Removal of Microplastics from Domestic Wastewater

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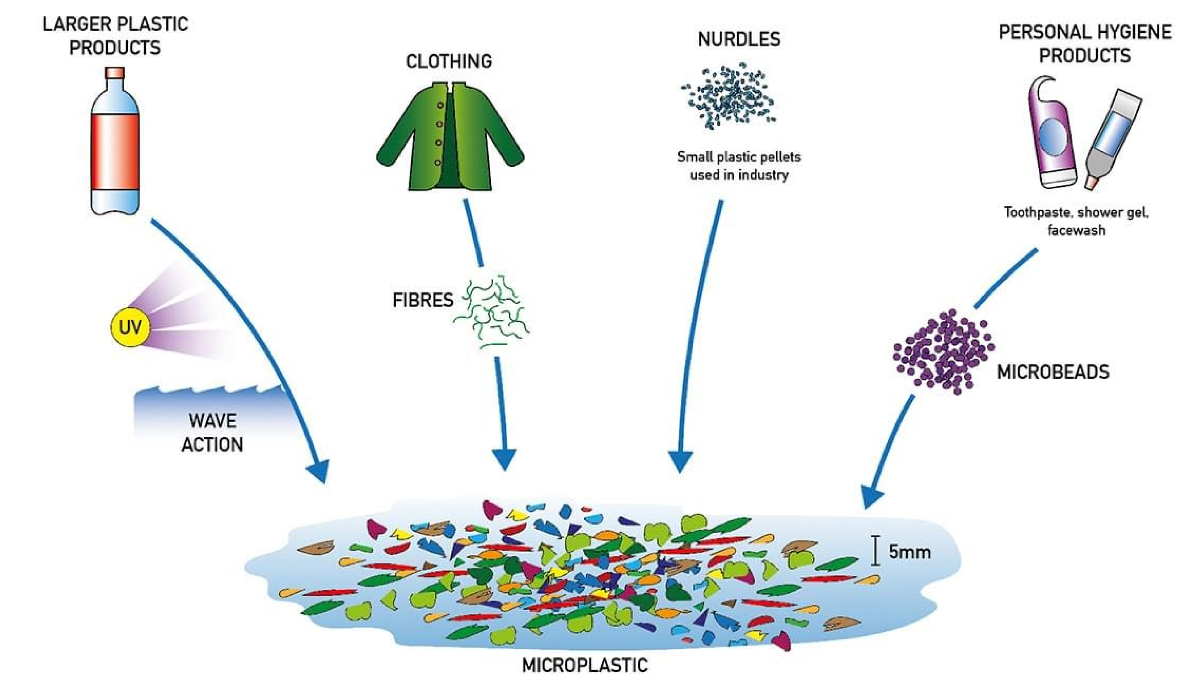
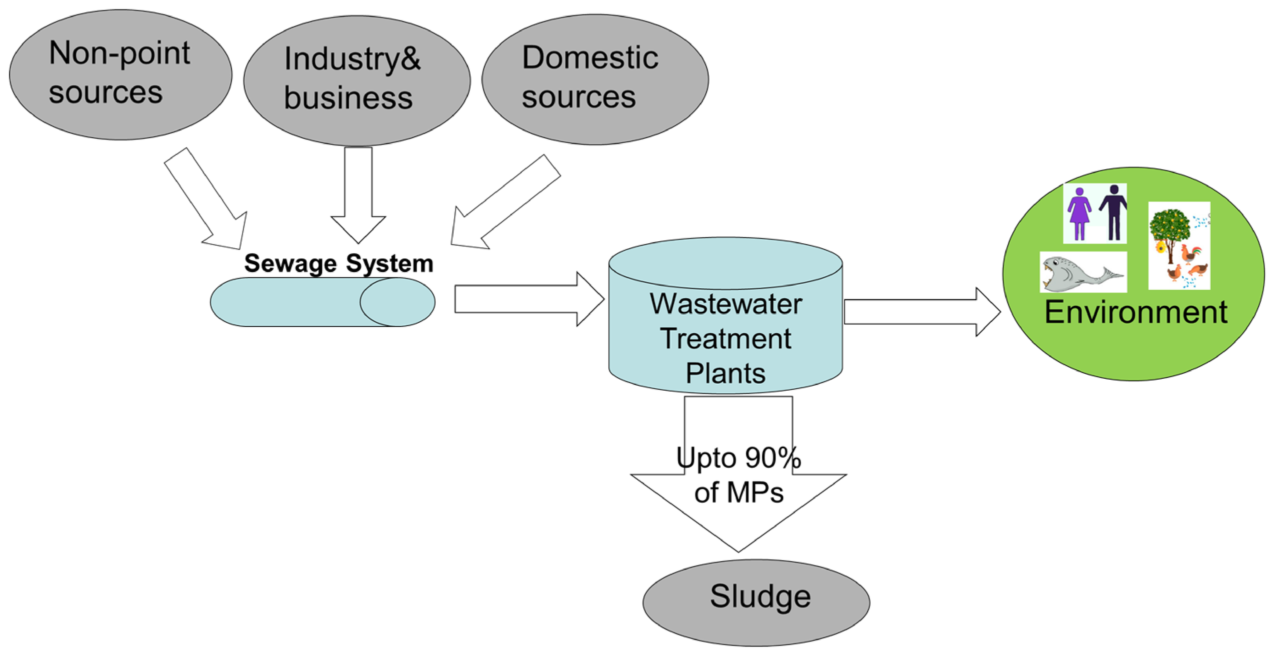
Background and motivation



