THE STORAGE OF MICROPLASTICS IN CHANNEL SEDIMENTS

Hazel Beaumont*, Andrew Geary, Neil Philips

College of Arts, Technology and Environment

UWE Bristol

Microplastics (MPs) is an emerging research area. It is argued that the ultimate sink is the ocean (Lebreton *et al.*, 2017) which has been estimated to store up to 98% of all MP (Andrady, 2011; van Sebille *et al.*, 2015). However, recent research suggests MPs are transported and stored within river systems at much higher concentrations (Jambeck *et al.*, 2015; Nel *et al.*, 2018) but the amount of research currently being undertaken in on MPs in fluvial systems is minimum (Qi *et al.*, 2020).

Research into MP transfer in river environments thus far has concentrated on calculating the amount of MP in the river (Nel *et al.*, 2018) rather than working towards understanding where MPs are stored within river systems and understanding the linkage of MPs with sediment bedforms and an understanding of MP dispersal across the floodplain. It is important to understand how rivers transport and store MPs as soils are vital for vegetation growth which will impact on environment and human health. This work aims to understand where microplastics (MPs) are stored within rivers. MPs are becoming prevalent in the news as studies are finding up to 14 million-tonnes of MPs on the ocean floor (Barrett *et al.*, 2020). This is an issue as rivers drain directly into the ocean and there is a current lack of understanding of where and how MPs travel through and are stored within river systems.

The work seeks to be 'proof of concept' for a river sediments sampling methodology along the river bed without disrupting bedforms. The work will use the River Frome, Frenchay, Bristol (**Figure 1**), as the river here is shallow and has relatively low flow rates over the summer months (**Figure 2**); therefore the objectives are:

:

1 – Collect whole bedforms including sediment and MPs from the river bed.

2 – Determine how MPs influence and are stored in the bedforms

3 – Core the floodplain to determine the amount of MPs stored

4 – Undertake lab work to separate the microplastics from the sediment and complete petrographical analysis to determine the type MP.

