DRAINAGE DATASHEET
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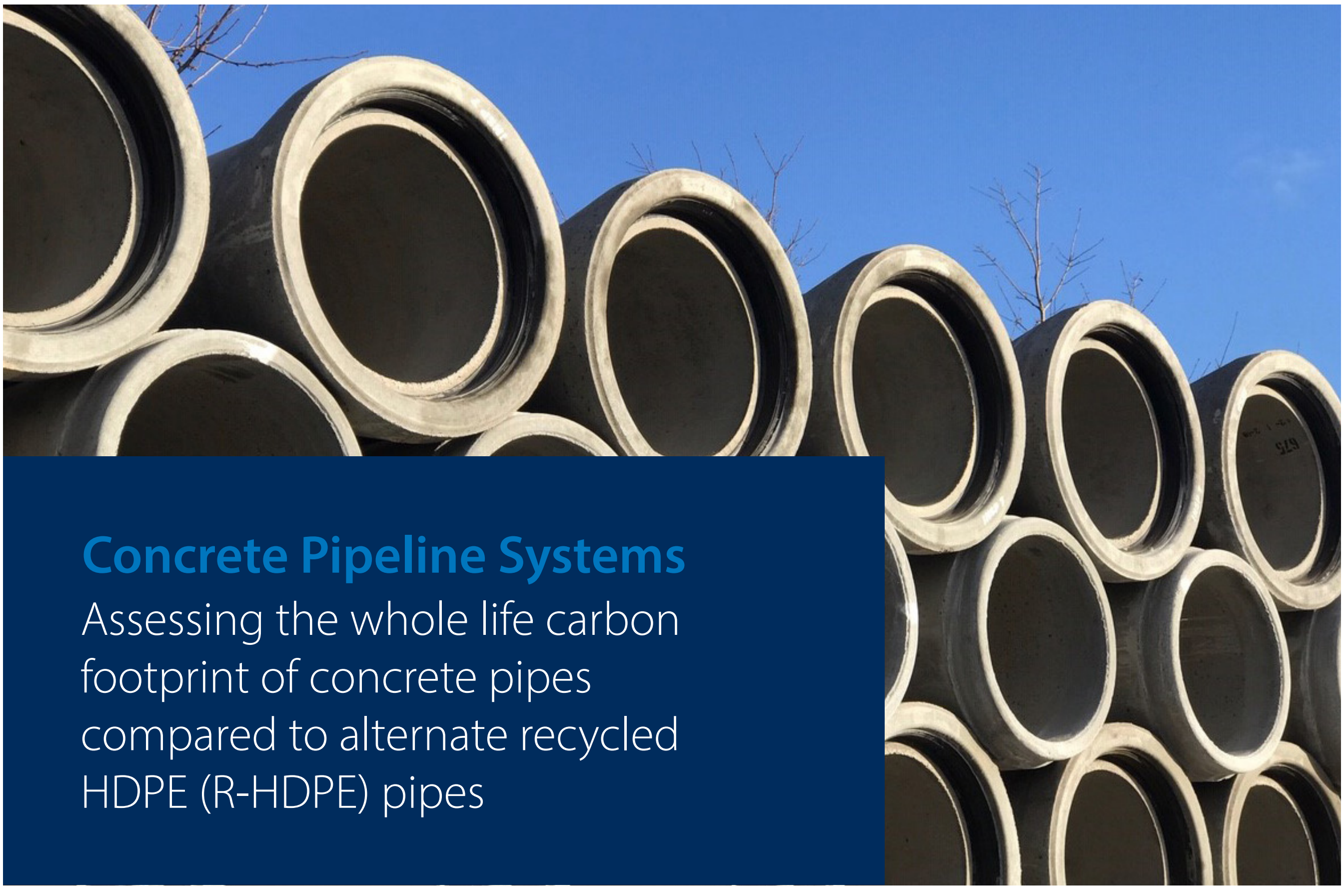

Concrete Pipeline Systems

Assessing the whole life carbon footprint of concrete pipes compared to alternate recycled HDPE (R-HDPE) pipes

In the Autumn of 2021, MPA carried out a simplified Whole Life carbon assessment exercise to understand the likely carbon footprint of pipes made of recycled HDPE.

