Environment and Natural Resources Trust Fund

2027 Request for Proposal

General Information

Proposal ID: 2027-309

Proposal Title: Integrated PFAS Capture and Destruction on Tribal Lands

Project Manager Information

Name: Rylee Hince

Organization: Prairie Island Indian Community

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Project Basic Information

Project Summary: Demonstrate a closed-loop system capturing and destroying PFAS from groundwater and vegetation at Prairie Island Indian Community, advancing scalable land-based solutions for protecting Minnesota water, ecosystems, and cultural food systems.

ENRTF Funds Requested: $613,000

Proposed Project Completion: June 30, 2030

LCCMR Funding Category: Land (F)

Project Location

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

Region(s): SE

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.

Per- and polyfluoroalkyl substances (PFAS), often called "forever chemicals," persist in soils, vegetation, and shallow groundwater, creating long-term constraints for land stewardship in contaminated areas of Minnesota. The State's 2018 settlement with 3M ($850 million) recognized documented damages to drinking water and natural resources associated with historical PFAS releases and highlighted the need for long-term environmental management solutions.

Prairie Island Indian Community (PIIC) is among Minnesota communities addressing PFAS contamination affecting land and water resources, including areas used by Tribal members for subsistence harvesting and cultural food systems. Early research conducted with regional partners has detected PFAS in cultural foods (e.g. maple sap/syrup; walleye) and in local wells and surrounding ecosystems. These findings underscore concerns for community health, food sovereignty, and ecosystem stewardship.

PFAS move through groundwater, accumulate in vegetation, and can re-enter soils when contaminated biomass is burned or disposed without controlled treatment, creating a persistent exposure pathway. Capturing and destroying PFAS at these points could reduce long-term contaminant cycling, particularly where they enter food systems and drinking water. Although Minnesota requires PFAS testing prior to biosolids land application, no field-validated land-based system currently captures PFAS, treats contaminated biomass, and returns treated materials as beneficial soil amendments.

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.

PFAS mobility through soil–plant–water systems presents both an environmental management challenge and an opportunity for landscape-scale capture. Studies show PFAS accumulation in woody and herbaceous vegetation growing on impacted soils. This project leverages these pathways to concentrate PFAS from contaminated landscapes while preventing re-release during biomass management.

PIIC will lead land-centered research and demonstration in partnership with the University of Minnesota (UMN), integrating phytoremediation, groundwater capture, and engineered treatment to interrupt PFAS cycling in soils and vegetation. This approach targets PFAS removal from natural pathways before they re-enter water and food systems. Cottonwood trees and existing prairie vegetation will be evaluated for PFAS uptake, while PFAS-impacted groundwater will be treated using biochar or activated carbon filtration systems known to concentrate PFAS.

PFAS-laden carbon materials and harvested biomass will then undergo catalytic microwave-assisted pyrolysis (CMAP), an advanced treatment approach developed by UMN researchers. Unlike conventional technologies that transfer PFAS in filters or residual wastes, CMAP has demonstrated laboratory-scale PFAS breakdown under controlled conditions. Previous studies report >94% PFOA removal and >99.99% PFAS removal in treated carbon at 500 °C with CaO catalyst. Treatment performance will be verified through fluorine mass balance and monitoring of off-gas streams.

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?

We will evaluate the feasibility of a closed-loop ecosystem-wide PFAS removal system. Outcomes include: (1) quantification of PFAS capture through groundwater filtration and biomass; (2) verified PFAS destruction by CMAP in biomass and carbon, including off-gas monitoring and reuse potential of syngas; (3) evaluation of treated materials to assess if they can be reused without re-release; and (4) integrated life-cycle assessment and techno-economic analysis to evaluate feasibility for broader land-based deployment in Minnesota landscape. Results will be translated into culturally relevant guidance for PIIC land stewardship and educational resources distributed to broader Minnesota audiences through UMN Extension.

