Impact Priority 2

IP2.02.01

Understanding Microplastics

Sustainable Communities and Waste

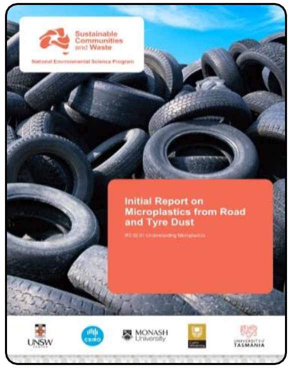
National Environmental Science Program

Key Achievements and Progress to Date

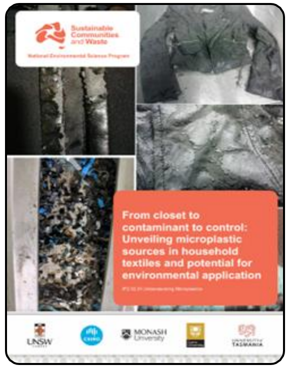
Sustainable Communities and Waste
National Environmental Science Program

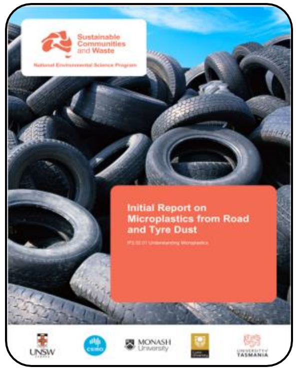
Reports

2023

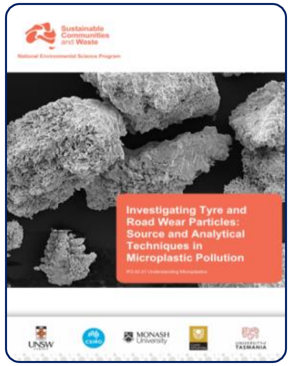


2024

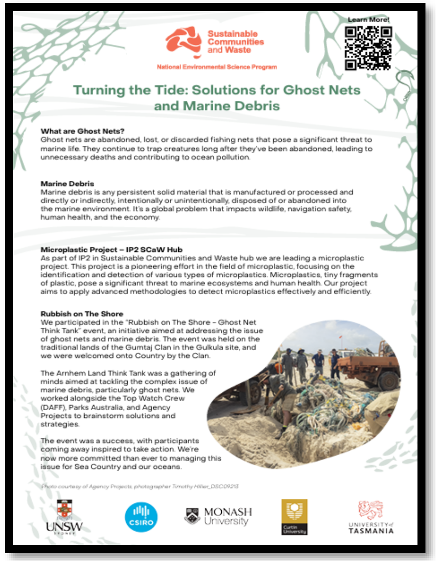


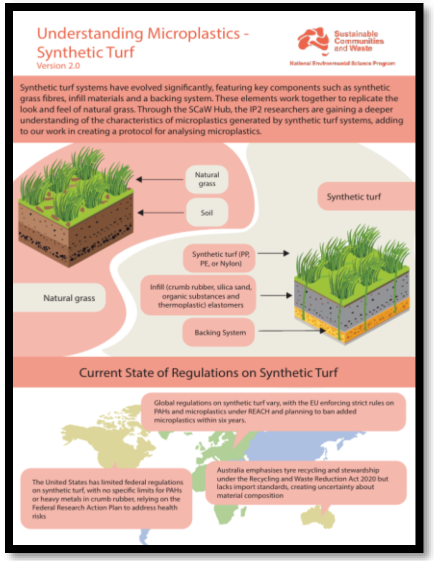


2025



Factsheets





https://www.nespsustainable.edu.au/

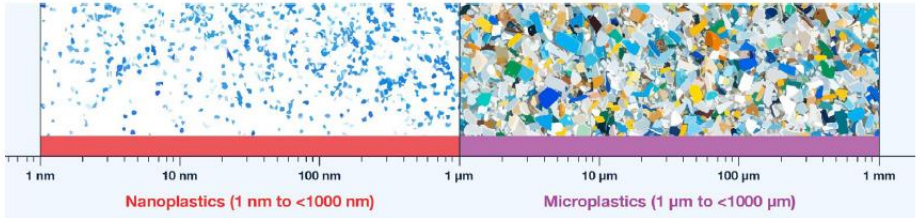
Advancing Plastic Particle Analysis: A micro to nano toolkit

The growing presence of microplastics and nanoplastics in our surroundings necessitates advanced analytical approaches for their identification, quantification, characterisation, and fractionation.
A concise overview of the essential techniques and their applications in the analysis of plastic particles spanning the nanometre to micrometre size range is presented.

This factsheet offers a reference for scientists, researchers, and environmental professionals to:

- Choose appropriate analytical techniques
- Conduct comprehensive analysis of plastic particles
- Understand environmental impact through contamination and degradation studies.

Particle Size Range



Size Range Origins

Primary Sources: Intentionally manufactured small plastics (e.g., microbeads).