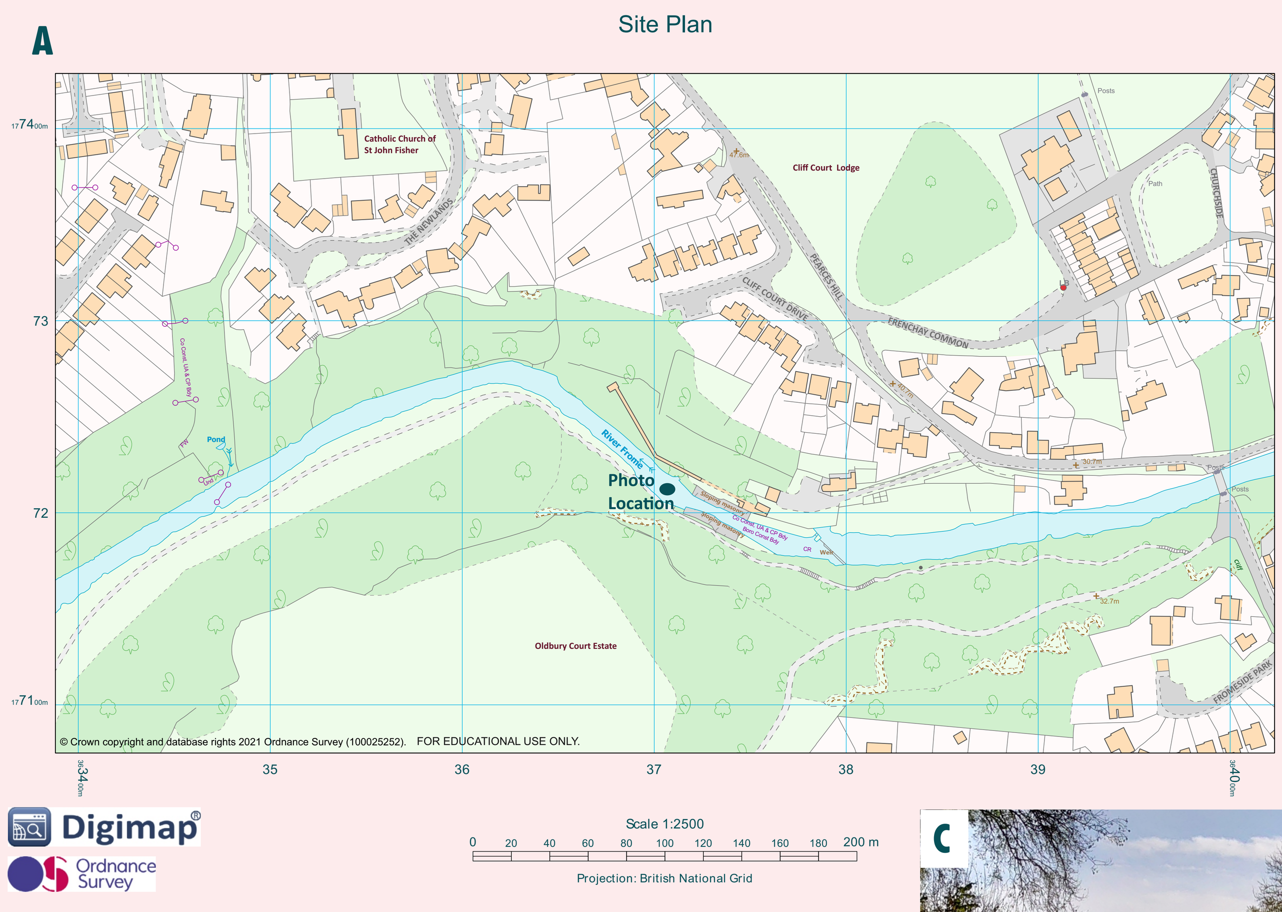


Figure 1: Location and photo of the field site. A) Zoomed in location of Frenchay with the Frome River Valley site next to the sluice (gauge station) monitored by the Environmental Agency; B) Map of the UK indicating where Frenchay is in the southwest of the UK, and; C) A photograph looking east southeast into the sluice where the top of the sluice is 20 m apart. To the north of the river are houses and to the south woodland and public walkways (locations of the coring).

