Examining Microplastic Occurrence at Green Stormwater Infrastructure Sites

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OVERVIEW

Microplastics (MPs) are defined as plastics between 1-µm and 5-mm in length. MP contamination is a growing problem due to their potential threat to human and environmental health. There is an urgent need to quantify and characterize MPs in the environment, including the role of green stormwater infrastructure (GSI). The present study involves collection, quantification, and chemical characterization of MP particles from stormwater (water), bioretention media (soil), and atmospheric deposition (air) at GSI sites in a densely urban setting and rural setting.
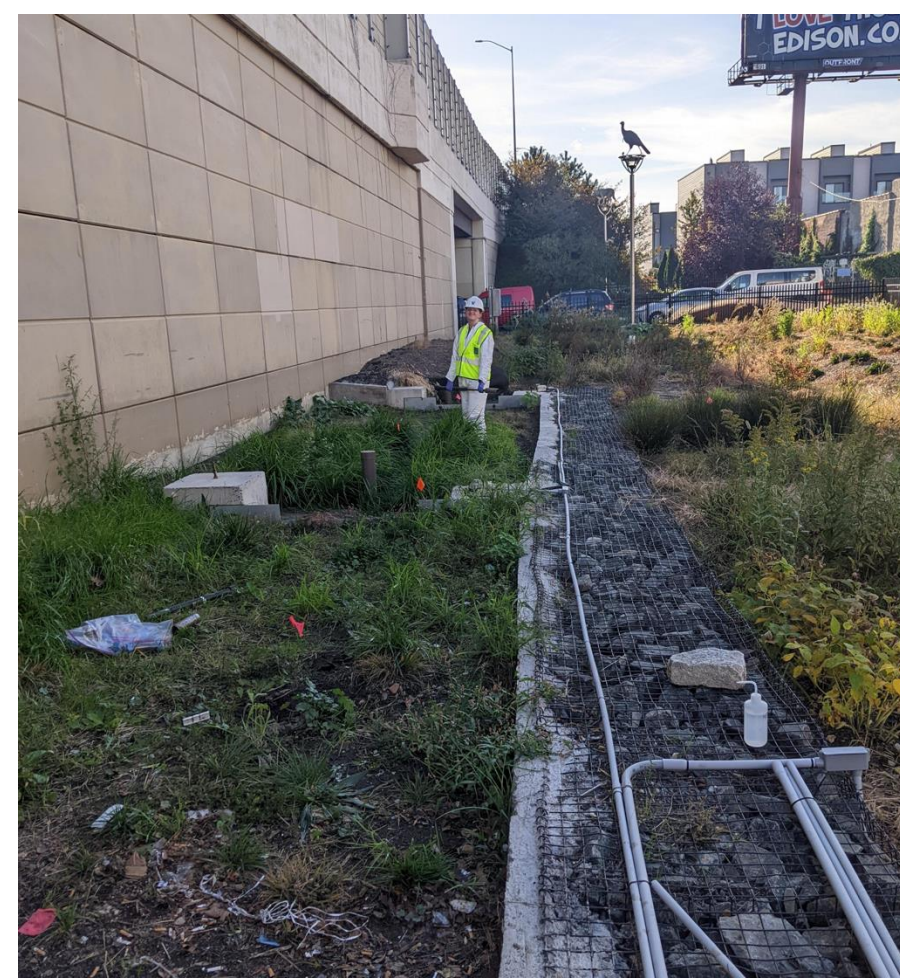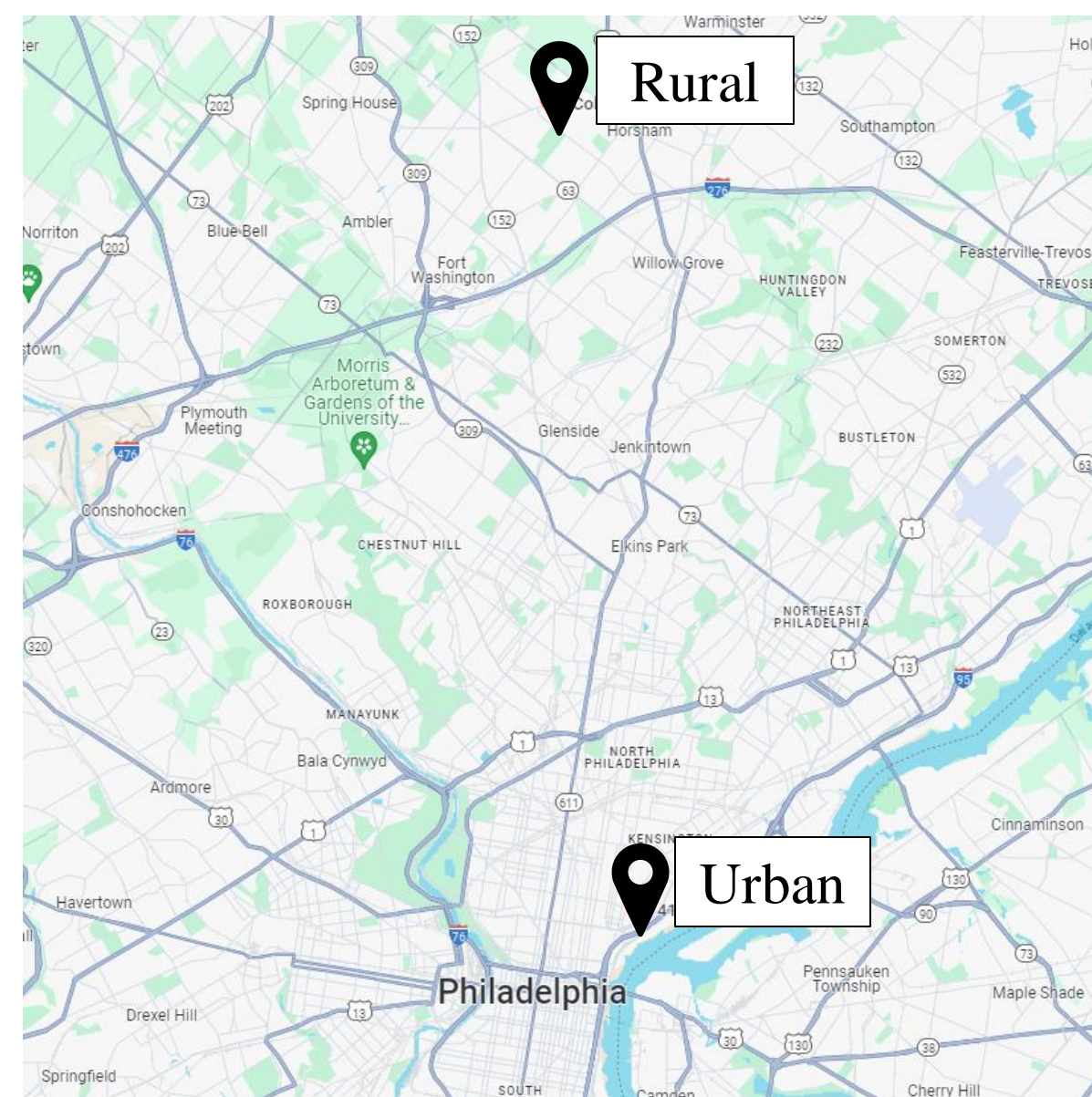