Using data available in the public domain, both locally and internationally, we adapted a calculator tool developed for us by consultants Circular Ecology to compare the carbon footprints of concrete pipes and pipes made of recycled HDPE materials. Our assessment revealed very little difference between a 100% recycled content pipe and some alternatives made of virgin HDPE. Concrete pipe installations performed better compared to recycled HDPE pipes in terms of carbon emissions by 51% to 56%. Even when the same service life (50 years) is assumed, the carbon emissions associated with concrete pipe installations were still up to 8% lower.

1. Introduction

With the rise in use of recycled HDPE in drainage and sewerage pipeline products, questions are being raised across the water industry about the likely carbon footprint of such types of pipes. Despite the availability of literature on the carbon benefits of recycled HDPE, it is still unclear how such types of pipes would perform against virgin HDPE pipes or other alternative pipeline systems such as concrete pipes. There is every reason for a 100% recycled content pipe to have a significantly low carbon footprint as the process of recycling is unlikely to lead to Greenhouse gas (GHG) emissions as significant as those associated with virgin olefins. A study by the European Commission's JRC found out that injection moulded R-HDPE chairs can have a carbon footprint 28% lower than chairs made of virgin HDPE. However, the carbon footprint of a recycled plastic product is likely to include wider operations and more stages associated with reclaiming, sorting, and transporting plastic waste bales prior to recycling. Sourcing recycled HDPE from abroad could also add to the carbon footprint. The likelihood of further waste failing product specification could be high as well, leading to additional product waste and further carbon losses. All these elements combined can have an unexpectedly high impact on a carbon footprint.

This factsheet starts first with the development of a likely carbon footprint for an HDPE pipe with 100% recycled content R-HDPE. As much information as possible from manufacturers' websites and videos were used. A number of assumptions are made to develop a likely list of ingredients for the product in question. Scenarios were also developed to re-build a likely supply chain, involving plastic waste collection and transport of bales, for such product. A model is then used to compare two installed pipeline systems made of concrete and recycled HDPE pipes.

2. Understanding the carbon footprint of recycled HDPE pipes

2.1 Scope and boundary

The assessment suggested covers part of embodied carbon only. This includes Modules A, and Module B4 (replacement). Although the End-of-Life of concrete drainage products (Module C) is widely understood, that stage was excluded due to lack of information and understanding about R-HDPE drainage products and their likely use after their End-of-Life. It is not clear if such recycled HDPE will be reusable in any application whether today or in the future. Moreover, the calculator used did not account for EoL.

This is why Module C was excluded. The assessment is mainly for a Declared Unit of 1 metre of pipeline of recycled HDPE pipe. The study boundary used is as described in Figure 1.

2.2 Service life

In line with PAS 2080, a 120 years' lifespan for a pipeline is assumed (known as Reference Study Period in PAS 2080/ ISO 15978).
The service life for pipes made of recycled HDPE is assumed to be 50-60 years as this is the lifespan currently proposed in most BBA certificates for such type of pipes.

