Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-454

Proposal Title: Evaluating Microbial Recovery in Restored Minnesota Peatlands

Project Manager Information

Name: Brian Dingmann

Organization: U of MN - Crookston

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Project Basic Information

Project Summary: Microbial indicators of peatland restoration recovery in northwest Minnesota, producing a Microbial Recovery Index and Restoration Effectiveness Framework for watershed districts, with workforce development across three rural and tribal institutions.

ENRTF Funds Requested: $296,000

Proposed Project Completion: May 31, 2030

LCCMR Funding Category: Small Projects (G)
Secondary Category: Resiliency (A)

Project Location

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

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

When will the work impact occur?
During the Project and In the Future

Narrative

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

Minnesota contains approximately 7 million acres of peatland, more than any state except Alaska, representing the state's most concentrated terrestrial carbon reserve. In northwest Minnesota, county and state ditching programs beginning in the early 1900s lowered water tables across an estimated one-sixth of these peatlands, triggering aerobic microbial decomposition that oxidizes stored peat carbon. The MPCA ranks cultivated histosols as the state's fourth-largest greenhouse gas source.

Watershed districts and the MN DNR have invested substantially in re-wetting these systems through ditch plugging at Sprague Creek Peatland SNA and Winter Road Lake SNA. The Roseau River Watershed District maintains active hydrologic monitoring at several of these sites. Yet current restoration evaluation relies only on water-level measurements and vegetation surveys, indicators that cannot confirm whether carbon-stabilizing biological processes have actually recovered. Research at the SPRUCE (Spruce and Peatland Responses Under Changing Environments) whole-ecosystem experiment has shown that standard DNA-based community surveys often fail to detect functional change even when carbon fluxes shift substantially. Monitoring must target what microbial communities are actively doing, not just who is present. No systematic application of process-rate and RNA-based methods across a northwest Minnesota peatland restoration chronosequence currently exists.

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.

Minnesota's re-wetted peatlands lack biological evidence of microbial functional recovery. This project fills that gap with process-rate assays, porewater greenhouse gas flux, and RT-qPCR targeting active mRNA — capturing what microbial communities are actively doing, not just who is present. These methods address what water-level gauges and vegetation surveys cannot: whether carbon-stabilizing anaerobic pathways have re-established.

The design is a restoration chronosequence comparing re-wetted sites at Sprague Creek and Winter Road Lake SNAs against intact reference peatlands at Red Lake and Luxemburg SNAs, revealing how quickly carbon-stabilizing function returns after re-wetting. Bi-seasonal sampling over two years captures the aerobic and anaerobic conditions driving peat carbon dynamics.

Deliverables: a Microbial Recovery Index, a Restoration Effectiveness Framework, and GHG avoidance estimates — give watershed districts biological evidence to verify restoration investments and support carbon funding. This framework is designed for all 46 Minnesota watershed districts, not just project sites. This project partners the University of Minnesota Crookston, Northwest Technical College, and White Earth Tribal and Community College, institutions serving first-generation, Pell-eligible, and White Earth Nation tribal students from rural northwest Minnesota, each employing students in full-time summer research appointments, rooting project knowledge and capacity in the communities most affected by restoration outcomes.

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?

1. Microbial Recovery Index (MRI) – First bioindicator for re-wetted Minnesota peatlands combining process rates with RNA-based gene expression; peer-reviewed with student co-authors.
2. GHG Avoidance Documentation – CO_2-equivalent emissions avoided per restoration stage, aligned with TNC Peatland Playbook and MPCA accounting.
3. Restoration Effectiveness Framework – Tiered protocols disseminated to all 46 watershed districts via MN BWSR and UMN Extension.
4. Water Quality Co-Benefits – DOC and dsrB activity linking re-wetting to downstream methylmercury risk reduction.

5. Workforce Development and Equity – Paid summer research positions at partnering institutions with conference presentations required; teaching lab integration trains 300+ students beyond the grant period.