Secondary Sources: Breakdown of larger plastics via weathering, abrasion, and biological degradation.

A single method cannot capture both micro- and nanoplastics due to their size and property differences, posing challenges for unified analysis.

Why Micro- and Nanoplastics Need Different Analysis

Size is Key: Micro- and nanoplastics differ greatly in size, which means we need different tools to detect them.

Finding Them: Tools that detect microplastics often aren't sensitive enough for nanoplastics. Smaller particles need more advanced equipment.

Zooming In: Nanoplastics require powerful microscopes, unlike microplastics, which can often be seen with basic tools.

Sorting Them: Nanoplastics are harder to separate than microplastics and require specialised sorting methods.

How They Act: Nanoplastics have a high surface area, so they stick to other substances and behave differently—calling for different types of testing.

Measuring Them: Nanoplastics require different methods for counting and weighing than microplastics.

Current and Future Analytical Strategies

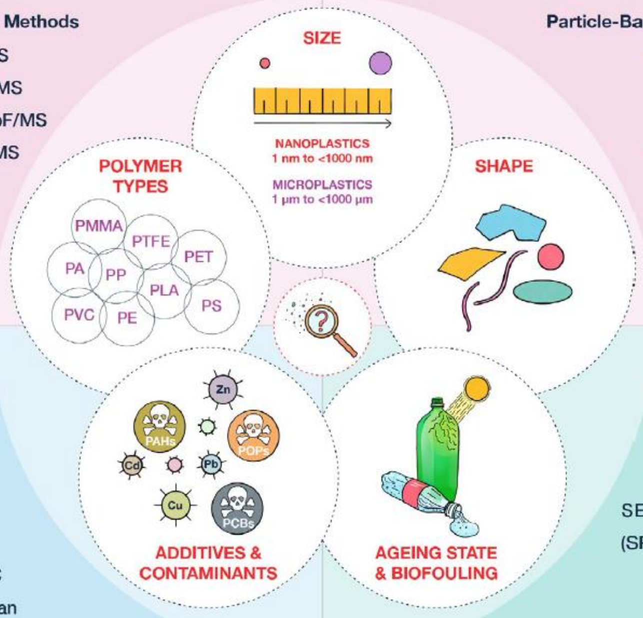
Microplastic analysis demands evolving from basic identification methods to comprehensive, standardised analytical frameworks that can track sources, assess environmental impacts, and inform effective mitigation policies across all environmental compartments.

Identification
Determine what type of plastic is present using Mass-Based Methods

Mass-Based Methods
- Py-GC/MS (current)
- TED-GC/MS (current)
- MALDI-ToF/MS (future)
- TD-PTR/MS (future)
- qNMR (future)
- HPLC (future)
- DSC (future)

Quantification
Determine how much plastic is present using Particle-Based Methods

Particle-Based Methods
- ATR-FTIR (current)
- μ-(FT)IR (current)
- μ-Raman (current)
- ToF-SIMS (future)
- CARS (future)
- SRS (future)
- NIR (future)



- HDC-SEC (future)
- FFF-Raman (future)
- FFF-Py-GC/MS (future)

- SEM/EDX (current)
- SEM-Raman (current)
- (SP)-ICP-MS (current)
- O-PT-IR (future)
- AFM-IR (future)
- Nano-FTIR (future)

Fractionation
Separate plastics by size or other physical/chemical properties

Characterisation
Understand the shape, structure, and degradation state of plastic particles.

KEY
- **Current analytical techniques:** characterisation methods currently used by researchers, including advanced characterisation techniques
- **Future analytical techniques:** emerging and future methods for micro- and nanoplastic characterisation.

This figure illustrates current and future analytical techniques for identifying, quantifying, characterising, and fractionating microplastics, considering their size, shape, polymer type, additives, contaminants, and ageing state.

Published July 2025 | Learn more about IP2 here

The Sustainable Communities and Waste Hub is funded by the Australian Government under the National Environmental Science Program.

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ROYAL SOCIETY OF CHEMISTRY


Environmental Science Nano
ROYAL SOCIETY OF CHEMISTRY
CRITICAL REVIEW
A comprehensive toolkit for micro- to nanoplastic analysis
Rumana Hossain and Veena Sahajwalla
1. Introduction

Hossain, R., & Sahajwalla, V. (2026). A comprehensive toolkit for micro-to nanoplastic analysis. *Environmental Science: Nano*.

