RECLAIM OUR RIVERS: WALLINGFORD BEACH

Citizen Science Water Quality Sampling Report 2023

Photo credit: Richard Harding

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Executive Summary

More people than ever are connecting with their local waterways and greenspaces, with a countrywide rise in the number of people taking to their local river for recreation and exercise. The health of our inland waterways has garnered increasing media attention in recent years, leading to an awareness that open waters may not provide safe spaces for recreational use. Meanwhile, there is a lack of information available to the public providing up-to-date, localised water quality data. In Wallingford and the surrounding areas of South Oxfordshire, the river Thames is a treasured natural and cultural asset, demonstrated by its historical swimming spots, rowing races, tourist boat tours and considerable resident boat community. Locals in Oxfordshire have shown demand for a cleaner, healthier river, as evidenced by the successful Bathing Water designation at Port Meadow in Oxford in 2021 and the several attempts to obtain a designation at Wallingford Beach by Thames21 and the Riverside Working Group.

Bathing Water Designations are a means to create more clean, safe outdoor bathing sites. Such sites are tested weekly throughout the bathing season, allowing users to better understand the risks and make informed choices. Designation also helps to increase pressure and direct investment from water companies for improvements required for healthier rivers. Previous attempts to obtain Bathing Water Status have not been successful at Wallingford Beach for various reasons. However, Thames21 has worked with the local authorities and the local community throughout 2023 to prepare and put forward a new application that meets all the required criteria. This project involved weekly sampling at Wallingford Beach, community and stakeholder consultations, and user surveys taken throughout the bathing season.

This report presents the findings of the 2023 bathing water quality sampling, evaluates the potential causes of pollution, and recommends further action needed to ensure our rivers are healthy enough to swim in.

Water Quality Sampling 2023

Water quality sampling during the bathing season monitored levels of 'Faecal Indicator Organisms' (FIOs), here meaning the bacteria Escherichia coli (EC) and Intestinal Enterococci (IE). These bacteria indicate faeces and urine of warm-blooded animals and are a significant threat to human health. The most common risks being gastrointestinal illnesses and infections of the eyes, ears, skin, and kidneys, caused by ingestion or intake of polluted water through open cuts and wounds.

Citizen scientists were trained in both 2022 and 2023 to use an aseptic sampling protocol developed by TH Environmental Ltd for The Rivers Trust (appendix 1). Samples were analysed at Thames Water's accredited laboratory in Reading, using a standard culturing method for bacteria species E Coli and intestinal enterococci ('faecal indicator organisms' or FIOs). The results obtained were compared to the standards for bathing waters set out in the Bathing Waters Directive (2013), as shown in Table 1.

Samples were taken at the bathing site weekly from May to September 2023, equalling 20 samples in all (Figure 1).

Figure 1 - Location of Wallingford bathing water site

Table 1 - Standards for inland bathing waters (Harris 2022; Sagarduy et al.2019)

Parameter	"Excellent"	"Good"	"Sufficient"
Intestinal enterococci(1)	200(2)	400(2)	330(3)
Escherichia coli(1)	500(2)	1,000(2)	900(3)

(1) Colony forming units per 100 millilitres ("cfu/100 ml").
(2) Based upon a 95-percentile evaluation
(3) Based upon a 90-percentile evaluation

Levels of rainfall, as well as the ratio of E.Coli (EC) and Intestinal Enterococci (IE) are important factors in understanding the origins of the FIOs for each sampling point. Due to the different survival rates of Intestinal Enterococci (IE) and Escherichia coli (EC), in this study an EC:IE ratio of 2:1 to 4:1 is assumed to be indicative of point source inputs (e.g. untreated sewage, either from storm overflows or partially treated final effluent) whereas a EC:IE ratio closer to 1:1 is associated with diffuse inputs (e.g. livestock excreta, misconnections). These ratios can help point towards the source of the faecal indicator organisms, although further monitoring and research is needed to evidence those sources (Harris 2022).