Activities and Milestones

Activity 1: PFAS Capture from Groundwater and Existing Biomass

Activity Budget: $190,000

Activity Description:
This activity will quantify PFAS capture from groundwater and naturally occurring vegetation at PIIC. Groundwater from the well supplying the PIIC Land and Environment Building (a site with documented PFAS contamination) will be directed through fixed-bed columns packed with biochar and, where appropriate, activated carbon (AC) to concentrate PFAS from water. Column testing will be conducted under controlled hydraulic conditions to evaluate PFAS removal efficiency, adsorption capacity, and breakthrough behavior. Influent and effluent PFAS concentrations will be measured using LC-MS/MS with standard quality assurance procedures. Operational parameters including flow rate, contact time, and media replacement intervals will be documented to support PFAS mass balance calculations and system modeling. Vegetation from PIIC (e.g. cottonwood, willow, and representative prairie species) will be sampled and harvested aligning with existing stewardship practices. Plant tissues and associated soils will be analyzed to quantify PFAS uptake and distribution across plant components. Harvest yield and PFAS mass per biomass unit will be documented to estimate capture potential. Spent filtration media and harvested biomass will be prepared as feedstocks for catalytic microwave-assisted pyrolysis (CMAP) treatment in Activity 2.

Activity Milestones:

Description	Approximate Completion Date
Baseline PFAS characterization of well water, soils, and vegetation.	December 31, 2027
Groundwater filtration dataset with quantified PFAS mass loading.	June 30, 2028
Biomass harvest and PFAS mass quantification completed; feedstocks prepared for CMAP treatment.	December 31, 2028

Activity 2: CMAP PFAS Mineralization and Fluorine Verification

Activity Budget: $250,000

Activity Description:
This activity will evaluate CMAP for destruction of PFAS captured in filtration media and biomass. Experiments conducted at the UMN will determine operating conditions that promote cleavage of carbon-fluorine bonds and conversion of PFAS to stable inorganic fluorine species. Treatment experiments will examine key operating parameters including microwave power density, temperature, residence time, carrier gas (e.g., N2 with controlled oxidizing fraction), feedstock composition, and catalyst presence. Off-gas streams will be directed through staged condensation and alkaline scrubbing systems designed to capture volatile fluorinated species. Treatment performance will be evaluated through fluorine mass balance across solid residues, condensates, scrubbing solutions, and gas phases. Analytical measurements will include targeted PFAS by LC-MS/MS, fluoride by ion chromatography (IC), and where appropriate total or extractable organic fluorine (TOF/EOF). Monitoring will also evaluate potential formation of short-chain PFAS or other fluorinated byproducts. Energy intensity (kWh kg^{-1} treated) and syngas composition (H_2, CO, CO_2, and light hydrocarbons by GC) will be quantified to evaluate potential energy recovery and support techno-economic analysis outlined in Activity 4.

Activity Milestones:

Description	Approximate Completion Date
Optimized CMPA operating window	June 30, 2028
Fluorine mass balance verification	September 30, 2029
Energy intensity and emission evaluation	December 31, 2029

Activity 3: Biochar Characterization and Soil Compatibility

Activity Budget: $75,000

Activity Description:
This activity will evaluate whether CMAP-treated carbon materials can be safely reused within PIIC's land stewardship systems. Treated biochar derived from filtration media and biomass-derived carbon materials from CMAP will be characterized for physicochemical properties, including pH, mineral content, and surface characteristics relevant to soil and water treatment applications. Residual PFAS concentrations will be measured using LC-MS/MS and compared against defined criteria for return-to-land use. Leachability testing under controlled moisture conditions will assess potential PFAS remobilization. Treated carbon materials will also be evaluated for adsorption performance to determine their suitability for reuse in groundwater treatment systems. Where appropriate, controlled soil microplots or mesocosms will be used to confirm soil compatibility and absence of detectable PFAS release under representative environmental conditions. This activity establishes objective criteria for reuse of CMAP-treated carbon materials within the circular PFAS management system.

Activity Milestones:

Description	Approximate Completion Date
Comprehensive physicochemical and residual PFAS characterization of treated carbon	December 31, 2029
Soil compatibility and leachability evaluation	March 31, 2030

Activity 4: Integrated Closed-Loop Modeling, TEA, and LCA

Activity Budget: $45,000

Activity Description:
This activity will integrate PFAS capture and treatment data from Activities 1–3 into a closed-loop system model quantifying PFAS capture, destruction performance, and carbon material reuse within the system. A preliminary techno-economic analysis (TEA) will evaluate system cost drivers including filtration media replacement frequency, CMAP energy requirements, preprocessing needs, and scale sensitivity. A life-cycle assessment (LCA) will compare the closed-loop system with conventional management pathways, focusing on contaminant transfer risk, energy demand, and implications of carbon reuse. These analyses will identify conditions under which the system could support broader land-based PFAS management applications.