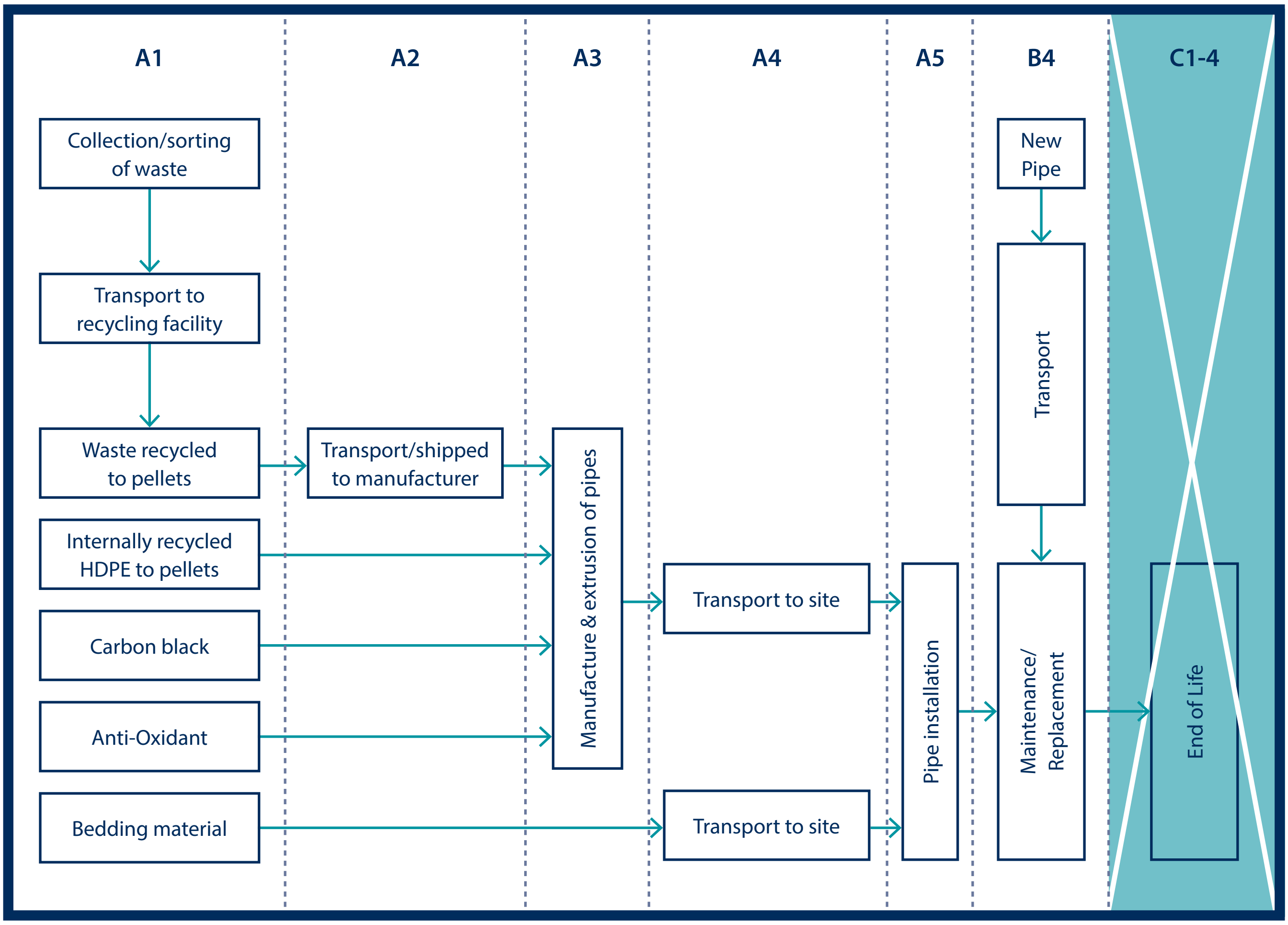

Figure 1
Lifecycle stages included in the carbon assessment.

2.3 Cradle to Gate (A1 – A3)

Three main sources were assumed for the recycled HDPE, requiring three different scenarios for the assessment of Lifecycle Modules A1 (raw material supply) and A2 (transport of raw material):

2.3.1 Local waste handlers

Local waste handlers such as Biffa and Veolia can all supply recycled HDPE pellets or waste plastic products which a pipe manufacturer can then recycle and use. The impacts of a local waste handler recycling were based on carbon factors reported by Biffa (Biffa, 2019). For pipe manufacturer recycling, assumptions were made for the impact of collecting and sorting suitable plastic waste, transport of waste bales to a pipe manufacturing recycling facility and further transport to manufacturing sites.

