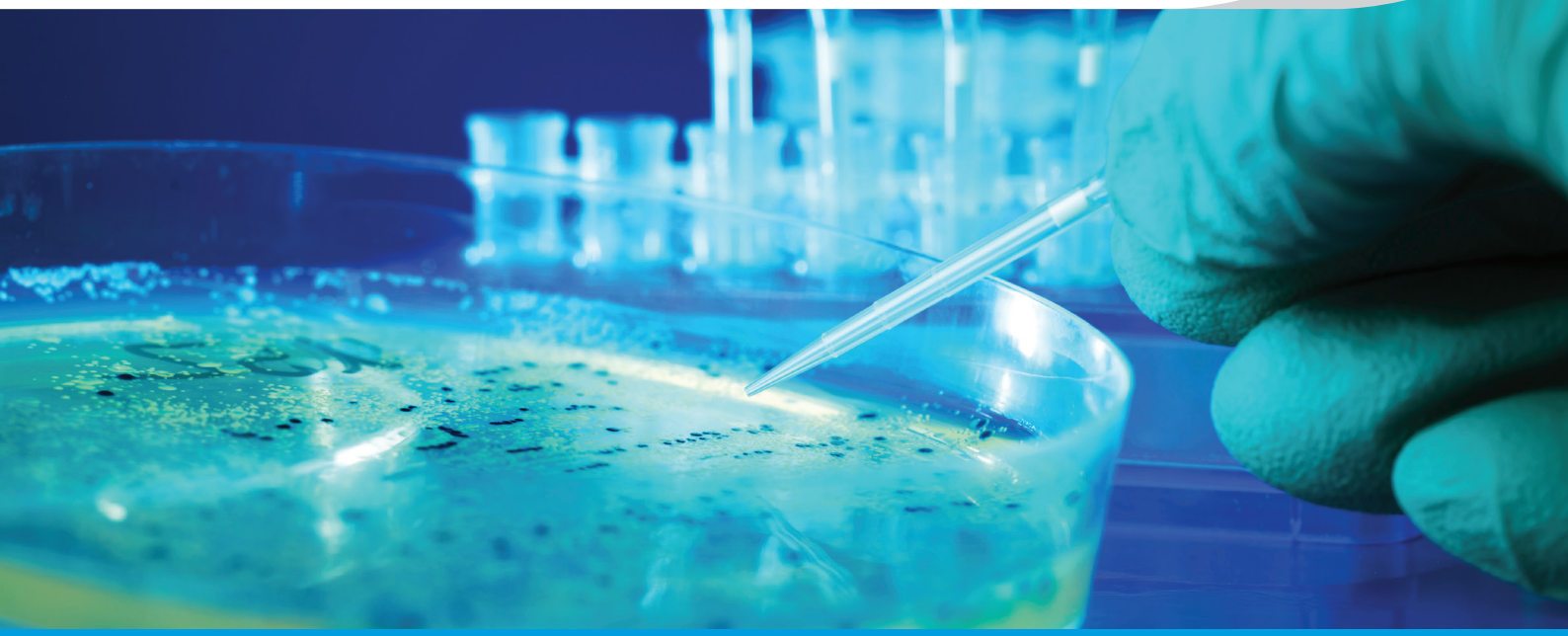
Water Research AUSTRALIA

Research

Response Protocol

Project 1101



Utility Response Protocol for Management of Environmental *E. coli* Blooms

Collaborate Innovate Impact

Utility Response Protocol for Management of Environmental *E. coli* Blooms

WaterRA Project #1101

Utility Response Protocol for Management of Environmental *E. coli* Blooms

This Protocol has been developed to assist the water industry's response to blooms of environmental *E. coli* strains in water storages used for drinking water supply. This document should be read in conjunction with the Fact Sheet – Management of Environmental *E. coli* Blooms. Accurate identification of such blooms is essential to ensure correct classification of the catchment risk level under the proposed health-based targets system for the Australian Drinking Water Guidelines.

