Environment and Natural Resources Trust Fund

2021 Request for Proposal

General Information

Proposal ID: 2021-361

Proposal Title: Microplastics: Transporters of Contaminants in Minnesota Waters

Project Manager Information

Name: Lee Penn

Organization: U of MN - College of Science and Engineering

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Project Basic Information

Project Summary: Microplastics are ubiquitous and may contain chemicals of concern (COCs). We propose to determine the effect that microplastics have on the fate and transport of COCs in Minnesota waters.

Funds Requested: $426,000

Proposed Project Completion: 2024-06-30

LCCMR Funding Category: Water Resources (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

Narrative

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

Plastic pollution is a growing environmental problem, and microplastics are tiny pieces of plastics that have broken off bigger plastic objects (e.g., clothing, bags, containers) or were added to products (e.g., microbeads). Microplastics pose a major threat to our environment. We propose to study how microplastics can serve as vehicles to transport contaminants of concern (COCs) within the environment.

Microplastics are problematic for three reasons. First, organisms, on land and in water, eat microplastics, and those microplastics can severely disrupt digestion, sometimes even resulting in death. Second, microplastics can absorb contaminants (i.e. plasticizers, pesticides, drug molecules). This makes microplastics potential vehicles for transporting contaminants within the environment and delivering contaminants to organisms that eat those microplastics. Third, microplastics may act as reservoirs for many contaminants of concern (COCs) in the environment, including pesticides and plasticizers. There are two important types of COCs to consider: molecules used in the fabrication of plastics (e.g., plasticizer) and molecules absorbed from the plastic product's surroundings (e.g., pesticides or herbicides). How much and which COCs are carried by microplastics in water has not been studied in the environment, and not at all in Minnesota.

What is your proposed solution to the problem or opportunity discussed above? i.e. What are you seeking funding to do? You will be asked to expand on this in Activities and Milestones.

Here, we propose to examine how microplastics change the fate and transport of COCs in Minnesota waters. We propose to do this by:

- Determining how much and which COCs are taken up by several types of common microplastics
- Determining how microplastics continue to break down and how they settle out from water
- Modeling the fate and transport of COCs, in order to learn how things change with microplastics present
- Collecting and characterizing microplastics collected from Minnesota waters to ground-truth what we learn from the above three activities.

Major Results Expected:

1. Determination of how much and which COCs are taken up by common microplastics.
2. Improved understanding of how microplastics change the fate and transport of COCs in Minnesota Waters, which will lead to better predictions about environmental impact.

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?

The results from this project will enable the State of Minnesota to better predict the impact of environmental contamination with chemicals and microplastics and develop better approaches to prevention and remediation. In addition, the team will give open scientific presentations and publish scientific papers addressing the above objectives.

Activities and Milestones

Activity 1: Lab Studies to Determine Fate and Transport of COCs by Microplastics

Activity Budget: $307,000

Activity Description:
We will combine select COCs and common types of microplastics in batch experiments. Target COCs include plasticizers (e.g., per- and polyfluoroalkyl substances (PFAS), polychlorinated biphenyls (PCBs)) and current-use organochlorine pesticides. Target microplastics include fibers of polyester, Rayon, Nylon, polyurethane, and polyethylene terephthalate (fleece). Fibers will be introduced to glass containers of aqueous solutions with known amounts of COCs, allowed to equilibrate for 24 hours on a wrist-action shaker, filtered, and analyzed for COCs in the water and microplastic. How much COC is taken up by each plastic will be calculated.
Many COCs are "removed" from water through settling and burial in sediments. Settling of naturally occurring particles is already well understood. However, microplastics have different shapes, densities, and surface chemistry, which affect how quickly particles settle and are burried. We will use glass columns to measure settling rates of microplastics in waters. Because particles scatter light, small lasers will enable detection of particles at specified heights along the column. We will perform these experiments with "virgin" microplastic particles and microplastic particles after exposure to COCs in purified water and lake water samples.
Results will be used in models designed to predict fate and transport of COCs associated with

Activity Milestones:

Description	Completion Date
Determine partitioning of COCs with each type of microplastic	2022-06-30
Settling Velocities of microplastics	2022-06-30
Fate and Transport Model	2023-06-30

Activity 2: Ground-truthing with Environmental Samples

Activity Budget: $119,000

Activity Description:
Twenty Minnesota waters (rivers and lakes) will be sampled and filtered for both microplastics and natural particles. Both the filters and filtrates will be analyzed for COCs and microplastics. Initial determination of the amount of microplastics in a field sample will use light microscopy after dying with Nile Red or another dye that does not dye the naturally occurring particles (e.g., small sediment particles or organisms) but only dyes the plastics. Settling experiments, as described above, will be performed using the plastics collected from the environment. The microplastic particles will be further characterized in order to identify the polymer (e.g., polyurethane, polyethylene terephthalate, etc…) and identify whether biofilms are present. Results from the settling experiment will enable characterization of the potential impact of biofilms on settling velocities. Results from the field samples will be compared to the laboratory results and predictions produced from activity one.

Both activities have been updated to reflect feedback received during the peer review of our 2019 submission, which was recommended for funding.

Activity Milestones:

Description	Completion Date
Validation of models	2024-06-30

Environmental sampling and characterization	2024-06-30
Settling velocities of microplastics	2024-06-30

Project Partners and Collaborators

Name	Organization	Role	Receiving Funds
Matt Simcik	University of Minnesota - Twin Cities School of Public Health	Dr. Simcik is in the Division of Environmental Health Sciences in the School of Public Health. Dr. Simcik is an expert in the fate and transport of organic contaminants in the environment. Dr. Simcik will serve as primary supervisor to the lab manager and the graduate assistant.	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 be funded?

Results from this project will enable the State of Minnesota to better predict the impact of environmental contamination with chemicals and microplastics and develop better approaches to prevention and remediation. The results of this project will enable managers of Minnesota's water resources and legislators to better address the issue of environmental contamination.

Other ENRTF Appropriations Awarded in the Last Six Years

Name	Appropriation	Amount Awarded
Solar Cell Materials from Sulfur and Common Metals	M.L. 2014, Chp. 226, Sec. 2, Subd. 08a	$494,000

Project Manager and Organization Qualifications

Project Manager Name: Lee Penn

Job Title: Professor

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

Dr. Lee Penn will lead the project and work closely with Dr. Matt Simcik in coordinating experiments and field sampling geared towards improving understanding of the effect that microplastics have on the fate and transport of contaminants of concern in Minnesota waters. They will co-advise two graduate students. The post-doctoral research will serve as a mentor towards the graduate student.

Dr. R. Lee Penn will be the primary project manager. Dr. Penn is a Full Professor in the Chemistry Department at the University of Minnesota and an expert in particles in the environment. Dr. Penn is also on the graduate faculty of the Water Resource Sciences Program and in the Department of Earth Sciences. Dr. Penn will be responsible for project and data management and will serve as primary supervisor two one of the Graduate Assistants.

Dr. Matt F. Simcik will be the secondary Project Manager. Dr. Simcik is an Associate Professor in the Division of Environmental Health Sciences in the School of Public Health at the University of Minnesota. Dr. Simcik is also on the graduate faculty of the Civil, Environmental and Geoengineering Department and the Water Resource Sciences Program. Dr. Simcik is an expert in the fate and transport of organic contaminants in the environment. Dr. Simcik will serve as primary supervisor to the lab manager and the second Graduate Assistant.

Organization: U of MN - College of Science and Engineering

Organization Description:
The University of Minnesota College of Science and Engineering brings together the University's programs in engineering, physical sciences, mathematics and computer science into one college. Because of this unique structure, the college is uniquely positioned to provide the vision, leadership, and intellectual capital that underwrite interdisciplinary progress in the 21st Century. The college is ranked among the top 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 and products, new medical devices, digital and electronic technologies, and a strong national infrastructure. The college has collaborations with the University of Minnesota’s world-renowned medical school, locally-based companies such as 3M and Medtronic, as well as universities around the globe.
Partnerships with the private sector nurture the work of College of Science and Engineering faculty and students. Input from leading companies helps shape the college's curriculum, ensuring that students' skills match industry needs. In return, the college offers a wealth of resources to help businesses succeed.

