

# Impact Priority 2

IP2.02.01

Understanding Microplastics



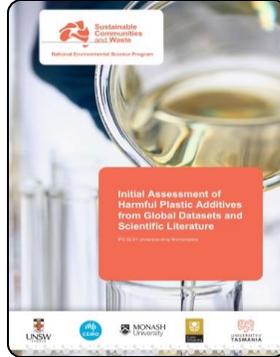
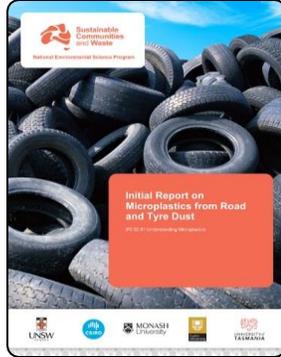
**Sustainable  
Communities  
and Waste**

**National Environmental Science Program**

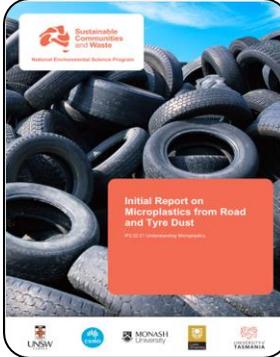
## Reports

## Factsheets

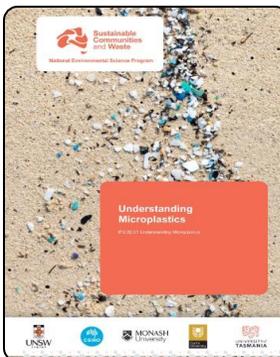
2023



2024



2025



### Deepening our understanding of tyre and road wear particles

Tyre and road wear particles (TRWP) are microparticles generated by the interaction of tyres with road surfaces. Through the SCAW Hub, the IP2 researchers are gaining a deeper understanding of TRWP sources, sinks and characteristics, adding to our work in creating a protocol for analysing microplastics.

- Tyre particles account for ~28% of global microplastic pollution.
- In 2022-23, 760,000 tonnes of tyres were consumed.
- 545,000 tonnes of tyres were disposed of or recovered.
- Tyre particles pose environmental and health risks due to their composition.

TRWP can end up in our soil and environment via airborne particles or rain water runoff.

TRWP can end up in our marine environments via airborne particles or rain water runoff.

TRWP sources include Tyre Treads, Road Markings and Bitumen Binders.

### Turning the Tide: Solutions for Ghost Nets and Marine Debris

**What are Ghost Nets?**  
Ghost nets are abandoned, lost, or discarded fishing nets that pose a significant threat to marine life. They continue to trap creatures long after they've been abandoned, leading to unnecessary deaths and contributing to ocean pollution.

**Marine Debris**  
Marine debris is any persistent solid material that is manufactured or processed and directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment. It's a global problem that impacts wildlife, navigation safety, human health, and the economy.

**Microplastic Project - IP2 SCAW Hub**  
As part of IP2 in Sustainable Communities and Waste hub we are leading a microplastic project. This project is a pioneering effort in the field of microplastic, focusing on the identification and detection of various types of microplastics. Microplastics, tiny fragments of plastic, pose a significant threat to marine ecosystems and human health. Our project aims to apply advanced methodologies to detect microplastics effectively and efficiently.

**Rubbish on the Shore**  
We participated in the 'Rubbish on the Shore - Ghost Net Think Tank' event an initiative aimed at addressing the issue of ghost nets and marine debris. The event was held on the traditional lands of the Gurtnaj Clan in the Okulka site, and we were welcomed onto Country by the Clan.

The Anrhem Land Think Tank was a gathering of minds aimed at tackling the complex issue of marine debris, particularly ghost nets. We worked alongside the Top Watch Crew (DAPF), Parks Australia, and Agency Projects to brainstorm solutions and strategies.

The event was a success, with participants coming away inspired to take action. We're now more committed than ever to managing this issue for Sea Country and our oceans.

### Methodology for Identifying Locations to Investigate Sources and Characteristics of Microplastic

Version 1.1

Lucas Way, George Kamateros, Anirban Ghose, Rumana Hussain, Veena Sahajwala  
The SCAW Hub is funded by the Australian Government under the National Environmental Science Program.