DOI: 10.1039/d5en00856e
https://doi.org/10.1039/D5EN00856E

How the New Microplastics Standard will Help the Community & Legislation

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AS ISO 5667.27:2025 — Standard for Microplastic Sampling in Water

AS ISO 24187:2025 — Principles for the analysis of microplastics present in the environment

1. Enabling Evidence-Based Policy & Legislation

How it helps:

- Establishes a consistent, science-based method for analysing microplastics in air, water, and soil
- Enables accurate, credible data collection by regulators and researchers

Impact:

- Supports targeted regulations and bans on specific plastics and additives
- Strengthens environmental protection laws with reliable scientific data
- Informs Environmental Impact Assessments (EIAs) for new developments

2. Empowering Communities & Local Councils

How it helps:

- Provides councils and citizen science groups with a unified tool to monitor microplastics in local environments

Impact:

- Strengthens community-led initiatives like cleanups and awareness programs
- Aids early identification of pollution hotspots for quicker response Helps councils seek funding or improve waste infrastructure (e.g., filtration systems)


ME-009
Microplastics
14 February 2025

STANDARDS Australia

Standards Australia -
Certificate Of Appreciation

Presented to Rumana Hossain

For your valued contribution to the development of this Australian Standard®

AS ISO 24187 Principles for the analysis of microplastics present in the environment

Tracey Gramlick
Chair of the Board

Kareen Riley-Takos
Chief Operating Officer


ME-009
Microplastics

STANDARDS

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Liberation, separation, identification and analysis of meso- and microplastic pollution in urban stormwater drains captured using captured using Ocean Guard from Ocean Protect

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Study Overview

- Investigation of samples collected in the Ocean Guard Pit inserts in stormwater drains across **industrial, commercial, and residential catchments.**
- Establish baseline contamination levels and identify **predominant** plastics and **microplastics** across different urban land uses.

Sampling Design

- **Study Sites:** 9 properties across three land use categories: Industrial (3 sites), Commercial (3 sites), Residential (3 sites)
- **Collection Frequency:** Quarterly (every 3-4 months), **Duration:** 3 collection rounds over approximately 8 months
- **Sampling intensity:** 3 samples per site per collection event
- **Total samples:** 81 (9 sites × 3 collections × 3 samples)

Methodology

- Aligned with **AS ISO 24187:2025** standards.
- Sequential steps: **Manual Sorting → Sieving → Flotation → Digestion → Density Separation →Optical examination → FTIR identification**

Key Findings

- **Commercial:** Highest plastic abundance; dominated by **large (>5 mm)** and **medium (1–5 mm)** fragments from packaging & vehicular activity.
- **Industrial:** Moderate, diverse loads; balanced size distribution from packaging, construction residues, operational waste.
- **Residential:** Lower total mass but **higher fine microplastics (500–1000 μm)** from domestic runoff & textile fibres.

Polymer Types

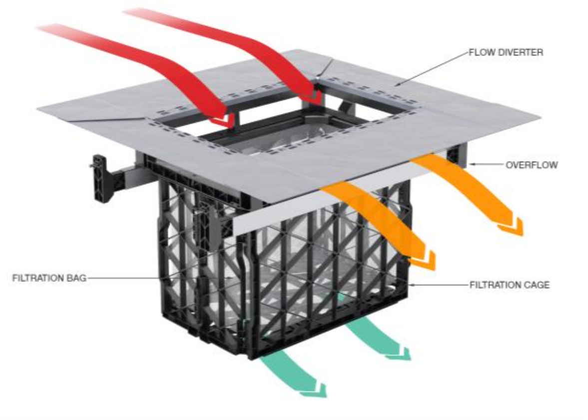
Predominantly **PE & PET**, followed by **PP, PS, PVC**

- **Most Prevalent:** Polyethylene (e.g. plastic bags) and Miscellaneous.
- **Significant Presence:** Polypropylene, Polystyrene & Polyester (e.g. bottle caps, disposable cutlery, plastic bottles)
- **Least Detected:** Hydrocarbon wax & silicone (e.g. car wax & tyre shine sprays)

Pollution Gradient

- Commercial = most microplastics & macroplastics
- Industrial = least microplastics by weight
- Residential = least microplastics by count

Sampling design



Ocean Guard

Property type	Collection frequency (months)	Month of 1st Collection	Month of 2nd Collection	Month of 3rd Collection	Total sample from study
Industrial 1	3*	February**	May**	August	9
Industrial 2	4	March	July	October**	9
Industrial 3	4	March	July	October	9
Commercial 1	4	March	July	October	9
Commercial 2	4	March	July	October	9
Commercial 3	4	March	July	October	9
Residential 1	4	March	July	October	9
Residential 2	4	March	July	October	9
Residential 3	4	March	July	October	9
				In-total	81

*Note: At the start of the study, Industrial 1 was set for the four monthly (4) collection frequency, however closer to the first collection the property requested their assets to be maintained three monthly (3).