Activities and Milestones

Activity 1: Site Confirmation, Protocol Development, and Baseline Sampling

Activity Budget: $126,000

Activity Description:
Anderson leads site coordination at Sprague Creek and Winter Road SNAs, securing MN DNR access permits and receiving existing RRWD monitoring data. Dingmann designs the complete analytical protocol suite across three measurement domains. The RNA preservation workflow—field collection directly into a −80°C portable freezer within 30 minutes of coring—is laboratory-validated before field deployment. Murphy processes all baseline samples: SIR incubations, enzyme assays, RNA and DNA extractions, and PLFA. Mukku establishes chemical sampling protocols consistent with M.L. 2021. Chapman leads soil carbon chemistry interpretation and GHG flux analysis, integrating porewater redox and CO_2/CH_4 data with the existing hydrologic sensor network already in place at project sites. Contracted hydrologic engineering services (competitive bid) provide independent review of hydrologic restoration status at Sprague Creek and Winter Road.

Key deliverables include: MN DNR access permits confirmed; RRWD data integrated; hydrologic engineering contract awarded; RNA protocol laboratory-validated; protocol manual completed across all three measurement domains; monitoring equipment installed at all four sites; and baseline peat cores and chemical samples collected from all sites.

Activity Milestones:

Description	Approximate Completion Date
Hydrologic engineering contract awarded; RNA cold-chain protocol laboratory-validated.	June 30, 2027
MN DNR access permits confirmed; RRWD received and integrated existing monitoring data.	August 31, 2027
Protocol manual completed across all three measurement domains; monitoring equipment installed at all four sites.	August 31, 2027
Baseline peat cores collected from all four sites; baseline chemical and molecular sampling complete.	October 31, 2028
Baseline characterization report completed across all three measurement domains.	February 28, 2030

Activity 2: Bi-Seasonal Integrated Monitoring — Years 1 and 2

Activity Budget: $102,000

Activity Description:
Two full bi-seasonal monitoring cycles across all four sites—spring thaw (June) and late summer (August) each year. Anderson coordinates logistics and collects all peat cores and porewater samples at all sites across both monitoring years. Murphy runs dual-track laboratory workflows: (1) functional assay track—SIR CO_2 evolution at 24h, enzyme fluorometric assays within 24h of collection; and (2) molecular track—RNA extraction from −80°C-preserved subsamples for RT-qPCR and DNA extraction for standard qPCR. Porewater GHG samples are analyzed by GC within 48 hours. Mukku coordinates monthly DOC and quarterly redox sampling at site outlets. Chapman analyzes soil carbon chemistry and GHG flux data, integrating porewater redox potential, CO_2/CH_4 concentrations, and DOC chemistry with hydrologic records from the existing monitoring network; she also leads applied biological condition assessments annually.

Key deliverables include: Year 1 and Year 2 spring and summer sampling completed at all four sites; RT-qPCR, qPCR, SIR, enzyme, and PLFA analyses complete for both years; hydrologic recovery models and biological condition report finalized; and an integrated master dataset compiled and quality-controlled.

Activity Milestones:

Description	Approximate Completion Date
Year 1 spring and summer sampling completed at all four sites, all three measurement domains.	August 31, 2027
Year 1 RT-qPCR, qPCR expression analyses, and functional assays complete.	December 31, 2027
Year 2 spring and summer sampling completed at all four sites.	August 31, 2028
Year 2 full laboratory analyses complete; integrated master dataset compiled and QC'd.	March 31, 2029
Hydrologic recovery models and the biological condition report have been finalized.	May 31, 2029

Activity 3: Framework Synthesis, Dissemination, and Workforce Integration

Activity Budget: $68,000

Activity Description:

Dingmann leads integrated analysis across all three measurement domains, synthesizing the two-year master dataset into the Microbial Recovery Index (MRI) and Restoration Effectiveness Framework. The MRI combines process-rate assays, PLFA biomass, and RT-qPCR mRNA expression into a tiered bioindicator scored against intact reference peatland benchmarks established in Activities 1 and 2. GHG avoidance estimates are calculated per restoration stage and aligned with TNC Peatland Playbook and MPCA accounting frameworks. Anderson coordinates final verification field visits; the hydrologic engineering contractor provides an independent Year 3 framework review.

