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CIWEM Urban Drainage Group Annual Conference 2023

6 – 8 December 2023

The Eastside Rooms Birmingham

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Microplastics in highway runoff

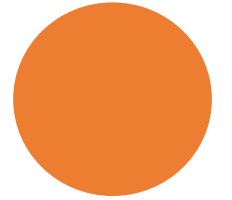
Dr Judith Brammer, Prof Richard Thompson and
Florence Parker-Jurd

FCIWEM



Who makes the most tyres each year?

- Lego!
- Peak production of 381 million
tyres in 2010



Why are we
interested in
highway runoff?





Objectives

- Quantify the contribution from the National Highways Strategic Road Network (SRN) to aquatic environments
- Quantify the magnitude of difference between straight and curved sections of the network
- Explore the retention effectiveness of existing management approaches

Literature review findings

- Sources of microplastics are well understood and include; tyre wear particles, road markings/surfaces and road dust
- Research of Ecotoxicology of microplastics is in its infancy
- Further research is needed into:
 - The implications of using more plastic additives in road surface materials
 - Influence of variables controlling microplastics
 - More quantitative studies are needed, especially in UK
 - The effectiveness of road drainage infrastructure and how to optimise design and maintenance

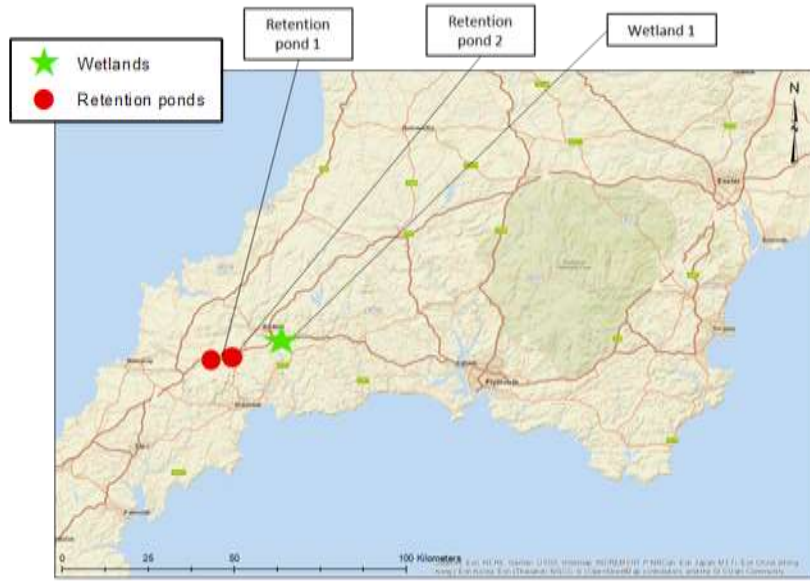




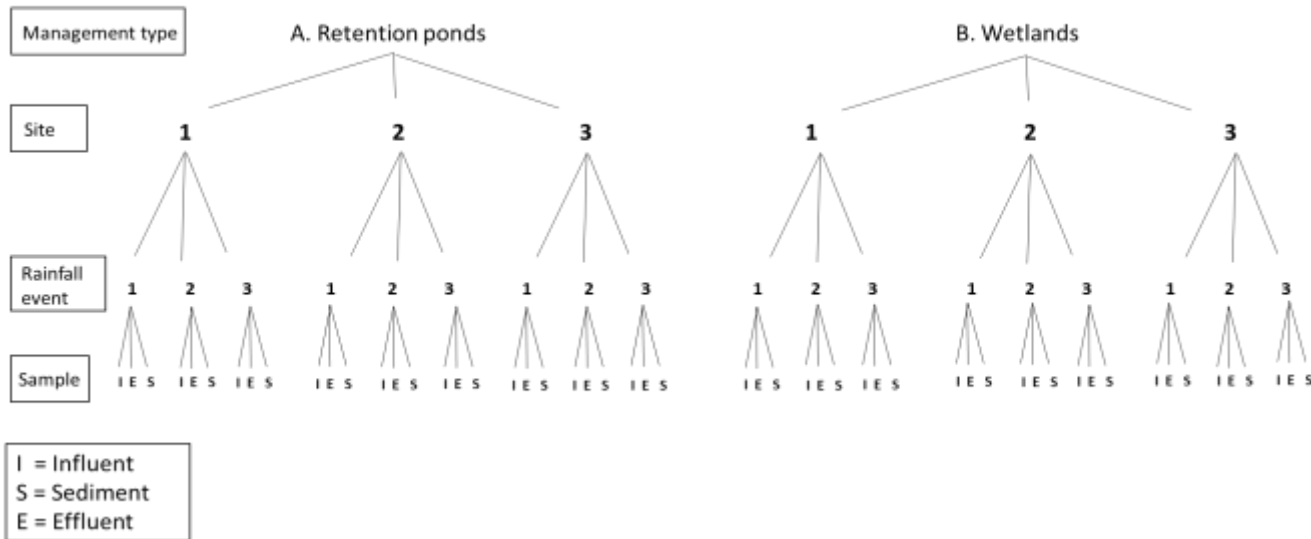
Literature review findings

- Analytically new techniques are being developed;
 - e.g. the use of organic tyre constituents as markers and the use of a LDIR (laser direct infrared) analyser.
 - density of tyre wear particles is variable and can influence behaviour
 - visual identification of yellow and black particles
 - method for paint fragment analysis.
- There's a growing body of research on most appropriate methods, and considerations to be undertaken, for sampling microplastics.
- Monitoring data now exists for roadside drains, road dust, runoff treatment basins and soil adjacent to roads.

Sampling design & site selection



Survey sites.

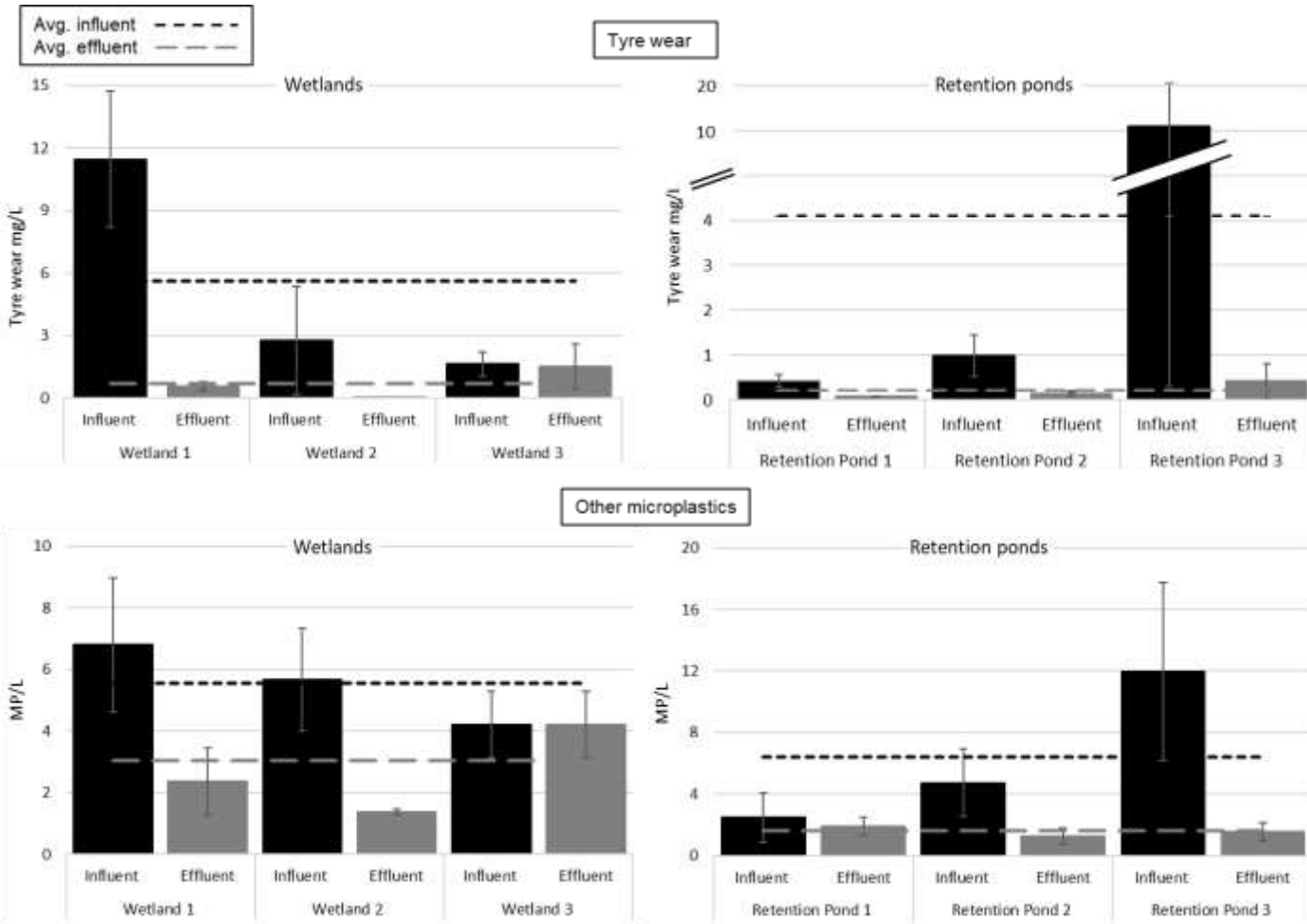


Sampling design.



