Australian Government
National Health and Medical Research Council

BUILDING
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AUSTRALIA

Australian Drinking Water Guidelines Administrative Report

Updated guidance on the microbial quality of drinking water

NHMRC

Contents

Administrative Report: Updated guidance on the microbial quality of drinking water

Summary

The National Health and Medical Research Council (NHMRC) has updated guidance on the microbial quality of drinking water in the *Australian Drinking Water Guidelines (2011)* (the Guidelines). This update brings the Guidelines in line with international best practice for managing the microbial safety of drinking water.

The updated guidance replaces Chapter 5 and sees the inclusion of microbial health-based targets in the Guidelines. Also included in the updates is the addition of an appendix (Appendix 3) to provide technical information on the assumptions and calculations that underpin the updated guidance. This document summarises the advice development process.

Background

NHMRC issues guidelines under section 7(1) of the *National Health and Medical Research Council Act 1992* (the NHMRC Act). NHMRC maintains the Guidelines through a rolling review process to ensure they provide an up-to-date evidence-based framework for the management of drinking water quality. The Guidelines contain information and guidance on the physical, microbial, chemical and radiological quality of drinking water.

The first Guiding Principle of the Guidelines is **"***The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised***".**

Microbial quality is a key factor in determining the ongoing safety of water supplies for human consumption. Prior to the update and inclusion of microbial health-based targets, the main performance measure for microbial quality in the Guidelines was that **"***Escherichia coli (E. coli) should not be detected in any 100ml sample of drinking water"***.** However, as an indicator organism for other bacteria as well as viral and protozoan pathogens there are several key limitations. *E. coli* as a performance measure does not support key operational elements of the Framework for Management of Drinking Water Quality outlined in Chapter 2 of the Guidelines to the extent required by the water industry.

The inclusion of microbial health-based targets provides a quantitative measure of the microbial safety of drinking water, which is a clear gap in the Guidelines. The updated guidance adapts the Quantitative Microbial Risk Assessment (QMRA) approach used by the World Health Organization (WHO). QMRA is a framework or mechanism that allows for quantitative scientific data to be interpreted in the context of estimated health outcomes to support water safety management (WHO 2016). This approach is consistent with the framework used in the *Australian Guidelines for Water Recycling* (NRMMC, EPHC and AHMC 2006; NRMMC, EPHC and NHMRC 2008).

Development of guidance

Since 2009, NHMRC has been working to develop microbial health-based targets guidance for inclusion in the Guidelines with input from the Water Quality Advisory Committee (the Committee). Members of the Committee's Health-Based Targets Working Group (the Working Group) in collaboration with NHMRC drafted the guidance. The guidance drafting process involved considering the WHO guidance alongside the current Australian water industry application of microbial health-based targets for drinking water and recycled water purposes.

The Working Group drafted updates to Chapter 5 and developed a supporting technical appendix to ensure the Guidelines align with international best practice on management of microbial quality of drinking water. The updates will

also provide regulators and other users of the Guidelines with additional information on pathogen risks in drinking water including, enteric pathogens, toxic cyanobacteria, nuisance organisms and opportunistic pathogens found in drinking water supplies.

The following major changes were made to the Guidelines:

- inclusion of guidance on QMRA to estimate exposure to pathogens and the resulting health impact
- introduction of a health outcome target of $1x10^{-6}$ Disability Adjusted Life Years (DALY) (or 1 µDALY) per person per year (pppy)
- updates to guidance on classifying and verifying source water pathogen risks
- inclusion of treatment targets for protozoa, bacteria and viruses and indicative pathogen $\log_{10}$ reduction values (LRVs) for various treatment barriers.

Additional information is also included in Chapter 5 to strengthen and clarify principles of managing microbial quality of drinking water and applications in the Australian context.

Key steps of the guidance development process are summarised in **Figure 1**. A timeline of the guideline development process including key meetings and stakeholder workshops where the project was discussed is provided in **Table 1**.

