Environment and Natural Resources Trust Fund
2020 Request for Proposals (RFP)

Project Title: **ENRTF ID: 087-B**

Microplastics: Transporters of Contaminants in Minnesota Waters

Category: B. Water Resources

Sub-Category:

Total Project Budget: $ 448,630

Proposed Project Time Period for the Funding Requested: June 30, 2023 (3 yrs)

Summary:

Microplastics are ubiquitous environmental contaminants, can transport contaminants of concern (COCs), and pose a major environmental threat. We will determine how microplastics affect contaminant fate and transport in Minnesota waters.

Name: Lee Penn

Sponsoring Organization: U of MN

Job Title: Professor

Department: Chemistry

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Web Address:

Location:

Region: Statewide

County Name: Statewide

City / Township:

Alternate Text for Visual:

Microplastics are everywhere in the environment, including in sediment, water, wildlife, and other biota. Microplastics can help contaminants move in the environment and get into organisms, including people.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

PROJECT TITLE: Microplastics as Transporters of Contaminants of Concern in Minnesota Waters

I. PROJECT STATEMENT

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.

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.

Deliverables: The team will give open scientific presentations and publish scientific papers addressing the above objectives. In addition, 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.

II. PROJECT ACTIVITIES AND OUTCOMES

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

Description: We will perform batch experiments combining select COCs and common types of microplastics. We will measure how much of the COCs partitions (i.e., is absorbed) into the microplastic particles. Target COCs will include plasticizers used to make plastics (e.g., per- and polyfluoroalkyl substances (PFAS), polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs)) and current-use organochlorine pesticides. Target microplastics will 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 finally analyzed for COCs in both the water and microplastic particles. Partition coefficients, which are a quantitative description of how much of each COC is taken up by a particular plastic, will be calculated.

Many COCs are "removed" from water through settling and subsequent burial in sediments. The settling behavior of naturally occurring particles is already well known. However, microplastics have different shapes, densities, and surface chemistry. These properties affect how quickly a particle settles and is buried in the sediments of an aquatic system (e.g., lake or river). Therefore, we investigate the settling properties of

microplastics in natural waters. We will perform column experiments. A glass column will be filled with a suspension of microplastic particles in water. Because particles scatter light, we will use small lasers to detect particles at specified heights along the column. This procedure will enable us to measure the settling rate of the particles. We will perform these experiments with "virgin" microplastic particles and microplastic particles after exposure to COCs.

These results will be used in a model designed to predict the fate and transport of COCs associated with microplastics.

ENRTF BUDGET: $324,315

Outcome	Completion Date
1. Determine partitioning of COCs with each type of microplastic	*June 2021*
2. Settling velocities of microplastics	*June 2021*
3. Fate and Transport Model	*June 2022*

Activity 2: Ground-truthing with Environmental Samples

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, which does not dye the naturally occurring particles (e.g., small sediment particles or organisms) and only dyes the plastics red. The microplastic particles will be further characterized in order to identify the polymer (e.g., polyurethane, polyethylene terephthalate, etc…). Results from the field samples will be compared to the predictions resulting from activity one.

ENRTF BUDGET: $ 124,315

Outcome	Completion Date
1. Environmental sampling and characterization	*June 2023*
2. Model validation	*June 2023*

III. PROJECT PARTNERS AND COLLABORATORS:

Prof. Melissa Mauer Jones from the University of Minnesota – Duluth (UMD) is studying how microplastic particles form from larger pieces of plastic. We will partner with her research group in using microplastic particles generated in her experiments as standards and test samples in our batch and column experiments described in activity 1.

Prof. Penn and Simick have been collaborating since 2005.

IV. LONG-TERM IMPLEMENTATION AND FUNDING:

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.

V. SEE ADDITIONAL PROPOSAL COMPONENTS:

A. Proposal Budget Spreadsheet
B. Visual Component or Map
C. Parcel List Spreadsheet
D. Acquisition, Easements, and Restoration Requirements
E. Research Addendum (Not required at proposal submission stage. Required later in process, if proposal is recommended. Staff will provide further information at that time)
F. Project Manager Qualifications and Organization Description
G. Letter or Resolution
H. Financial Capacity