The MRI methodology, GHG avoidance documentation, and water quality co-benefit findings are submitted for peer-reviewed publication with student co-authors from all three institutions. The Restoration Effectiveness Framework and MRI rapid-assessment field guides are disseminated to all 46 Minnesota watershed districts through MN BWSR and UMN Extension. Student researchers present findings at NCUR and ASM Microbe. Project methods are integrated into teaching labs at UMC, NTC, and WETCC, establishing the workforce pipeline beyond the grant period.

Key deliverables: peer-reviewed MRI manuscript with student co-authors; Restoration Effectiveness Framework and field guides distributed to all 46 watershed districts; student conference presentations at NCUR and ASM Microbe; teaching lab integration at all three institutions.

Activity Milestones:

Description	Approximate Completion Date
Integrated master dataset fully analyzed; MRI scores calculated for all sites and restoration stages.	May 31, 2029
GHG avoidance estimates and water quality co-benefit findings completed; peer-reviewed manuscript submitted with student co-authors.	December 31, 2029
Restoration Effectiveness Framework and MRI field guides printed/distributed to all 46 Minnesota watershed districts.	February 28, 2030
Student researchers from UMC, NTC, and WETCC present findings at NCUR/ASM Microbe; travel complete.	April 30, 2030
Project methods integrated into teaching labs at UMC, NTC, and WETCC; workforce pipeline established/documented.	May 31, 2030

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.
Project results will be actively disseminated to ensure that findings support improved peatland management across Minnesota. The Microbial Recovery Index (MRI), Restoration Effectiveness Framework, and associated protocols will be distributed to all 46 Minnesota watershed districts through partnerships with the Minnesota Board of Water and Soil Resources (BWSR) and University of Minnesota Extension, ensuring that agencies responsible for peatland restoration can directly apply project outcomes to evaluate restoration success. Workshops and presentations will be offered to watershed districts, tribal natural resource departments, and state agencies, including the Minnesota Pollution Control Agency (MPCA) and Minnesota Department of Natural Resources (DNR), to promote awareness and application of the project's monitoring tools.

Peer-reviewed publications and conference presentations (e.g., ASM Microbe and the National Conference on Undergraduate Research) will disseminate scientific findings to the broader research community while including undergraduate co-authors from participating institutions. The project's datasets, protocols, and analytical frameworks will be archived through the University of Minnesota's institutional repositories and made accessible for long-term use by researchers and land managers.

Educational integration ensures broader public engagement and long-term impact. Project methods will be incorporated into teaching laboratories at the University of Minnesota Crookston, Northwest Technical College, and White Earth Tribal and Community College, training hundreds of students in wetland science and restoration monitoring. Student researchers will present their results to local communities and stakeholders, increasing awareness of the benefits of peatland restoration. All public-facing materials, reports, and presentations will acknowledge the Environment and Natural Resources Trust Fund, ensuring that Minnesotans understand how these funds support research that protects carbon-rich wetlands, improves water quality, and strengthens climate resilience across the state.

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 Peatland Restoration Effectiveness Framework and Microbial Recovery Index (MRI) will be distributed to all 46 Minnesota watershed districts through BWSR and UMN Extension, with the Roseau River Watershed District immediately incorporating Tier 1 rapid assessment into restoration reporting. The Tier 1/2/3 protocol structure ensures usability across resource levels. Ongoing monitoring may be supported through USDA RCPP, MPCA Clean Water Fund, NRCS, EPA restoration grants, and emerging carbon credit programs. Methods integrated into teaching labs at UMC, NTC, and WETCC will sustain regional analytical capacity, while Tier 1 protocols enable deployment by tribal natural resource staff without laboratory

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Exploring Minnesota's Wetlands: Our Resource For Future Medicine	M.L. 2021, First Special Session, Chp. 6, Art. 6, Sec. 2, Subd. 03k	$210,000

Project Manager and Organization Qualifications

Project Manager Name: Brian Dingmann

Job Title: Associate Professor of Biology

Provide description of the project manager's qualifications to manage the proposed project.
Dr. Brian J. Dingmann (Ph.D., Biology, Georgia Institute of Technology) is Associate Professor of Biology at UMN Crookston and a 2025–2026 Fulbright U.S. Scholar. His research centers on wetland microbial ecology and ecotoxicology, expertise directly applied to this project. As PI of M.L. 2021, he managed a $210,000 LCCMR grant to full completion at 99.6% budget utilization, produced undergraduate-co-authored peer-reviewed publications, and trained over 150 students in molecular ecological techniques. A first-generation college student himself, Dr. Dingmann has a documented record of recruiting and retaining first-generation and rural students in research roles and is an ASM Faculty for the 21st Century Fellow and mentor.