**About this fact sheet**  
This fact sheet outlines a systematic methodology for selecting locations to investigate the sources and characteristics of microplastics. It aims to enhance understanding of how microplastics enter and accumulate in various environments, supporting efforts to mitigate their impacts. The document provides insights into the objectives, site selection criteria, and analytical techniques that will be used in the study, highlighting the collaboration with Ocean Protect and the focus on practical, evidence-based solutions to address microplastic pollution.

This fact sheet complements our full report on [Methodology for Identifying Locations to Investigate Sources and Characteristics of Microplastics](#).

The report, titled "Methodology for Identifying Locations to Investigate Sources and Characteristics of Microplastics," delves into the systematic approach for selecting study sites, analysing microplastic pollution, and developing effective mitigation strategies.

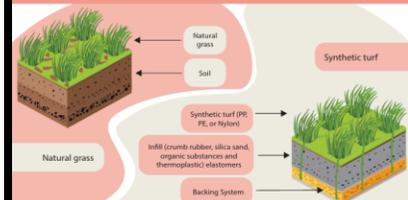
**Methodology for Identifying Locations for Case Studies**  
This methodology involved a systematic approach that included data gathering, site assessment, and prioritisation based on environmental and logistical factors. Researchers started with a comprehensive literature survey to identify key microplastic sources and their effects on ecosystem diversity, and potential human and ecological impacts.

In collaboration with Ocean Protect, the project evaluated and selected key sites in the Blacktown Local Government Area (LGA) in New South Wales, chosen for its extensive stormwater intervention infrastructure. By targeting specific locations and using advanced analytical techniques, the project aims to provide detailed insights into microplastic sources and sinks. This approach supports the development of effective mitigation strategies and evidence-based policy recommendations.

### Understanding Microplastics - Synthetic Turf

Version 2.0

Synthetic turf systems have evolved significantly, featuring key components such as synthetic grass fibres, infill materials and a backing system. These elements work together to replicate the look and feel of natural grass. Through the SCAW Hub, the IP2 researchers are gaining a deeper understanding of the characteristics of microplastics generated by synthetic turf systems, adding to our work in creating a protocol for analysing microplastics.



**Current State of Regulations on Synthetic Turf**

Global regulations on synthetic turf vary, with the EU enforcing strict rules on PFAS and microplastics under REACH and planning to ban added microplastics within six years.

The United States has limited federal regulations on synthetic turf, with no specific limits for PFAS or heavy metals in crumb rubber infill on the Federal Research Action Plan to address health risks.

Australia emphasises tyre recycling and stewardship under the Recycling and Waste Reduction Act 2020 but lacks report standards, creating uncertainty about material composition.

# 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.

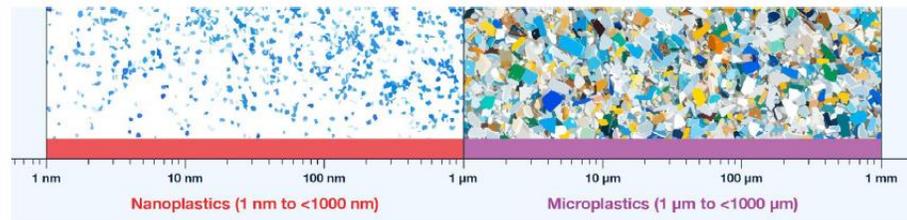
This factsheet offers a reference for scientists, researchers, and environmental professionals to:

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.

