Environment and Natural Resources Trust Fund

M.L. 2020 Approved Work Plan

General Information

ID Number: 2020-040

Staff Lead: Michael Varien

Date this document submitted to LCCMR: August 13, 2021

Project Title: Microplastics: Transporters Of Contaminants In Minnesota Waters

Project Budget: $425,000

Project Manager Information

Name: Lee Penn

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Project Reporting

Date Work Plan Approved by LCCMR: August 13, 2021

Reporting Schedule: April 1 / October 1 of each year.

Project Completion: June 30, 2024

Final Report Due Date: August 14, 2024

Legal Information

Legal Citation: M.L. 2021, First Special Session, Chp. 6, Art. 5, Sec. 2, Subd. 04c

Appropriation Language: $425,000 the second year is from the trust fund to the Board of Regents of the University of Minnesota to study how several types of common microplastics transport contaminants of concern in Minnesota waters.

Appropriation End Date: June 30, 2024

Narrative

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.

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

Plastic pollution is a growing environmental problem. 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.

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

Activities and Milestones

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

Activity Budget: $306,000

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 microplastics.

Activity Milestones:

Description	Completion Date
Determine Partitioning of COCs with Each Type of Microplastic	June 30, 2022
Measure Settling Velocities of Microplastics	June 30, 2022
Fate and Transport Model: Use Experimental Results to Develop a Predictive Model	June 30, 2023

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 activity one and two have been updated to reflect feedback received during the peer review of our submission, after it was recommended for funding.

Activity Milestones:

Description	Completion Date
Environmental Sampling from Twenty MN Locations (Rivers and Lakes)	November 30, 2022
Characterize Samples Collected from the Field	March 31, 2024

Measure Settling Velocities of Microplastics Collected from the Field	March 31, 2024
Validation of Models Using Experimental and Field Results	May 31, 2024
Prepare Final Report and Disseminate Data and Results	June 30, 2024

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

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.
The team will give open scientific presentations at both local and national meetings and publish scientific papers addressing the above objectives. We will also prepare a webpage to convey results to the public.

The Minnesota Environment and Natural Resources Trust Fund (ENRTF) will be acknowledged through use of the trust fund logo or attribution language on project print and electronic media, publications, signage, and other communications per the ENRTF Acknowledgement Guidelines.

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

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								
University of Minnesota - Twin Cities College of Science and Engineering Characterization Facility	Internal services or fees (uncommon)	Internal 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). Personnel supported by this award will perform the characterization.				0.03		$9,000
							Sub Total	**$9,000**
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					$9,000
	Tools and Supplies	Filters	Filters for removal of microplastics from experimental and natural waters					$12,000
							Sub Total	**$30,331**
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								
							Sub Total	**-**
							Grand Total	**$425,000**

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	The investigators will also devote 1% time per year in-kind ($9,089 3 year total).	Potential	$19,231
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
			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
Tab 7 background check form	f65adf65-0ef.pdf

Difference between Proposal and Work Plan

Describe changes from Proposal to Work Plan Stage

We added milestones as requested. We updated dates for milestone completion. We modified the budget so that it matches with the amount recommended.

We moved 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) to professional, tech, service, contracts.

Additional Acknowledgements and Conditions:

The following are acknowledgements and conditions beyond those already included in the above workplan:

Do you understand and acknowledge the ENRTF repayment requirements if the use of capital equipment changes?

N/A

Do you agree travel expenses must 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 agree to the UMN Policy.

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

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

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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