**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**

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| **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**