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

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

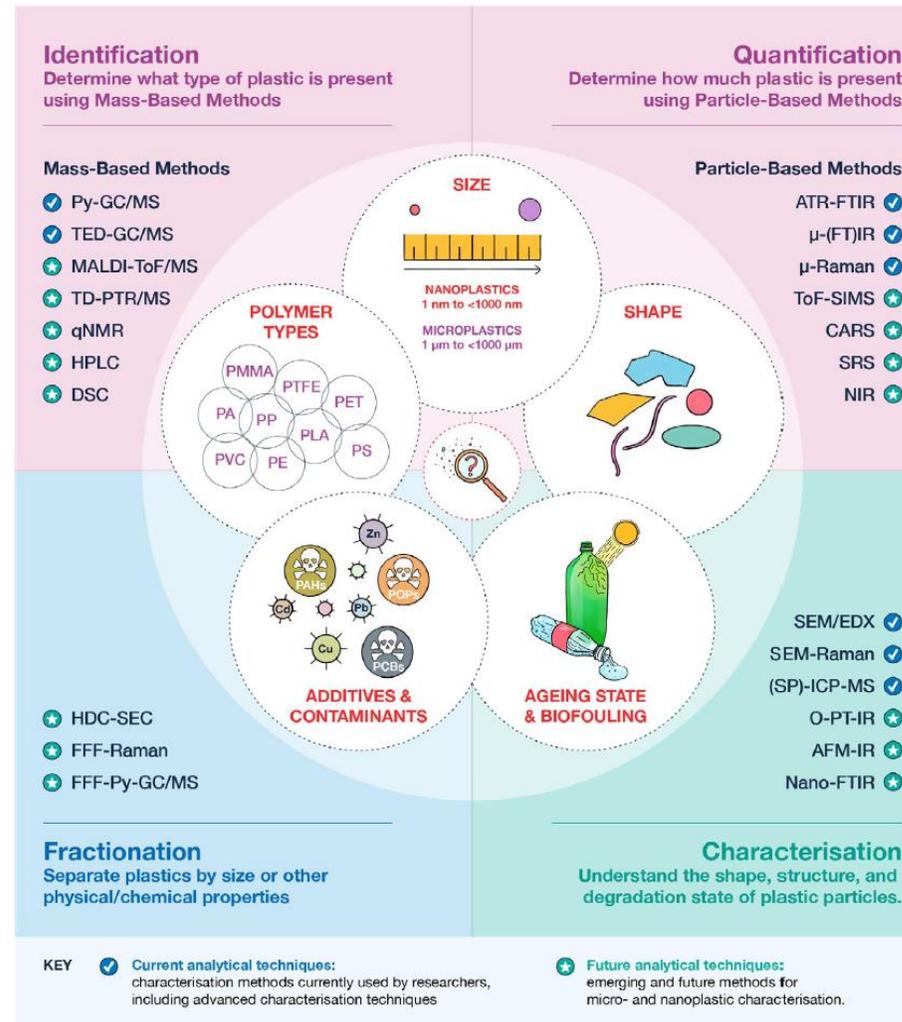
**Finding Them:** Tools that detect microplastics often aren't sensitive enough for nanoplastics. Smaller particles need more advanced equipment.

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

**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.



**Environmental Science Nano**

**CRITICAL REVIEW**

Check for updates

Cite this: Environ. Sci. Nano, 2025, 12, 122–149

Rumana Hossain and Viena Sahajwalla

**A comprehensive toolkit for micro- to nanoplastic analysis**

Micro- and nanoplastic (MNP) particles have emerged as a novel class of anthropogenic contaminants, now recognised as pervasive across all environmental compartments and local and global water. Their extreme heterogeneity in size, morphology, identity, polymer type, surface chemistry, and degree of aging presents major analytical challenges, with reported abundances spanning up to six orders of magnitude. Reliable assessment of their occurrence and impacts therefore requires advanced analytical approaches capable of identifying, quantifying, fractionating, and characterising these particles across scales. This review systematically evaluates state-of-the-art analytical strategies for MNP detection, organised into four major categories: mass-based identification methods (e.g., Py-GC/MS, TED-GC/MS, MALDI-ToF/MS), particle-based quantification techniques (e.g., µ-FTIR, µ-Raman, ToF-SIMS), separation and fractionation methods (e.g., FFF and HSC-SEC coupled with spectroscopy or mass spectrometry), and morphological and surface characterisation tools (e.g., SEM/EDX, AFM-IR, nano-FTIR, SP-ICP-MS). For each category, we critically assess detection limits, strengths, and limitations, highlighting their suitability for micro- versus nanoplastic detection. Special attention is devoted to emerging approaches that push detection beyond the nanometre, as well as the need for harmonisation and standardisation across methodologies. By comparing and integrating these techniques, we outline how complementary approaches can provide comprehensive characterisation of MNPs and support realistic risk assessment. Finally, future perspectives are discussed for advancing analytical sensitivity, method automation, and cross-disciplinary standardisation to address the global challenge of MNP pollution.