Flow Data

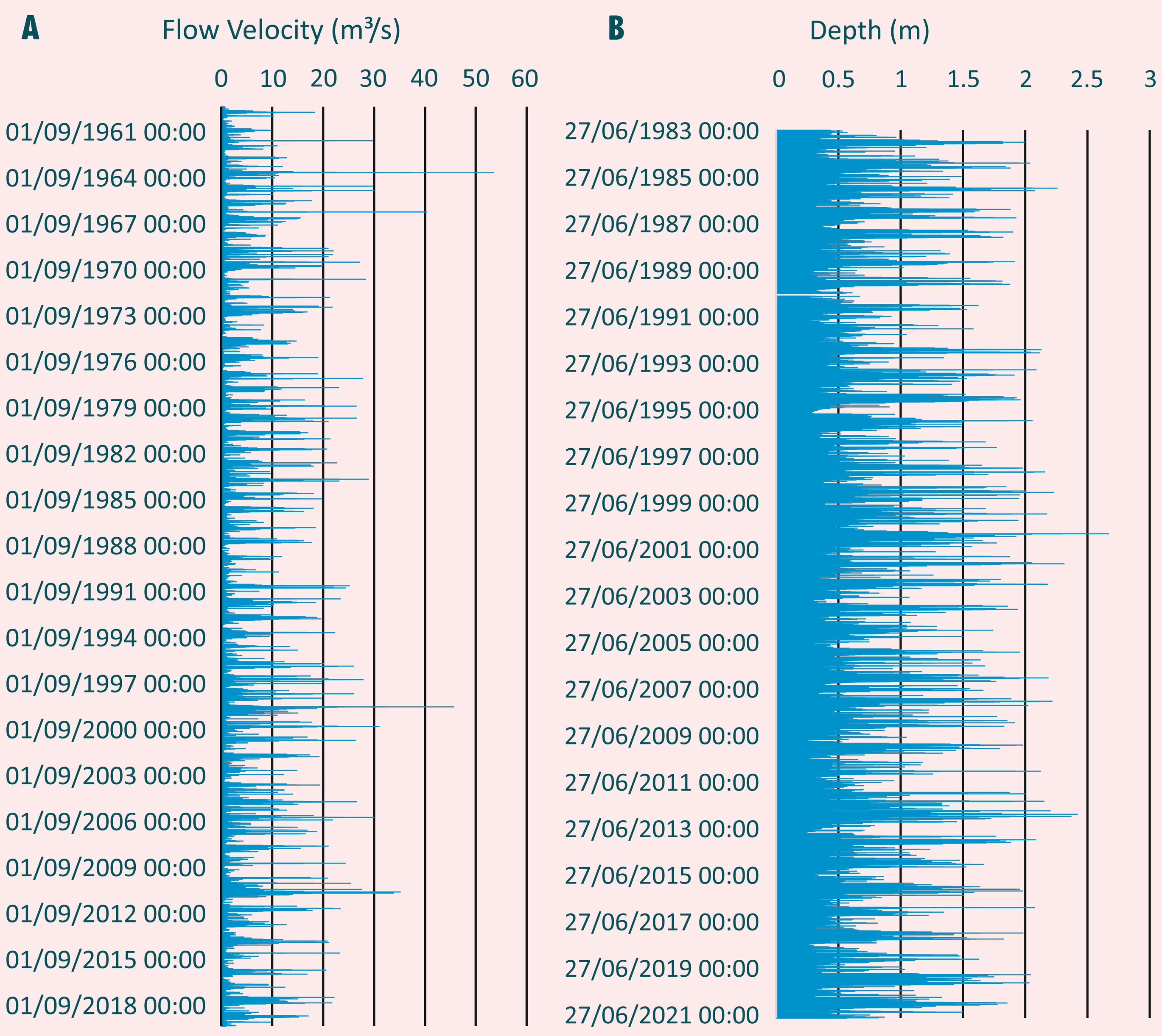
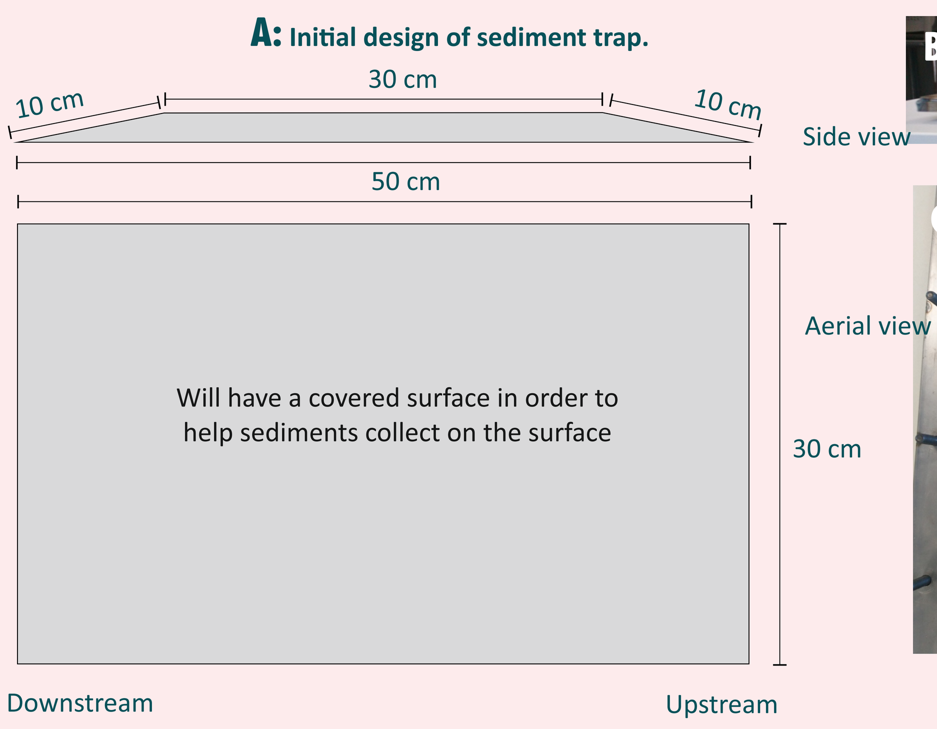
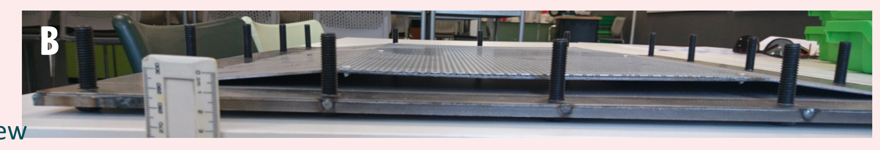


