# Management of Environmental *E. coli* Blooms

## Recognition of environmental *E. coli* strains

*Escherichia coli* is a bacterial species which is excreted in high numbers from the intestinal tract of humans, other mammals and birds. The vast majority of *E. coli* strains are harmless, and these bacteria are considered to be a beneficial inhabitant of the healthy human digestive system, however a few types are able to cause disease in humans (pathogenic *E. coli*). For many decades it was thought that *E. coli* could grow only within human or animal hosts, and that it died quickly in the natural environment. Therefore, the presence of *E. coli* in water was regarded as an indicator of recent faecal pollution, with the possibility that faecal pathogens could also be present. In recent years, it has been demonstrated that some strains of *E. coli* have adapted to live and grow in the environment, meaning that the presence of this bacterium in water may not always indicate faecal pollution. These environmental strains are genetically distinct from the *E. coli* strains derived from human or animal faeces, and evidence indicates that they do not carry the genes needed to cause disease.

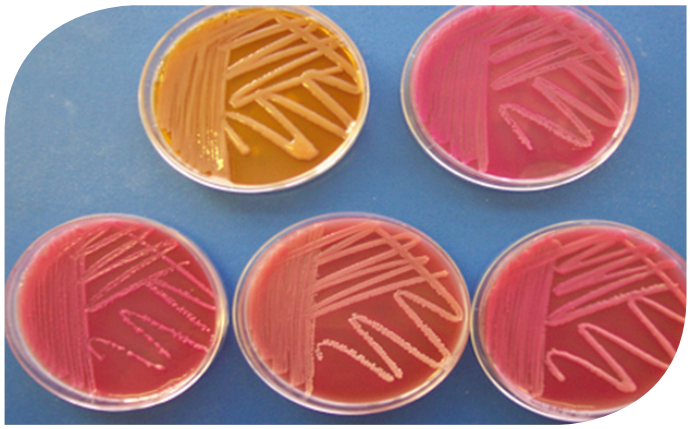
## Environmental *E. coli* and Health Based Targets

Environmental *E. coli* strains cannot be distinguished from faecal strains by routine tests, and their detection in water triggers the same operational response as the detection of *E. coli* derived from faecal contamination. Environmental *E. coli* usually occur in very low numbers in water bodies, and therefore do not pose a problem for water quality management. However, some environmental *E. coli* strains form high density 'blooms' in water storages, including those used to supply drinking water. Under the proposed health based targets system for the Australian Drinking Water Guidelines, the maximum levels of *E. coli* detected in untreated water will be used to classify the level of potential risk from pathogenic faecal microorganisms in each water catchment. The risk classification will determine the degree of water treatment needed to produce drinking water. In order to ensure accurate assessment, it is important that water suppliers are able to identify environmental *E. coli* blooms and demonstrate that they do not arise from faecal contamination, so that these events can be excluded from the risk classification process.

## Environmental *E. coli* blooms in Australia

Environmental *E. coli* blooms have been documented in Lake Burragorang, NSW (the impoundment for the Warragamba Dam) since at least 1975, and in Lake Burley Griffin, ACT (the impoundment for the Scrivener Dam) since the late 1990s. Although recurrent bloom events have been observed in a small number of reservoirs, this phenomenon remains rare overall. It is believed that in these lakes a sudden change in the growth rate of bloom-forming *E. coli* strains is triggered by an increase in nutrient levels in combination with warm water temperatures, however, the specific nutrient factors involved in this phenomenon are unknown.

Eight bloom-forming *E. coli* strains have been characterised, and all produce a Group 1 extracellular polysaccharide capsule. Production of this type of capsule is rare among *E. coli* strains. Three bloom-forming strains have been associated with bloom events in six reservoirs located in the ACT, NSW and Queensland (designated as East coast strains). Only one bloom has been documented in WA, and five strains which were different from those seen in the eastern states were isolated from this event (designated as West coast strains).



## Water industry experience of environmental *E. coli* blooms

Information about water quality and environmental factors associated with bloom events has been collected from six Australian water organisations and analysed. The affected reservoirs varied from 1 gigalitre to more than 2,000 gigalitres in capacity (1 gigalitre = 1,000,000,000 litres). Catchment types ranged from mixed rural and urban uses (some with primary contact recreational water activities), through to a well-protected catchment with no public access to the water storage. The key findings were:

- Bushfires or planned burns in the catchment, dust storms, and algal blooms were identified as predisposing events for blooms. Any one of these events, in combination with a rapidly falling dam level, significantly increases the likelihood of a bloom within the following few months.
- Bloom events generally occurred in spring or early summer when weather conditions were dry, and water inflows to the reservoir were low or absent. Water temperatures were 18°C or higher, but in most instances it was uncertain if thermal stratification was present in the water body.
- Blooms were not associated with noticeable changes in water quality parameters such as turbidity.
- Levels of enterococci bacteria remained normal during *E. coli* blooms. Enterococci are a different group of bacteria sometimes used as an indicator of faecal contamination.
- For most events, the first sign of a bloom was an *E. coli* reading in untreated water that was about 100-times higher than levels previously seen during routine monitoring. Peak concentrations up to 10,000-times higher than normal were recorded in some events. Levels as high as 298,000 *E. coli* colony forming units /100 mL have been observed.
- Where water sampling was carried out at different depths and locations across reservoirs, high *E. coli* counts were found over large areas and at depths down to at least several metres.
- Bloom duration was usually three to four weeks, although durations up to three months have been seen in recent years in one major reservoir.

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## Identification and typing of *E. coli* bloom strains

The genetic diversity of *E. coli* isolates from a suspected bloom may be characterised using established methods to look at variations in genes for basic cell functions that are carried by all *E. coli* bacteria (so-called 'housekeeping' genes). If contamination of water has arisen from faecal sources, then a high degree of strain diversity will be seen when the *E. coli* isolates are tested in this way. However during bloom events, it has been found that only a few strains will account for the majority of isolates. Another characteristic of bloom-forming strains is their mucoid colony appearance, caused by capsule production, when they are grown on agar plates. In addition, the genes for capsule formation can be detected and characterised using specific DNA probes. Variations in the capsule genes can be detected, and this allows the strains to be compared to known bloom-forming strains.

## Effectiveness of water treatment and disinfection processes

The responses of bloom-forming environmental *E. coli* strains to common water treatment and disinfection processes have been tested and compared to *E. coli* strains from human and bird faeces. The processes assessed were coagulation (with alum or ferric iron compounds), filtration, chlorination, chloramination and UV disinfection. These experiments showed that the responses of bloom isolates were not significantly different from those of faecal *E. coli* strains. Therefore, commonly used water treatment and disinfection processes are considered to be effective to remove bloom-forming *E. coli* strains from water.

## Utility Response Protocol

A Utility Response Protocol has been developed (see below) from the collective experience of Australian water organisations that have encountered environmental *E. coli* blooms over the last decade, and the perspectives of health regulatory agencies. This protocol enables water suppliers to recognise blooms in drinking water storages, and provides guidance on appropriate management measures.

## References


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**Utility Response Protocol for Management of Environmental *E. coli*. Water Research Australia (2019)**




### Utility Response Protocol