**Environmental significance**

Micro- and nanoplastic (MNP) are emerging contaminants of global concern, yet their detection, characterisation, and quantification across environmental compartments remain methodologically challenging. The current diversity of particle sizes, morphologies, polymer chemistry, and ageing states demands a methodological approach that seeks to address this field by consolidating and critically assessing a state-of-the-art and integrating mass-based, particle-based, and ageing methods, highlighting their respective strengths, limitations, and complementarity in identifying the most relevant gaps—such as the lack of reference materials, harmonised QC/QA protocols, and validated assessment strategies—the study provides a roadmap for generating reliable, comparable, and environmentally realistic MNP data. These advances are crucial for understanding the environmental fate, transport, and impacts of MNPs, thereby informing risk assessment, policy, and mitigation strategies.

**1. Introduction**

Microplastics (MPs) and nanoplastics (NPs) are small polymer fragments ubiquitously distributed across ecosystems, including marine and freshwater environments, soils, sediments, air, and even food and drinking water, and are now recognised as emerging pollutants of global concern.<sup>1–3</sup> The term microplastics was first introduced in 2004 by Thompson et al. as the smallest of marine plastics, with an upper size limit of 5 mm. Later, nanoplastics (NPs) were defined as particles smaller than 1 µm or classified as nanoplastics,<sup>4,5</sup> while those between 1 µm and 1 mm are termed microplastics.<sup>6,7</sup> Fragments in the 1–5 µm range are often referred to as ‘large nanoplastics’.<sup>8</sup> Plastic materials possess a unique combination of properties—lightweight, versatile, durable, and resistant to corrosion, heat, and flames—that have propelled their production and use for billions of people worldwide. Plastics are increasingly ubiquitous in the environment and even coating the food chain, creating a growing global concern. While European production declined slightly between 2018 and 2019, global output has continued to climb, reaching approximately 411.4 million metric tons in 2021.<sup>9</sup> The most widely produced

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**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

**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)



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

## 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

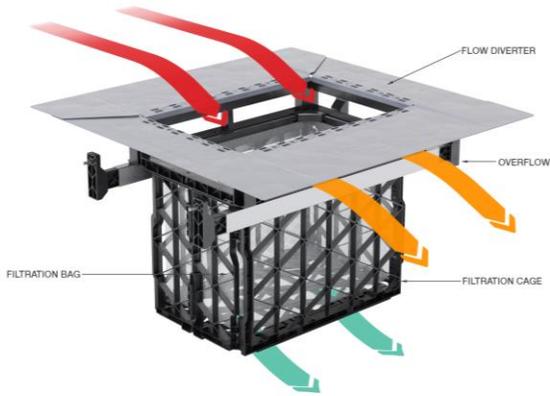
Predominantly **PE & PET**, followed by **PP, PS, PVC**

- **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 1 <sup>st</sup> Collection	Month of 2 <sup>nd</sup> Collection	Month of 3 <sup>rd</sup> 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
<b>In-total</b>					<b>81</b>

\*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).