His team's credentials match every project domain: Dr. Katy Chapman (Ph.D., environmental soil science, Purdue; USDA post-doc; published in Journal of Environmental Quality and Soil Science) leads soil carbon and GHG avoidance estimation; Dr. Venugopal Mukku (Ph.D., Organic Chemistry, Andhra University; UMC Director of Research Labs; prior LCCMR recipient) leads peat and water chemistry; Hannah Murphy, Molecular Lead and Lab Manager, provides innovative molecular expertise; and Karl Anderson (Ph.D. candidate, Environmental Science, NDSU; Biology Faculty at Northwest Technical College (NTC); USDA-ARS researcher) leads field operations and holds the established RRWD and MN DNR site relationships essential to project access.

Dr. Dingmann designed the microbial functional and molecular analysis framework for this proposal, including the RT-qPCR expression index and Microbial Recovery Index methodology. His expertise spans bacterial isolation, microbial culturing, molecular characterization, substrate-induced respiration assays, and extracellular enzyme analysis, the core methods proposed here. His established relationships with RRWD and MN DNR regional staff, prior LCCMR management record, and leadership of the M.L. 2021 methodological foundation make him well-suited to manage this project through completion.

Organization: U of MN - Crookston

Organization Description:
The University of Minnesota Crookston (UMC) is a baccalaureate polytechnic institution of the University of Minnesota system located in the Red River Valley of northwest Minnesota. More than 60 percent of UMC's 2,800 students are first-generation, with a significant share qualifying for Pell grants. UMC administers grants through the University of Minnesota's Office of Sponsored Projects Administration, providing full compliance infrastructure. UMC's prior LCCMR award (M.L. 2021, $210,000) was completed at 99.6% budget utilization with peer-reviewed publications and is the direct methodological predecessor to this project.

This project partners UMC with two additional institutions in northwest Minnesota. Northland Community and Technical College (NTC), headquartered in Thief River Falls, is a Minnesota State two-year institution; NTC's Karl Anderson (Ph.D., Environmental Science, NDSU) serves as the field operations Co-PI and holds established relationships with the Roseau River Watershed District and the MN DNR, which are essential to site access. White Earth Tribal and Community College (WETCC), located on the White Earth Nation reservation in Mahnomen, is a tribally chartered institution ensuring Indigenous students from communities most affected by peatland restoration outcomes are full research participants. Together, all three institutions are located within the project's field geography, rooting

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
PI/Project Manager (Brian Dingmann)		Project management, RT-qPCR + MRI framework design, integrated analysis, and manuscripts overview.			38.5%	0.39		$45,000
Co-PI (Venugopal Mukku)		Chemistry, DOC, $SUVA_{254}$, redox potential, LOI, bulk density, N-mineralization, as well as an undergraduate mentor.			38.5%	0.26		$29,000
Co-PI (Karl Anderson)		Field ops, all-site sampling, RNA cold-chain, lab support; research/teaching credits management for undergraduate researchers, as well as mentor for undergraduates.			0%	0.39		$15,000
Co-PI (Hannah Murphy)		Molecular techniques: lead and laboratory supervisor; SIR; enzyme; PLFA; RNA/RT-qPCR; DNA/qPCR; QA/QC, as well as an undergraduate mentor.			38.5%	0.26		$25,000
Co-PI (Katy Chapman)		Soil carbon chemistry, GHG flux interpretation, GC gas analysis, biological condition scoring, and undergraduate mentor.			38.5%	0.66		$30,000
University of Minnesota Crookston (UMC) student researchers		Field + lab; functional assay + RT-qPCR methods training; applicable workforce skills development and career exploration under supervisor by faculty mentors.			0%	0.99		$44,000
White Earth Tribal and Community College (WETCC) student researchers/internship participants.		Field + lab; functional assay + RT-qPCR methods training; applicable workforce skills development and career exploration under supervisor by faculty mentors; internship placement through the WETCC curriculum.			0%	0.99		$27,000
							Sub Total	**$215,000**
Contracts and Services								
Hydrologic Engineering Services	Service Contract	Site hydrology review (Y1) + framework independent review (Y3); awarded by competitive bid				0		$3,000
							Sub Total	**$3,000**