- Global plastic production has been increasing;
- Microplastics (MPs) are widespread, either manufactured in small size or are degraded from macroplastics
- An emerging environmental and public health concern (picture adapted from Plastics Europe 2021)



- Wastewater Treatment Plants (WWTPs) receive wastes, including microplastics, from point and non-point sources
- Although not designed to treat MPs, WWTP can eliminate most of the MPs
- There are still numerous microplastic particles being released into the environment via wastewater effluent
- Current sampling and testing methods take days to complete one sample, with potential sample contaminations, microplastics loss, and inaccuracies.

Goals and Objectives

Research goals

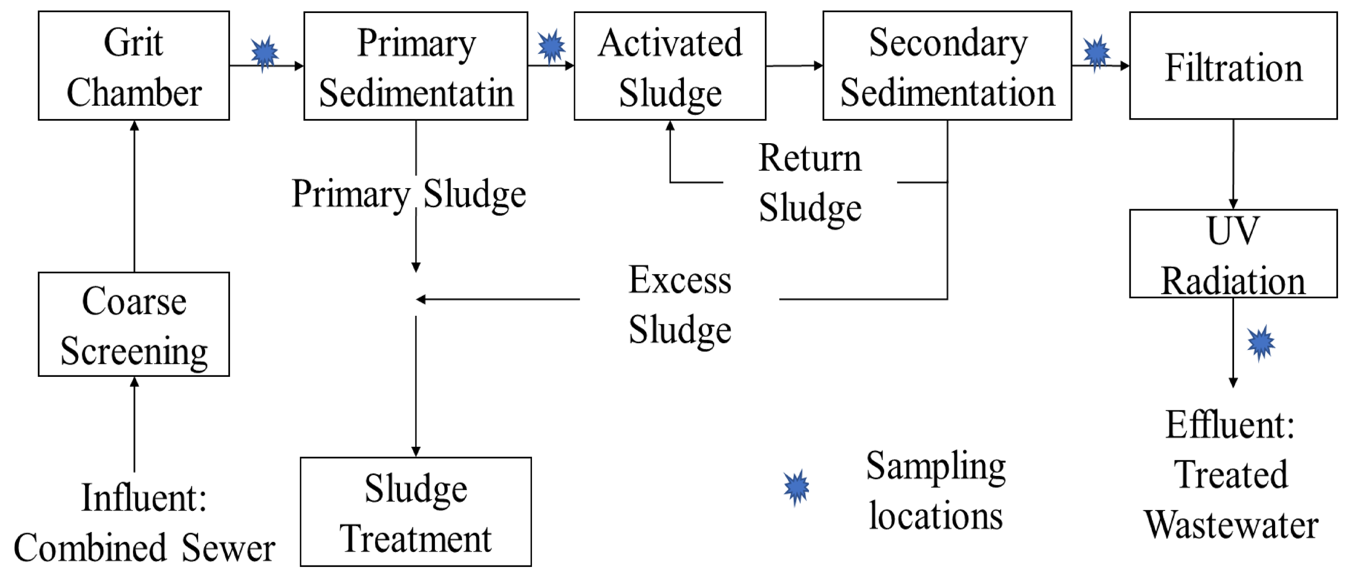
- To better understand the presence and removal of microplastics in wastewater by improving current sampling and testing procedures

Specific objectives at Phase I

- Improving and streamlining current microplastics sampling and testing procedures in wastewater
- identifying the quantities and types of microplastics present in the Muncie WWTP at each major treatment stage

