SAS Citizen Science

Water testing data interpretation guidance

January 2025

Background

What are we testing for?

The Bathing Water Regulations testing regime (the methodology we are using) tests for two types of bacteria – *Escherichia coli* (*E. coli*) and intestinal Enterococci. These are also often referred to as faecal indicator organisms (FIOs). Both of these bacteria are naturally found in the intestines of many warm-blooded organisms, including humans, cattle, and birds. Because of this, they are good indicators of the presence of faecal matter (and therefore sewage) in the environment.

E. coli (figure 1) is a species of bacteria that is often harmless but contains some strains which can be pathogenic (harmful) to humans. Enterococci (figure 2) are a genus (group containing multiple species) of bacteria. Both of these bacteria are usually harmless while in the intestines, but can sometimes cause harm when we are exposed to them in other ways (for example, via ingestion or through broken skin).

Why do we test for them?

E. coli and Enterococci are only a small part of a large variety of bacteria and viruses present in sewage that can make us ill, but they are useful proxies to determine the presence of sewage overall for the following reasons;

- They are commonly present in faecal matter
- They are cheap and relatively easy to analyse using standard laboratory techniques that do not require expensive analytical instrumentation
- Unlike many bacteria, they grow happily in a laboratory environment (therefore are easy to detect)
- They are fairly persistent in the secondary environments. This means that once they leave their natural environment (i.e. the gut) and enter our sewers and waterways, they generally remain alive long enough to allow us to collect and analyse the sample
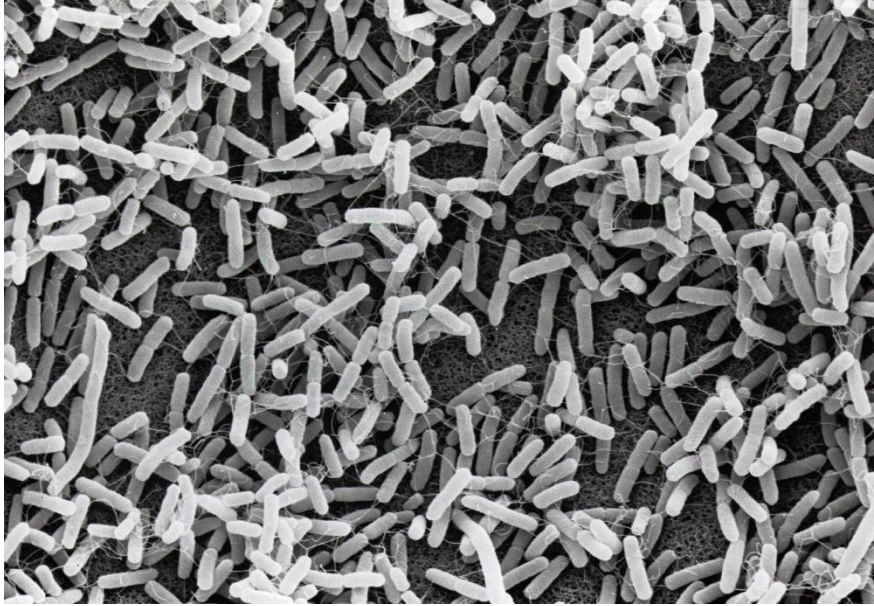
Figure 1 Scanning electron microscope image of *Escherichia coli* on agar. David Gregory & Debbie Marshall. Attribution 4.0 International (CC BY 4.0). Source: Wellcome Collection. https://wellcomecollection.org/works/mdw7sxbp
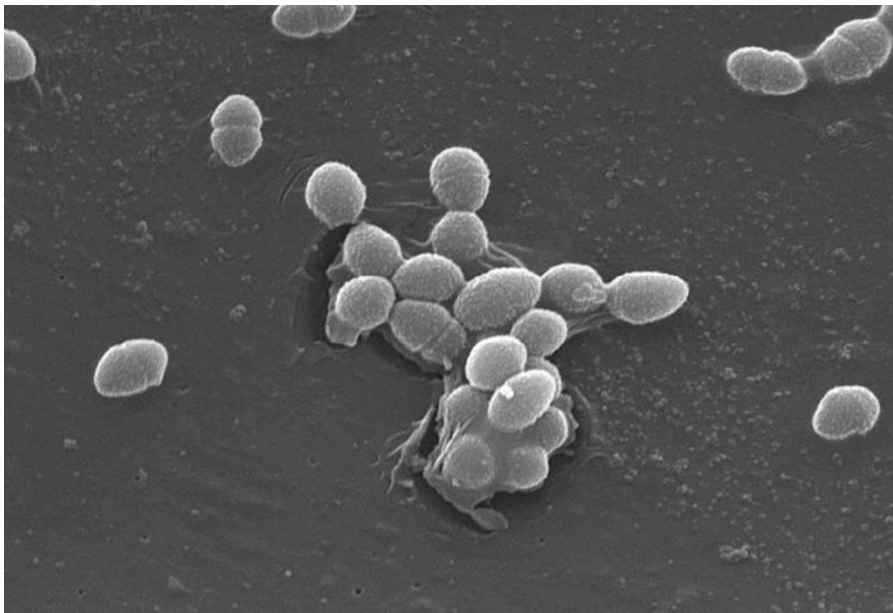