The Protocol was developed from information provided by six Australian water utilities that have experienced environmental *E. coli* blooms within the last 10 years. Perspectives from three state health regulators about public health concerns relating to the management of environmental blooms have also been incorporated.

The Protocol outlines a basic level of response to rule out faecal contamination as the source of elevated *E. coli* counts, and ensure drinking water safety is not compromised. In addition, there are optional elements which may be added if a more extensive investigation is desired for the first event, or if subsequent blooms occur in the same reservoir. The use of optional elements may also be determined by the type of evidence required by health regulatory agencies to make a determination that the event is environmental in origin.

The Utility Response Protocol assumes that water utilities are already operating under the principles embodied in the Australian Drinking Water Guidelines *Framework for Management of Drinking Water Quality*, and that procedures exist for risk assessment and management of individual water supply systems. It is also assumed that in situations where different organisations are responsible for management of the catchment/reservoir and the drinking water treatment plant (DWTP), a cooperative relationship exists which facilitates communication and investigation of the reasons for changes in the microbial quality of raw water. This protocol, in effect, provides an additional 'branch pathway' to be added to existing protocols for investigation of elevated *E. coli* numbers detected by raw water monitoring programs.

A Bayesian Network Model has been developed to predict the likelihood of blooms based on historical data for water quality, weather conditions, occurrence of predisposing events (bushfires/ planned burns, dust storms or algal blooms) and the rate of change in reservoir levels. This model can be used to run scenarios based on catchment/reservoir conditions to predict the likelihood of the occurrence of a bloom, provided that sufficient data are available. If a high likelihood is predicted, a more intensive sampling campaigns focused on the identified predictors could be triggered, in order to collect more information and to improve the understanding and modelling of future environmental *E. coli* blooms.

References

Management of Environmental *E. coli* Blooms - Fact Sheet (2019) Water Research Australia.

http://www.waterra.com.au/publications/fact-sheets/

Bayesian Network Model. Contact Water RA for further information.