Figure 2: Displaying the flow velocity and depth of the River Frome through the sluice in Frenchay, Bristol. A) The average velocity here is around 2 m^3/s with the peak been 53.5 m^3/s. The dataset is polymodel displaying the average of every month from September 1961 to August 2021, and; B) The average depth here is around 0.7 m with the peak been 2.67 m. The dataset is polymodel displaying the average of every month from June 1983 to August 2021. This data was used to assess when would be the best time to place the sediment collector within the river: August time. Data from Environmental Agency, 2021.

Samplers





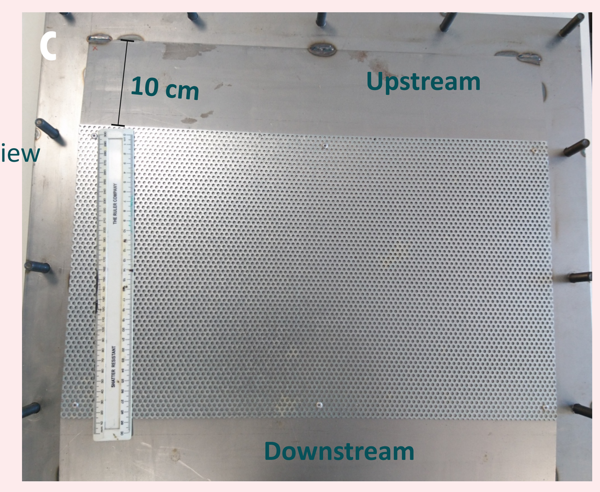


Figure 3: A) Initial sampler design, and; B & C) The built sampler, having tried to place this in the river there are clear issues with the overall design.

What's Next?

Moving forwards the sampler needs to be modified to be lighter with no screws to influence the flow (**Figures 3 & 6**). To continue collecting core data from the area to continue building up a temporal record of the MP flux throughout the area (**Figures 4 & 5**).

Also once data is collected using the newly developed sampler, the project needs to be upscaled for larger rivers that contain more Mps, such as the River Usk (**Figure 7**).

Figure 6: A) Borehole cover with pitting on the top (acting like the channel floor) to allow for bedload sediment collection, image from Specified by (2023), and; B) Tubing to protect the bedforms of sediments as the borehole cover is removed from the channel floor, image from Drainage Superstore (2023).

Figure 7: (above) Image of the Usk River, Newport, South Wales, taken on the Transporter Bridge gondolar looking northeast up the river, in this picture the river is at low tide where the river is around 140 m wide.

Methodology

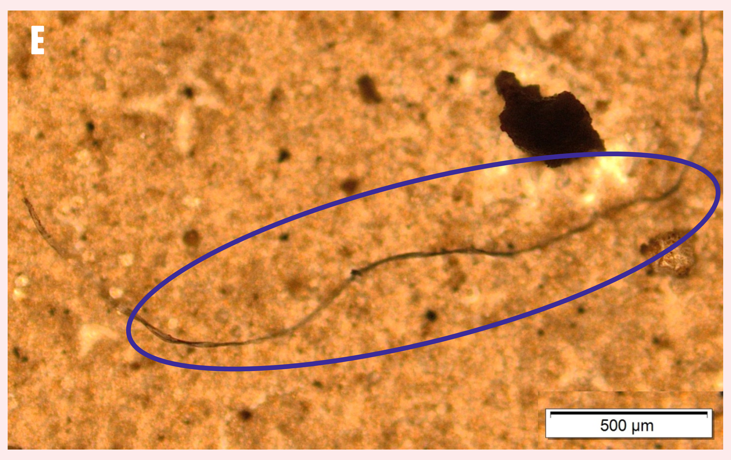
M1 will seek data for **Objective 1** by determining potential storage locations of MPs within rivers. This will involve developing multiple tray/box mechanisms (**Figure 3**) that can sit on the riverbed and allow for bedforms to travel over them. The speed in which the sediment will travel over the tray will need to be worked out from flow rate data (**Figure 2**). We will then turn this tray into a box so water run-off does not destroy the sedimentology when removing this from the river. These trays will need to be replaced every multiple times a year for reliable datasets.