It was assumed that 33.3% of all resin used was supplied via such route.

2.3.2 International suppliers

The UK is a net importer of recycled PE resin. This is believed to be the main route for many users of recycled PE in the UK. However, it was not possible to identify the most likely source of recycled HDPE exported to the UK. A source in East Asia was assumed as many of the world's top exporters of R-HDPE are located there. Data for the carbon impacts of HDPE recycling were sourced from an International study by University of California (Zheng & Suh, 2019). Additional impacts were added for the shipping of recycled HDPE resin and some land transport to, and from, ports.

It was assumed that 33.3% of all resin used was supplied from abroad.

2.3.3 Internal recycling

A third viable source is pipe manufacturers' own re-processing of production waste and offcuts. Product waste and off-cuts sourced from manufacturers of similar products was also treated as internal recycling. Internal recycling in EN 15804 based assessment is usually treated in a similar manner to virgin products being internally reprocessed. The structure of the current Plastics Europe study (the one used for baseline data on pipes' carbon footprint) does not characterise factory and off-cut waste as ZERO carbon.

It was assumed that 33.3% of all resin used was supplied via this route.

2.4 Transport and construction on site (A4-A5)

A transport distance (from pipe factory to site) of 100 km was assumed. The Recycled HDPE pipe will require a full bedding surround (Bedding Class S).

2.5 Replacement (B4)

Recycled HDPE pipes are currently not designed to any specific standards and are offered 50 years lifetime only in BBA Certifications. Based on EN 15978, in order for such pipes to serve for 100+ years at least one replacement will need to be accounted for during the pipeline service life period.

The calculator model developed by Circular Ecology, did not include a complete End-of-Life Stage (Module C). Therefore, this stage was excluded from the assessment.

The service life for pipes made of recycled HDPE is assumed to be 50-60 years as this is the lifespan currently proposed in most BBA certificates for such type of pipes.

3. Comparison with concrete pipes over 120 years RSP

The recycled HDPE pipe with a Class S bedding was compared with a concrete pipe with a half surround bedding (Class B). The comparison accounted for the fact that concrete pipes are likely to require no replacement as relevant specifications offer concrete pipes and other concrete structures a 120+ years' service working life (Highways England, 2014). Table 1, below, summarises specifications for the two pipeline systems.

	Concrete pipeline	Recycled HDPE pipeline
Declared Units compared	1 metre of DN 600, DN900, DN1500 and DN2100	1 metre of DN 600, DN900, DN1500 and DN2100
	Bedding Class B	Bedding Class S
Reference Service Life	120 years	50 – 60 years
Number of replacements after 50 years	0 replacement	1 replacement
Distance from factory to construction site	100 km	100 km
End of Life Scenario	Excluded	Excluded (unknown)

Table 1
Main study specifications and scenario assumptions.

4. Conclusions

Figure 2 shows the overall findings of the assessment. The results clearly show that concrete pipes are likely to have better performance over the Whole life.

As explained above, End-of-Life impacts were not accounted for in this assessment.

Figure 2 summarises the results of the comparison:

- The Cradle to End-of-Service carbon footprint of a concrete pipe installation was consistently 50-53% lower than for a recycled HDPE pipe.
- The Cradle to Grave carbon footprint of a concrete pipe installation is likely to be >53% higher than that for a recycled HDPE pipe. However, End-of-Life was not included in this exercise.

In general, R-HDPE have a significantly lower carbon footprint than virgin HDPE.

However, when looking at a wide range of aspects such as transport, sorting, management of bales, import of R-HDPE resin from abroad, pipes' type (structured wall with SN4 or SN8 compared to SN2), service life and the nature of their installations, the impacts of R-HDPE pipes can turn out to be significantly high. With the lack of any ISO 14025 and EN 15804 compliant EPDs for plastic pipes manufactured in the UK, it is very difficult to understand the true environmental impact associated with HDPE pipes.

