Fate and transport of microplastics in three different water recycling plants

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INTRODUCTION

Microplastics (MP) have negative impacts on aquatic organisms and implications for human health. Existing water recycling plants (WRPs) are not designed for MP removal and can be a significant source of MP in the environment. **As the first long-term (2-year) MP study undertaken at Australian WRPs**, this study investigates MP characteristics and removal at three different WRPs.

METHODOLOGY

WRP sites: Three WRPs using different treatment processes.
Sampling: Six sampling events over 24 months with grab samples at various points along the WRP treatment process.
MP concentration and separation: A series of 20 cm stainless-steel mesh filters (25-100 µm, 100-200 µm, 200-500 µm and >500 µm) (Figure 1).
MP characterisation and quantification: Stereo microscope (Leica S9d) and fourier-transform infrared spectroscopy (FTIR).

Table 1 Three different WRP study sites.

WRP	Catchment	Process	Inflow
A	Residential (95.3 %) Commercial and industrial (4.7 %)	Screen-Activated sludge-Ultrafiltration-UV-Chlorination (Class A)	4698 ML/yr
B	Residential (99.4 %) Commercial and industrial (0.6 %)	Facultative and maturation lagoons (Class C)	288 ML/yr
C	Residential (92.1 %) Commercial and industrial (7.9 %)	Screen-Activated sludge and maturation lagoons (Class C)	2291 ML/yr

Fig.1. MP concentration and separation apparatus. Grab samples were pumped through four stainless steel filters of decreasing mesh size.

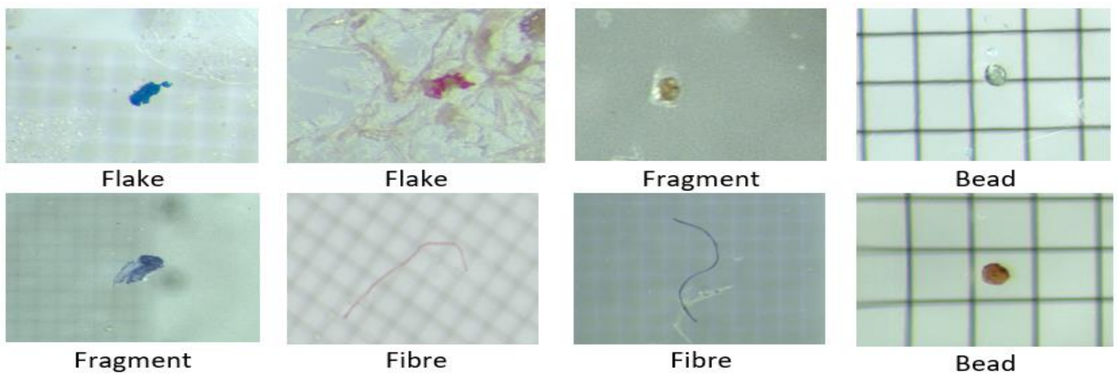

Fig.2. Typical MP types identified in wastewater in this study.

RESULTS

- MP concentration reduced along each treatment process (Figure 3).
- Existing treatment processes can effectively remove MP.
- Fibres were the dominant MP type in influent and effluent at all WRPs (Figures 2 and 4).
- For WRPs A and C the proportion of small MP (25-100 µm) were the highest in the plant influent (Figure 5).
- The majority of MP removed from the wastewater are transferred to the sludge/biosolids.

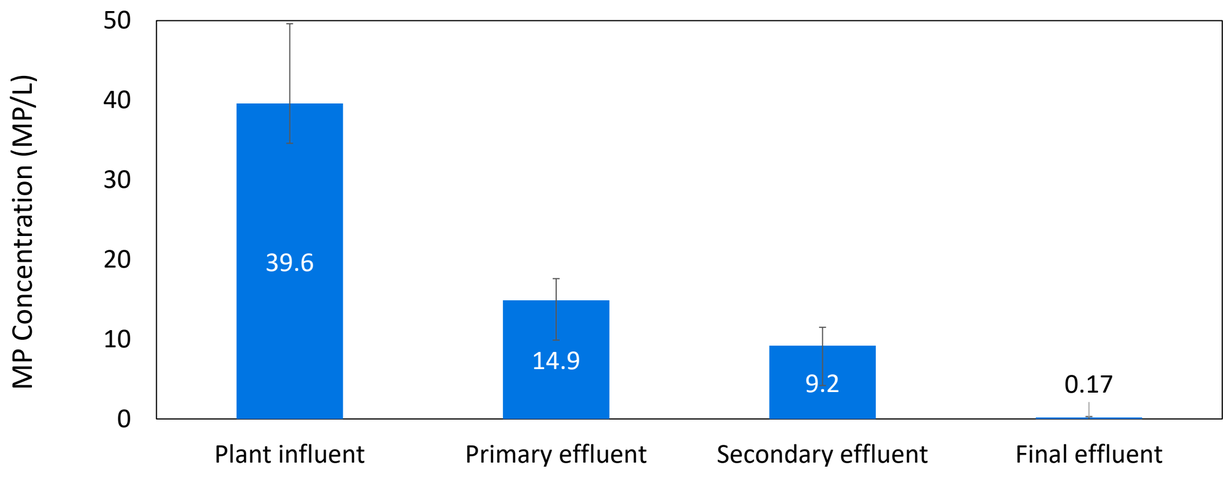

Fig.3. MP concentration at different points along the WRP A treatment process.