\*\* ● Analysis and report complete ● Analysis on-going ● Samples collected

# Sample collection



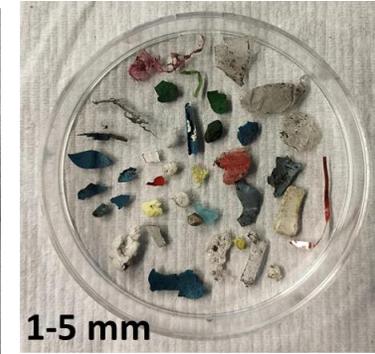
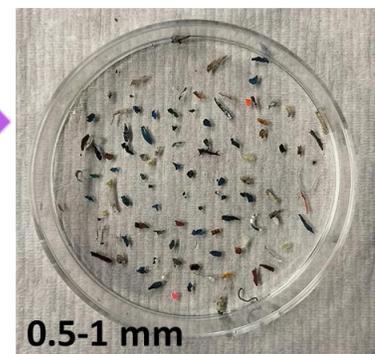
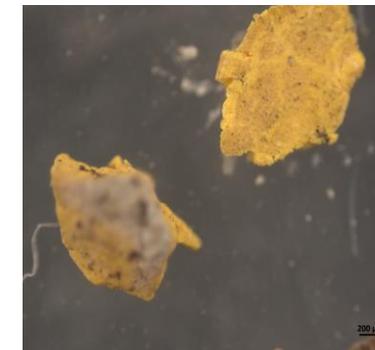
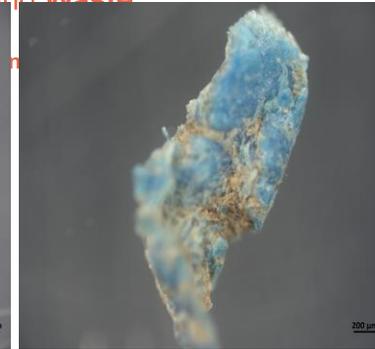
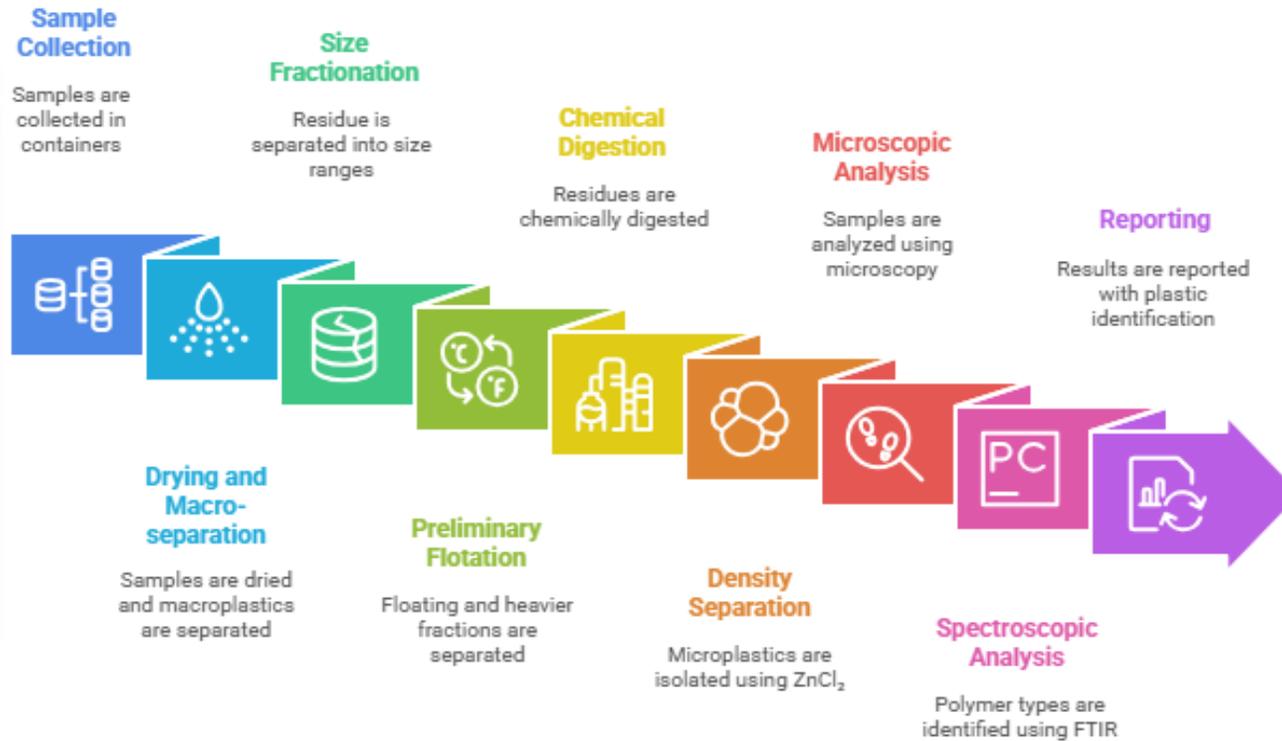
Mesh bag with  
200  $\mu\text{m}$  pore size