Budget Summary

Category / Name	Subcategory or Type	Description	Purpose	Gen. Ineligible	% Benefits	# FTE	Classified Staff?	$ Amount
Personnel								
Lab Manager		Manage PI lab operations			25.4%	0.24		$17,736
Principal Investigator		Supervise graduate student; perform electron microscopy on samples; co-lead sample collection in the field; evaluate data and design experiments.			36.5%	0.27		$62,228
Co-Principal Investigator		Supervise graduate student;lead sample collection in the field; evaluate data and design experiments.			36.5%	0.27		$45,673
Graduate Research Assistant (Beginner)		Design and execute experiments and sample collection; characterize standard and field samples of polymer fibers.			44.54%	1.5		$150,771
Graduate Research Assistant (Advanced)		Co-advised and working in close collaboration with members of each PI's research group; Design and execute experiments and sample collection; quantify absorption of contaminants in standard and field samples of polymers.			22.77%	1.5		$108,261
							Sub Total	**$384,669**
Contracts and Services								
							Sub Total	**-**
Equipment, Tools, and Supplies								
	Tools and Supplies	Model contaminant compounds	Model contaminant compounds					$4,000
	Tools and Supplies	long glass column, six small lasers for light scattering measurements	Supplies for settling experiments					$3,331
	Tools and Supplies	Supplies for Materials Characterization	microscopy and spectroscopy for polymer characterization before and after use in batch experiments and for characterization of samples collected from the field; microscopy slides and stubs, conductive glue and paste, standards					$2,000

	Tools and Supplies	Chemical Supplies	salts, water purification cartridges, glass containers					$10,000
	Tools and Supplies	Filters	Filters for removal of microplastics from experimental and natural waters					$12,000
							Sub Total	**$31,331**
Capital Expenditures								
							Sub Total	**-**
Acquisitions and Stewardship								
							Sub Total	**-**
Travel In Minnesota								
	Miles/ Meals/ Lodging	Travel to/from field site	Travel to/from field sites for sample collection; travel to/from University of Minnestoa - Duluth for collaborative meetings, sample collection, and experiments					$1,000
							Sub Total	**$1,000**
Travel Outside Minnesota								
							Sub Total	**-**
Printing and Publication								
							Sub Total	**-**
Other Expenses								
		Technical Services	User fees for instrumentation (microscopy and spectroscopy for polymer characterization) at the University of Minnestoa - College of Science and Engineering's Characterization Facility ($3k/yr)					$9,000

							Sub Total	**$9,000**
							Grand Total	**$426,000**

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	University of Minnesota	In-kind Overhead for administrative and operational expenses that will support the research described within this application.	Potential	$202,106
In-Kind	University of Minnesota	The investigators will also devote 1% time per year in-kind ($9,089 3 year total).	Potential	$19,231
			Non State Sub Total	**$221,337**
			Funds Total	**$221,337**

Attachments

Required Attachments

Visual Component

File: 3af18d68-174.pdf

Alternate Text for Visual Component

Microplastics are ubiquitous and may contain chemicals of concern (COCs). Microplastics pose a major threat to our environment. The schematic shown here highlights some of the places we find microplastics contamination (water, lake sediment, plant materials, fish, animals, and more). We propose to study how microplastics can serve as vehicles to transport contaminants of concern (COCs) within the environment.

Optional Attachments

Support Letter or Other

Title	File
UMN Letter of Intent from Sponsored Projects	407810a9-bc3.pdf

Administrative Use

Does your project include restoration or acquisition of land rights?

No

Does your project have patent, royalties, or revenue potential?

No

Does your project include research?

Yes

Does the organization have a fiscal agent for this project?

No

Microplastics: Transporters of Contaminants in Minnesota Waters

Project Managers:

R. Lee Penn
Chemistry - UMN

Matt Simcik
School of Public Health
UMN

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