Activity Milestones:

Description	Approximate Completion Date
Closed-loop PFAS mass flow model	January 31, 2030
Preliminary TEA and LCA	March 31, 2030
Final technical report, implementation roadmap, and stakeholder dissemination	June 30, 2030

Activity 5: Tribal Engagement and Outreach

Activity Budget: $53,000

Activity Description:
UMN Extension partners (Water Resources and Soil Health and Regional Sustainable Development Partnerships (RSDP)) and PIIC will lead ongoing outreach within and beyond PIIC throughout the project. Engagement will follow a "good

relative" approach grounded in Tribal partnerships, with an intentional focus on trust-building and mutual learning that emphasizes listening, cultural respect, and alignment with PIIC land stewardship practices.
Early project activities will include site visits and land walks with the PIIC Land and Environment team to understand current land management practices, identify opportunities for biomass harvesting and carbon material reuse. Discussions will address community concerns regarding PFAS, water quality, and food safety.
Three community workshops will be hosted throughout the duration of the project: (1) Soil health and soil testing; (2) PFAS movement through soils, groundwater, vegetation, and food systems, and (3) project findings on thermochemical PFAS treatment and management considerations for contaminated biomass and carbon materials.
Educational materials will be developed for two audiences: (1) Tribal communities (PIIC and others), and (2) MN land managers facing PFAS contamination challenges (ag land, urban and peri-urban lands, landfills, etc), contingent on the study findings. Final outputs will define advancement thresholds and staged scaling criteria.

Activity Milestones:

Description	Approximate Completion Date
PIIC/UMN relationship development and Land walks (UMN)	May 31, 2027
Workshop 1 (PIIC): Soil health and soil testing	July 31, 2027
Workshop 2 (PIIC): PFAS movement through ecosystems/food systems	July 31, 2028
Workshop 3 (PIIC): Project findings	September 30, 2029
Educational Materials development and distribution (for PIIC & MN audiences; shared at PIIC and throughout MN)	December 31, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Roger Ruan	University of Minnesota – Department of Bioproducts and Biosystems Engineering	Co-PI: Leads development and operation of catalytic microwave-assisted pyrolysis (CMAP) for PFAS destruction. Oversees thermochemical system design, experimental validation, and fluorine mass balance verification.	Yes
Dean Current	University of Minnesota – Department of Forest Resources	Leads techno-economic analysis (TEA), life-cycle assessment (LCA), and system modeling to evaluate feasibility and scalability of the closed-loop PFAS management system.	Yes
Andi Sutton	University of Minnesota Extension – Regional Sustainable Development Partnerships (RSDP)	Leads community engagement and partnership coordination with PIIC. Facilitates relationship-building, co-develops culturally relevant programming, and ensures alignment of research activities with Tribal priorities and land stewardship practices.	Yes
Bailey Tangen	University of Minnesota Extension (Water Resources Center; Agricultural & Natural Resource Systems)	Extension Educator leading outreach and translation of research findings into applied guidance. Supports development of educational materials, stakeholder workshops, and statewide dissemination focused on PFAS management in soil and water systems.	Yes

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.
Prairie Island Indian Community (PIIC) and University of Minnesota Extension (Water Resources and Soil Health Extension Educator and Regional Sustainable Development Partnerships) will coordinate dissemination of project findings within PIIC and across Minnesota. Dissemination will focus on ensuring that Tribal governments, land managers, Minnesota communities, and state agencies responsible for environmental protection are aware of the project and able to apply the results to management of PFAS-impacted landscapes. Translation of research results is critical to this Extension project partner's role. She will translate results into practical guidance for both PIIC and Minnesota land managers who are evaluating vegetation-based capture strategies, carbon filtration systems, and treatment options for contaminated biomass, which can be used in programming beyond the life of this project. These will be focused on PFAS management in soils, water, and vegetation.

Within PIIC, dissemination will occur through three workshops and land-based learning activities developed with the PIIC Land and Environment Department. These engagements will involve modeling soil testing practices, review of project findings on PFAS capture in vegetation and groundwater systems (including culturally important foods), treatment of PFAS-laden biomass and carbon materials, and considerations for managing contaminated vegetation and soil

amendments. Educational materials will be developed with PIIC staff to support culturally applicable land stewardship guidance. PIIC Land and Environment staff will further disseminate results to our tribal partners through Minnesota's Tribal Environmental Working Group, at the Tribal Lands and Environment Forum (annual conference), and the Tribal Environmental Management Program conference.