Recommendations

- Irrespective of the Bathing Water Status application at Wallingford Beach, targeted higher resolution sampling is recommended to determine sources of FIOs affecting this popular bathing site. This ideally would incorporate both spot sampling and real time probes. eDNA tracing would also help to evidence source apportionment.

Project Methodology

1. Sampling Location

In 2022, eight sample points were chosen to be sampled within the zone of influence to Wallingford Beach (Harris and Walker, 2022), this indicates the impact polluted water from upstream has on the bathing site as it flows downstream. In 2023, samples were taken from a single sample point at the bathing water site (see fig.1) to reflect the methodology the Environment Agency uses for designated sites. Weekly results were displayed on the project Storymaps online.

2. Sampling Frequency

From 15th May to 30th September 2023, samples were taken at the bathing water site on a weekly basis, by trained volunteers. Samples were then couriered to Thames Water's accredited lab in Reading for analysis. All trained samplers followed an aseptic sampling protocol developed by TH-Environmental Ltd for The Rivers Trust (see appendix 1).

3. Sample Analysis

All samples were analysed for presence of Total Coliforms (TC), Escherichia coli (EC) and Intestinal Enterococci (IE) at Thames Water's laboratory, using methods laid out in the Microbiology of Drinking Waters (2018). The method used to analyse samples for EC and TC is the multiple tube method 'Colilert', producing a confirmed result within 18-24 hours. The method used to analyse samples for IE is a 0.45-micron membrane filtration onto selective media (Slanetz & Bartley 1957), producing a confirmed result within 40-48 hours. All samples were carefully handled, and analysed on the same day as sampling, as per requirements laid out in the Bathing Water Regulations (2013) (Harris 2022).

4. Statistical Analysis

All results obtained were required to be statistically analysed and converted to a "percentile value", based on a percentile evaluation of the log10 normal probability density function of microbiological data used for the assessment, as detailed in the Bathing Water Regulations (2013).

To be able to derive a percentile value the following method (Harris 2022) was followed:

a) take the log10 value of all bacterial concentrations in the data sequence to be evaluated or, if a zero value is obtained, take the log10 value of the minimum detection limit of the analytical method used.
b) calculate the arithmetic mean ("μ") of the log10 values taken under paragraph (a);
c) calculate the standard deviation ("σ") of the log10 values taken under paragraph (a);
d) derive the upper 90-percentile point of the data probability density function from the following equation: upper 90-percentile = antilog (μ + 1.282 σ); and
e) derive the upper 95-percentile point of the data probability density function from the following equation: upper 95-percentile = antilog (μ + 1.65 σ).

The conversion to a “percentile value” was done on all collated EC and IE results obtained from the sample point over a defined period, the obtained result was then compared against the outlined water quality standards (Table. 2).

Table 2 - Bathing water quality designations (Harris and Walker, 2022)

	E.coli		
	BW status	**Levels**	**Percentile**
	Excellent	500	95
	Good	1000	95
	Sufficient	900	90
	Poor	>900	90
	Enterococci		
	BW status	**Levels**	**Percentile**
	Excellent	200	95
	Good	400	95
	Sufficient	330	90
	Poor	>330	90

Results & Analysis

Bathing Water Status Overall Designation

Table 3 – Overall bathing water status designation (90th percentile)

	Log total A	No of Samples	Arithmetic Mean	Std Dev		
E.coli	52.24	20	2.61	0.30		
Enterococci	37.99	20	1.90	0.44		
E.coli						**overall status**
90 PERCENTILE				1002.46	Poor	Poor
95 PERCENTILE				1296.60	NA	
Enterococci						**overall status**
90 PERCENTILE				293.71	Sufficient	Sufficient
95 PERCENTILE				427.61	NA	

Weekly Breakdown

Table 4 – Weekly breakdown of results obtained from bathing water sample point: Values below 1000 MPN/100ml for EC or 400 cfu/100ml for IE are classified as good under the bathing water standards.

