Environment and Natural Resources Trust Fund

2026 Request for Proposal

General Information

Proposal ID: 2026-124

Proposal Title: Protecting Minnesota's Waters from Plastic- and Rubber-Derived Chemicals

Project Manager Information

Name: William Arnold

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: Strategies to protect surface and groundwater from pollutants leached from polymers, coatings, plastics, and tire rubbers using stormwater treatment will be developed by assessing pollutant sources, presence, and reactivity.

ENRTF Funds Requested: $600,000

Proposed Project Completion: June 30, 2029

LCCMR Funding Category: Water (B)

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.

Polymers, coatings, plastics, and tire rubbers are critical components of our infrastructure, yet as these materials age and wear, the chemical additives they contain are released. These toxic chemicals present a risk to Minnesota's surface and groundwater systems. The composition of these materials is complicated. They contain chemicals used in producing the materials to achieve desired performance and to protect them from wear or weathering by sunlight. Over time, these chemical additives are introduced into stormwater runoff as exterior building materials age, tires wear on our roads, and litter is left uncollected. These chemical additives include diphenylguanidines, benzotriazoles, benzothiazoles, melamines, and phenyl-p-phenylenediamine (PPDs). These pollutants are similar to pesticides with known toxicity. Thus, we need to know 1) the levels of these chemicals present in stormwater runoff and different stormwater collection ponds that drain into Minnesota's lakes, rivers, and groundwater; 2) what types of materials are the major sources of these chemicals; 3) whether natural processes can degrade these chemicals; 4) whether stormwater pond sediments can accumulate these chemicals; and 5) how to use this information to optimize removal in existing or new stormwater infrastructure so we can minimize negative impacts on surface and groundwater.

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.

Because chemical additives are continually released into Minnesota's water resources from polymers, coatings, plastics, and rubbers, information about their presence and persistence in the environment is critical. We propose the collection of field samples to determine the levels of selected chemicals leached from polymers/coatings/plastic/rubber in stormwater runoff and stormwater ponds, from which we will assess the scope of pollutant levels and distribution in Minnesota's stormwaters. Laboratory experiments will be used to quantify degradation rates by natural chemical and biological processes that occur in stormwater ponds. We will also measure the levels of the pollutants in stormwater pond sediments to determine if the particles collected in runoff from roads and buildings are serving as a source to the overlying water in ponds or have the potential to leach into groundwater. We will also identify whether the polymer material particle debris in stormwater runoff/ponds are from roads, buildings, or other sources. The collected information will be used to develop a model to estimate the inputs and degradation of these pollutants so that we can provide recommendations on how to minimize impacts of these chemicals on Minnesota's surface water systems that receive or are recharged via stormwater.

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?

Understanding the loadings, sources, and fate of polymer/coating/plastic/rubber-derived chemicals to Minnesota's surface water and groundwater systems will allow 1) assessment of risks to aquatic species and impacts on waters used as drinking water sources; 2) evaluation of stormwater treatment infrastructure to remove these chemicals and protect downstream lakes, rivers, and groundwater; 3) assessment of whether stormwater ponds (and their sediments) are a reservoir of these harmful chemicals or if they are a place where degradation occurs; and 4) recommendations on improvements to stormwater infrastructure and management to minimize impacts of these chemicals on surface water and groundwater.

Activities and Milestones

Activity 1: Quantify polymer/coating/plastic/rubber-derived chemicals in stormwater, stormwater ponds, and identify potential sources of these pollutants into the environment.

Activity Budget: $276,000

Activity Description:
Various toxic chemicals are used as crosslinking agents, vulcanization accelerators, and anticorrosion and UV-light stabilizers in the production of plastics, rubbers, and coatings used in cars, roads, and buildings. Stormwater runoff is the major carrier of the chemicals entering the environment as these materials wear and degrade. While the oxidation product of the tire chemical 6-PPD, known as 6-PPDQ, has received attention due to its potential toxicity to fish, our preliminary results indicate that other compounds, specifically 1,3-diphenylguanidine (used in rubber manufacture), hexamethoxymethmelamine (a crosslinking agent), and 1H-benzotriazole (a corrosion inhibitor) are present at 50 to 500-fold greater concentrations in urban stormwater ponds than 6-PPDQ. Thus, this work will collect materials used in Minnesota (plastics in buildings, used tires, coatings) to assess potential sources of these chemicals. We will measure the concentrations of the chemicals in stormwater runoff from roads and building roofs and in stormwater pond waters and sediments. Additionally, we will identify the type and measure the amount of rubber/plastic particles present in stormwater pond sediments to determine if pond sediments are a source or sink of these chemicals, based on the amount of material present and its potential to leach these chemicals into stormwater ponds.