Basic Utility Response Protocol

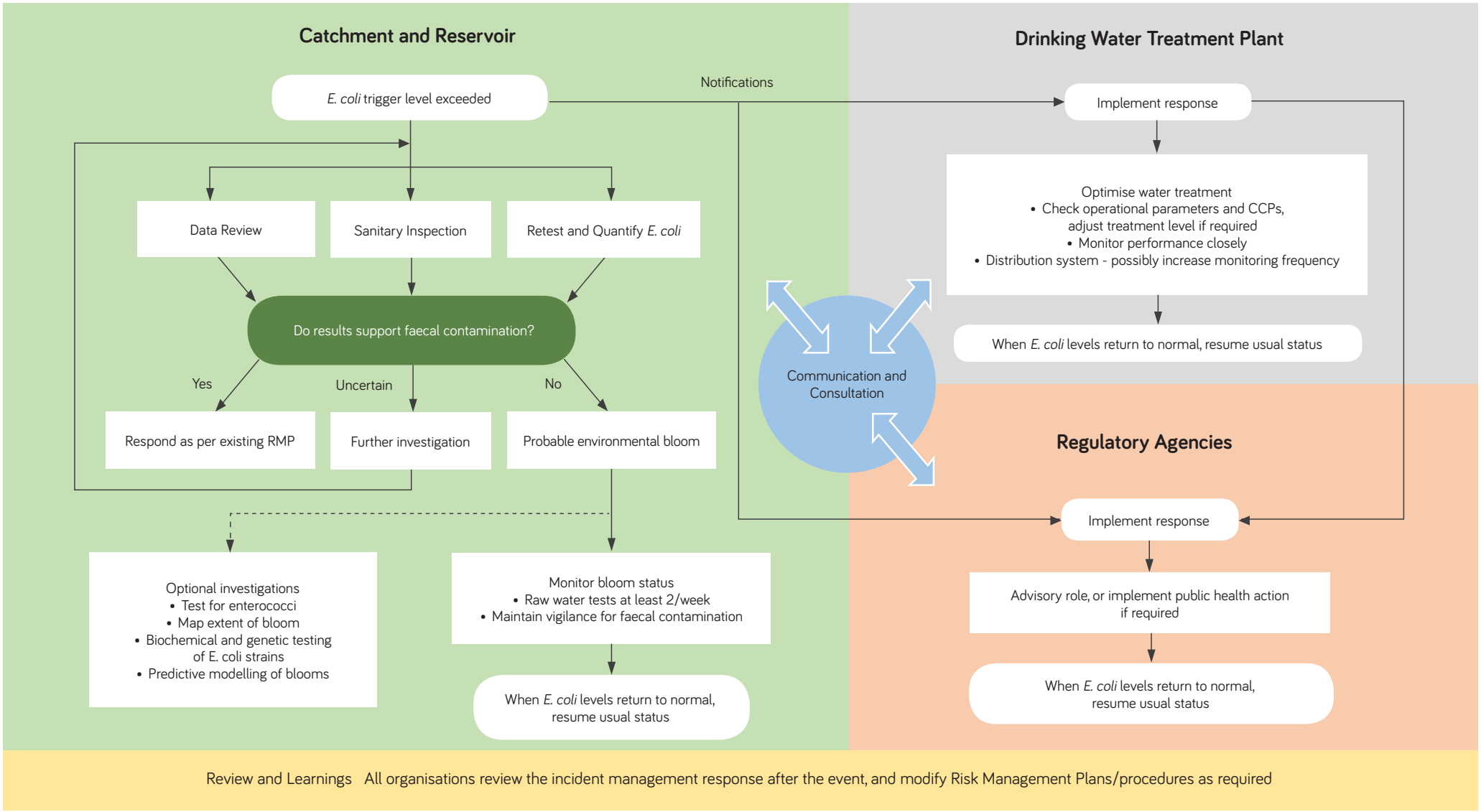
Element	Description
***E. coli* trigger level**	A value that would trigger investigation of presumed faecal contamination should be defined for the *E. coli* level in raw water entering the treatment plant (i.e. samples collected at the water offtake or the raw water tank at the treatment plant). If a trigger level does not already exist, considerations for setting such a level might include: • a value based on the 'high end' of routine *E. coli* monitoring results • a value based on the assessed log reduction capability of the drinking water treatment plant taking into account potential bacterial levels in raw water, from historic monitoring results • a boundary value for health-based-target catchment classifications Depending on the existing routine monitoring program, it may also be desired to define trigger levels for locations in the reservoir.
Data review and sanitary inspection	Established procedures for investigation of potential faecal contamination events should be implemented. These are likely to include a review of recent water quality monitoring results and weather data, and sanitary inspection of the catchment and reservoir.
Resampling to confirm and quantify *E. coli* level	Samples should be collected at the site(s) where the initial high *E. coli* reading(s) were recorded. Additional samples should be taken at other locations as part of normal investigation procedures and at any suspect locations identified by the data review and/or sanitary inspection. If laboratory testing for *E. coli* does not currently include quantification of high concentrations when all test wells are positive, then this should be requested for the confirmatory samples. Consideration should also be given to instructing the laboratory to retain the incubated test trays and/or plates to permit strain characterisation, should this be desired at a later stage.
Decision point. **Do the results support faecal contamination?**	If the high *E. coli* count is confirmed and the data review and sanitary inspection reveal a likely source of faecal contamination, the investigation and operational response should proceed according to existing risk management plans for the water supply. If the results are conflicting (e.g. high *E. coli* count not confirmed, but data review and sanitary inspection indicate a likely source of faecal contamination) then further sampling and investigations should be undertaken. If the high *E. coli* count is confirmed but the data review and sanitary inspection do not show any evidence of a source or event that could have caused faecal contamination, this should be taken as preliminary evidence of an environmental bloom.
Notifications and communication	Notifications about unusually high *E. coli* levels in raw water entering the treatment plant should be made under existing legislative obligations, MOUs or other formal agreements with regulatory agencies and other organisations. Depending on usual practices, contact may also be made with regulatory agencies and other organisations to advise them of the situation, even if notification is not mandatory. The health regulator should always be advised if there is doubt about the capability of the DWTP to provide safe water. This is a legislated requirement under some state and territory laws. Communication and consultation between all involved organisations should be maintained throughout the incident.
Drinking Water Treatment Processes (DWTP)	The operational parameters and critical control points of the DWTP should be checked and performance optimised. Depending on judgement regarding the performance of the plant, consideration may be given to enhancing coagulation and/or increasing disinfection above usual levels. The operation of drinking water treatment processes should be closely monitored until *E. coli* levels in raw water return to the normal range. For conventional treatment this would include monitoring compliance with targets for individual filter bed turbidity and for disinfectant levels. If the log reduction capability of the DWTP is considered inadequate or borderline, consideration should be given to cease harvesting the raw water source temporarily, or relocating the raw water offtake location or level to avoid areas with high *E. coli* counts, if this is feasible.