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

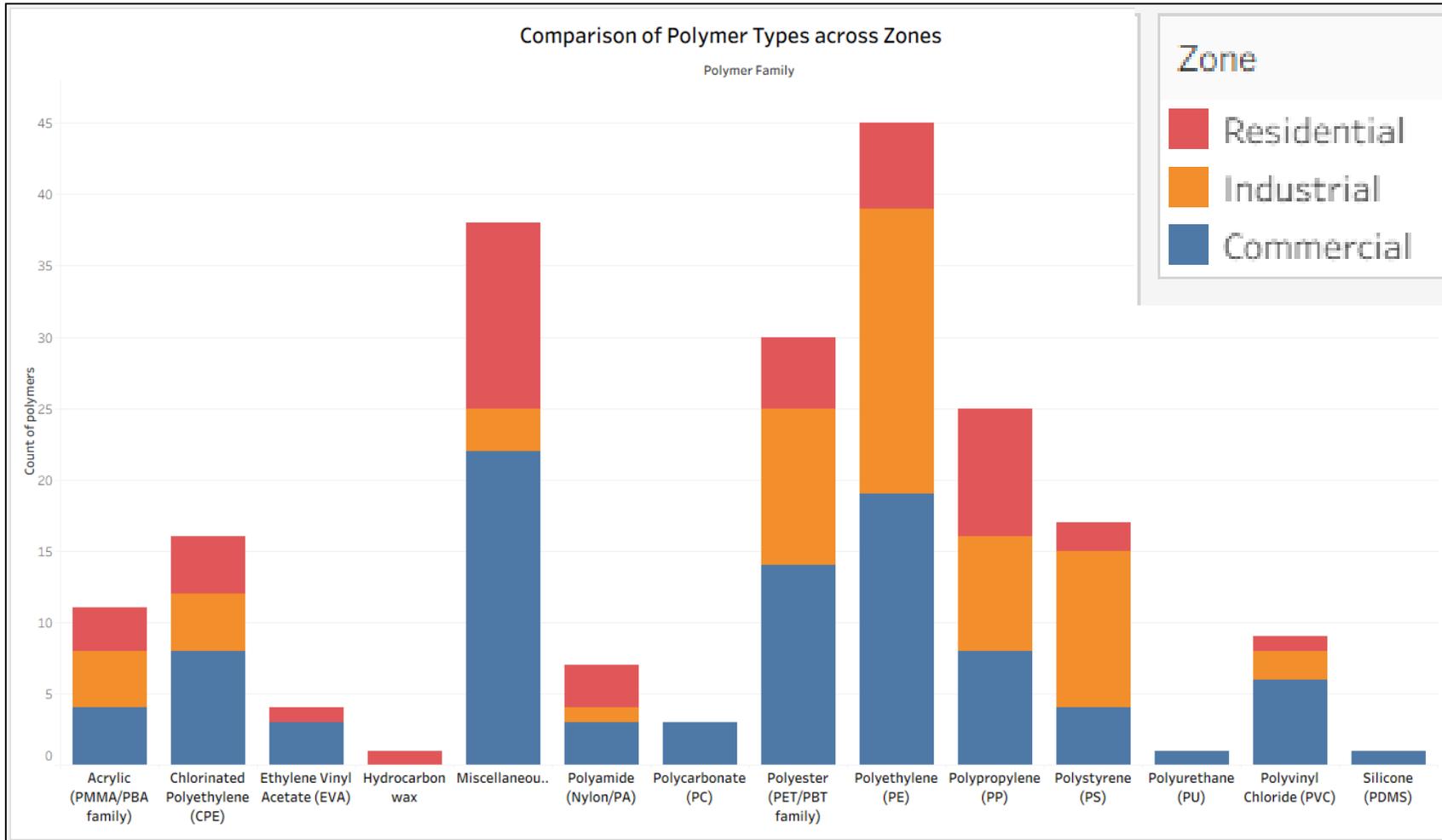


(c, d) Samples stored in  
plastic containers for  
transportation