Figure 1. **Overview of guidance development process**

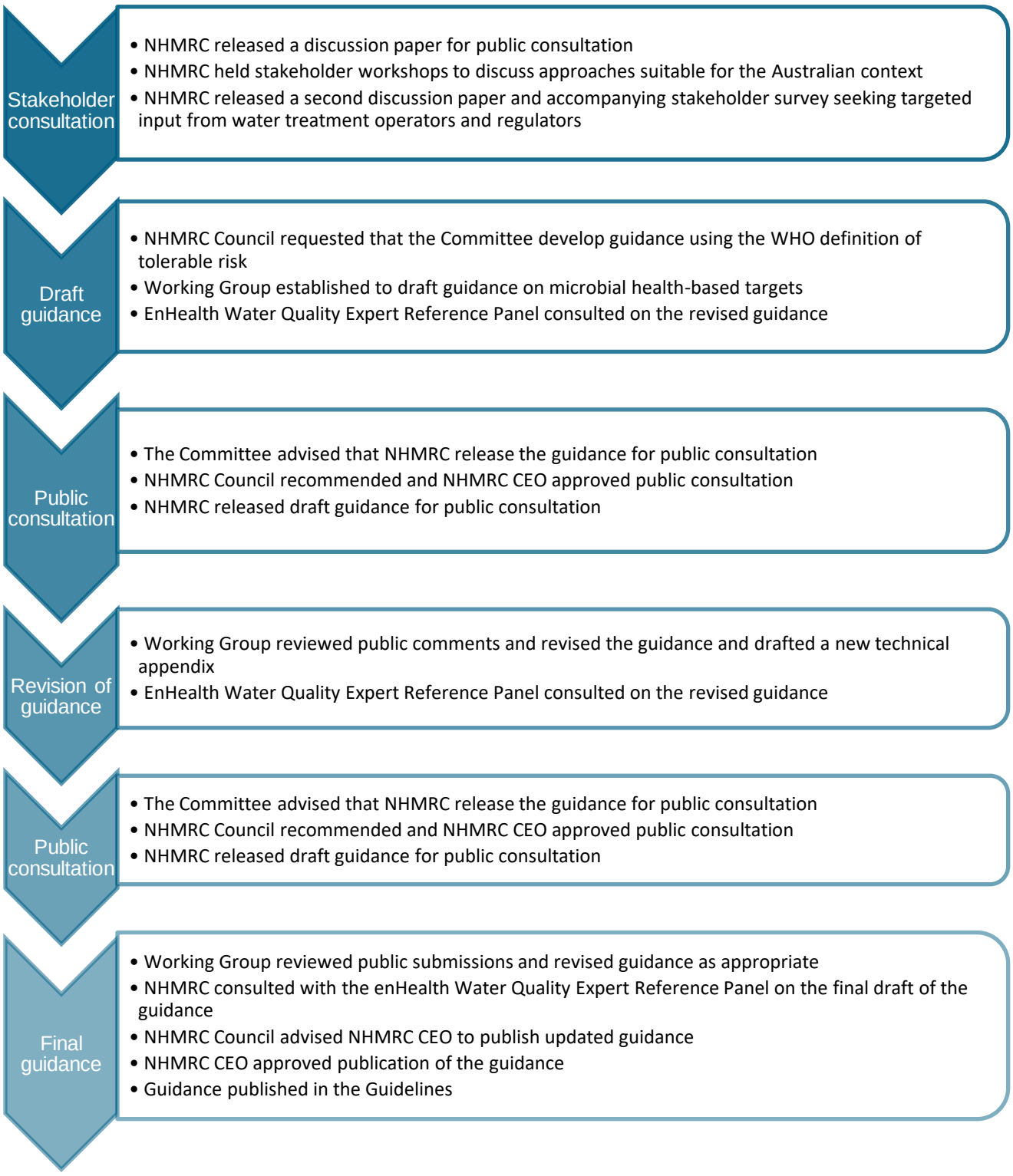

Table 1. **Timeline for updated microbial quality of drinking water guidance**

Key guidance development steps	Date
Preliminary meeting between representatives of NHMRC Water Quality Advisory Committee (the Committee) and health and water agency representatives	2008
NHMRC – released discussion paper for public consultation	October 2009
NHMRC – held stakeholder workshop in Canberra	May 2012
NHMRC – released discussion paper and stakeholder survey seeking targeted input from water treatment operators and regulators	22 August 2014 – 3 October 2014
Formation of Health-Based Targets Working Group (Working Group)	November 2014
Working Group – drafted guidance on microbial health-based targets	November 2014 – December 2015
Review of draft guidance by the Committee and members of Environmental Health Standing Committee (enHealth) Water Quality Working Panel with subsequent revisions	January – June 2016
NHMRC Council – advised NHMRC CEO to release draft guidance for public consultation	14 July 2016 (208th session)
NHMRC CEO – approved release draft guidance for public consultation	18 August 2016
Public consultation opened	5 September 2016
Public consultation closed	4 November 2016
Working Group – revised Chapter 5 and drafted technical appendix to address public consultation feedback (**see Appendix B**)	December 2016 – October 2017
EnHealth Water Quality Expert Reference Panel (WQERP) consultation on revised guidance (**see Appendix A**)	November 2017
NHMRC Council – advised NHMRC CEO to release draft guidance for public consultation	21 March 2018 (213th session)
NHMRC CEO – approved release draft guidance for public consultation	10 April 2018
Public consultation opened	30 April 2018
Public consultation closed	29 June 2018
Working Group – revised guidance to address public consultation feedback (**see Appendix B**)	July 2018 – December 2021

Key guidance development steps	Date
EnHealth Water Quality Expert Reference Panel consultation on revised guidance (**see Appendix A**)	December 2021
EnHealth Water Quality Expert Reference Panel consultation on final guidance (see **Appendix A**)	11 March 2022
NHMRC – finalised guidance for NHMRC Council	15 March 2022
NHMRC Council – advised NHMRC CEO publish the guidance in the Guidelines	31 March 2022 (225th session)
NHMRC CEO – approved publication of guidance in the Guidelines	19 June 2022

Water Quality Advisory Committee advice

The NHMRC Water Quality Advisory Committee (the Committee) provides expert advice to NHMRC on public health issues related to drinking water quality. The primary role of the Committee is the rolling review of the Guidelines.

Work commenced in 2009 on developing guidance for microbial health-based targets for inclusion in Chapter 5 of the Guidelines. Early discussions with the Committee identified a need for targeted consultation with stakeholders. Several discussion papers were developed with input from the Committee and released to get early stakeholder feedback on preferred approaches to managing microbial water quality.

NHMRC with assistance from the Committee held several stakeholder workshops in 2014 to further explore preferences. A 2014 stakeholder survey, together with workshop outcomes identified that of the already established frameworks, the WHO QMRA approach was the preferred approach for the Guidelines.

Based on these findings, NHMRC Council requested that the Committee develop guidance on microbial health-based targets using the WHO definition of tolerable risk. The Committee supported this recommendation, as did the members of the Environmental Health Standing Committee (enHealth) Water Quality Expert Reference Panel. In 2014 the Health-Based Targets Working Group (the Working Group) was formed as a subgroup of the Committee. Members of the Working Group were involved in drafting the health-based targets guidance using the best available published Australian data and assumptions.

Iterations of the draft guidance were provided to the Committee and the enHealth Water Quality Expert Reference Panel before and after public consultation in 2016 and 2018. After the 2016 public consultation, the Working Group significantly revised the draft guidance to consider and address stakeholder feedback. The 2018 public consultation resulted in a large number of responses from the water sector that required a significant amount of time by NHMRC, the Working Group and the Committee to consider and discuss responses.

The 2018-2021 Committee term ended 31 December 2021 before the guidance was finalised. The Working Group had discussed and agreed on key issues at previous meetings. There were several outstanding edits and issues that required further discussion. NHMRC considered issues that had been raised and made edits where appropriate. Technical issues were considered in consultation with the enHealth Water Quality Expert Reference Panel. The enHealth Water Quality Expert Reference Panel supported publication of the guidance, noting that a number of topics will be considered as part of the rolling review of the Guidelines (see **Appendix A**).

EnHealth consultation

The enHealth Water Quality Expert Reference Panel provided expert feedback on several iterations of the draft Guidance. Panel membership includes jurisdictional representatives working in the field of drinking water quality and public health who can provide feedback on the feasibility and accuracy of NHMRC advice.

The enHealth Water Quality Expert Reference Panel was formally consulted on the draft guidance in June 2016, November 2017 and December 2021, in addition to ongoing informal consultation. NHMRC and the Committee agreed on a number of changes to the draft guidance as a result of feedback provided. The enHealth Water Quality Expert Reference Panel also provided expert review of the final guidance in March 2022.

Further details on the issues raised by enHealth Water Quality Expert Reference Panel on the final guidance and how these issues were addressed is provided in the 'Final expert review' section below and **Appendix A**.

Public consultation

NHMRC conducted public consultations on two separate occasions (2016 and 2018). Each time stakeholders were invited under paragraph 13(d) of the NHMRC Act to make submissions to NHMRC about the draft text presented. The aim of these public consultations was to seek stakeholder feedback on the draft guidance. This included the proposed approach for setting health-based targets for the microbial safety of drinking water.

The first round of public consultation occurred in 2016 after the Committee had drafted the guidance. NHMRC Council considered the draft guidance at its 208th session on 14 July 2016 and recommended that the NHMRC CEO release it for public consultation. The CEO approved the release of the draft guidance for public consultation on 18 August 2016. Public consultation was held from 5 September 2016 to 4 November 2016. NHMRC worked with the Committee and Working Group to ensure due consideration was given to all matters raised during public consultation.

The second round of public consultation occurred in 2018 once the draft guidance was revised to incorporate public comments from the first round of public consultation. NHMRC Council considered the draft guidance at its 213th session on 21 March 2018 and recommended that the NHMRC CEO release it for public consultation. The CEO approved the release of the draft guidance for public consultation on 10 April 2018. Public comment was sought from 30 April 2018 to 29 June 2018.

A summary of the 2016 and 2018 public consultation processes, including the key issues raised and how these were addressed to finalise the Guidance is provided in **Appendix B**. Full public submissions are available in **Appendix C** where permission has been given to publish.

Final expert review

The 2018-2021 Committee term ended on 31 December 2021. NHMRC completed work to address public feedback and revise the draft guidance where appropriate. The work by NHMRC to finalise the guidance was guided by the expert advice of the enHealth Water Quality Expert Reference Panel. In the final expert review members commented on issues such as readability, the suitability of the assumptions used and the expected challenges for water suppliers during implementation. NHMRC considered this feedback in the final draft of the revised guidance.

NHMRC and the enHealth Water Quality Expert Reference Panel met on 11 March 2022 to discuss responses to feedback and the final guidance. Members provided in principle support of publishing the guidance, noting that implementation will take time for many water suppliers. It was also noted that a number of issues raised could be considered for the rolling review of the Guidelines by the new Committee.