Date	Week	Sample ID	Sample Point	E.coli (EC) MPN/100ml	E.coli status	Enterococci cfu/100ml	Enterococci status
15/05/2023	1	F10591952	A	308	Good	29	Good
24/05/2023	2	F10591953	A	194	Good	26	Good
04/06/2023	3	F10591954	A	86	Good	10	Good
08/06/2023	4	F10591964	A	155	Good	27	Good
14/06/2023	5	F10591955	A	757	Good	30	Good
22/06/2023	6	F10591965	A	613	Good	121	Good
29/06/2023	7	F10591966	A	308	Good	45	Good
04/07/2023	8	F10591967	A	214	Good	40	Good
13/07/2023	9	F10591968	A	326	Good	120	Good
21/07/2023	10	F10591969	A	387	Good	72	Good
24/07/2023	11	F10591970	A	613	Good	125	Good
02/08/2023	12	F10591971	A	326	Good	120	Good
07/08/2023	13	F10591956	A	517	Good	500	Poor
15/08/2023	14	F10591957	A	488	Good	113	Good
21/08/2023	15	F10591958	A	687	Good	105	Good
31/08/2023	16	F10591960	A	727	Good	160	Good
04/09/2023	17	F10591961	A	205	Good	105	Good
11/09/2023	18	F10591963	A	816	Good	58	Good
20/09/2023	19	F10591962	A	1553	Poor	760	Poor
27/09/2023	20	F10789483	A	856	Good	130	Good

Rainfall Impact

Rainfall can increase FIO levels in rivers. Heavy rainfall can increase agricultural inputs entering the river, cause storm overflow and combined sewers overflows (CSO) to spill, and cause sewage treatment works to exceed capacity.

The highest rainfall recorded this bathing season at Benson rainfall monitor was on 19.05.23 at 19.2mm. The month with the highest total rainfall recorded at Benson was August, with total rainfall at 67.2mm and a daily average of 2.2mm (Table 5).

Table 5 - monthly precipitation recorded at Benson rainfall monitor (DEFRA N.D)

Monthly Precipitation (mm)	Averages	Totals
May	1.1	19.2
June	1.7	51.6
July	2.0	63.2
August	2.2	67.2
September	1.9	56.4

To assess the impact of rainfall events on sampled FIO levels in rivers we need to know if there was any rainfall up to 72 hours before the sampling was done. Prior to 72 hours before sampling, the impact of rainfall events is negligible on FIO levels due to their lifespan within the river. EC and IE have variable survival periods when outside of the host body, with EC surviving between 36-48 hours and IE between 72-96 hours in both a terrestrial and aquatic environment when variables such as solar degradation and temperatures are accounted for (Harris 2022).

Table 6 - Rainfall event details correlating to sampling dates

Precipitation (mm)		
Sampling Date	Preceding 72 hrs	On Sampling Day
14.06.23	26.4	-
22.06.23	17.2	0.8
29.06.23	4.4	-
04.07.23	3.0	7.0
13.07.23	8.4	0.8
24.07.23	9.0	0.6
02.08.23	5.6	8.4
07.08.23	13.6	1.6
15.08.23	10.8	-
31.08.23	1.6	6
04.09.23	0.4	-
11.09.23	1.2	0.4
20.09.23	24.8	12.4
27.09.23	1.2	-

As table 6 depicts, rainfall events of varying precipitation levels occurred shortly before or during sampling on 14 out of 20 dates. Figures 2 and 3 demonstrate how these rainfall events regularly correlate to spikes in FIO levels, such as after heavy rainfall (17.2mm) on 19.06.23 and in the 72hrs preceding sampling on 20.09.23 (24.8mm). On this sample date, river levels at Benson Lock were 0.09m higher (0.24m) than the average levels (0.15m) recorded during the 2023 bathing water season (River Levels N.D).