Left: A wetland on the A453 in the Midlands. Right: A retention pond on the A30 Nr. in Cornwall.

Study findings



Concentrations of TWPs (mg/L) and other MPs (MP/L) in the influent and effluent of three wetlands (left) and three retention ponds (right), averaged over three separate rainfall events. Error bars represent standard error over the three sampling occasions. Dashed lines represent the average concentration across all sites and rainfall events.

TWPs

Wetlands

- Wetlands removed between 13.6 and 99.7 % of TWP mass (Avg. 72.6 % \pm 14.5)

Retention ponds

- Retention ponds removed between 38.4 – 99.9 % of TWP mass (Avg. 77.2 % \pm 7.4)

Other MPs

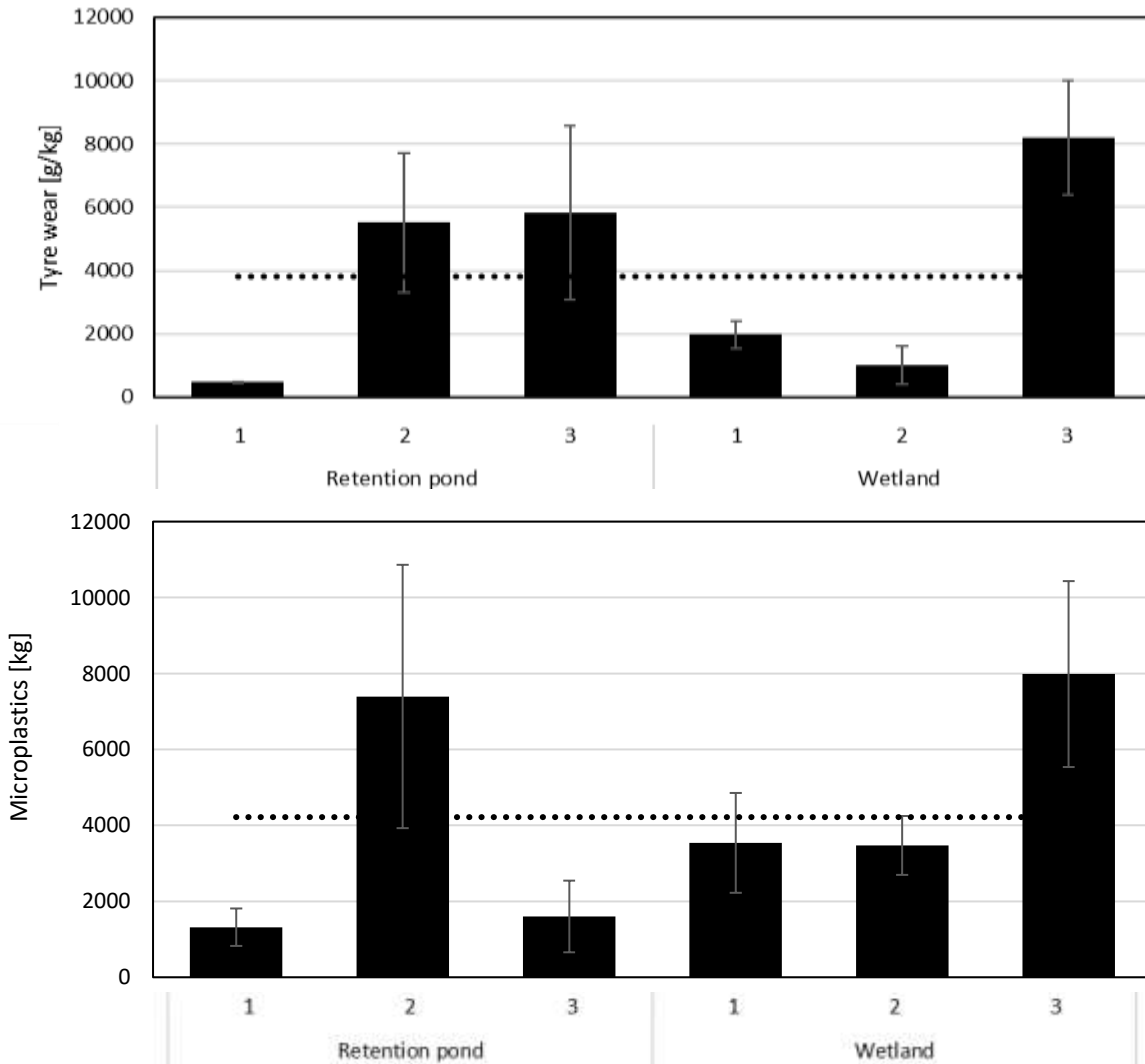
Wetlands

- Wetlands removed between 25 and 93.3 % of other MPs (Avg. 36.5 % \pm 15.7)

Retention ponds

- On average retention ponds removed 42.7 % \pm 16.4 of other MPs

Study findings



Concentrations of TWP's mg/g (top) and other microplastics MP/g (bottom) in the sediment from three wetlands and retention ponds, averaged over three separate occasions. Error bars represent standard error of the three sampling events. Dashed lines represent the average concentration across all sites and sampling events.