A key issue raised in the final expert review was the expected challenges for small water suppliers. The enHealth Water Quality Expert Reference Panel recommended that NHMRC consider updating and recommissioning the Community

Water Planner to aid small water suppliers. The online tool for the Community Water Planner was developed in 2010. It was decommissioned by NHMRC in 2020 as the IT platform was no longer supported. The enHealth Water Quality Expert Reference Panel also recommended that to ensure consistent and up to date guidance the rolling revisions to the Guidelines should include:

- further guidance on data requirements
- revision of selected disinfection information sheets to better align with the updated guidance
- reviewing water consumption assumption information used in the updated guidance
- revisions to selected microorganism factsheets with consideration to public health concerns with in-premise plumbing and nuisance organisms.

Further detail on the comments and feedback provided by the enHealth Water Quality Expert Reference Panel and NHMRC responses is in **Appendix A**.

Contributors

The Committee, in particular the Working Group, led the development of the guidance. This work was undertaken over multiple terms of the Committee from 2013 to 2021.

Water Quality Advisory Committee

Committee membership is outlined below.

Previous members of Water Quality Advisory Committee over period 2009-2012

- Professor Don Bursill (Chair 2009-2010), University of South Australia
- Ms Jan Bowman, Victorian Department of Human Services
- Dr David Cunliffe (Chair 2011-2012), South Australia Department of Human Services
- Mr Chris Davis, University of Technology Sydney
- Mr Bruce Gray, Department of the Environment, Water, Heritage and the Arts
- Dr Stuart Khan, The University of New South Wales
- Dr Karin Leder, Monash University
- Associate Professor Greg Leslie, University of New South Wales
- Mr Adam Lovell, Water Services Association of Australia
- Mr Tom Mollenkopf, Australian Water Association
- Dr Martha Sinclair, Monash University.
- Mr David Sheehan, Coliban Water
- Dr Andrew Humpage, SA Water
- Professor Wayne Smith, New South Wales Health
- Associate Professor Heather Chapman, Griffith University
- Mr Richard Walker, Water Corporation
- Mr Alex Percival (consumer representative until 2010)

- Ms Caitlin Whiteman (consumer representative 2011-2013)
- Associate Professor Sophie Dwyer, Health Protection Queensland Government
- Professor Michael Moore (Observer), Water Quality Research Australia
- Mr Brian Bycroft (Observer until late 2013), Department of Sustainability, Environment, Water, Population and Communities
- Ms Jenny Paradowski (Observer), Department of Health and Ageing.

2013 – 2015 Water Quality Advisory Committee (1 February 2013 to 31 December 2015)

- Dr David Cunliffe (Chair), Department of Health South Australia
- Mr Adam Lovell, Water Services Association of Australia
- Dr Andrew Humpage, SA Water
- Mr David Sheehan, Coliban Water
- Dr Frederic Leusch, Griffith University
- Professor Michael Moore, Water Research Australia
- Mr Phillip Callan, Independent Consultant
- Mr Richard Walker, Water Corporation
- Associate Professor Sophie Dwyer, Health Protection Queensland Government
- Dr Stuart Khan, The University of New South Wales
- Professor Wayne Smith, Department of Health
- Ms Caitlin Whiteman (Consumer representative until 2013)
- Ms Carolyn Stanford (Consumer Representative from 2014-2015), Stanford Marketing
- Mr Brian Bycroft (Observer until late 2013), Department of Sustainability, Environment, Water, Population and Communities
- Dr Chris Hepplewhite (Observer from late 2013), Department of the Environment.

2015-2018 Water Quality Advisory Committee (24 March 2016 to 31 December 2018)

- Associate Professor Frederic Leusch (Chair), Griffith University
- Dr Daniel Deere, Water Futures Pty Ltd
- Dr Stuart Khan, The University of New South Wales
- Professor Jochen Mueller, The University of Queensland
- Dr Joanne O'Toole, Monash University
- Associate Professor Susan Petterson, Griffith University and Water and Health Pty Ltd
- Dr Tahna Pettman, The University of Melbourne
- Professor Craig Simmons, Flinders University
- Ms Carolyn Stanford (Consumer Representative), Stanford Marketing

- Mr Tim Hoar (Observer), Department of Agriculture and Water Resources
- Dr Nick Fletcher (Observer), Food Standards Australia New Zealand.

2018-2021 Water Quality Advisory Committee (2 January 2019 to 31 December 2021)

- Professor Fred Leusch (Chair), School of Environment and Science, Griffith University
- Ms Miranda Cumpston, Monash University and University of Newcastle
- Dr David Cunliffe, South Australian Department for Health and Wellbeing
- Mr Cameron Dalgleish, Tasmanian Department of Health
- Dr Dan Deere, Water Futures Pty Ltd
- Professor Cynthia Joll, Curtin Water Quality Research Centre, Curtin University
- Professor Stuart Khan, Water Research Centre, University of New South Wales
- Associate Professor Susan Petterson, Water & Health Pty Ltd / Griffith University
- Professor Craig Simmons, Australian Research Council / National Centre for Groundwater Research and Training, Flinders University
- Ms Carolyn Stanford (Consumer Rep), Stanford Marketing, Victoria
- Dr Katrina Wall, New South Wales Health Department
- Dr Nick Fletcher (Observer), Food Standards Australia New Zealand
- Ms Amy Lea (Observer), Department of Agriculture, Water and the Environment
- Mr Marcus Walters (Observer until 2020), Department of Agriculture, Water and the Environment
- Mr Adam Lovell (Observer), Water Services Association of Australia.

Health-Based Targets Working Group

Drafting of the guidance and subsequent revisions was undertaken by Committee members who were part of the Working Group during different periods from 2014-2021.

The following members of the 2013 - 2015 Water Quality Advisory Committee formed the Working Group until 2015:

- Dr David Cunliffe
- Mr David Sheehan
- Professor Wayne Smith
- Mr Richard Walker
- Mr Phillip Callan.

The following Water Quality Advisory Committee members formed the revised Working Group in May 2016:

- Associate Professor Susan Petterson
- Dr Dan Deere
- Dr Joanne O'Toole.

The following members of the 2018 – 2021 Water Quality Advisory Committee formed the Working Group until 2021:

- Associate Professor Susan Petterson (Working Group Chair)
- Dr Dan Deere
- Dr David Cunliffe
- Professor Craig Simmons
- Mr Cameron Dalgleish
- Dr Katrina Wall.

NHMRC Project Team

Early work on the project was undertaken by the Environmental Health section of the Research Translation branch. From mid-2018 onwards the project was managed by the Water Team in the Public Health section of the Research Translation branch.

Declarations of Interest

Appointees to committees of NHMRC are required to disclose their interests consistent with Section 42A of the NHMRC Act, and instructions issued under sections 16A and 16B of the Public Governance, Performance and Accountability Rule 2014 (made under subsection 29(2) of the *Public Governance, Performance and Accountability Act 2013* (PGPA Act)). Prospective members were specifically asked to identify, to the best of their ability, interests including:

- financial interests: an interest must be declared when benefits or losses either in money or in-kind have occurred or may occur at a level that might reasonably be perceived to affect a person's judgement in relation to fair decisions about evidence and their participation in group decision-making
- other relationships: an interest must be declared when a strong position or prejudice or familial connection or other relationship held by a person could reasonably, or be perceived to, affect a person's judgement in relation to fair decisions about evidence and their participation in group decision-making including making an effort to arrive at a consensus
- affiliations to or associations with any organisations or activities that could reasonably be perceived to be an influence due to a competing interest, either for or against the issues being considered by the committee
- any other influences that might reasonably be considered likely to affect the expert judgement of the individual, or lead to the perception by others that the judgement of the individual is compromised.

Under the PGPA Act, members have a responsibility to declare any interests to the whole committee, and members have a joint responsibility to decide on the management of any perceived or real conflict. No unmanageable conflicts were identified by the Committee or NHMRC.