While demonstrated at PIIC, the system is designed to inform application across PFAS-impacted lands in Minnesota, including agricultural, urban, and landfill-affected areas. At the statewide level, University of Minnesota Extension will share findings through Extension programming, technical bulletins, statewide communications and presentations (through partner RSDP) and stakeholder workshops led by the participating Extension Water Resources and Soil Health Extension Educator. Project findings will also be disseminated through peer-reviewed publications in journals such as Environmental Science & Technology, Water Research, or Journal of Hazardous Materials, and through presentations at professional conferences including the American Chemical Society (ACS), and soil and water conservation meetings. These venues will share technical results related to PFAS capture pathways, CMAP treatment performance, and feasibility analysis.

Technical documentation, including PFAS capture data, CMAP treatment performance, operating conditions, and feasibility analyses, will be shared with Minnesota state agencies and PFAS response initiatives to inform future pilot evaluations and resource management strategies. Where appropriate, datasets and case studies will be incorporated into University of Minnesota teaching materials and Extension training programs focused on environmental remediation and sustainable land management.

Project data and documentation will be archived through University of Minnesota data management systems to ensure long-term accessibility and also follow UMN practices on data sovereignty for research with Tribal partners. All publications, presentations, and outreach materials will acknowledge support from the Environment and Natural Resources Trust Fund and follow ENRTF Acknowledgment Requirements and Guidelines, including use of the ENRTF logo and attribution language.

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 results will establish technical criteria for evaluating future pilot-scale implementation of a closed-loop PFAS land management approach at PIIC and other PFAS-impacted landscapes in Minnesota. The project will provide verified treatment performance data, operational parameters, and feasibility analyses needed to guide next-stage deployment decisions. If performance benchmarks are met, PIIC and the UMN will pursue funding for phased pilot-scale implementation through programs supporting contaminant remediation, sustainable land management, and tribal environmental infrastructure, including federal research programs (EPA, USDA, NSF), state remediation initiatives, future ENRTF proposals, and opportunities aligned with Minnesota's PFAS settlement-supported environmental restoration efforts.

Project Manager and Organization Qualifications

Project Manager Name: Rylee Hince

Job Title: Director of Natural Resources and Land Planning

Provide description of the project manager's qualifications to manage the proposed project.
Rylee Hince is a natural resource professional with more than 15 years of project management experience in her

respective field. She has a strong background in quantitative and qualitative research analysis and interpretation, especially around complex environmental challenges. She oversees a skilled team of water resource and land management experts at PIIC who have been highly engaged on PFAS issues across Minnesota and within tribal communities.

Rylee's background spans numerous inter-disciplinary advisory groups including a 4-year term on Minnesota's Clean Water Council, a 4-year term on Minnesota's Environmental Quality Board, the updating of Minnesota's Public Drainage Manual, and the Upper Mississippi River Basin Association's sediment transport working group. Her public policy background allows her to see and plan for research applications beyond initial metrics that inform long-term land planning and land management strategies.

In her current role, Rylee is responsible for setting the strategic direction of all natural resource and land planning activities across 5,000 acres of tribal land, including the Mississippi River floodplain, restored prairie and oak savanna, historic archeological sites, bison pasture, agricultural leases, and cultural/medicinal gardens and food forests. Her departments work cooperatively with the wastewater department on the testing and application of biosolids on agricultural lands and contaminant testing in drinking water.

Rylee has managed long-term projects across multiple funding sources and is supported by a competent team of professionals. PFAS is a growing concern among PIIC tribal members and a priority issue for Tribal Council. Rylee's leadership on this proposal will provide the community with needed technical resources to continue exploring remediation alternatives with a holistic approach to ecological services.

Organization: Prairie Island Indian Community

Organization Description:

Prairie Island Indian Community is home to descendents of the Bdewakantunwan Band of Eastern Dakota Oyate (people). Dakota Oyate would gather across Prairie Island (Tinta Wita) to live, hunt, worship, and raise their families long before European settlers came to what is now the United States. Tinta Wita is a sacred, spiritual place and a final resting spot for many Dakota ancestors.