Research Design & Methods

Sampling



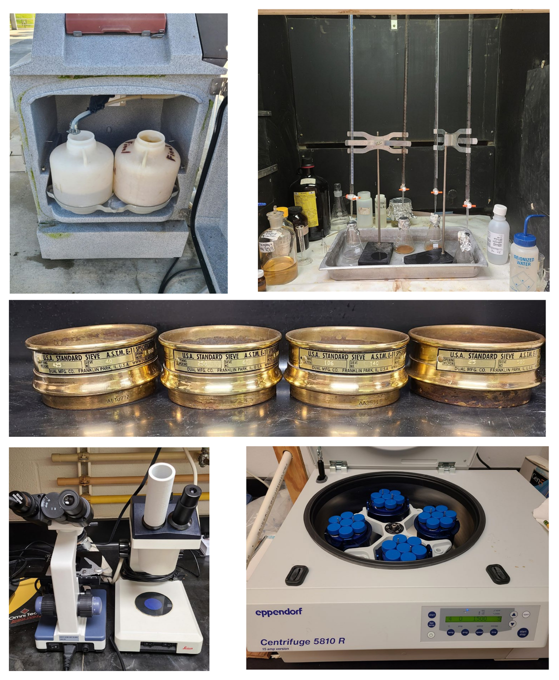
- Grab samples taken from Feb to May 2022 from the Muncie WWTP (domestic wastewater)
- Treatment processes and MPs sampling sites are illustrated in the picture

Sample Collection

Filtration & Digestion

Density Separation & Coloration

Optical Identification



Organic matter (OM) removal efficiency tests

- Presence of OM interferes with visual detection of MPs
- Fenton reagent has been commonly used to digest OM for better MP visualization
- Optimal dosage of Fenton reagent unclear
- Peat moss was used as an example of rich-OM material to test OM removal efficiency
- Two levels of peat moss was digested for 30 min, each using the reagent ratio shown in the table below

Treatment #	H_2O_2 (ml)	Fe_2^+ solution (ml)
No Treatment	---	---
Treatment 1	70	10
Treatment 2	70	5
Treatment 3	35	10
Treatment 4	35	5

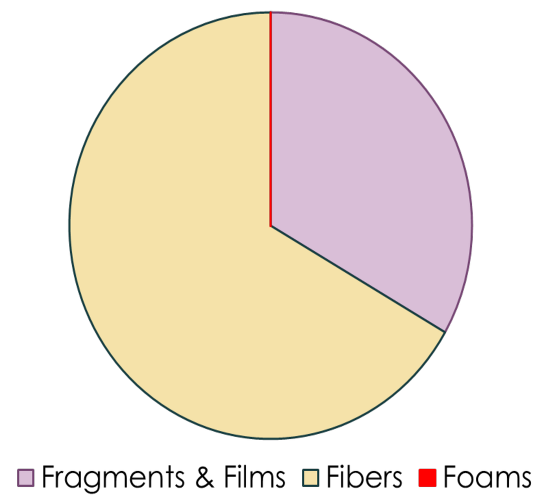
- OM content left after digestion was determined using Loss on Ignition (LOI) method
  - Dry samples at 150°C for 2 hours, weigh
  - Raise temperature to 550°C for 2 hours, weigh again
  - Calculate OM % using the formula:

$$\text{OM \%} = \frac{\textit{weight at } 150\ ^\circ\text{C} - \textit{weight at } 550\ ^\circ\text{C}}{\textit{weight at } 150\ ^\circ\text{C}} \times 100\%$$

Preliminary Results

- The original content of OM in the dry peat moss was found to be 76.83 ± 3.53 %. (No Treatment)
- The best optimal combination for high level of peat moss is Treatment 3 and for low level is Treatment 1

Sample weight	2.221 ± 0.11 g	0.795 ± 0.03 g
Treatment	OM % after digestion	
Treatment 1	65.73 ± 3.51 %	48.15 ± 6.83 %
Treatment 2	71.16 ± 2.23 %	62.59 ± 2.53 %
Treatment 3	62.92 ± 5.25 %	58.50 ± 3.75 %
Treatment 4	71.49 ± 2.37 %	70.40 ± 0.79 %



- 392 liters collected
- Fragments and Films: 1,089 in total (35.1%)
- Fibers: 2,009 in total, (64.7%)
- Foams: 7 in total (0.2%)

Next Steps

- Conduct more experiments and build a rating curve for the best Fenton dosage at various OM concentrations
- Eliminate unnecessary intermediate steps and reduce the running time
- Collect rich carbon material from wastewater treatment for further testing.

Supporting People, Planet & Prosperity

Benefit Local Collaborators

- Muncie Sanitary District, its Bureau of Water Quality (BWQ), and the WWTP by first-hand data of MPs in their water

Benefit science community

- Add to the knowledge base of current MP studies to better understand their existence and removal and complement the rich water quality dataset of the BWQ
- Provide a testing protocol that is considerably more streamlined, less time-consuming, and less confusing

Benefit Ball State University

- Train three graduate students, and involve undergraduate students

Benefit the Society

- Provide data supporting future innovations and decision-making on MP contamination control and regulation