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Microplastics and Sustainable Drainage Design

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Plastic pollution is an environmental topic that is getting increased coverage and is emerging on the public, scientific, and political agenda. It is also the focus of the work undertaken by Stormwater Shepherds and many other non-profit organisations across the globe. While plastic pollution is often highly visible, with a gratifying before and after picture of any clean-up operation, microplastics pose a significant threat to the ecosystem and often go unchecked.

A microplastic is defined as a plastic particle that is less than 5mm in length. While this does not seem that small, most microplastics are often much smaller, in the region of 1–1000 µm (microns). They are typically divided up into two main categories, dependant on their source.

Primary microplastics are plastic particles that are directly released in the environment as small particles and are estimated to represent about a third of microplastics in the oceans. The main sources of primary microplastics are laundering of synthetic clothes, abrasion of tyres through driving and intentionally added microplastics in personal care products.

Secondary microplastics tend to originate from degradation of larger plastic objects, such as plastic bags, bottles, or fishing nets and these account for about two thirds of microplastics found in the oceans.

The Scale of the Issue

Microplastics are found in growing and significant quantities in the ocean, some sources have estimated that there are as many as 50 trillion microplastic particles in the seas. Due to their hydrophobic surface, microplastics can adsorb and concentrate hydrophobic organic contaminants to a high degree. They also accumulate heavy metals such as cadmium, zinc, nickel, and lead, meaning the plastic itself is not the only potential contaminant.

Microplastics found in the sea can be ingested by marine animals, the plastic then accumulates and can end up in humans through the food chain. Studies show that they have been found in food and drinks in significant quantities, including (but not limited to) beer, honey and tap water.

A medical study has undertaken research on autopsies and discovered that worryingly microplastics are now often present in most organs in the human body in some form. Researchers found evidence of plastic contamination in tissue samples taken from the lungs, liver, spleen, and kidneys of donated human cadavers.

Microplastics in Water

Microplastics may enter drinking-water sources and the food chain in several ways. From developments and urban areas, the plastics come from surface run-off (including breakdown of macroplastics) and from wastewater effluent (both treated and untreated). There is also a significant

contribution from combined sewer overflows (a current hot topic), industrial effluent, degraded plastic waste and atmospheric deposition. For the primary microplastics, surface run-off (tyre wear) and wastewater effluent are globally recognized as the two main sources.

Road Drainage

A study undertaken in 2020 by DEFRA indicated the huge volumes of tyre microplastics being shed all along the UK's motorways and trunk roads. The report is the first to provide real-world evidence on plastic particles from tyres in road runoff, which is a significant contributor to microplastic pollution.

The report indicates that we could be contaminating up to 100 million square metres of the UK's river network and 50 million square metres of estuarine and coastal waters through tyre erosion. Experts have warned that there must be urgent action to protect rivers and seawaters at pollution hotspots.

Road drainage is often considered the antiquated old partner of new development drainage, with design codes and best practice trailing the current standards for residential or commercial schemes in both water quantity and water quality control.

A recent study suggests there should be more and better use of gully pots to catch debris, sediment and microplastics at the roadside. But gully pots in themselves do not prevent the captured sediment from being flushed out again during heavy storms. To avoid washout, gully pots need to be emptied frequently. This is an expensive option requiring lane/road closures and high levels of manpower to complete. New road designs must consider a sustainable drainage approach that will control pollution, water quality and capture microplastics as well as manage run-off from the road. Stormwater Shepherds Australia and Jo Bradley in the UK have a significant amount of knowledge and completed several research papers on this topic.

New Developments

There have been some studies in Europe that identify different SuDS features and their ability to remove microplastics from the run-off on site. In the effort to deliver a scheme that balances the four pillars of sustainable drainage, this is yet another variable to consider in the design.

The reduction of microplastics using SuDS has some variation dependant on the parameters of the area that is being examined, so there is not a one size fits all solution to include in the design. The high microplastic concentrations typically found in urban stormwater systems for new developments is a higher risk due to the potential for the system to attenuate and release water during significant storm event, increasing the chance of washout of sediment.

Given that there is a tendency for microplastics to stick to larger particles, the use of silt traps, catchpits and other such sediment removal devices can provide protection against the transit of microplastics to the end of the network.

Research indicates that stormwater ponds and wetlands installed at the downstream point of a new surface water system could be an efficient barrier of microplastics and prevent transit downstream. Selective planting and treatment methods within natural drainage devices could assist in the reduction of microplastics and should be considered as part of the overall design.

There is also benefit provided in systems that use a form of filtration media and stone, such as porous surfaces and rain gardens. These typically have a porous membrane as a filter material and can act as a barrier for microplastic transit or contain some biological product that can assist with the decomposition of pollutants.

Foul Water Treatment

Not much can be done on a site level to manage the wastewater discharge and remove any potential contaminants. Unless the site contains a specific foul water treatment unit, the discharge will likely flow to the local treatment works.

A critical review of wastewater treatment plants indicates that they removed an average of between 88% and 94% of microplastics. The study shows that most plastics were removed during preliminary and primary treatment.

Similarly, a study by Water UK indicates that over 99% of microplastics are successfully removed during water treatment for drinking water, although they do note that there should be a greater effort made to prevent microplastics entering the system at source. While this reduces the concern for our tap water, there is still a risk from the treated and untreated water entering the storm water network. So any potential design should consider foul water treatment on site as an environmentally sound alternative.

Summary

It cannot be denied that plastic is a vital raw material, integral to the manufacture of everyday products. The amount of plastic in the world is not going to decrease anytime soon, despite people's best efforts to use it sustainably. Two-thirds of the microplastics in the ocean can be controlled with better use and disposal of plastic products so they do not end up in a water body, which is something that we have the power to change.

There are a lot of facts stated above that are potential nightmare fuel, but we should not worry that everything we eat, or drink may be having a detrimental effect on us or putting foreign bodies inside us. Awareness is being raised and systems are being generated to ensure that microplastics are targeted in the treatment of items such as drinking water.

This of course does not solve the problem for marine life and our ecosystem (and ultimately our food chain). They still must deal with the significant volumes of plastic (macro and micro) entering water bodies. Therefore it is our responsibility to do what we can to design plastics and microplastics out of any run-off from developments and protect the downstream water network.

Sources

Microplastics in urban and highway stormwater retention ponds

Autopsies show microplastics in all major human organs

Microplastics removal in wastewater treatment plants: a critical review