Throughout the project, members were reminded of their obligation to consider any interest that may have arisen since the last meeting or with any particular agenda items. All disclosures and determinations about interests were recorded in the minutes of the Committee meetings. Members' relevant expertise and a summary of their disclosed interests were accessible on the NHMRC website throughout the duration of the project.

The relevant expertise of the Committee and a summary of their disclosed interests during the term of their membership is at **Appendix D**.

It is noted that several members of the Committee and Working Group (Dr Deere, Professor Khan, Dr Cunliffe, Dr O'Toole, Mr Walker and Associate Professor Petterson) are authors of publications and studies cited in the guidance.

Declarations of interest were routinely raised at meetings of the Committee and the Working Group during drafting of the guidance. Members of the Committee did not raise any concerns regarding these interests.

Project funding

This work was funded by NHMRC.

Acknowledgments

NHMRC would like to acknowledge the efforts and contributions of everyone who contributed to the updated guidance on the microbial quality of drinking water. This includes a special acknowledgement to the members of the 2018-2021 Working Group who went above and beyond to help the NHMRC project team review the large quantity of public consultation comments.

References

NRMMC (National Resource Management Ministerial Council), EPHC (Environment Protection and Heritage Council) and AHMC (Australian Health Ministers' Conference) (2006). Australian Guidelines for Water Recycling: Managing health and environmental risks (Phase 1). ***Note that this publication is currently under revision by the Environmental Health Standing Committee (enHealth).***

NRMMC (National Resource Management Ministerial Council), EPHC (Environment Protection and Heritage Council) and NHMRC (National Health and Medical Research Council) (2008). Australian Guidelines for Water Recycling: Augmentation of Drinking Water Supplies (Phase 2). Australian Government, Canberra.

World Health Organization (WHO) (2016). Quantitative Microbial Risk Assessment for Water Safety Management. Geneva, World Health Organization.

Appendix A – EnHealth feedback on draft guidance

The enHealth Water Quality Expert Reference Panel was formally consulted on four different iterations of the guidance. The first consultation was in June 2016 on the first public consultation draft. The second consultation was on the revised draft guidance in November 2017 before the 2018 public consultation. The third consultation took place in December 2021 following extensive revisions to the draft guidance in response to public consultation feedback. The fourth consultation took place in March 2022 on the final drafts of the guidance.

2016 EnHealth consultation on draft guidance

Early drafts of the 2016 public consultation documents were provided to the jurisdictions before public consultation. Feedback provided by the jurisdictions was collated and reviewed alongside submissions received by the public. Full submissions are provided in **Appendix C** where permission has been given to publish.

2017 EnHealth consultation on draft guidance

The following feedback was provided by members of enHealth Water Quality Expert Reference Panel in response to the first draft of the guidance provided for review in November 2017 to January 2018 prior to the 2018 public consultation. A technical appendix (referred to below as appendix A) was also provided.

NHMRC sought feedback on the following:

1. the proposed treatment targets (LRVs) in table 5.6, which are based on the assumptions outlined in appendix A.
2. the selection of reference pathogens and the assumptions used in calculating the treatment targets as outlined in appendix A.
3. the approach to interpreting the calculated LRV for practical treatment guidance as outlined in section A9.
4. whether you for see any difficulties in the implementation of these proposed treatment targets.
5. should a section on use of pathogen testing in the context of the framework be added?

The responses from each jurisdiction to the specific questions are provided in the **Table 2** below. Additional comments were provided in marked up versions of the draft documents which were also considered by the Working Group.

Table 2. 2017 enHealth comments on the draft guidance

#	enHealth feedback	NHMRC/Committee response
General comments		
1	I encourage the writers to consider options to make the documents as brief and clear as possible.	Noted. Numerous edits made to the draft to improve clarity.
2	Suggested edits and comments on writing style were also provided in marked up copies of documents provided for consultation.	Noted. The suggested edits provided were considered when revising content of Chapter 5 and technical appendix.
3	There are numerous typos, missing footnotes and missing units of measurement throughout the document.	Accepted. General edits have been made to the document.
4	Extending the use of Australian data to use of system specific data (i.e. in a Tier 2 type approach) is the only substantive issue identified (as discussed at the WQWG meeting). Utilities do not have to take this path but there are a few utilities that have large amounts of system specific data and guidance on how to use this data would be useful. This should not require a great deal of text as the tools for calculating LRVs from source concentrations are already provided in A9. The guidance should indicate that pathogen monitoring is not a necessary or required progression (i.e. the clear message should be that LRVs can be determined without expensive pathogen monitoring – particularly important for smaller utilities). On this note I probably wouldn't describe the two approaches as Tier 1 and Tier 2 as it could suggest a recommended/suggested progression from 1 to 2. The guidance should also discuss what to do if LRVs determined from the two approaches are substantially different.	Accepted. The reference to Tier 1 and Tier 2 assessments has been removed from the guidance. The guidance focuses on *E. coli* monitoring rather than monitoring of reference pathogens. The guidance also directs water utilities to consult the relevant health authority or drinking water regulator if source water assessments yield conflicting or substantially different LRVs.
5	In principle, the inclusion of this guidance in ADWG is supported, and including the selected reference pathogens. There are no foreseeable significant difficulties in implementing the proposed treatment targets, as reducing microbial risk to acceptable levels in drinking water is a requirement of the Safe Drinking Water Regulations 2015. Many water agencies currently utilise the *WSAA Manual for the application of health-based targets for drinking water safety(2015*); where there are variations between WSAA's and NHMRC's treatment targets this may cause concern for some water agencies. The rationale for treatment targets based on the given source water must be defensible and therefore further justification is required regarding calculation of treatment targets, particularly where professional judgement and pragmatism has been applied. To support the implementation of treatment targets it would be beneficial to include a section in the Draft Chapter 5 on the use of pathogen testing in the context of the framework.	Noted. Additional information has been included on use of enteric pathogen data.
Question 1: The proposed treatment targets (LRVs) in table 5.6, which are based on the assumptions outlined in appendix A		
6	The approach is sound	Noted.

#	enHealth feedback	NHMRC/Committee response
7	The treatment targets seem reasonable, and roughly align with the previous draft, give or take half a log. However, the explanation of the methodology for arriving at the LRVs remains obscure to anyone who does not have a grasp of epidemiology and/or QMRA. The *WSAA Manual for the application of health-based targets for drinking water safety (2015*) did a better job of making this topic easier to understand, but then again, they were working from your earlier draft, so they did not have to go back to the basic assumptions.	Noted. NHMRC's approach is based on the best available Australian data and uses different assumptions to *WSAA Manual for the application of health-based targets for drinking water safety (2015*). Information on development of LRVs is provided in the technical appendix. NHMRC has been in consultation with WSAA in development of the advice to discuss implications for water suppliers.
8	The targets are credible and are supported.	Noted.
9	The ability to meet the LRV requirement of 3 for protozoa for category 2 source water is generous for direct filtration The ability to meet the LRV requirement of 4 for protozoa for category 3 source water is generous for conventional filtration.	Noted. The column on Indicative specified treatment technologies has been removed from Table 5.6. Details on treatment Indicative pathogen LRV potentially attributable to treatment barriers are now provided in Table 5.7.
Question 2: The selection of reference pathogens and the assumptions used in calculating the treatment targets as outlined in appendix A		
10	The approach is sound.	Noted.
11	No objection to the selection of reference pathogens, but this is a very technical detail.	Noted.
12	Supported.	Noted.
Question 3: The approach to interpreting the calculated LRV for practical treatment guidance as outlined in section A9		
13	The approach is sound.	Noted.
14	We agree with the approach.	Noted.
15	Supported with one or two minor comments on Table A.	Noted. Minor edits made.
Question 4: Whether you for see any difficulties in the implementation of these proposed treatment targets		
16	Yes. it is anticipated that people will have questions about catchment risks and source categorisation. WaterRA project 1109-16 will hopefully help with this. There is no expected difficulty with the large metro utilities. There may be challenges to support implementation across regional areas. However, there is a strong interest in addressing regional infrastructure needs (including drinking water treatment).	Noted. Edits made to improve clarification on source categorisation have been made. Reference to relevant practical guidance have been included where appropriate. The guidance also recommends that water agencies consult with the relevant health authority or drinking water regulator for site specific application.