Urban Site

Rural Site

SAMPLING LOCATIONS

Rural Site
- 51.8-acre drainage area
- Summer camp located in Horsham, PA
- Samples collected from a wetland
- Constructed in 2015

Urban Site
- 0.87-acre drainage area
- Located on the side of I-95 in the Fishtown neighborhood of Philadelphia
- Samples collected in GSI used for highway stormwater collection
- Constructed in 2021

Sampling Locations

METHODS

Raw Sample
- Sample is collected in clean glass jar
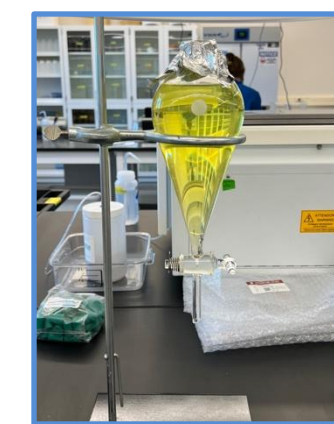- Stored in safe environment until processing

Wet Sieve
- Raw sample poured on 20 µm sieve and thoroughly rinsed
- Particles transferred to 1 L beaker and placed in oven

Wet Peroxide Oxidation
- H_2O_2 and Fe_2SO_4 added to oven dried sample and placed on hotplate with stir bar at 50°C and 100 rpm
- Additional H_2O_2 is added if needed to remove organics

Density Separation
- 1.4-g/mL $CaCl_2$ solution added to the oxidation beaker
- Solution transferred to density separation apparatus and left undisturbed for 24 hours

Vacuum Filtration
- Solution from density separation is poured on to vacuum filter with 1 µm filter
- Density separation apparatus and vacuum filtration rinsed thoroughly to collect all particles on filter
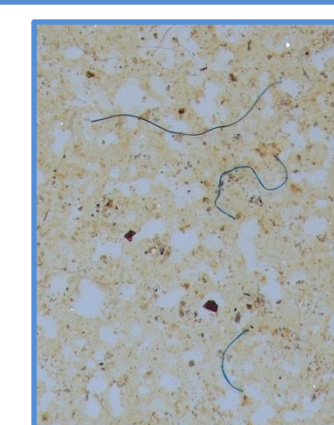
Visual Microscopy
- Filter is transferred to microscope
- Examine filter to identify and quantify microplastics from the sample

Raw Samp.	Wet Sieve	Oven Dry	Wet Peroxide Oxidation	Density Separation	Vac. Filt.	Visual Microscopy
0.5 Hours	0.5 Hours	24 Hours	1 Hour	24 Hours	0.5 Hours	~2 Hours
Total Time: 3 Days/Sample (3 Samples at a time)						

PRELIMINARY RESULTS

Air deposition rates varied across sample locations.

Sample ID	Plastic Particle Count	Concentration (particles/in²/day)
Rural	250	11
Urban	724	31

Common plastic types found in all sample media.

Plastic Type	Common Uses	Plastic Particle Count	Percentage of Total Plastics
Polyolefins	Plastic wrap, food packaging, milk cartons	8637	55%
Polystyrenes	Foam, food packaging, disposable medical equipment	3196	20%
Polyesters	Transportation, automobiles, electric appliances	1802	11%
Other		2237	14%

CONCLUSIONS & FUTURE WORK

Key Takeaways
- Developing procedure was more difficult to develop than anticipated
- Analysis of a sample is a time-consuming effort that takes multiple days to perform
- Soil samples require a different procedure than the water and air deposition samples
- Urban samples have higher MP deposition rate than rural
- Polyolefins most common MP type found across all samples

Future Work
- Finalize the individual procedures for each media type
- Continue analysis of data of original samples collected