** (blue) Analysis and report complete (green) Analysis on-going (purple) Samples collected

Sample collection

Mesh bag with 200 µm pore size

(a, b) Samples deposited in the mesh bag inside the OceanGuard

(c, d) Samples stored in plastic containers for transportation

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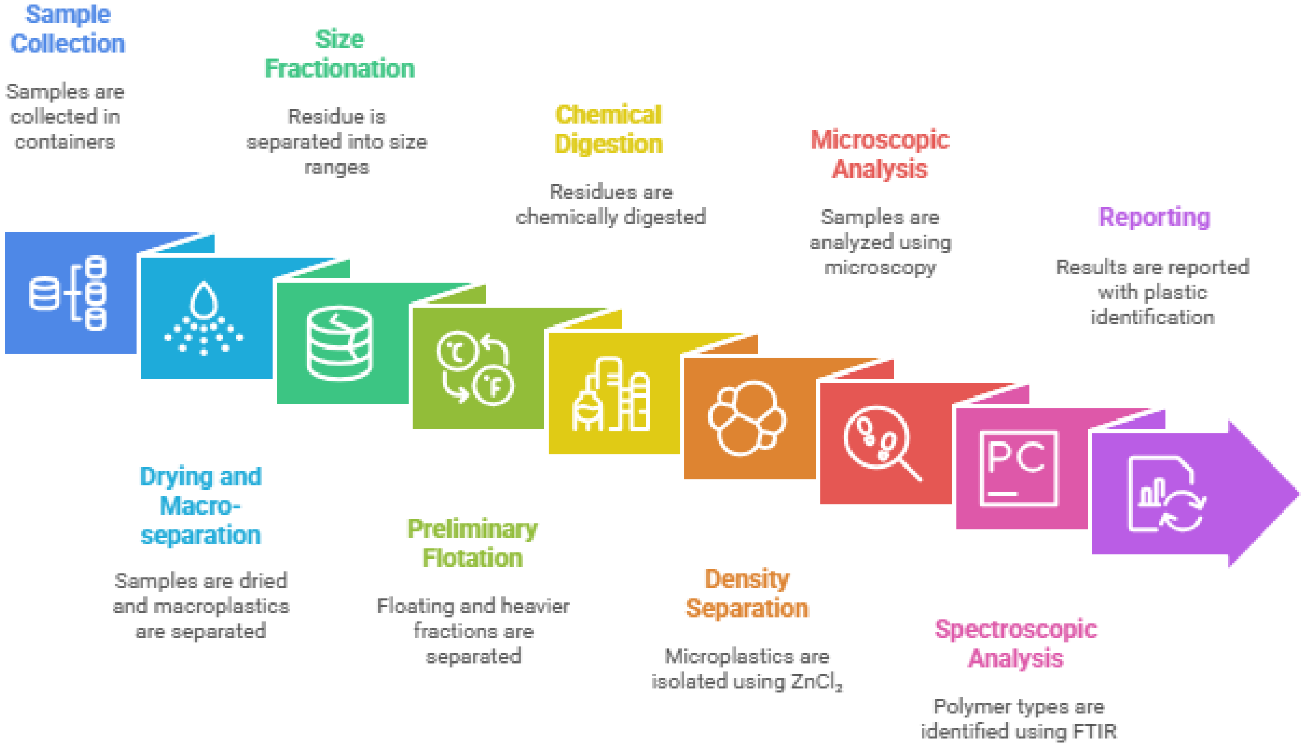
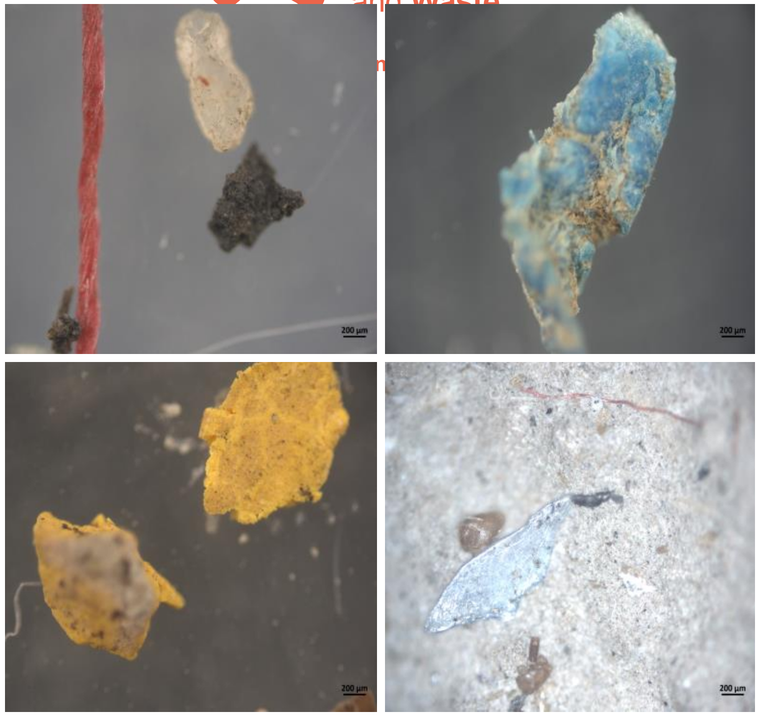
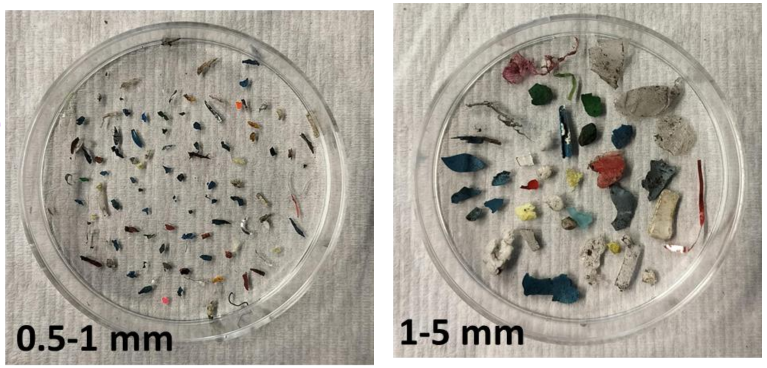
February and May collections: Analysis and reporting complete
July -August collection: Analysis 90% complete, and reporting
October collection: Analysis 40% complete, and reporting