Sediments

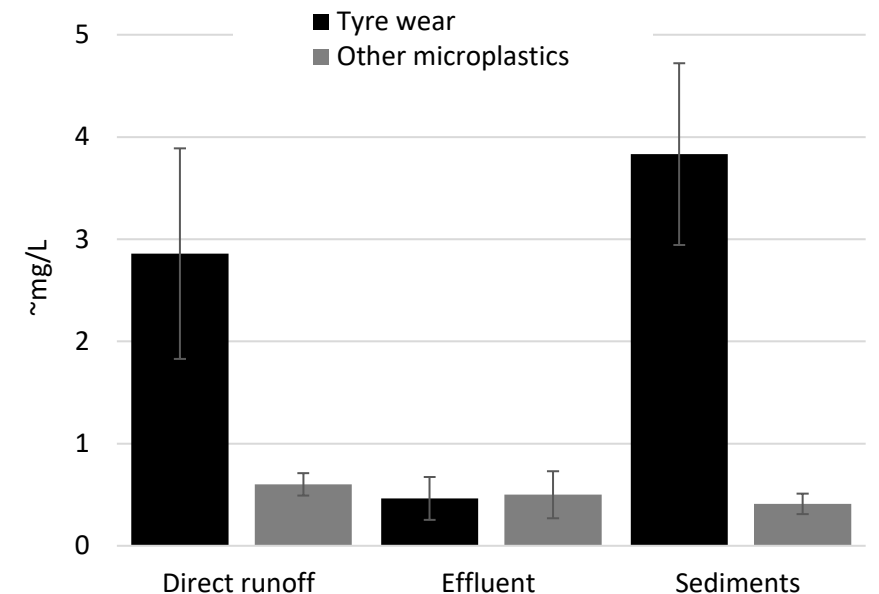
- Concentrations of TWP's and other MP's per kg of sediment far exceeded concentrations per kg (or litre) of influent -> further evidencing their removal from suspension

Total Suspended Solids (TSS)

- The relationship between TWP's & TSS content were significantly correlated indicating a possible proxy for tyre wear -> but requires a more targeted study

Key findings

- Confirmation that TWP and other MPs are prevalent in road runoff from the SRN
- TWP are at the lower end of the ranges in published literature & other MPs within ranges previously reported
- The presence of a wetland or retention pond typically reduced emissions of TWPs and other MPs entering receiving waters but considerable variability was observed among sites
- TWP mass was greater than the *estimated* mass of other MPs in runoff from the SRN and in wetland and retention pond sediments -> the mass of both TWPs and the *estimated* mass of other MPs in pond effluent were similar, evidencing TWPs were more readily removed than other MPs
- The removal ranges are in line with established removal efficiencies for dissolved copper, dissolved zinc and suspended solids
- The statistically significant correlation between TWPs and TSS content is promising; however, further study is recommended
- The knowledge gaps identified during this research into TWP and other microplastics reflect the emerging nature of these pollutants.



The relative mass of tyre wear (mg/L or mg/g) vs. the estimated relative mass of other microplastics (mg/L or mg/g) within direct drainage, pond effluent and pond sediments

Recommendations for further study

- Establish which permutations of pond design influence TWP & MP retention
- Sample at greater range of spatial and temporal scales
- Investigate what permutations of tyre tread design influence wear rates
- Detailed examination on the suitability of TSS as a proxy for TWPs in future monitoring,
- Assess relative importance of influencing of factors such as driving style & vehicle maintenance on TWP contamination

Potential mitigation measures

- Enforce policies around wear rate limits -> more viable than retrofitting drainage assets across the SRN or capturing particles once in the environment
- Optimise the maintenance schedules of assets to maintenance to maintain efficiency
- Increase the frequency of cleaning and maintenance of roadside litter -> reduce fragmentation of larger items of litter by mechanical action of passing vehicles or by strimming/mowing of roadside banks

**Any modifications to mitigate TWPs & other MPs should be implemented with consideration of requirements for flood risk management*

National Highways Research Publications

Phase 1

Investigation of 'microplastics' from brake and tyre wear in road runoff (2019-2020 publications)

Phase 2

Microplastics and Contaminants of Concern in the Strategic Road Network (2023-2024 publications)

Research Publications available at:

<https://nationalhighways.co.uk/our-work/innovation-and-research/research/research-publications/>



Thank you

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 **AtkinsRéalis**

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Steering group members:
Environment Agency, Defra, Roadcare
and British Tyre Association