Figure 3 - Levels of E.Coli & Intestinal Enterococci throughout sampling season

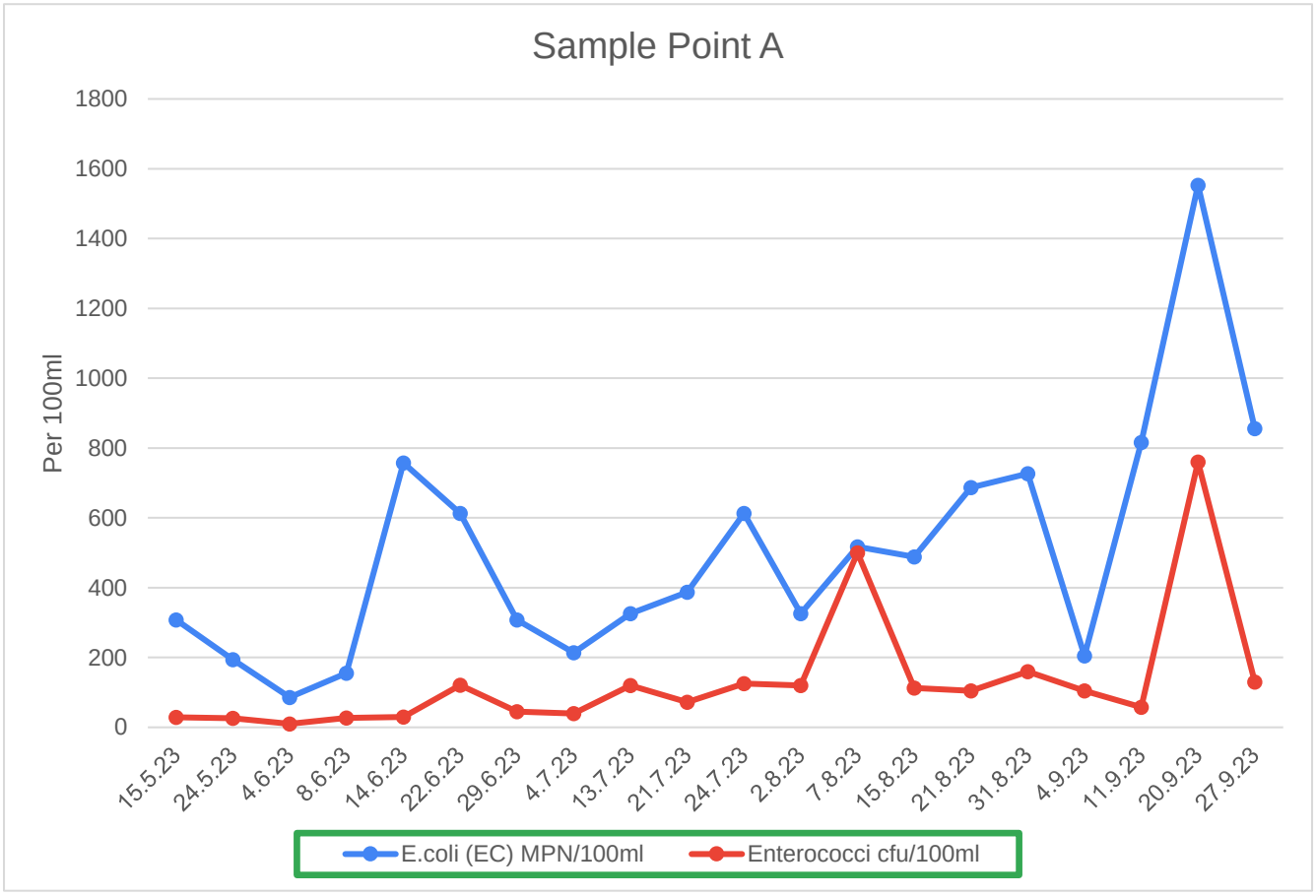
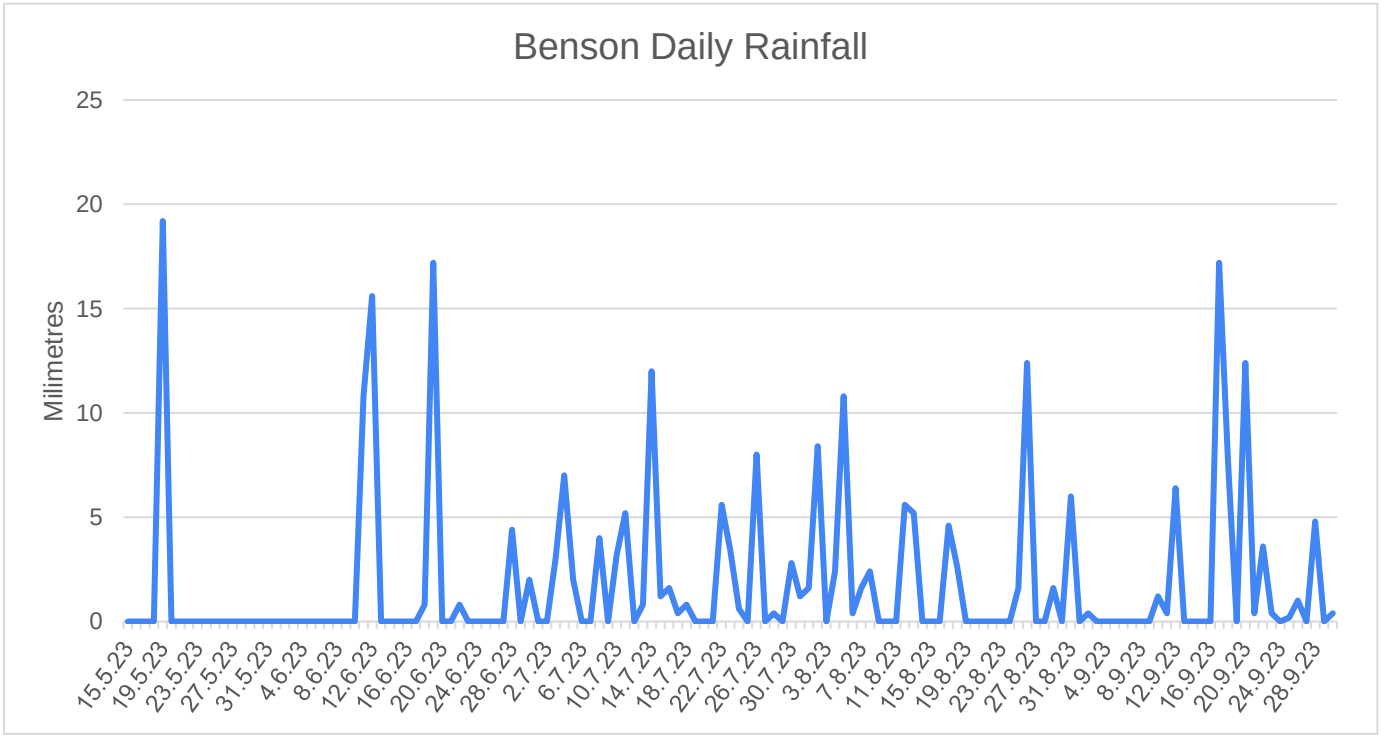