Diversity of microplastics across different zones

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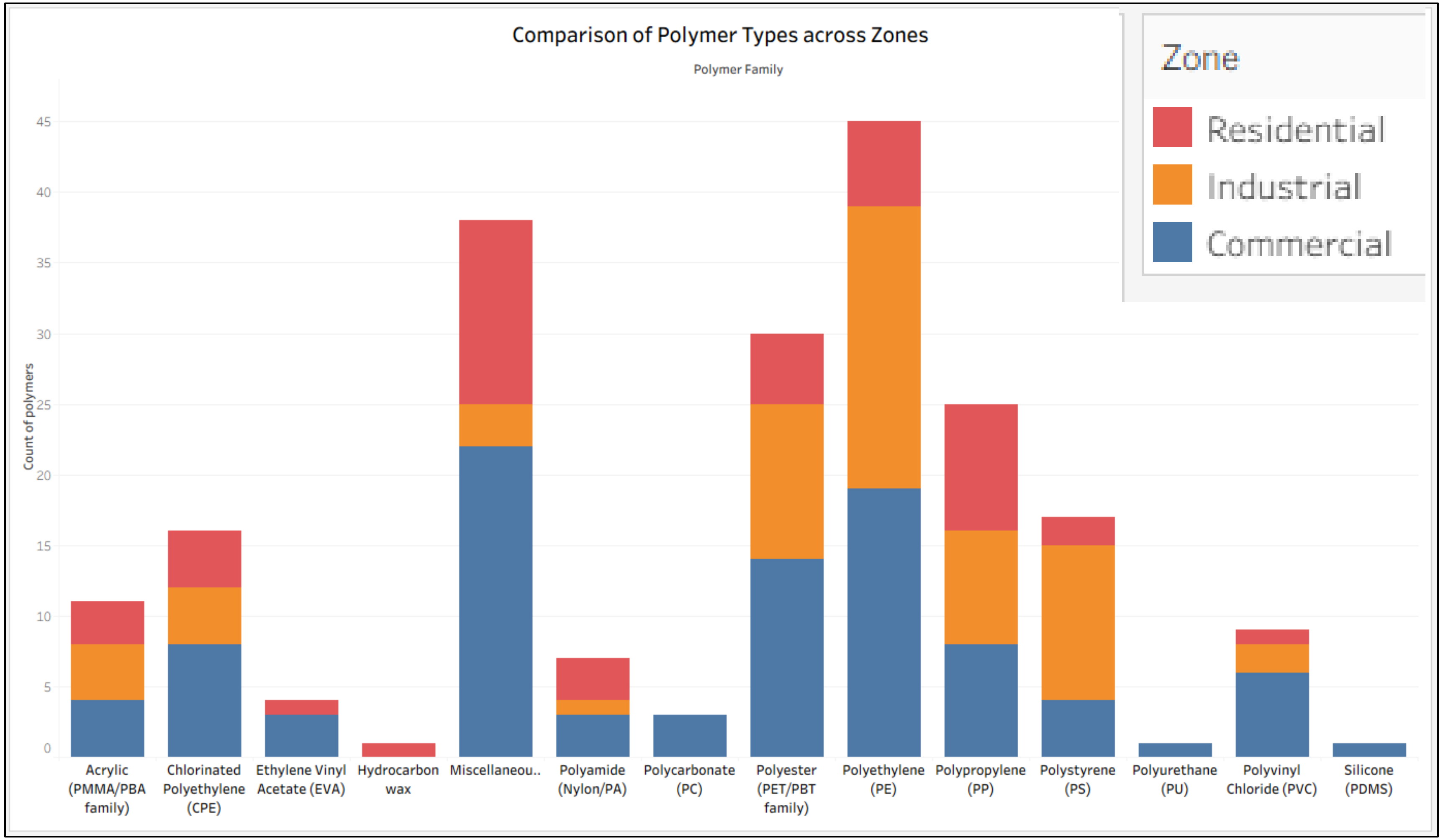