Activity Milestones:

Description	Approximate Completion Date
Finalize contaminant list and verify analytical method	October 31, 2026
Laboratory leaching experiments with rubber, coating, and plastic material used in Minnesota	June 30, 2027
Measure chemicals in collected runoff and stormwater pond water samples	December 31, 2027
Evaluate pond sediments as repositories of particles and sources of chemicals via leaching experiments	June 30, 2028
Manuscript publication	December 31, 2028

Activity 2: Evaluate degradation processes of rubber, coating, and plastic derived chemicals by chemical and biological processes in stormwater ponds

Activity Budget: $234,000

Activity Description:
Stormwater ponds are the location where the rubber, coating, and plastic derived chemicals are most likely to end up via transport by runoff. Thus, it is important to understand if and how these chemicals are degraded in ponds. This will help determine if ponds are useful in protecting downstream surface water bodies and groundwater from these chemicals, or if they are merely serving as repositories that hold and then transfer the pollutants to water resources with economic and environmental value. Because the surfaces of ponds are exposed to sunlight, the process of photolysis (reaction driven by light) is one possible degradation process that will be explored. We will also test if highly reactive radicals produced when light shines on water degrade the chemicals. The bacteria naturally present in the pond waters may also have the capability to degrade some of the target chemicals. We will also assess the capacity of pond sediments to degrade the pollutants, both in the presence and absence of oxygen.

Activity Milestones:

Description	Approximate Completion Date
Direct and indirect photolysis experiments	December 31, 2027

Aqueous biodegradation experiments	June 30, 2028
Sediment microcosms (aerobic and anaerobic)	December 31, 2028
Manuscript publication	June 30, 2029

Activity 3: Develop models for inputs and fate of chemicals and recommendations to protect surface and groundwater

Activity Budget: $90,000

Activity Description:
Using information on sources, loadings, and degradation rates of the target chemicals obtained from Activities 1 and 2, we will build a general mass balance model for stormwater ponds that accounts for different runoff volumes, pollutant loading, and pond design. The model will allow assessment of potential capture, degradation, and accumulation of the target compounds in the stormwater pond system. Using this information, we will propose modifications that would lead to increased capture or removal of the pollutants. Input from stakeholders and watershed managers will be sought to maximize the potential impact of the recommendations and extent of water resource protection.

Activity Milestones:

Description	Approximate Completion Date
Model loads to stormwater infrastructure	June 30, 2028
Kinetic/transport models in stormwater ponds	December 31, 2028
Recommendations and communication with stakeholders	March 31, 2029
Manuscript/report publication	June 30, 2029

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Boya Xiong	University of Minnesota, Civil, Environmental, and Geo-Engineering	Co-Investigator. Quantification of polymer/plastic/rubber particles present in stormwater, ponds, and sediment. Identification of particle sources. Experiments to determine materials that leach chemicals to stormwater. Graduate student supervision.	Yes
Poornima Natarajan	UMN Saint Anthony Falls Laboratory	Co-Investigator. Stormwater, stormwater pond water, and sediment collection. Development of models for inputs and fate of chemicals and recommendations to protect surface and groundwater. Supervision of undergraduate students/field crews.	Yes
Kristine Wammer	University of St. Thomas, Department of Chemistry	Co-Investigator. Chemical and biological degradation of stormwater chemicals in stormwater pond waters and sediments. Supervision of undergraduate students.	Yes

Long-Term Implementation and Funding

Describe how the results will be implemented and how any ongoing effort will be funded. If not already addressed as part of the project, how will findings, results, and products developed be implemented after project completion? If additional work is needed, how will this work be funded?

Results will be implemented via communication with watershed managers, MPCA scientists, polymer manufacturing industry contacts, and other stakeholders. We will connect with the stakeholders through the Minnesota Stormwater Seminar Series and other avenues. The collected data and model will be made available in the Data Repository of the University of Minnesota to maximize availability. If additional work is needed, other federal, state, and local funding will be pursued.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Removing CECs from Stormwater with Biofiltration	M.L. 2023, , Chp. 60, Art. 2, Sec. 2, Subd. 04j	$641,000

Project Manager and Organization Qualifications

Project Manager Name: William Arnold

Job Title: Distinguished McKnight University Professor

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

Dr. William Arnold is a Distinguished McKnight and the Joseph T. and Rose S. Ling Professor in the Department of Civil, Environmental, and Geo- Engineering at the University of Minnesota. He received his B.S. in Chemical Engineering from MIT in 1994 his M.S. in Chemical Engineering from Yale in 1995, and a Ph.D. in Environmental Engineering from The Johns Hopkins University in 1999. He has supervised 25 Ph.D. students and 24 M.S. students. He has been studying the fate of micropollutants, including pharmaceuticals, pesticides, and PFAS compounds in aquatic environments for twenty years. As part of these studies, he has evaluated the presence and removal of various CECs in Minnesota's waters, including past work supported by the ENRTF. His work has specifically focused on how sunlight in natural and engineered systems leads to transformation of pollutants. He has also evaluated how organic matter from wastewater or stormwater produces reactive species that can degrade contaminants when exposed to sunlight. Past ENTRF funded work has been impactful to Minnesota, particularly work on triclosan and quaternary ammonium compounds.