Figure 2 - Daily rainfall at Benson rainfall monitor



THAMES21

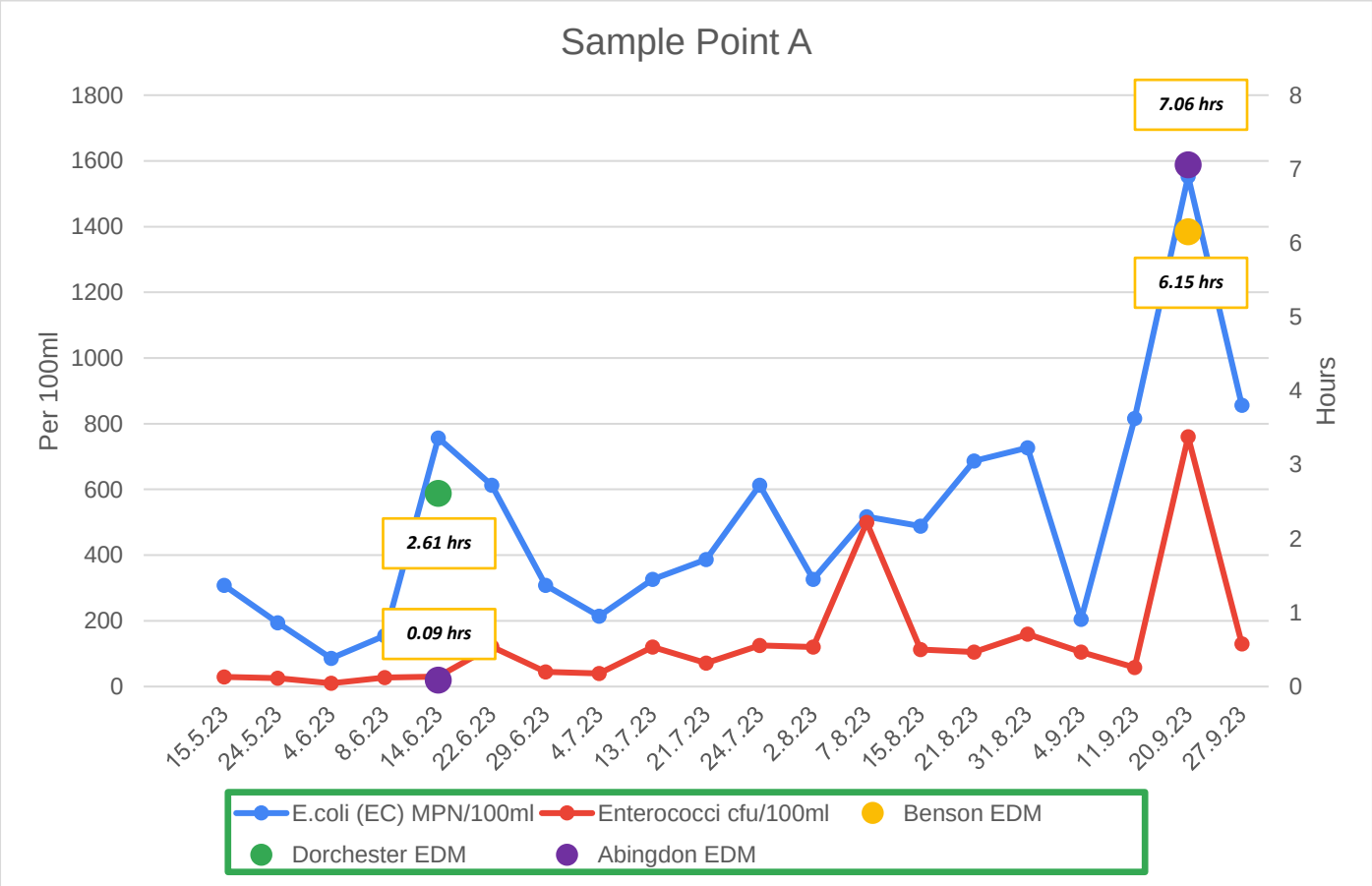
Spill Correlation

Thames Water event duration monitoring (EDM) data was correlated against rainfall data and FIO levels during the bathing water sampling period. When looking for correlation of spills, data was assessed against the following criteria:

- Was the spill no more than 72 hours before the sample date?
- Did the correlation pattern show a significant increase in EC and IE levels, causing BW status to fall to 'Poor'?

EDM spills at Benson, Dorchester and Abingdon sewage treatment works (STW) appeared to correlate to the heavy rainfall dates mentioned above, with the exception of the heavy rain seen on 19th May which did not appear to trigger any EDM spills.