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



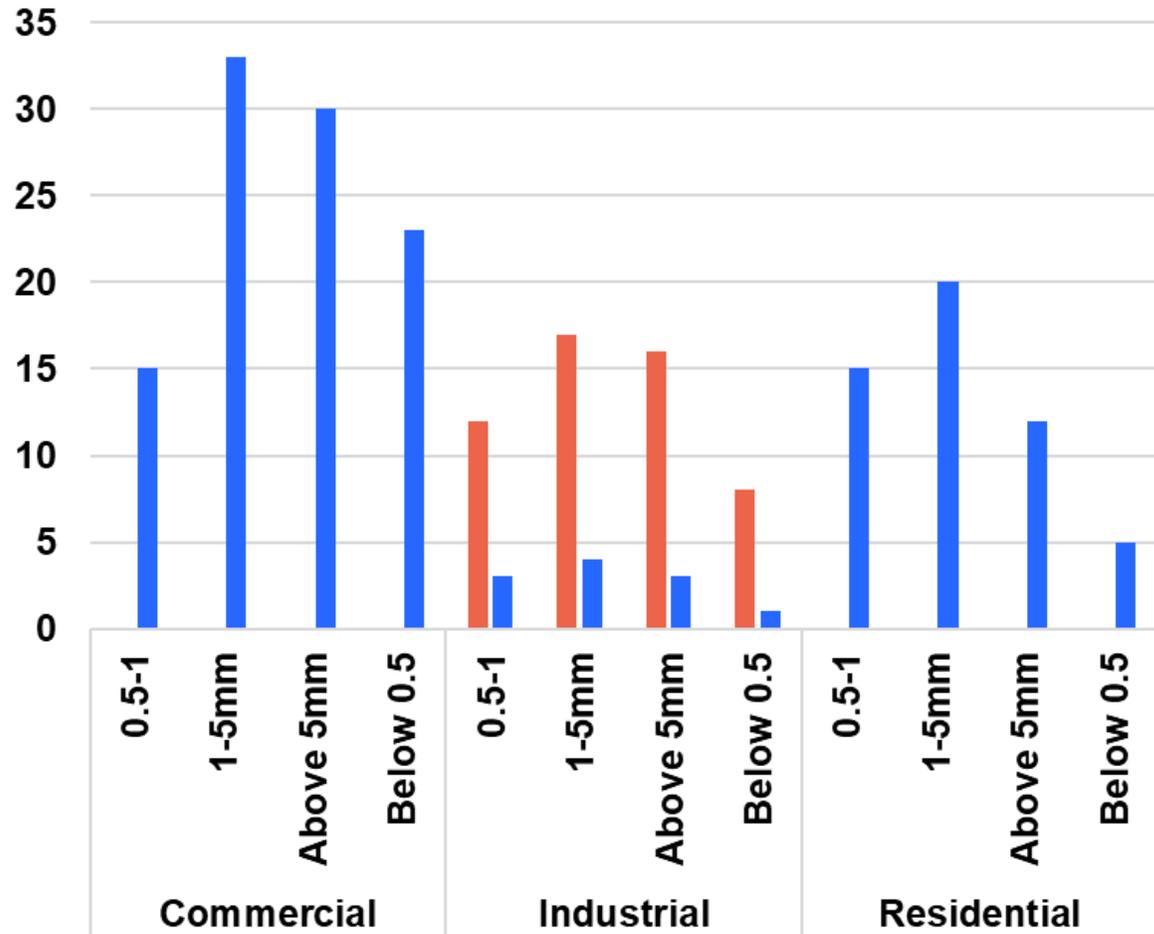
# Diversity of microplastics across different zones