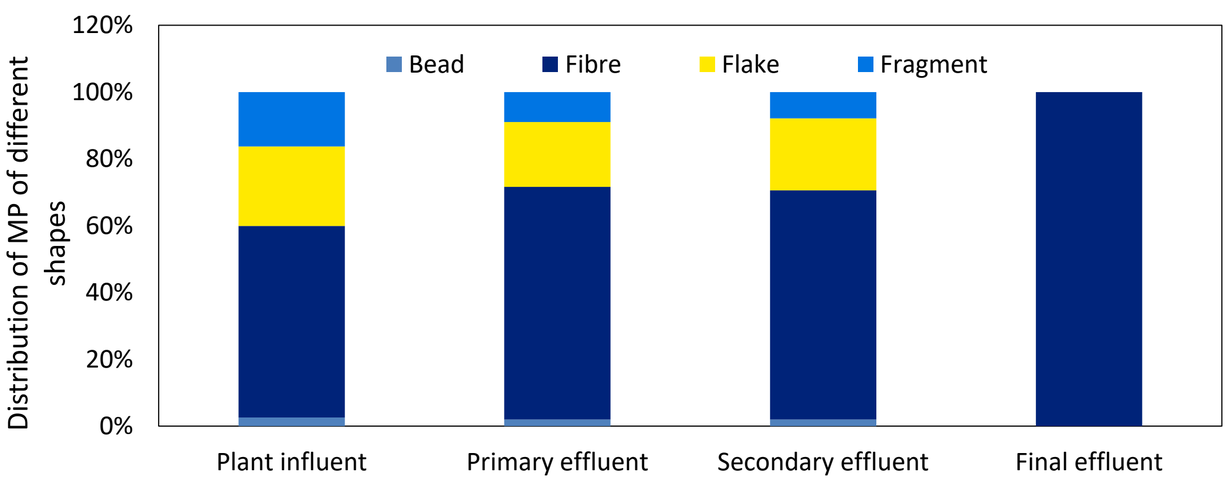

Fig.4. Distribution of MP type along the WRP A treatment process.

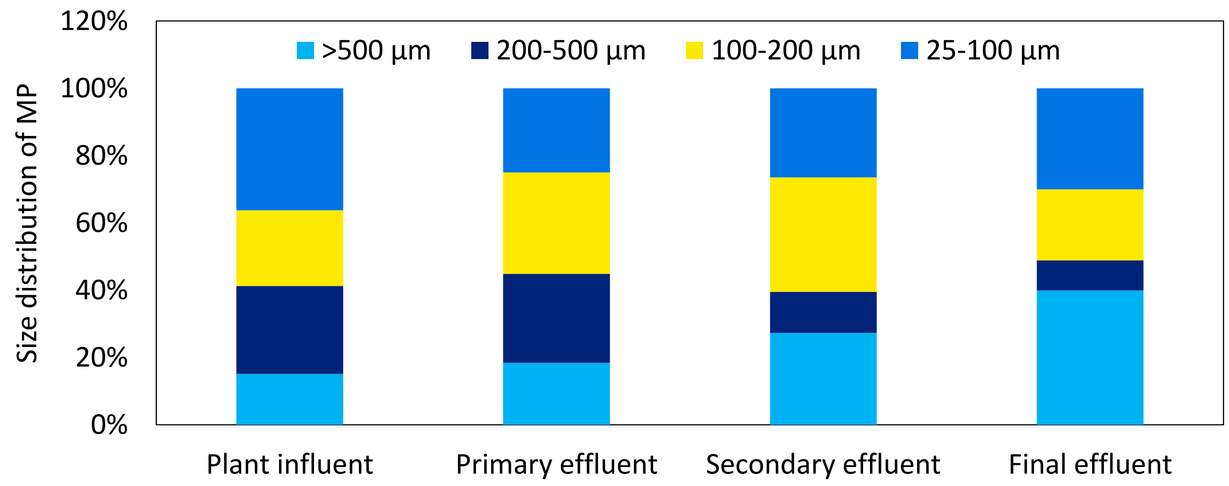

Fig.5. Size distribution of MP along the WRP A treatment process.

CONCLUSIONS

- MP concentrations in WRP influent and effluent were 39.6-52.5 MP/L and 0.17-1.66 MP/L, respectively.
- Tertiary treated Class A recycled water from WRP A was shown to have the most MP removed (99.5%).
- Lagoon-based secondary treated Class C recycled water from WRPs B and C was shown to have significant MP removed at 96% and 98.4% respectively, with the screen-activated sludge process of WRP C being more effective than the facultative lagoon of WRP B.
- The majority of MP are removed through primary treatment processes with 62% and 55% of MP removed through the primary treatment processes at WRPs A and C, respectively.
- Fibres were the most abundant MP type (>50%) in the influent, followed by flakes, fragments, and beads, at all three WRPs.