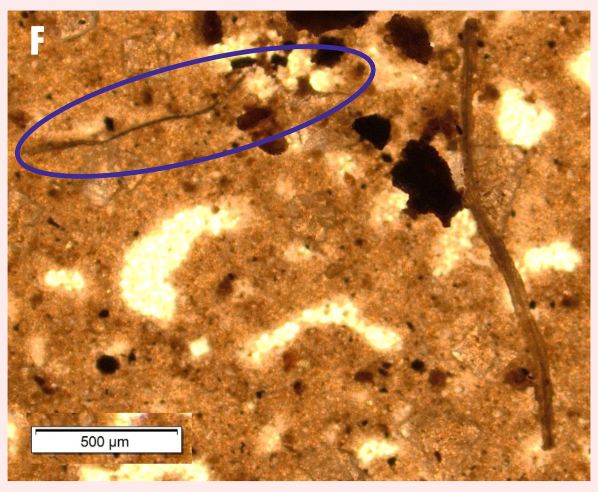
M2 will collect data for **Objective 3** by coring the floodplain (**Figure 4a, 4b**) in a grid system (Bridge *et al.*, 1995) to see how MPs vary spatially across the floodplain. It is highly likely that river flooding will significantly influence this and coring will occur over a number of years to give a temporal dataset.

M3 will core the sediment on the trays for **Objective 2** to see the distribution of MPs across the bedforms. Gelatin-like substance will then be added to the rest of the material on the tray so that the MP influence on the bedforms can be analysed.

Completing **Objective 4** will require separating the MPs from sediments from all core samples (**Figure 4c-4F**) following the methods set out by Coppock *et al.* (2017).

Core Data





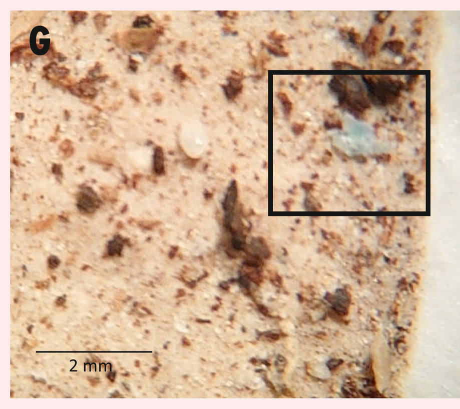


Figure 4: Methodology for collecting and separating MPs. A) Dr Chris Spencer pushing the corer into the floodplain; B) The core material in the corer; C) The sediment-microplastic isolation (SMI) unit containing sodium chloride (using 337g of powder for 1 litre of water (Coppock *et al.,* 2017)); D The separated material ready for the microscope, and; E, F & G) MPs seen within samples; here we see black fibres highlighted by the dark blue coloured ovals (E & F) and pale blue fragment highlighted by the black box (G).

