**PROJECT TITLE: Microplastics: Occurrence, Toxins, and Detection with Drones**

**I. PROJECT STATEMENT**

Microplastic pollution of water resources is a worldwide problem, and Minnesota is no exception. Humans and wildlife consume microplastics via water and food, but the distribution of microplastics and their health effects on people and ecosystems have yet to be determined in Minnesota. Cost effective techniques to quantify the occurrence, transport, and fate of microplastics, including the chemical pollutants they carry, in Minnesota waters are urgently needed*.*

Ingestion of microplastics by humans results in uptake and bioaccumulation of harmful chemicals, including known carcinogens (e.g., polychlorinated biphenyls [PCBs] and polycyclic aromatic hydrocarbons [PAHs]) as well as emerging contaminants such as pesticides, pharmaceuticals, and endocrine disrupting compounds. In addition, ingested microplastics cause digestive and reproductive problems, as well as death in fish, birds, and other animals. Microplastics may even harbor pathogenic bacteria. Recent research by the US Geological Survey and U of MN indicates that high concentrations of microplastics are potentially present in Minnesota waters. Little is known, however, about the amount and types of microplastic released, the spatial distribution of microplastics, and the type and concentration of chemicals associated with microplastics in Minnesota waters. This study will quantify the occurrence and concentration of microplastics and provide new insights into the pathways by which toxic chemicals are carried by microplastics into Minnesota’s aquatic environments and drinking water systems. This project will also lead to technology development for cost effective *drone-based sensing of microplastics****.*** The objectives of the project are to:

* Quantify microplastics in Minnesota’s natural and engineered waters,
* Develop a relationship between watershed characteristics and microplastic type/abundance,
* Identify toxic chemicals absorbed and transported by microplastics,
* Develop and validate a drone-based remote sensing technique for quantifying microplastics in lakes and rivers, and
* Disseminate the findings to stakeholders, legislators, and the public for strategic planning and awareness.

There is no comprehensive assessment of the occurrence of microplastics or the pollutants associated with them in Minnesota waters. A technique to rapidly and broadly detect microplastics is critically needed. *The results of this work will allow identification of the sources of microplastics and inform potential mitigation strategies to limit environmental and human health effects of related contamination in Minnesota.*

**II. PROJECT ACTIVITIES AND OUTCOMES**

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| **Activity 1:****Frequencies, types, concentrations and toxicity of microplastics in natural and engineered waters** |  **ENRTF Budget:**  **$152,000** |

Samples from streams, rivers and lakes (60), storm water (20), and treated wastewater effluents (20) will be collected throughout Minnesota to provide a baseline survey of the occurrence, types and concentration of microplastics. Half of the samples will be analyzed to study the adhered chemicals. The sampling will be conducted during low and high runoff conditions over the first year to quantify seasonal changes in concentration of microplastics. Water samples will be analyzed to determine the type of microplastics as fragments, pellets/beads, lines/fibers or foams for all samples. For the streams, rivers and lakes, data on watershed attributes (land cover, population density, agricultural developments, wastewater effluent, storm water input locations) will be compiled and used to establish the relationship between the occurrence and type of microplastics and watershed attributes. This will allow identification and prediction of the areas most vulnerable to microplastic pollution.

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| **Outcome** | **Completion Date** |
| 1. *Water samples collected, analyzed for microplastic types and abundance* | 2/31/2020 |
| *2. Data analyzed and statistical relationships established* *based on watershed variables* | 6/31/2020 |
| *3. Dissemination findings of Activity 1 via at least 2 open access journal publications*  | 1/30/2021 |

**Activity 2: Assess the contaminants absorbed and transported by microplastics****ENRTF Budget:**

 **$156,500**

The source and type of microplastic will affect the contaminants it carries. For example, PAHs and pesticides are likely to be associated with microplastics from urban runoff, whereas those in wastewater may carry various emerging contaminants, including endocrine disruptors. Different plastic materials (e.g., plastic strips in a metal cage) will be deployed in wastewater effluents and streams to assess how plastic material affects contaminant uptake. Specific indicator chemicals (high volume use pesticides, pharmaceuticals) or target chemicals of specific concern (PCBs, PAHs) will be quantified. These chemicals will also be quantified in the microplastics collected in Activity 1. In the laboratory, release rates from pre-loaded microplastics will be used to assess the potential for long range facilitated transport of contaminants by microplastics.

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| **Outcome** | **Completion Date** |
| 1. *Verification of methods for extracting contaminants from microplastics*  | 06/30/21 |
| *2. Deployment of plastics in wastewater, urban and rural streams* | 09/30/22 |
| *3. Quantification of contaminants in deployed and collected microplastics* | 03/30/23 |
| *4. Assessment of contaminant release from microplastics* | 03/30/23 |
| *5. Dissemination of Activity 2 findings via at least 2 open access journal publications* | 6/30/2023 |

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|  **Activity 3: Develop drone-based remote sensing tools to detect microplastics in surface**  **waters** | **ENRTF Budget:**  **$141,500** |

Timely detection and monitoring the movement of microplastics in surface waters requires a cost-effective monitoring technology. We propose a drone-based remote sensing technology. Microplastics of various materials will be introduced into the outdoor reactors and experimental stream facilities as the Saint Anthony Falls Laboratory (SAFL) to develop a drone sensing technique. To that end, a new hyperspectral spectroradiometer needs to be purchased and installed over the bioreactors and the outdoor stream facilities to determine key wavelengths that can be used by commercial lightweight cameras (e.g. MicaSens Altum, available with SAFL drone) to quantify microplastic type and abundance in the field.

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| **Outcome** | **Completion Date** |
| 1. *Collect samples of spectral properties of water with different concentration of microplastic* | 06/01/22 |
| *2. Data analysis to inference spectral bandwidth for sensing of microplastics using drones* | 01/01/22 |
| *3. Conduct field scale validation of the tool using the existing SAFL drone (LCCMR funded)* | 06/01/23 |
| *4. Dissemination of Activity 3 findings via at least 2 open access journal publications*  | 06/01/23 |

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**III. PROJECT PARTNERS:**

1. **Partners receiving ENRTF funding**

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| **Name** | **Title** | **Affiliation** | **Role** |
| William Arnold | Professor | U of MN, CEGE | Co-investigator |
| Miki Hondzo | Professor | U of MN, CEGE | Co-investigator |

**IV. LONG-TERM- IMPLEMENTATION AND FUNDING:** This project will provide a baseline assessment of the occurrence and toxicity of microplastics in Minnesota waters impacted by humans, establish relationship between the microplastic levels and watershed natural and urban attributes and lead to cost effective technologies for drone-based monitoring of microplastics. This work will provide methods to the state agencies, if needed, for establishing guidelines to control and reduce microplastics at the sources, advance our storm water management systems and treatment plants to protect public from this emerging treat.

**V. TIME LINE REQUIREMENTS:** The project will be completed in a three-year period. The sample collection and method development for analyzing occurrence of microplastics, extracting the adhered toxic substances and understanding the electromagnetic properties of microplastics in water all require attention to detail and replication.