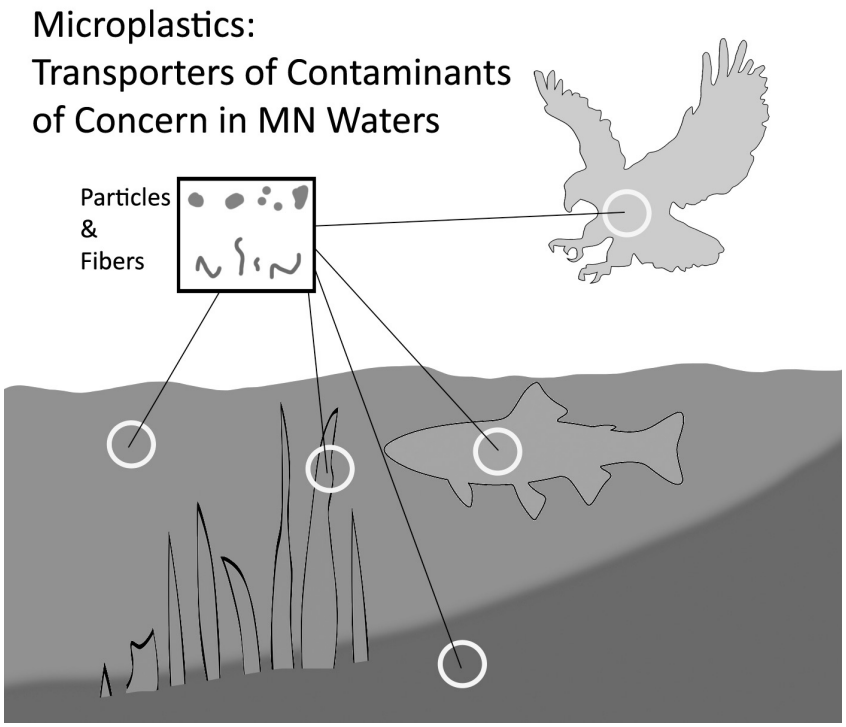
Attachment A: Project Budget Spreadsheet
Environment and Natural Resources Trust Fund
M.L. 2020 Budget Spreadsheet
Legal Citation:
Project Manager: R. Lee Penn
Project Title: Microplastics: Transporters of Contaminants in Minnesota Waters
Organization: University of Minnesota
Project Budget: 448,630
Project Length and Completion Date: 3 years; complete June 2023
Today's Date: 3/15/19

ENVIRONMENT AND NATURAL RESOURCES TRUST FUND BUDGET	Budget	Amount Spent	Balance
BUDGET ITEM			
Personnel (Wages and Benefits)	$ 388,630	$ -	$ 388,630
R. Lee Penn (PI): $48,537 (10% effort all three years). Fringe is 34.2% of salary. Supervise graduate student; perform electron microscopy on samples; co-lead sample collection in the field; evaluate data and design experiments.			
Matt F. Simcik (Co-PI): $49,241 (10% effort all three years). Fringe is 34.2% of salary. Supervise graduate student;lead sample collection in the field; evaluate data and design experiments.			
Lab Manager: $13,796 (8% effort all three years) Fringe is 28.4% of salary			
Grad RA 1: $139,272 (50% effort all three years, fringe is 17.7% of salary plus tuition at $15,522/year). Co-advised and working in close collaboration with members of each PI's research group; Design and execute experiments and sample collection; characterize standard and field			
Grad RA 1: $137,784 (50% effort all three years, fringe is 17.7% of salary plus tuition at $15,522/year). 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.			
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	$ -	$ 9,000
Equipment/Tools/Supplies			
Model contaminant compounds	$ 4,000		
General chemical supplies (salts, water purification cartridges, glass containers)	$ 10,000		
Filters for removal of microplastics from experimental and natural waters	$ 12,000		
Two wrist action shakers	$ 8,000		
Supplies for settling experiments (long glass column, six small lasers for light scattering measurements)	$ 4,000		
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)	$ 2,000	$ -	$ 2,000
Travel expenses in Minnesota			
Travel to/from field sites for sample collection; travel to/from University of Minnestoa - Duluth for collaborative meetings, sample collection, and experiments	$ 1,000	$ -	$ 1,000
COLUMN TOTAL	$ 438,630	$ -	$ 400,630

SOURCE AND USE OF OTHER FUNDS CONTRIBUTED TO THE PROJECT	Status (secured or pending)	Budget	Spent	Balance
Non-State:		$ -	$ -	$ -
State:		$ -	$ -	$ -
In kind:	secured	$ 191,969	$ -	$ 191,969
The investigators will also devote 1% time per year in kind ($1,507).				
Because the project is overhead free, laboratory space, electricty, and other facilities/adminstrative costs (54% of direct costs excluding permanent equipment and graduate student academic year fringe benefits) are provided in-kind				

Other ENRTF APPROPRIATIONS AWARDED IN THE LAST SIX YEARS	Amount legally obligated but not yet spent	Budget	Spent	Balance
Protecting bacteria from contaminants to preserve water quality		$ 279,000	$ 279,000	$ -
Solar Cell Materials from Sulfur and Common Metals (M.L. 2014)		$ 494,000	$ 494,000	
Protecting Minnesota Waters by Removing Contaminants from Wastewater		$ 250,000	$ -	$ 250,000

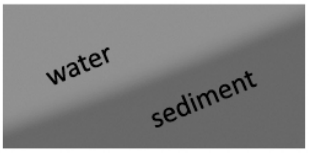
B. Visual Component or Map



Microplastics are everywhere in the environment, including in sediment, water, wildlife, and other biota.

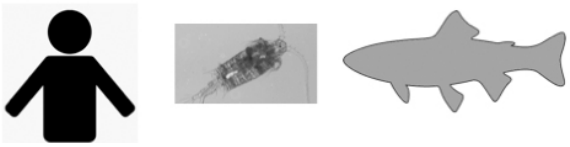
WITHOUT MICROPLASTICS

Contaminants take slow boat to sediments



WITH MICROPLASTICS

Contaminants take fast train to organisms



PROJECT TITLE: Microplastics: Transporters of Contaminants in Minnesota Waters

Project Management: 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.

Project Manager Qualifications:
Dr. R. Lee Penn will be the 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 Co-PI. 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.

Sponsoring Organization:
Regents of the University of Minnesota
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