- **Most Prevalent:** Polyethylene (e.g. plastic bags) and Miscellaneous.
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Diversity of microplastics across different zones

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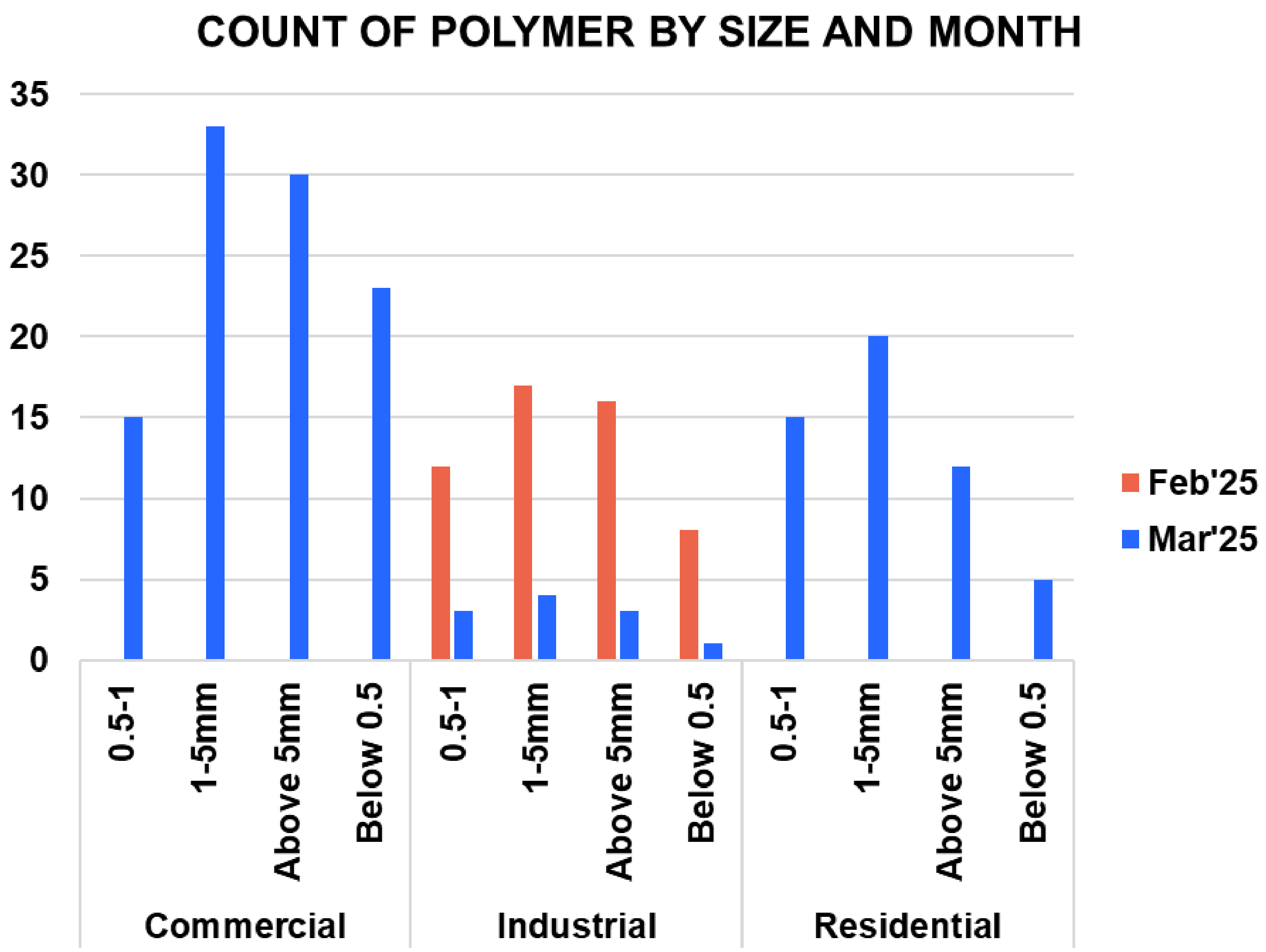
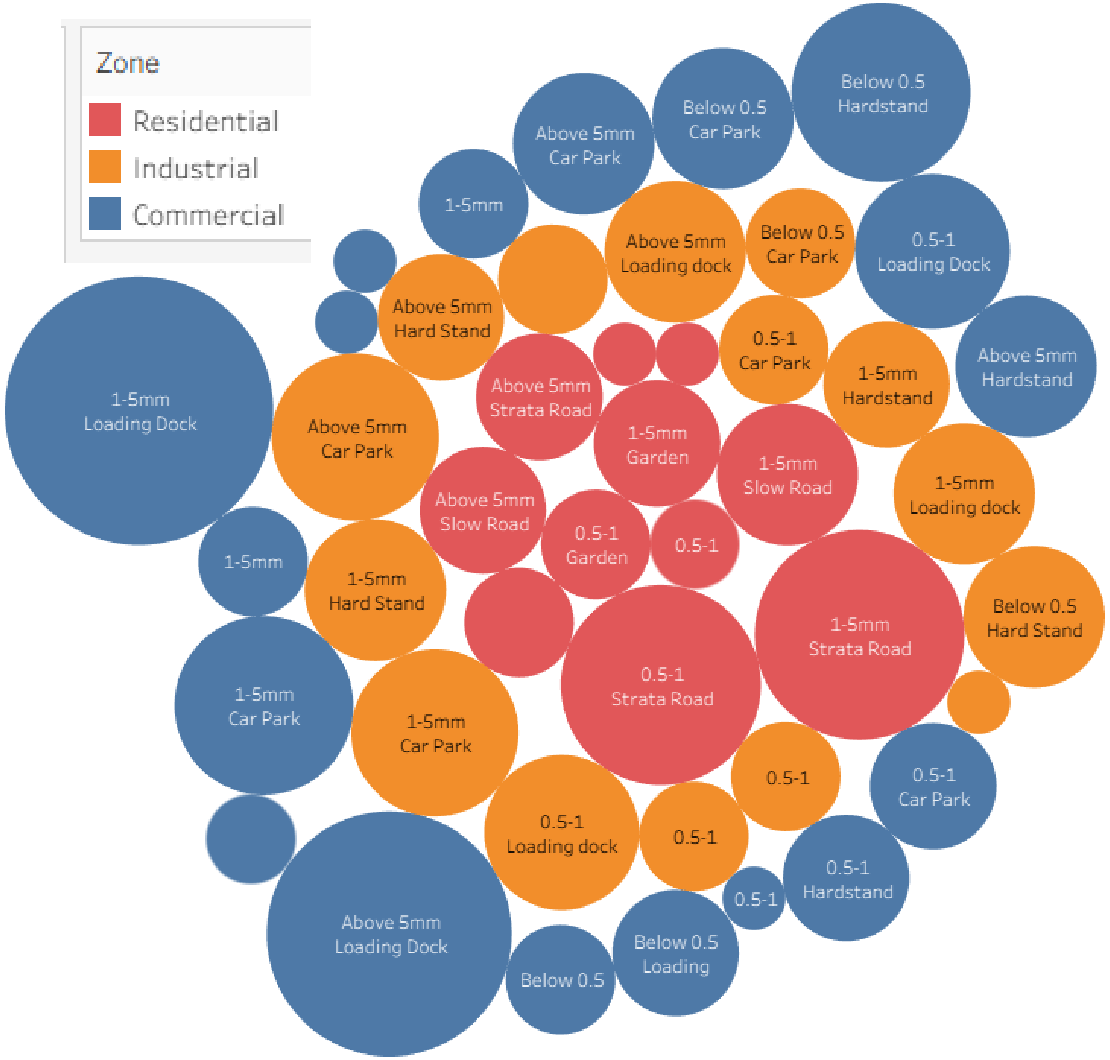


