Session, Chp. 4, Art. 2, Sec. 2, Subd. 04m	$350,000

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
John Nieber		Modeling activities, data analysis, report writing, manuscript writing			33.5%	0.09		$17,086
Chris Lenhart, PI		Project management, data acquisition, data interpretation and modeling			33.5%	0.51		$50,109
Timothy Griffis		Management of micromet towers and data analysis/interpretation, and modeling			33.5%	0.15		$28,256
Post-doctorate researcher		Manage and monitor micromet towers, data collection, data analysis, report writing			20.9%	2		$125,000
graduate research assistant		Assist in monitoring micromet towers and small column experiments and mercury in streams data collection, data analysis, modeling			66%	1.2		$116,223
undergraduate research assistant		assist with field data collection and system maintenance, results illustration.			0%	0.5		$11,148
							Sub Total	**$347,822**
Contracts and Services								
U.S. Forest Service	Sub award	Technical staff person from USFS to run chamber-based gas flux equipment and provide other technical assistance as needed. They would work 10% FTE or (200 hours per year) at a rate of $6,000 per year and $18,000 over 3 years. Cost is 90% salary and 10% benefits				0.36		$18,000
AmeriFlux	Sub award	Technical assistance to set up flux towers and maintain them, including travel and staff time. The breakdown would be approximately $10,500 for staff time and $1500 for travel.				0.2		$12,000
University of Minnesota, mercury lab in Soil, Climate, and Water Department	Internal services or fees (uncommon)	they will analyze water samples for total mercury and methylmercury necessary to complete the mercury portion of our study. They charge $100 per sample, a reduced rate for University of Minnesota staff.				0.2		$21,925
							Sub Total	**$51,925**

Equipment, Tools, and Supplies								
	Tools and Supplies	general supplies	required supplies for setup of experimental measurements at peatland sites, including soil and vegetation sampling supplies for data collection at each peatland site					$7,958
							Sub Total	**$7,958**
Capital Expenditures								
		Micrometerological towers (three towers at $100,000 each). They are composed of mulitple components that total approximately $100,000 each	To measure the exchange of carbon dioxide and methane with the surface of the peatland test sites.	X				$300,000
		water level and velocity probes (3 sets for restored, ditched and natural) peatland watershed outflow monitoring). Each ultrasonic or Area-Velocity probe is approximately $6500 plus $500 needed for mounting equipment	for monitoring streamflow in mercury study necessary to quantify total load of mercury moving downstream from peatlands	X				$20,000
							Sub Total	**$320,000**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	50 trips, 15,000 miles ($0.625/mile), 2 people: 75 nights lodging (UMn-Cloquet)- ($40/night), 100 people-days meals ($40/day), vehicle rental $3000	travel to field sites to set up equipment, maintain experimental sites, and acquire data					$22,495
	Conference Registration Miles/ Meals/ Lodging	present at WRC meeting or peatland meeting with TNC	describe project and results					$800
							Sub Total	**$23,295**
Travel Outside Minnesota								
							Sub Total	**-**

Printing and Publication								
	Publication	publication of guidance documents and scientific articles	to distribute information about project results					$3,000
							Sub Total	**$3,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$754,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request
Capital Expenditures		Micrometerological towers (three towers at $100,000 each). They are composed of mulitple components that total approximately $100,000 each	The towers are critical to obtain net flux of carbon dioxide and methane at a height above the ground from 2 meters to 20 meters. They are absolutely essential to do this project, it could not be done without them. **Additional Explanation :** The flux towers are essential to collect the data on carbon gas flux, above the surface of the peatland recording continous data on carbon dioxed and methane levels in the air. They will be setup and used throughouth the life of the project. The AmeriFlux and USFS technicians will help maintain them.
Capital Expenditures		water level and velocity probes (3 sets for restored, ditched and natural) peatland watershed outflow monitoring). Each ultrasonic or Area-Velocity probe is approximately $6500 plus $500 needed for mounting equipment	Mounted flow probes are required to monitor stream flow in the mercury study portion of this project. Without the probes a person would have to go out and measure by hand, which would be impossible. They are the only way to get the data needed for the study **Additional Explanation :** we'll be able to use flow monitoring devices for years to come through the BBE Department. Streamflow measurement is one of the most basic things to our research in the Ecological Engineering program.

Non ENRTF Funds

Category	Specific Source	Use	Status	$ Amount
State				
In-Kind	University of Minnesota	Indirect costs on project	Secured	$267,950
			State Sub Total	**$267,950**
Non-State				
In-Kind	The Nature Conservancy	Ongoing restoration work at the Sax-zim bog; use of Li-Cor sampling device; collaborative planning	Secured	$175,000
			Non State Sub Total	**$175,000**
			Funds Total	**$442,950**

Attachments

Required Attachments

Visual Component

File: a97cc859-c93.pdf

Alternate Text for Visual Component

Top diagram conceptualizes greenhouse gases entering the air, and mercury entering streamwater, from ditched peatlands, impacting climate, water quality, and human health. Maps show ditching in Minnesota's peatlands, and locations of the three restoration study sites in northern Minnesota. A photo of an eddy flux tower is shown....

Optional Attachments

Support Letter or Other

Title	File
Institutional Approval to submit	3c01a9f8-c09.pdf
LoS LCCMR peat proposal letter from KBlann	d165e915-a4b.pdf
Nieber LCCMR letter from US Forest Service	f2114187-002.pdf
background check	9d0a2a89-d80.pdf
Addendum for peatlands study Feb. 2023	2598fc5d-ce0.docx

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

We changed the study sites to center around the Sax-Zim area northwest of Duluth for travel, logistics and feasibility reasons. By having all the study sites within 30 miles of each other will make the project more feasible and cost-effective.

We shifted funding between staff to include more funding for technicians to help with the eddy covariance towers, taking one year of time from the post-doc position and one year from the graduate student. The USFS will be receiving funding for a technician and AmeriFlux - an academic consortium working with Dr. Tim Griffis on gas flux monitoring.

We reduced the travel cost estimate since we can stay at the Cloquet Forestry Center for $40 per night and mileage, food and lodging costs were reduced by doing all the research around the Sax-Zim area. We added $800 in the travel costs and reduced the other travel costs to keep the category total the same.

The total amount of funding requested has not changed.

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 agree travel expenses must 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 agree to the UMN Policy.

Does your project have potential for royalties, copyrights, patents, or sale of products and assets?

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