#	enHealth feedback	NHMRC/Committee response
17	As the documents admit, implementation outside metro areas will be challenging. We will have to ask many drinking water scheme managers to just trust the process, and there will be a degree of scepticism from some. We still have many suppliers with quite basic DWQMPs, so moving to HBTs will be problematic. Many schemes will fall into Category 3 or 4, on the basis of run of river supplies or complete absence of source water quality data. But there will not be the financial resources to upgrade their treatment to achieve the high LRVs that would be required to achieve 1 microDALY. We are also likely to have trouble convincing our economic regulators that upgrades are justified on the basis of what appear to be theoretical levels of risk. We have already found that the challenge of just achieving compliance with the existing ADWG is pushing some local governments to consider de-registering as drinking water providers, and just managing their supplies as non-potable. This is, generally speaking, an undesirable outcome.	Noted. The guidance is based on international best practice with consideration to potential challenges for implementation. Edits made to clarify expectations for small water suppliers including recommendations that water agencies consult with the relevant health authority or drinking water regulator for advice on site specific expectations.
18	There will always be challenges with increasing treatment targets as systems get smaller. This also happened with implementation of the Framework. It needs to be recognised that implementation will take time. In the end implementation will underpin improvements in the safety of drinking water supplies. Cost implications will be low for larger utilities with many having adopted features of HBTs including benchmarking of drinking water systems against LRVs developed by USEPA which are not dissimilar to those included in Table 5.6. In relative terms costs will be higher for systems with the biggest problems. The safety of some of these supplies is questionable.	Noted. The guidance acknowledges that it will be more challenging for some drinking water suppliers to meet this target, particularly those in rural and remote areas. The guidance also notes that getting started towards meeting the target is important.
Question 5: Should a section on use of pathogen testing in the context of the framework be added?		
19	Yes, as there are some large utilities already doing some pathogen testing so a national approach would be ideal. This would allow for better sharing of data if standardised.	Noted.
20	This is a question that is going to be asked by some drinking water service providers so I think a para or two would not go astray. For example, we have had some issues with some of our far northern water supplies where small local governments are managing run of river supplies with chlorination only, no filtration. They seem confident that crypto is not in their catchment yet has been found in nearby catchments of similar type. Then there are the problems of viability and human infectivity and so reaching a firm conclusion from pathogen monitoring is itself problematic.	Noted. Additional guidance on enteric pathogen sampling has been included. Noting that pathogen data should be considered alongside the indicator data and vulnerability classification to ensure that the overall assessment is consistent.
21	As discussed above, including a section on using pathogen results is supported.	Accepted. Additional guidance on enteric pathogen data has been included in Guidelines.
Comments on specific sections of the draft guidance and appendix		
22	A4 Selection of reference pathogens pg. 4: The rationale for selecting Campylobacter as the reference organism for bacteria should not be based on AGWR. The scientific justification should be provided in ADWG. Consider removing reference to AGWR – this document should stand on its own.	Noted. Additional wording included to explain the rationale for selecting *Campylobacter* and reference to WHO 2014 also included.
23	Table A.1 pg. 5: Information is presented associated with pathogens other than the selected reference pathogens. This is of questionable value and may confuse readers. Consider including information in the table relative to the selected reference pathogens only.	Not accepted. On advice from the Committee the six candidate reference pathogens were retained.

#	enHealth feedback	NHMRC/Committee response
24	A5 Level of reference pathogen contamination in Australian source waters pg. 5: 'Water utilities may hold data…Gathering further data, and publishing or making available the existing data, would assist with improving the accuracy of QMRA for drinking water'. It's unclear whether this is requesting that data be made available for further assessment. It also implies that if further data becomes available that the QMRA would be revised. Consider removing this information as it causes uncertainty. The limitations of the current QMRA are stated in the preceding text.	Partially accepted. Statement edited to reduce uncertainty.
25	Table A.3 pg. 7: The purpose of inclusion of Table A.3 is inadequately explained in the text. Consider Including additional discussion on the purpose of Table A.3.	Accepted. The information in Table A.3 has been summarised into a smaller table to show key information with further explanation provided in the preceding text.
26	A5 Consumption volume of unheated water per person per day pg. 10: There are other sources (such as foods) that contribute to water consumption volume. [Note: this is the same section reference (A5) as that above with a different section title]. Consider clarifying that the assessment relates to consumption of tap/drinking water only. Further discussion with the working group is required on the consumption of water adopted for the risk assessment. The studies referred to are at least 10 years old and current trends in health promote tap water as the drink of choice and to reduce the consumption of sugary-sweetened drinks. The 2 litres should be maintained as per current ADWG guidelines unless there is robust scientific basis to move away from this. The calculated LRVs will need to be revised accordingly.	Accepted. Edits made to provide clearer explanation of the consumption value and include discussion of the effect the consumption volume has on the final treatment requirements.
27	Table A.7 pg. 12: Information is presented associated with pathogens other than the selected reference pathogens. This is of questionable value and may confuse readers. Consider including information in the table relative to the selected reference pathogens only.	Not accepted. The table has been retained consistent with the content in Table A.1
28	Box A.3 pg. 13: Greater explanation of the calculation workings is required for it to provide value to readers. There appears to be a typo in the calculation [source concentration: 0.7 or 0.8?]. Additional information to step readers through the calculation would provide greater value.	Partially accepted. The LRV example calculation was removed on advice from the Working Group.
29	Figure A.3 pg. 14: There is little narrative provided to explain how Figure A.3 may be applied. Provide additional narrative on the purpose and application of the figure.	Accepted. Edits made to narrative for figure A.3.
30	Section A.9 pg. 15: States that an arbitrary reduction in the Cryptosporidium log reduction value has been based on 'professional judgement'. If the reduction has been based on the reasoning provided (in the two dot points in this section) then this should be stated; currently it remains unclear. The term 'professional judgement' is not aligned with the evidence-based nature of the ADWG. Clarify the basis on which the LRV reduction has been applied. Request data for publication to inform an evidence-based QMRA and provide references to support critical assumptions.	Accepted. Edits made to clarify the basis for the LRV reduction applied to Cryptosporidium.
31	Section A.9 pg. 15: 'It may be that in certain situations even greater reduction would be appropriate. In this situation the case to further reduce the LRV should be made directly to the regulator'. Advising utilities to refer to the regulator in some instances may lead to a variety of different outcomes across jurisdictions. The Appendix should provide technical guidance on these aspects to aid consistency. Sufficient guidance should be provided in ADWG to reduce the need for utilities to refer to the regulator, leading to more consistent outcomes (i.e. regarding high ambient temperature, long travel time of oocysts).	Not accepted. It is not practical to go into detailed guidance for all situations. It is important for water utilities to engage with the relevant health authority or drinking water regulator to ensure site specific requirements are appropriately addressed.

2021 EnHealth consultation on draft guidance

The following feedback was provided by the enHealth Water Quality Expert Reference Panel in response to the draft Guidance provided for review in December 2021.