Figure 2 Scanning electron microscope image of *Enterococcus faecalis*, Source: Centre for Disease Control (CDC) https://phil.cdc.gov/Details.aspx?pid=258

How are the samples analysed and what units are the data reported in?

Samples are analysed in the laboratory by filtering 100mL of water sample through a small filter which allows the water to pass through but captures the bacterial cells. This is then placed on a petri dish containing agar. The petri dish is then incubated overnight, and the bacteria multiply to form colonies. These colonies are large enough to see, so they can be counted and recorded. Because each colony has grown out of a single bacterial cell, the number of colonies represents the number of cells in that sample of water. That is why you will see the data reported in **Colony Forming Units (CFU) per 100mL.**

WHAT DOES THE DATA MEAN?

The framework that we use for assessing the data is based on the 2006 European Bathing Waters Directive, and is used by the environmental regulator in the UK (the Environment Agency, Natural Resources Wales, the Scottish Environmental Protection Agency or the Northern Ireland Environment Agency) to classify bathing waters into different water quality categories based on the results from the samples which are taken (Figure 3). These categories provide an indication of how safe the water is to swim in.

Figure 3 Bathing Water Classifications

Thresholds for classification

There are thresholds, based on the number of *E. coli* and Enterococci present in the samples, which classify the bathing waters into these categories. The thresholds are different for coastal and inland waters, because coastal waters are expected to have lower bacterial numbers than inland waters due to the pollution dilution factor (table 1).

It is important to note that there are no official thresholds for individual samples. This is because the thresholds are based off a statistical calculation of all of the samples taken throughout a bathing season, which looks at how often poor water quality results occur throughout the sampling period overall*. **However, the thresholds can work to provide a general indication of water quality when looking at individual samples.**

*This is why the thresholds for Sufficient are lower than the thresholds for Good in inland bathing waters – whilst the threshold for Sufficient is lower, it requires *more* samples to meet this threshold throughout the bathing season, because it uses the 90th percentile (i.e. looks at the top 10% of the data) whereas

the threshold for Good is slightly higher but requires less samples to meet this threshold because it uses the 95th percentile (i.e looks at the top 5% of the data).

Table 1 Classification thresholds for coastal and inland bathing waters (European Bathing Water Directive 2006)

Classification (coastal waters)	Thresholds (CFU/100mL)	
	E. coli	Intestinal enterococci
Excellent	<250 (95th percentile)	<100 (95th percentile)
Good	<500 (95th percentile)	<200 (95th percentile)
Sufficient	<500 (90th percentile)	<185 (90th percentile)
Poor (advice against bathing)	Values are worse than sufficient	
Classification (inland bathing waters)	Thresholds (CFU/100mL)	
	E. coli	Intestinal enterococci
Excellent	<500 (95th percentile)	<200 (95th percentile)
Good	<1000 (95th percentile)	<400 (95th percentile)
Sufficient	<900 (90th percentile)	<330 (90th percentile)
Poor (advice against bathing)	Values are worse than sufficient	

How to interpret these thresholds for your own data

The data produced from the SAS citizen science programme can be matched against these thresholds to give an idea of water quality at your testing location. However, just remember that when reporting your data, individual samples cannot officially be classified into these categories, but the categories can provide a general indication. SAS have developed a statistical calculator (which replicates what the regulator uses) so that we can take all of the samples at the end of the bathing season and categorise them as above.