Bdewakantunwan translates to those born of the waters. Protecting and preserving the land, air, and water that surrounds Tinta Wita is among one of the community's most important responsibilities. These lands and waters continue to be a place to gather foods and medicines that nourish and heal the Dakota Oyate.

Located in the Mississippi-Lake Pepin Watershed between the city of Hastings, MN and Red Wing, MN, PIIC sits just north of Lock and Dam #3 in the Mississippi River. Since its establishment, PIIC has remained resilient against the impacts of flooding, nuclear waste, railroads, and now the persistent threat of forever chemicals (i.e. PFAS).

PIIC's mission supports its resiliency: embrace innovation to ensure the well-being of their tribal members, to honor those who came before us, and to prepare for the next seven generations.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Project Manager		PI - Leads overall project direction, coordination, and implementation on Tribal lands. Oversees integration with PIIC land stewardship practices, ensures alignment with community priorities, and guides application of results to land management decisions. Oversight as an in-kind contribution and is not requesting ENRTF salary support			0%	0.15		-
							Sub Total	-
Contracts and Services								
University of Minnesota	Subaward	University of Minnesota personnel will conduct PFAS capture, CMAP treatment, fluorine mass balance verification, and TEA/LCA modeling (Activities 1–4). Includes 1 postdoctoral researcher, 2 faculty oversight, 2 Extension coordination, and 1 technical support for field sampling, laboratory experiments, data analysis, reporting, and coordination with PIIC.				3.75		$392,557
University of Minnesota	Subaward	Laboratory supplies and non-capital equipment (<$5,000 per item) supporting PFAS capture and CMAP treatment. Includes reagents, analytical standards, biochar, activated carbon, catalysts, gas supplies, modular reactor components, off-gas capture (condensation and scrubbing), monitoring instrumentation, adsorption systems, and materials for community meetings and engagement.				0		$184,193
University of Minnesota	Subaward	In-state travel for coordination with Prairie Island Indian Community, field sampling, and stakeholder engagement. Includes site visits, groundwater and vegetation sampling, participation in community meetings, and a Year 1 PIIC visit to the University of Minnesota laboratory. Mileage calculated at $0.725 per mile.				0		$6,750
University of Minnesota	Subaward	Analytical and technical services supporting PFAS measurement and material characterization. Includes confirmatory PFAS analysis (LC-MS/MS), fluoride				0		$29,500

		quantification, and characterization of catalysts and treated carbon materials to support quality assurance, fluorine mass balance closure, and verification of treatment performance.						
							Sub Total	**$613,000**
Equipment, Tools, and Supplies								
							Sub Total	**-**
Capital Equipment								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
							Sub Total	**-**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$613,000**

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: $613,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: 9b2bf457-f70.pdf

Alternate Text for Visual Component

Closed-loop PFAS land management system to be evaluated at Prairie Island Indian Community. PFAS captured through groundwater filtration and vegetation uptake are concentrated in carbon media and biomass, treated using catalytic microwave-assisted pyrolysis (CMAP), and evaluated for carbon reuse pathways supporting ecosystem restoration and statewide knowledge dissemination....

Board Resolution or Letter

Title	File
PIIC Authorization Letter	f6e2b80f-581.pdf
Correspondence Form	931b5eea-ec0.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Do you understand that travel expenses are only approved if they follow the "Commissioner's Plan" promulgated by the Commissioner of Management of Budget or, for University of Minnesota projects, the University of Minnesota plan?

N/A

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

Yes

Do you understand and acknowledge IP and revenue-return and sharing requirements in 116P.10?

Yes

Do you wish to request reinvestment of any revenues into your project instead of returning revenue to the ENRTF?

No

Does your project include original, hypothesis-driven research?

Yes

Does the organization have a fiscal agent for this project?

No

Does your project include the pre-design, design, construction, or renovation of a building, trail, campground, or other fixed capital asset costing $10,000 or more or large-scale stream or wetland restoration?

No

Do you propose using an appropriation from the Environment and Natural Resources Trust Fund to conduct a project that provides children's services (as defined in Minnesota Statutes section 299C.61 Subd.7 as "the provision of care, treatment, education, training, instruction, or recreation to children")?

No

Provide the name(s) and organization(s) of additional individuals assisting in the completion of this proposal:

Rylee Hince, Prairie Island Indian Community

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

N/A