The following questions were used to guide feedback:

1. Do you have any comments on the overall approach to assessing and managing microbial risk in source water outlined in section 5.3?
2. The treatment targets as log reduction values (LRVs) in table 5.6 were derived using Australian data and the assumptions are outlined in the technical appendix. Do you have any specific comments on these values and /or how they were derived?
3. These targets are consistent with the Australian Drinking Water Guidelines framework for managing drinking water. Do you foresee any major difficulties in the implementation of these proposed treatment targets? If so, what are they and how could they be resolved?
4. Do you have any comments on the following sections:
    a. section 5.5 on opportunistic pathogens
    b. section 5.6 on cyanobacteria
    c. section 5.7 on nuisance organisms
5. Is the approach as articulated in the technical appendix clear? If not, how could it be made clearer?

Feedback on the chapter, technical appendix or questions and answers resource were also sought.

Jurisdictional feedback mostly supported the release of the draft Guidance for public consultation. The following key issues were raised for consideration by NHMRC and the Committee when finalising the draft Guidance are provided in **Table 3** below.

Table 3. 2021 enHealth comments on the draft guidance

#	Comment	NHMRC Response
1	Chapter 5 and technical appendix multiple sections: It could be useful to increase the citation of references containing more prescriptive information, particularly when those texts are in the public domain e.g. the *WSAA Manual for the application of health-based targets for drinking water safety (2015)*. Suggest editing text accordingly.	Accepted. Additional references to practical guidance available in the public domain included in the Q&A resource and Chapter 5.
2	Chapter 5 Section 5.2: In the paragraph on fungi, the term "oligotrophic" is used. Usage of this term could not be found elsewhere in the main ADWG document. Suggest replacing "oligotrophic" with "low nutrient" which is used on the next page.	Accepted. Terminology updated to "low nutrient".
3	Chapter 5 Section 5.2: Paragraph on Opportunistic pathogens, The third sentence refers to plumbing networks "*where nutrients are available*". Suggest replacing "where nutrients are available" with "where conditions are suitable" as it is not just availability of nutrients (which typically are low in drinking water systems) but also water temperature, low disinfectant residual and presence of OP's in source waters.	Accepted. Wording replaced as suggested.
4	Chapter 5 Section 5.2: Paragraph on Opportunistic pathogens, The sentence "*Naegleria fowleri is one such free living amoeba that can lead to primary amoebic encephalitis (PAM).*" is potentially confusing. It could be understood, by non-technical readers, to be highlighting *Naegleria* as a "drinking water" risk when the key exposure is via the nasal cavity. Re-word the sentences to "*Naegleria fowleri is a free-living amoeba found in natural waters that can enter the central nervous system via the nasal cavity and cause primary amoebic encephalitis (PAM)*".	Accepted. Sentence reworded as suggested.
5	Chapter 5 Section 5.3: Wording could include clarity that there is not the expectation that drinking water service providers undertake a QMRA, rather they need to ensure their operations are such that they are able to meet the safety targets identified by any existing relevant QMRA. Consider addition of statement to clarify expectation of drinking water service provider.	Not accepted. The principles and the practical expectations are outlined earlier in section 5.3 and discussed further in sections 5.4, 5.5 and 5.6. No edits made to text after consulting enHealth Water Quality Expert Reference Panel.
6	Chapter 5 Section 5.4.2: The first sentence states the same thing as the first sentence under the heading "surface water". Delete 1st sentence of 5.4.2 and begin that section with the 2nd sentence.	Accepted. Edits made to the sentences.
7	Chapter 5 Section 5.4.2: Surface water, 2nd para, 1st sentence. This could be simplified by referring to plumbing infrastructure generically. Delete "*connecting buildings to sewers, leaking sewerage*"	Accepted. Text deleted as suggested.
8	Chapter 5 Section 5.4.2: Last paragraph on P8 references unpublished data. Yet NHMRC declares that consideration cannot be given to that when making decisions. Does it require a rewording or an explanation as to why unpublished data has been considered?	Not accepted. The reference is retained as it is linked to a peer reviewed published study.
9	Chapter 5 Section 5.4.2: In the first para in 5.4.2 add at the end of the para the following text "*…in the drinking water catchment*". This is just to clarify that human or animal contamination that may be nearby but outside the catchment is not likely to be of significant concern. Edit text accordingly.	Accepted. The suggested text added to end of paragraph.

#	Comment	NHMRC Response
10	Chapter 5 Section 5.4.2: In 5.4.2, In the sentence "*Direct release of faeces during public access to water sources may result in human pathogens entering surface water sources*." add the text *"(for example during swimming in a water storage)"* between the words "*sources*" and "*may*". Edit text accordingly.	Accepted. Text added as suggested.
11	Chapter 5 Section 5.4.2: In 5.4.2, The sentence "*Virtually all vertebrates carry zoonotic bacterial pathogens*." can be deleted as it is very similar to the previous sentence. Edit text accordingly.	Accepted. Text deleted as suggested.
12	Chapter 5 Section 5.4.2: The 6th dot point under the heading "Groundwater" In the dot point "*leaky boreholes …leading to shallow aquifers entering bores*" it is suggested that this be amended to say "*…leading to groundwater from shallow aquifers entering bores*". Edit text accordingly.	Accepted. Text amended as suggested.
13	Chapter 5 Section 5.4.2: Second dot point under "*Other drinking water sources*", Suggest rewriting as "*Reuse of water drawn from storm water, greywater or treated sewage is addressed under the Australian Guidelines for Water Recycling (Phase 2) (2008 & 2009)".* Edit text accordingly.	Accepted. Text reworded as suggested.
14	Chapter 5 Section 5.4.2: Groundwater, the text is confusing and wordy "*Note that a drinking water bore can potentially be shown to be secure at a point in time when an assessment of its security is undertaken. However, if the security of that bore changes due to any of numerous independent possible failure modes it is often difficult to detect until after contamination has arisen. Evidence of bore security needs to be collected and evaluated on a timely (ideally continuous) basis as part of routine operational monitoring with defensible, valid targets/operational limits set. These should be linked to timely (ideally automated) corrective actions as part of reliable, auditable operational procedures and process control systems, e.g. inline bore monitoring. Refer to Chapter 9.3 for further guidance on developing monitoring programs. 9 Any assessment should include both a bore-by-bore evaluation and an overall aquifer-by-aquifer assessment. This is critical due to the spatial scales and processes involved in transferring pollutants from the pollution source to the drinking water bore. Suitably qualified scientific, hydrogeological and engineering knowledge should be used to demonstrate such bore security with confidence. A high degree of caution needs to be exercised as multiple waterborne disease outbreaks have arisen where bores were incorrectly assumed to be secure. Discussions surrounding bore security should be discussed with the relevant drinking water regulator or health authority. Water treatment should be designed assuming that the risks in the groundwater are the same as those in the surrounding and recharging surface water, unless there is evidence of aquifer protection*". Suggested rewording: "*Note that a drinking water bore may be considered secure at a point in time when an assessment is undertaken. However, if the security of that bore changes due to any of numerous independent possible failure modes it is often difficult to detect until after contamination has arisen. Evidence of bore security needs to be collected and evaluated on a timely (ideally continuous) basis as part of routine operational monitoring with defensible, valid targets/operational limits set. These should be linked to timely (ideally automated) corrective actions as part of reliable, auditable operational procedures and process control systems, e.g. inline bore monitoring of physiochemical parameters to detect changes that may suggest security has been impacted. Refer to Chapter 9.3 for further guidance on developing monitoring programs. It is essential that any assessment of bore security be carried out at the individual bore scale and at the aquifer scale. This is critical due to complex transport processes that occur within and between aquifers and bores. Suitably qualified scientific, hydrogeological and engineering knowledge should be sought to demonstrate bore security. A precautionary approach should be taken as multiple waterborne disease outbreaks have arisen where bores were incorrectly assumed to be secure. Discussions surrounding bore security*	Accepted. The suggested rewording has been included in the chapter text.