Comparison of Polymer Types across Zones



Analysis of degradation levels and understanding of microplastic generation from **Synthetic Turfs** in Ku-ring-gai council (Phase I) and Sydney Coastal Councils (Phase II)

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Study Objective

- Comprehensive assessment of degradation in synthetic turf systems and their potential to generate microplastics and contribute to environmental pollution

Sampling strategy

The study employed a **multi-zone sampling approach** to capture different degradation patterns across synthetic turf fields:

- **Drainage System Samples:** Collected from drains where water runoff accumulates, captures materials transported via stormwater pathways
- **Debris /Wash-off Samples:** Gathered piled-up debris for analysis, represents accumulated degraded materials
- **Central Field Area:** Sampled to represent average usage conditions, baseline degradation assessment
- **High-Activity Zones:** Targeted corners and goal post areas, captures intensive wear patterns from concentrated use
- **Seating/Peripheral Areas:** Samples from sideline and spectator zones, assesses peripheral wear and boundary effects

Analysis Methods

- Field observations, microscopic imaging, and spectroscopic analyses of blades and crumbs (FTIR and Raman spectroscopy), and elemental analyses of water samples (ICP)

Degradation Assessment

- Degradation indices determined by FTIR for Grass Blades, and Raman spectroscopy for Rubber Crumbs

Study Sites

Phase I

Two **Ku-ring-gai Council** sports fields were studied in Phase I

- North Turramurra Recreation Area (NTRA)
- Charles Bean Oval (CB)

Phase II

Bay Side Council

- Hensley Athletic Field
- Brighton Memorial Field
- J Graham Field
- Ador Avenue Reserve
- Gardiner Park
- Arncliffe Park