Organization: U of MN - College of Science and Engineering

Organization Description:
The University of Minnesota (UMN) is one of the largest, most comprehensive, and most prestigious public universities in the United States. The College of Science and Engineering at the University of Minnesota is ranked among the top engineering and science academic programs in the country. The college includes 12 academic departments offering a wide range of degree programs at the baccalaureate, master's, and doctoral levels. Researchers within the College of Science and Engineering are on the leading edge of finding ways to solve some of the world's greatest problems by developing new forms of environment-friendly energy, designing new medical devices, improving digital and electronic technologies, and developing a strong national infrastructure. The College of Science and Engineering also offers students a rigorous, world-class education tailored to their interests and goals. The Department of Civil, Environmental, and Geo- Engineering (CEGE) at UMN is known for its pioneering work in analytical, computational, and experimental methods. We practice research excellence grounded in rigorous fundamentals for wide-ranging applications. The laboratories in CEGE and centralized research facilities have all of the necessary space and equipment to perform the proposed work.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
William Arnold, Senior Investigator		Project Manager			27%	0.18		$61,011
Boya Xiong		co-Investigator			27%	0.18		$35,054
Poornima Natarajan, Research Associate		co-Investigaor			27%	0.24		$26,969
Graduate student 1		Field studies and modeling			44%	1.5		$176,054
Graduate student 2		conduct laboratory degradation experiments, characterize particles			44%	0.75		$88,027
Undergraduate 1		Assist with field sampling and sample processing			0%	0.75		$17,490
Undergraduate 2		Assist with field sampling and sample processing			0%	0.75		$17,490
							Sub Total	**$422,095**
Contracts and Services								
University of St Thomas	Subaward	co-investigator Kristine Wammer will supervise two undergraduates who will work on the degradation experiments (personnel $74910, fringe 6%, laboratory supplies $15,000)				1.92		$89,910
Agilent	Service Contract	service and maintain the mass spectrometry system required for analysis of the targeted chemical pollutants				0.3		$32,000
							Sub Total	**$121,910**
Equipment, Tools, and Supplies								
	Tools and Supplies	Chemicals, glassware, solvents, extraction materials, safety equipment, isotopically labelled standards, and general laboratory supplies.	The supplies are needed to process field samples, quantify chemicals and particles, conduct laboratory experiments, and laboratory analyses.					$40,000

							Sub Total	**$40,000**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Conference Registration Miles/ Meals/ Lodging	registration fees, mileage, and parking	present at MN based water conferences					$2,995
	Miles/ Meals/ Lodging	vehicle rental and or mileage. Estimate 10 trips per year.	travel to stormwater ponds for sample collection.					$3,000
							Sub Total	**$5,995**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
	Publication	publication fees	open access for journal publications					$10,000
							Sub Total	**$10,000**
Other Expenses								
							Sub Total	**-**
							Grand Total	**$600,000**

Classified Staff or Generally Ineligible Expenses

Category/Name	Subcategory or Type	Description	Justification Ineligible Expense or Classified Staff Request

Non ENRTF Funds

Category	Specific Source	Use	Status	Amount
State				
			State Sub Total	**-**
Non-State				
In-Kind	Indirect costs associated with University of Minnesota projects	facilities and administrative support	Secured	$261,000
			Non State Sub Total	**$261,000**
			Funds Total	**$261,000**

Total Project Cost: $861,000

This amount accurately reflects total project cost?

Yes

Attachments

Required Attachments

Visual Component

File: f16eedf9-16e.pdf

Alternate Text for Visual Component

Rainwater falls on buildings, roads, and tires leaching pollutants from the plastics, coatings, and rubbers. The water drains into a stormwater pond. In the pond, the pollutants are stored in the sediment and may be partially removed by sunlight and bacteria. Remaining pollutants are released to a river and groundwater....

Supplemental Attachments

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

Title	File
UMN Submission Approval	206a5307-bf4.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?

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:

Enoch Pan, Finance Professional, University of Minnesota

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