#	Comment	NHMRC Response
	should occur with the relevant drinking water regulator or health authority. Water treatment should be designed assuming that the risks in the groundwater are the same as those in the surrounding and recharging surface water, unless there is evidence of aquifer protection and bore security".	
15	Chapter 5 Section 5.4.3: Subpoint 1 on page 10 under heading Benchmark of Safety, Text states "*…for defining safe water*"". Suggest change to "*…as the key target for defining microbially safe water*".	Accepted. Text changed as suggested.
16	Chapter 5 Section 5.4.3: Vulnerability classification, the text is unclear about how the classification is determined for the system. A sanitary survey is suggested to confirm the category but may be better placed to generate the evidence to determine the category Include a basic level of instruction such as "*Conduct a rapid risk assessment…*" or "*Match your catchment to one of the category descriptions in Table 5.2*".	Accepted. Edits made to "*Vulnerability classification*" to provide the key steps for classifying a water source.
17	Chapter 5 Section 5.4.3: Benchmark of Safety: Microbial Safety and the Water Safety Continuum. The first para uses both DALY and µDALY. The 2nd and 3rd paras use only DALY. The 4th para uses both DALY and µDALY. Consider consistency.	Accepted. Wording updated to ensure consistent use of terminology.
18	Chapter 5 Section 5.4.3: Source Water Category. Under Step 3, the reference to "vulnerability assessment" should be replaced with "vulnerability classification". Edit accordingly.	Accepted. Suggested edits made.
19	Chapter 5 Section 5.4.3: Assess Treatment Requirements. 2nd para, 2nd last sentence. This does not hold true for the protozoa LRVs owing to the reduction afforded to crypto infectivity. It is not until one interrogates the Appendix that this becomes clear. Consider adding a sentence that accounts for the difference in the upper range of protozoa not being adopted in the LRV Table.	Accepted. Edits made to clarify the different approach for selecting values for protozoa.
20	Chapter 5 Section 5.4.3: For dot point 1, This text may be interpreted in a way such that water suppliers believe they could use ozone, UV, or filtration without chlorination (whereas chlorination will almost always be required for protection of water in the distribution system). Include text that reminds water suppliers that they should achieve a disinfection residual throughout their network wherever possible.	Accepted. Edits made including that the maintenance of residual disinfection is a concern for all categories. Text after the dot points has been included based on Information Sheet 1.3 of the Guidelines.
21	Chapter 5 Section 5.4.3: Site specific validation needs expanding: "*Site specific validation is therefore critical to ensure that the treatment process is performing as expected (see section 9.8). Site specific validation does not necessarily mean challenge testing, but will involve ensuring that the pathogen removal mechanisms of each treatment barrier are performing as expected. The basis for validating different processes are summarised in Table 5.6, with reference to industry documents that provide more detailed and pragmatic guidance. Operational monitoring is needed to ensure that the identified parameters remain within critical limits*". Suggested rewording: *"Site specific validation is therefore critical to ensure that the treatment process is performing as expected (see section 9.8). Site specific validation does not necessarily mean challenge testing, but will involve ensuring that the pathogen removal mechanisms of each treatment barrier are performing as expected at critical control points. The basis for validating different processes are summarised in Table 5.6, with reference to industry documents that provide more detailed and pragmatic guidance. Operational monitoring is essential to ensure that the identified parameters remain within critical limits, for example that turbidity targets are being met continuously for filtration barriers"*.	Accepted. The suggested rewording has been included in the chapter text.

#	Comment	NHMRC Response
22	Chapter 5 Section 5.4.3: The vulnerability section should be edited to highlight that while the information in Table 5.2 has been compiled to classify surface water sources it can also be used to classify ground water sources. Edit title of table 5.2 to reflect broader application i.e. not just surface water.	Not accepted. No edits required to the title for Table 5.2. The guidance notes that the classification is based on the assessment of recharging surface water until the groundwater security or the aquifer's ability to reduce pathogen concentrations can be proven.
23	Chapter 5 Section 5.4.3: Vulnerability classification (page 12) and Source water classification for unprotected groundwater (page 21) Q and A 18, The tables and discussion that follows the section titled Vulnerability classification are all focused on surface water – then on page 21 there is a small section about how you might apply the information to unprotected groundwater sources. Further, the Q and A document (q18) makes clear that a high degree of caution needs to be exercised where bores are incorrectly assumed to secure – if this is a significant risk it should be discussed in the body of ADWG not just highlighted in the Q and A. Insert new paragraph 3 under heading Vulnerability classification: While Table 5.2 has been compiled to classify vulnerability classes for surface water sources it can also be used to classify ground water sources. Then insert text from page 21 in relation to classification of unprotected groundwater sources and insert a statement advising how deep ground water sources (e.g. GAB) sources should be classified. Delete Source water classification for unprotected groundwater section on page 21.	Accepted. Discussion on groundwater classification moved under the "Vulnerability Classification" heading and a box included in Chapter 5 covering elements of groundwater risk. Edits also made to the text to highlight the key principle is that groundwater is considered unprotected unless proven otherwise. Note, specifics of depth have not been included as the focus is on the general process of proving the protection of groundwater.
24	Chapter 5 Section 5.5: Opportunistic pathogens does not mention the HBT, and the appendix states it is for enteric pathogens only. Clarify in section 5.5 that the HBT is not applied for these pathogens or add a similar statement to used in s5.7 on a quantitative limit.	Accepted. Text added to section 5.5 stating a health-based target for opportunistic pathogens is not practicable.
25	Chapter 5 Section 5.5: This paragraph needs rewriting: Whilst this chapter has focused on source water and treatment, it is noted that most (of the order 90%) waterborne disease outbreaks in the US are now arising from within the distribution system due to post-treatment contamination because starting in 1996 the US has been implementing its drinking water treatment rules to meet its health-based targets. Water can become re-contaminated with enteric pathogens via water storage tanks and into the distribution network due to ingress of contaminated material during periods of low pressure, negative pressure transients (e.g. due to water hammer) backflow, cross connection, and during maintenance. In particular, treated water storages are highly vulnerable to contamination from birds or access by other vertebrates. Waterborne disease outbreaks can also occur due to post treatment contamination. Health based targets were introduced in the US in 1996, and now around 90% of outbreaks are due contamination within the distribution system. Treated drinking water can become re-contaminated with enteric pathogens via water storage tanks and into the distribution network due to ingress of contaminated material during periods of low pressure, negative pressure transients (e.g. due to water hammer) backflow, cross connection, and during maintenance. In particular, treated water storages are highly vulnerable to contamination from birds or access by other vertebrates.	Accepted. The suggested rewording has been included in the Chapter 5 text.
26	Chapter 5 Section 5.5: The draft states: "*In-premise plumbing systems. Plumbing systems can create conditions conducive to opportunistic pathogen (in particular Legionella) growth. Plumbing systems should be designed and managed to avoid warm water (keep stored cold water cold at <18oC and stored hot water at >50oC (WHO 2011b; WHO 2017) and avoid stagnation. Detailed guidance on managing the risks are given in the Guidelines for Legionella Control in the operation and maintenance of water distribution systems in health and aged care facilities (enHealth 2015).*" In relation to hot water systems in Australia the enHealth guidance on legionella control refers to 60°C. Review 50°C. This may be a typo but if not, should we not adopt enHealth?	Accepted. The temperature information has been revised to be consistent with the *Guidelines for Legionella Control in the operation and maintenance of water distribution systems in health and aged care facilities (enHealth 2015).*
27	Chapter 5 Section 5.7: The following text is not plain English – "*bacteria such as non-toxic planktonic and benthic cyanobacteria (blue-green algae)*".	Accepted. Suggested additional text included in chapter.