Figure 4- FIO levels with spill correlations



Key Findings and Conclusion

Bathing water quality status according to the Bathing Water Regulations (2013) at Wallingford Beach were 'Good' for the majority of the season. FIO levels were responsive to rainfall events, with increases in both bacteria recorded shortly after rainfall events in June, July and August. Only in the penultimate week of sampling were higher levels of IE and EC recorded, resulting in the overall status changing into 'Poor' for EC and 'Sufficient' for IE. This deterioration in water quality was preceded by 72 hours of consistent rainfall, and higher than average river levels. This indicates that the prospective bathing water site would have acceptable water quality for bathing water standards only during dry weather. Meanwhile, the continuous presence of both EC and IE throughout the sampling period even during dry weather, though relatively low, would suggest diffuse inputs such as livestock excreta, septic tanks, and misconnections, all of which can pose a risk to public health, albeit at a lower risk.

The sharp increases in FIO results at Wallingford Beach in June and September show the hallmarks of point source impacts that are possibly from upstream sewage treatment works, heavily affecting water quality. Interestingly, EDM data shows no discharges occurring in the 72 hours before sampling took place on 20.09.23. It does, however, show Abingdon and Benson STW's discharging just a few hours after samples were taken on this date, on which sharp increases in EC and IE were seen. Further investigations into upstream infrastructure, including evidence on the quality of treated effluent, are needed to identify the source of inputs for these sharp increases and to determine the measures needed to mitigate them.

Climate change is likely to continue to trigger extreme and sporadic weather events, such as heavy rain during the bathing season, meaning the poor conditions seen towards the end of the 2023 season may be seen more frequently throughout future seasons. Therefore, improvements and upgrades to wastewater treatment systems should be prioritised to mitigate against the impacts of climate change. In addition, greater awareness and transparency of current water quality data should be publicly available to allow for informed choices to be made when using the river.

References

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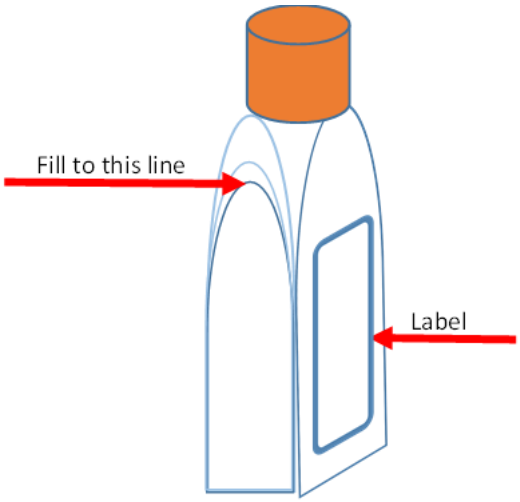
Appendix 1: Sampling Protocol

1. Before taking samples check for river users e.g. passing boats.
2. Take sample as close to the centre of the stream as it is possible to safely do using the sampling pole.
3. To take a sample, put gloves on, fill up and empty the sampling bucket in the river water a minimum of 3 times to rinse bucket.
4. Then fill sampling bucket once more, this time ensuring bucket is as full as possible.
5. Fill the red-lidded microbiology bottles up to the lowest ridge on the side of bottle (see diagram below)
6. **Label the bottles carefully.** Labels **must not go round corners or on lids**, please place them portrait on the bottle.
7. **Very important:** Send details including sample number (**F number**), photo (including timestamp and sample number), record the weather, whether it has rained in the past 24 hours and other visual notes (see box 1).
8. Using a disinfectant wipe clean sample bottle and all surfaces of the sampling bucket and the first few feet of the sample pole thoroughly making sure all are covered and then allow to air dry/dry with kitchen roll.
9. After the sample is taken, put sample in kit bag as soon as possible to minimise direct light.
10. Used gloves, wipes and other rubbish can be placed in the zip lock rubbish bag provided, to be disposed of once full in regular rubbish bin.



BOX 1 - VISUALS

Please make note of any or all of the following visual water qualities:

-Flow speed
-Water height
-Algal blooms
-Plastic or other litter pollution
-Physical signs of sewage
-Tar-like residues
-Animal faeces