Monitoring in distribution system	Additional monitoring in the distribution system for disinfection residual and other parameters (e.g. turbidity for unfiltered systems) may be advisable. If contamination of the distribution system is suspected, consideration for issuing a boil water advisory to eliminate other bacterial pathogens potentially present may be needed. In this situation, the health regulator should be consulted.
Monitor bloom status	Raw water monitoring (at least for water entering the treatment plant) should be increased to twice per week or more. Normal levels of vigilance for faecal contamination events in the catchment should be maintained throughout the bloom event.
Return to normal status	When *E. coli* levels return to the normal range, return to usual operational status.
Review and learnings	All involved organisations should review their incident management response after the event. If necessary, modifications should be made to Risk Management Plans to incorporate/refine bloom response information, trigger levels, communication protocols etc., in order to optimise the response to any future bloom events.

Optional Bloom Investigations

Investigation type	Description
Enterococci testing	Water samples may be tested for enterococci as well as *E. coli* to provide a comparative marker for faecal contamination. Addition of this test to the routine *E. coli* monitoring program for raw water entering the drinking water treatment plant should be considered if a second bloom event occurs in a reservoir.
Map extent of bloom	The extent of the bloom within the reservoir may be mapped by sampling at different depths in several different locations and testing for *E. coli*. Counts should be accurately quantified (this may require requesting that laboratory samples be diluted). This information will allow calculation of the amount of sewage effluent or animal waste that would have been required to produce the observed volume of contaminated water. This may provide evidence that a contamination event of this magnitude is not feasible, or at least extremely unlikely to have occurred in the absence of evidence from the sanitary inspection and the data review.
Genetic and/or biochemical testing of *E. coli* isolates **Some tests can be performed by extracting DNA directly from the wells on test trays (potentially from a mixture of strains in the water sample), while others require pure colonies for testing.**	Tests for strain diversity or strain origin: • genetic and/or biochemical typing of several isolates to characteristic strain diversity. These tests detect the DNA sequence or biochemical activity of a number of genes used for basic metabolic functions shared by most *E. coli* strains. During environmental *E. coli* blooms a small number of strains will dominate the population, and diversity will therefore be low. However, if faecal *E. coli* contamination has occurred, many strains will be present, and high diversity will be seen. Note that *E. coli* bloom strains may produce atypical results on some biochemical tests (e.g. chromogenic media) and some do not grow at the elevated incubation temperature (44.2°C) used in some tests. • microbial source tracking may provide evidence that isolates are not of faecal origin. Tests to identify bloom-forming strains: • membrane filtration enumeration or streak plating to observe mucoid colony morphology consistent with capsule production. • specific multiplex PCR tests to confirm the presence of the Group 1 capsule genes and determine whether the isolates have capsule types matching those found in previously documented blooms.
Predictive modelling of blooms	To gain a better understanding of the factors which cause blooms, the Bayesian Network Model could be used to define a likelihood level that would trigger more intensive water quality monitoring and/or testing for additional parameters.

Utility Response Protocol



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