Equipment, Tools, and Supplies								
	Tools and Supplies	SIR + Enzyme Assay Reagents (substrate, incubation supplies, MUB-fluorescent probes for phenol oxidase and β-glucosidase)	Lab supplies and pipettors are needed for the chemical analysis (extraction, fractionation, and purification) aspect of the project.					$18,000
	Tools and Supplies	RNA Extraction + RT-qPCR Reagents (RNeasy/TRIzol, SuperScript RT kits, RNA-specific mastermix, RNA storage buffer) + DNA Extraction + Standard qPCR (Qiagen kits; qPCR reagents for mcrA/dsrB/pmoA/nifH)	The research component requires soil microbiological (culturing and isolation) and molecular lab (DNA extraction and sequencing) supplies.					$21,000
	Tools and Supplies	PLFA Extraction Supplies (Bligh-Dyer reagents, SPE columns, GC standards) + Porewater GHG + Field Consumables (syringes, septa, headspace vials, GC calibration gas, coring equipment) + DOC + Redox Chemistry Supplies (filter apparatus, redox electrodes, LOI crucibles)	Consumable laboratory and field supplies are required across all three measurement domains for bi-seasonal sampling at four sites over two monitoring years.					$17,000
	Equipment	Portable Ultra-Low Temp Freezer (−80°C) for RNA cold-chain preservation in the field; reusable across all project years and for use in the expansion of the current pilot project.	The freezer will support the ongoing collection and preservation of RNA samples as the pilot project expands, ensuring readiness for federally funded research opportunities.					$4,000
							Sub Total	**$60,000**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Bi-seasonal field sampling at four sites across Roseau, Lake of the Woods, and Beltrami counties over two years; UMN mileage rates. Cross-campus coordination travel between UMC, NTC, and WETCC (Year 1 field orientation). Sampling in select sites in Minnesota. Travel ($0.725 per mile of travel, 1700 miles traveling in Northern Minnesota, $1,520); meals, 30 trips with 10 people, $1,480.	There are remote sites that will require long travel trips and require food and lodging funds.					$3,000

							Sub Total	**$3,000**
Travel Outside Minnesota								
	Conference Registration Miles/ Meals/ Lodging	Conference registration to American Society of Microbiology (ASM) Microbe and ASM Conference on Undergraduate Education (6 people X $450, $2,700), airfare (6 people X $500, $3,000) and hotel stays (6 people X $225 per night X 3 nights, $4,050), during conference. Additional $250 for meals not covered by conferences.	Dissemination of educational materials at ASMCUE and student presentations at ASM Microbe will be disciplinary dissemination.					$10,000
							Sub Total	**$10,000**
Printing and Publication								
	Printing	Printing of reports for stakeholders	Miscellaneous printing for production of learning module materials.					$500
	Publication	Article Page Charges	Dissemination of learning materials and description of VR wetland immersive educational process will require publication fees associated with educational journal article page charges					$4,500
							Sub Total	**$5,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$296,000**

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				
			Non State Sub Total	**-**
			Funds Total	**-**

Total Project Cost: $296,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: fe58ff24-cb5.pdf

Alternate Text for Visual Component

Infographic summarizing a Minnesota peatland restoration research project. It highlights how historic drainage released stored carbon, asks whether microbial carbon cycling returns after re-wetting, and shows the study's approach, microbial activity assays, genetic analysis, and greenhouse gas monitoring, leading to a Microbial Recovery Index, restoration guidance, and student workforce training...

Supplemental Attachments

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

Title	File
Dr. Randy Kolka Letter of Support	a15296e0-de9.pdf
White Earth Tribal and Community College Letter of Support	31cc379b-338.pdf
Approval Letter to Submit University of Minnesota	bee0e218-ba1.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

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:

Donna Larson, University of Minnesota Crookston Grant Officer

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