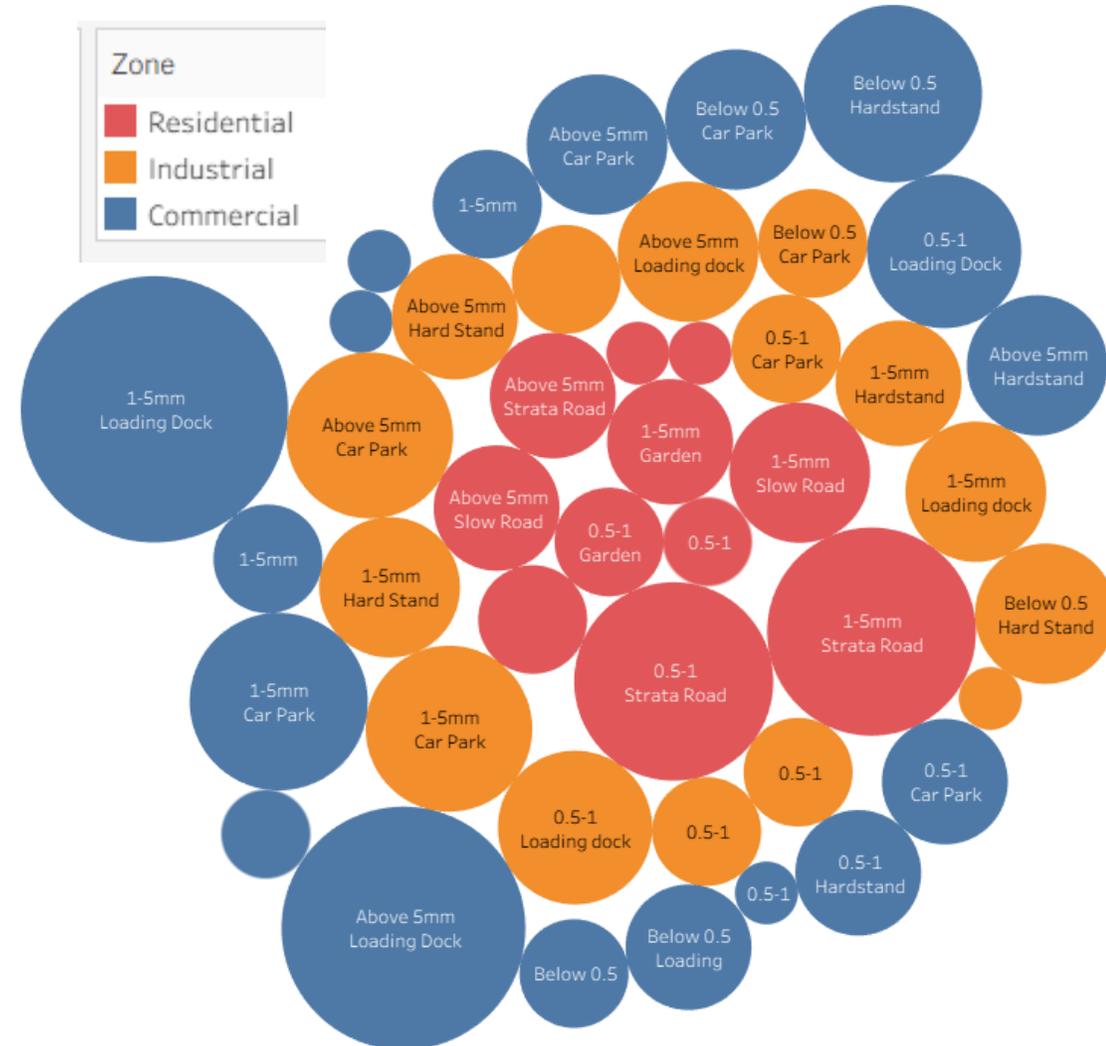
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- **Least Detected:** Hydrocarbon wax & silicone (e.g. car wax & tyre shine sprays)

# Diversity of microplastics across different zones

## COUNT OF POLYMER BY SIZE AND MONTH



## 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)



National Environmental Science Program

## 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 Park

#### North Sydney Council

- Cammeray Park



## Degradation Journey of a Single Synthetic Grass Blade