Sutherland Council

- Kareela Oval

Woollahra Council

- Andrew Petrie Oval

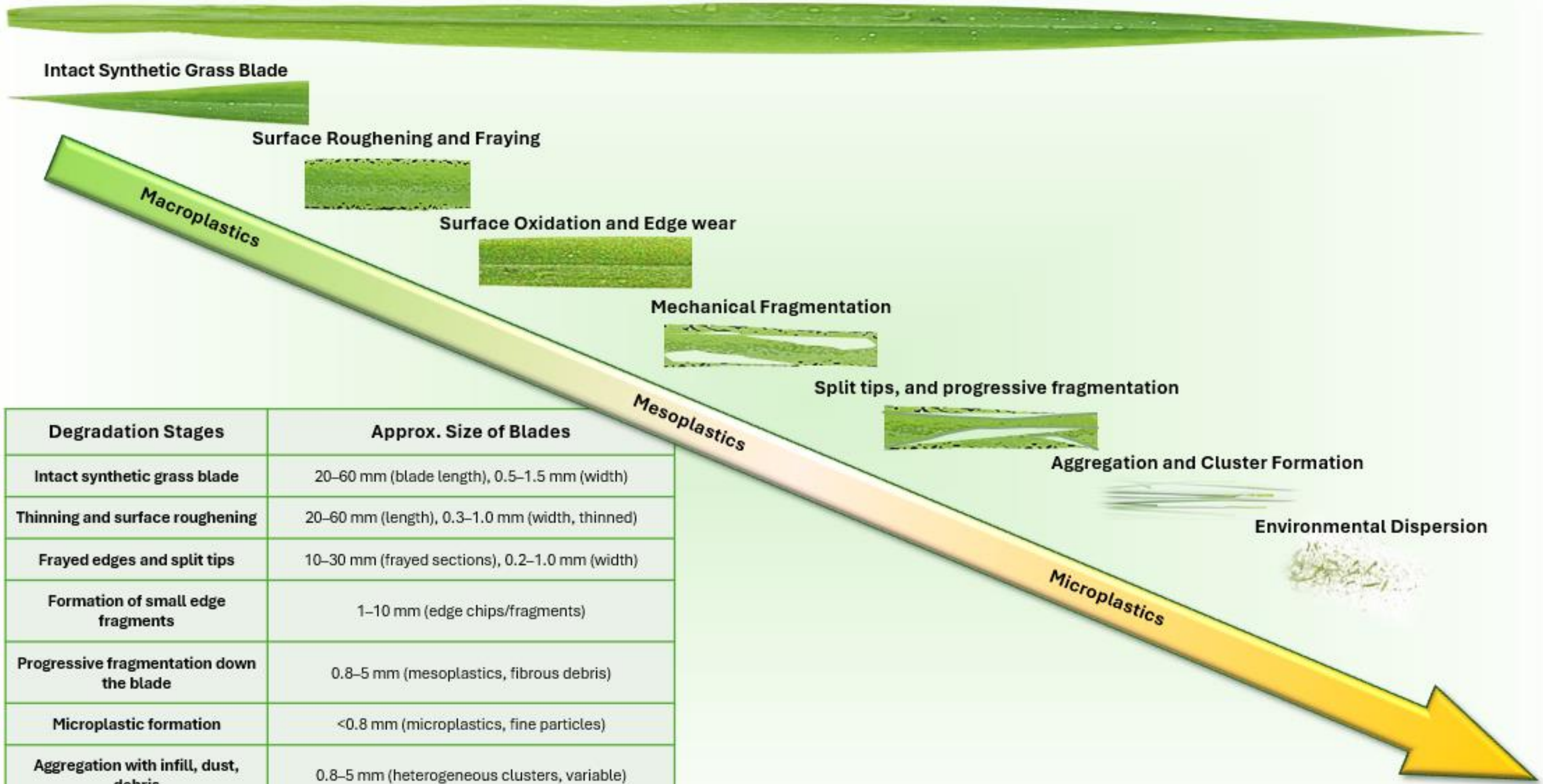
Willoughby Council

- Thomson Parl

North Sydney Council

- Cammeray Park

Degradation Journey of a Single Synthetic Grass Blade



Degradation Stages	Approx. Size of Blades
Intact synthetic grass blade	20–60 mm (blade length), 0.5–1.5 mm (width)
Thinning and surface roughening	20–60 mm (length), 0.3–1.0 mm (width, thinned)
Frayed edges and split tips	10–30 mm (frayed sections), 0.2–1.0 mm (width)
Formation of small edge fragments	1–10 mm (edge chips/fragments)
Progressive fragmentation down the blade	0.8–5 mm (mesoplastics, fibrous debris)
Microplastic formation	<0.8 mm (microplastics, fine particles)
Aggregation with infill, dust, debris	0.8–5 mm (heterogeneous clusters, variable)
Environmental dispersion	<5 mm (microplastic clusters, can be smaller depending on aggregation and breakdown)