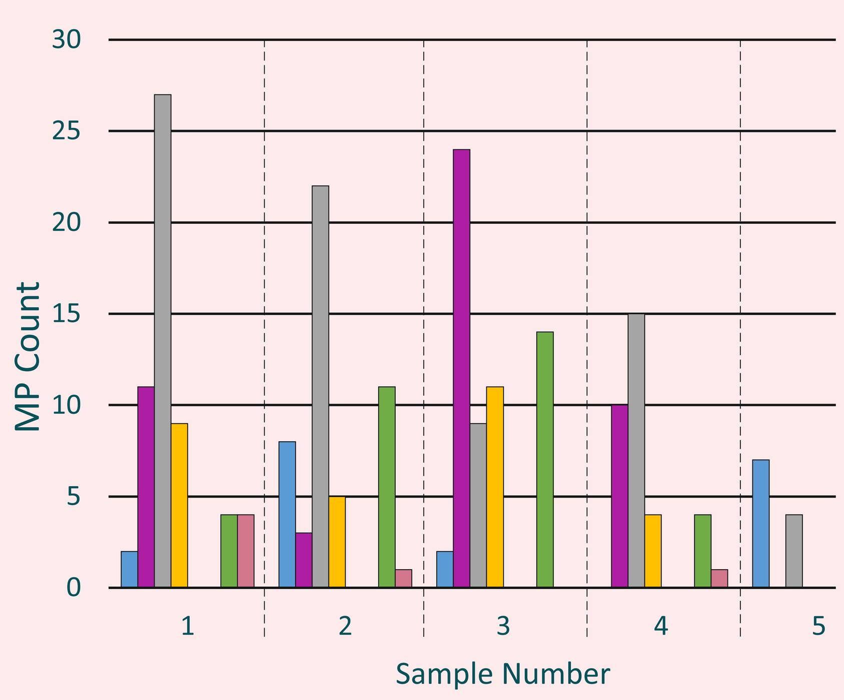


Figure 5: Graph indicating the number of MPs found in each sample from the single coring location as highlighted in **Figure 1**. While multiple cores have been taken not all samples are yet analysed; hence the sparsity of data here.

References

Andrady, A.L. (2011) Microplastics in the marine environment. *Marine Pollution Bulletin* [online]. 62 (8), pp.1596–1605 [Accessed: 25/01/2021].
Barrett, J., Chase, Z., Zhang, J., Holl, M.M.B., Willis, K., Williams, A., Hardesty, BD. and Wilcox, C. (2020) Microplastic Pollution in Deep-Sea Sediments From the Great Australian Bight, *Frontiers in Marine Science* [online]. 7, [Accessed 8/3/2021].
Bridge, J.S., Alexander, J., Collier, R.E.L.L., Gawthorpe, R.L. and Jarvisy, J. (1995) Ground-penetrating radar and coring used to study the large-scale structure of point-bar deposits in three dimensions. *Sedimentology*. 92, pp.839-852
Coppock, R.L., Coleb, M., Lindequea, P.K., Queirósa, A.M. and Galloway, T.S. (2017) A small-scale, portable method for extracting microplastics from marine sediments. *Environmental Pollution*. 230, pp.829-837.
Drainage Superstore, 2023. Accesso 600 mm chamber rise. Drainage Superstore [online] https://www.drainagesuperstore.co.uk/product/accesso-ic160-600mm-access-chamber-riser.html Assessed: 20/06/2023
Environmental Agency, 2021. Data given through email from EA servers.
Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman. M., Andrady, A., Narayan, R. and Law. K.L. (2015) Plastic waste inputs from land into the ocean. *Marine Pollution* [online]. 347 (6223) pp.768-771 [Accessed: 25/01/2021].
Lebreton L.C.M., Zwet, J.V.D., Damsteeg, J-W., Andrady A. and Reisser, J. (2017) River plastic emissions of the world's oceans. *Nature Communications* [online]. 8. [Accessed: 27/01/2021].
Nel, H.A., Dalu, T. and Wasserman, R.J. (2018) Sinks and sources: Assessing microplastic abundance in river sediment and deposit feeders in an Austral temperate urban river system. *Science of the Total Environment* [online]. 612, pp. 950–956. [Accessed: 21/07/2020].
Qi, R., Jones, D.L., Li, Z., Liu, Q. and Yan, C. (2020) Behavior of microplastics and plastic film residues in the soil environment: A critical review. *Science of the Total Environment* [online]. 703. [Accessed: 21/07/2020].
Specified by, 2023. 600 mm plastic manhole cover B125. Specified by a product of Causeway. https://www.specifiedby.com/briscover/600mm-plastic-manhole-cover-b125 [online] Assessed: 20/06/2023
van Sebille, E., Wilcox, C., Lebreton, L., Maximenko, N., Hardesty, B.D., van Franeker, V.A., Eriksen, M., Siegel, D., Galgani, F. and Law, K.L. (2015) A global inventory of small floating plastic debris. *Environmental Research Letters* [online]. 10 (12). [Accessed 25/01/2021].

Acknowledgements:

Vice Chancellors Early Career Award at the University of the West of England was used to fund this research.