MPA's assessment also does not account for the potential impact of the degradation and treatment of microplastics wastage from plastic recycling plants, which is thought to be significant (Brown, 2023). A more detailed assessment, with third party verification, is needed to further investigate the overall impact of R-HDPE pipes.

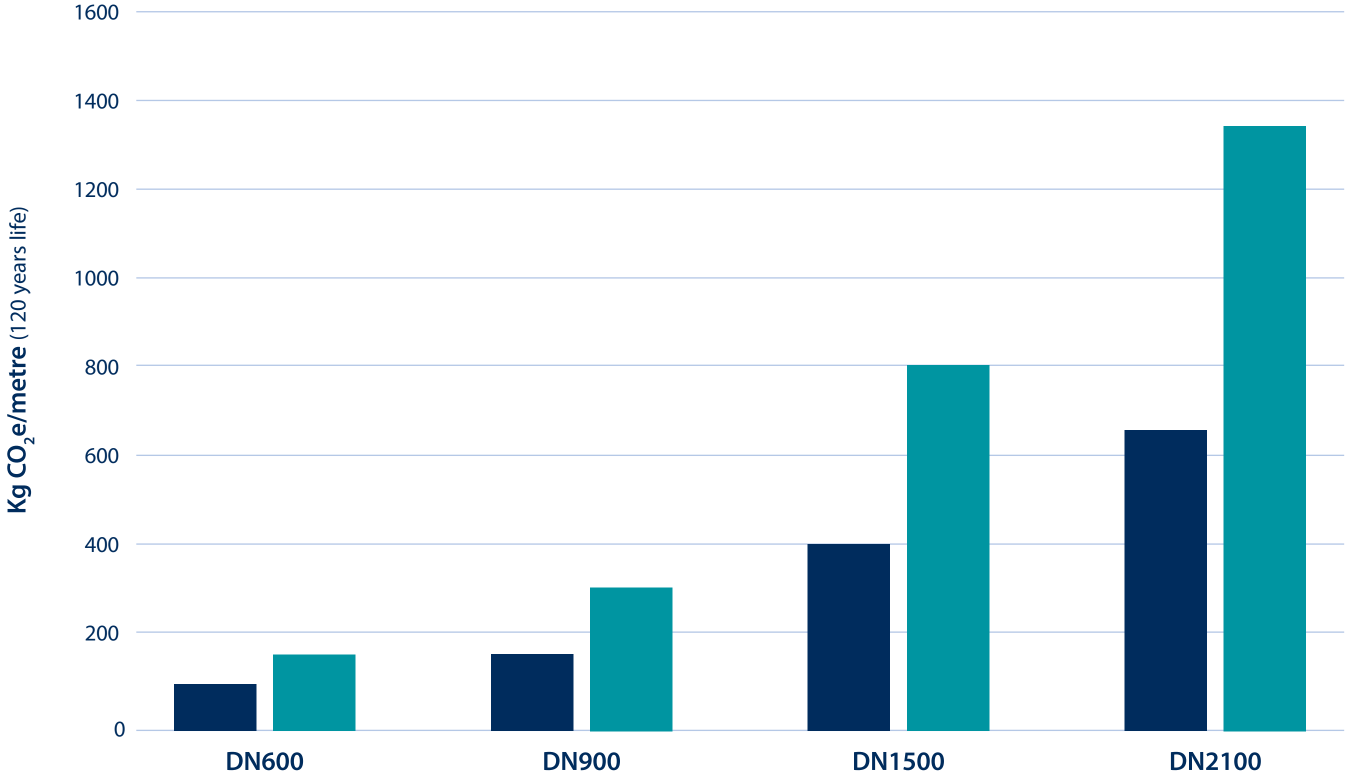

Figure 2
Whole Life Carbon (excluding Module C) comparison of concrete pipes vs recycled HDPE pipe.

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