#	Comment	NHMRC Response
	Suggested addition: "*bacteria such as non-toxic planktonic and benthic cyanobacteria (commonly known as blue-green algae)".*	
28	Chapter 5 Section 5.7: Although the text on P28-29 is currently used in Chapter 5 it may be useful to improve the wording as the second dot point at the top of page 29 could be interpreted to be saying that iron, manganese and sulphur are "nuisance organisms". Edit dot points to say: "*iron, manganese and sulphur reducing bacteria*", assuming that is what was intended.	Accepted. Dot points edited as recommended.
29	Chapter 5 Section 5.7.3: The following sentence requires further detail: The presence of these organisms may also indicate organic pollution of the aquifer. Suggested addition: The presence of these organisms may also indicate organic pollution of the aquifer and should trigger an investigation if populations are changing.	Accepted. Suggested additional text included in chapter.
30	Chapter 5 Section 5.7.4: There is no sentence on management or monitoring in this section. The other sections include some guidance on monitoring/control e.g. 5.7.3, 5.7.1, suggested addition: "*Changes to iron and sulphur bacteria populations may be detected due to aesthetic impacts and customer complaints and should trigger an investigation".*	Accepted. Suggested wording added to chapter.
31	Chapter 5 Section 5.7.5: There is no mention in this section of the problems caused by large numbers of crustacea, though they were listed at the start of the nuisance organisms section. Include problems caused by *Crustacea*; *Daphnia* have been known to clog filters when in huge numbers in response to cyanobacteria blooms. Also, for completeness, molluscs could be included, if wanted. Water suppliers have had main flow significantly reduced by masses of mussels.	Noted. Consider problems caused by *Crustacea* such as *Daphnia* and other nuisance organisms in rolling revision of the Guidelines.
32	Chapter 5 Box 5.1: There are circumstances whereby water agencies are using HBTs to justify deterioration of source water quality and compensating for this deterioration through treatment augmentation. Some water agencies are also pushing the adoption of QMRA in rationalizing whether a boil water advisory should be issued or which is not the intent of QMRA; and a move away from breaches in critical control points. Important to be clear what the QMRA can be and what is should not be used for. Insert statement after reference to the guiding principles and 12 elements, that the health-based targets must not be used as a licence to degrade source water. Water agencies should do all that is reasonably practicable to reduce risks to source waters and must not permit activities that risk degradation of source waters. Be clear that HBTs are used to assess the level of treatment that is required to manage microbial source water risk. Be clear that in this guidance, HBTs have not considered microbial risks in the distribution system.	Accepted. Edits made to highlight the purpose of health-based targets in Box 5.1.
33	Chapter 5 Box 5.1: Reference to the "actual risk" may not be entirely correct as the QMRA method adopted is based on an annualized probability of risk and therefore does an estimate of risk at a point in time associated with an event and in the guidance does not include quantification of microbial risk in the distribution system. Therefore, may not necessarily represent the 'actual risk' to the consumer. The guidance provides commentary about the increased incidence of waterborne disease associated with the distribution system. Beneficial to explain the scope and limitations of QMRA as it is currently applied in this guidance; i.e. at treatment plant, not distribution. Therefore worth reinforcing importance of critical control points, distribution system management and microbial water quality verification monitoring – and that this remains 'no detection'. Replace "*actual risk*" with "*treatment plant microbial water quality objectives*", or something to this effect.	Accepted. Edited to treated water risk to explain the scope and limitations of QMRA as it is currently applied in the guidance.

#	Comment	NHMRC Response
34	Chapter 5 Box 5.2: In Box 5.2, it is not clear what constitutes a small water supply. It is acknowledged that a definition is provided in the current chapter 4. Define or refer to a definition of a small water supply as this may vary between different jurisdictions.	Accepted. Text added to Box 5.2 specifying small water supplies are those community-based systems supplying fewer than 1000 people (as defined in Chapter 4 of the Guidelines).
35	Chapter 5 Box 5.2: Suggest some softening on the assessment of source waters used to supply small drinking water systems particularly where there is only limited data available. In this circumstance, on an interim basis, it could be reasonable to place a greater reliance on the vulnerability assessment (in consultation with the relevant regulator/health authority) while data is gathered. Placing all small supplies with limited *E. coli* data in the most conservative categories will have substantial impacts. Box 5.2 is a start, but this could be strengthened/broadened.	Accepted. Edits made to Box 5.2 to clarify expectations for small suppliers.
36	Chapter 5 Box 5.4: This statement is unclear "*Pathogens may be inactivated by kinetic and metabolic processes at rates that are related to temperature, sunlight and predation".* Suggested rewording: "*Some pathogens are settled by gravity if water is static and may also be inactivated by kinetic and metabolic processes at varying rates due to temperature, sunlight and predation*".	Accepted. Substantial edits made to the wording in box 5.4 to improve clarity.
37	Chapter 5 Box 5.4: Reservoirs and risk management: Use of hydrodynamic modelling to understand and manage reservoir short-circuiting and the influence on pathogen risk. The narrative does not make reference to waterfowl and whether this would be an important consideration especially if there are structures on the reservoir such as towers that may encourage roosting. Vulnerability classification versus E. coli results. Include consideration of waterfowl in narrative. If the *E. coli* results a lower level of microbial risk than inferred by the vulnerability classification, then the vulnerability classification should take precedence given the fragility of *E. coli* in the environment relative to other pathogens.	Accepted. Edits made to Box 5.4 to include waterfowl as a potential source of pathogens which can reach the offtake through short cutting. Note, the approach for managing conflicts between vulnerability class and microbial band allocation is included within the text.
38	Chapter 5 Box 5.4: This statement is unclear "*Pathogens may be inactivated by kinetic and metabolic processes at rates that are related to temperature, sunlight and predation".* Suggested rewording: "*Some pathogens are settled by gravity if water is static and may also be inactivated by kinetic and metabolic processes at varying rates due to temperature, sunlight and predation".*	Accepted. Substantial edits made to the wording in box 5.4 to improve clarity.
39	Chapter 5 Box 5.6: The way the text is drafted suggests that only treatment improvements can address the shortfall. However, if the shortfall is quite small, the shortfall could be achieved via improved catchment management. Include a sentence or two to indicate that catchment management improvements could be made to address shortfall.	Accepted. Increased source water protection included as a strategy to address LRV shortfalls in box 5.6
40	Chapter 5 Figure 5.2 and Box 5.3: The Box states that "*Short falls in log reduction values can be used to prioritise improvements*" however the continuum notes greater than 10^{-4} should prompt discussions on immediate actions and figure 5.3 text notes that improvement in water quality should ensure that improvements are prioritised for the riskiest supplies. Change Box 5.3 to say Shortfalls in log reduction values should be used to prioritise improvements.	Accepted. Edits made to content in Box 5.3 based on feedback provided.

#	Comment	NHMRC Response
41	Chapter 5 multiple sections: Specific validation issues may be resolved by collaborative research. Subjective interpretation should be limited by referring back to regulator – as the enHealth WQERP will discuss this regularly at their meetings. Problems with small and remote supplies and resources for implementing. Once determined, a close relationship would be needed between the regulator and the water supplier to ensure that there was a plan to address into the future. Edit text accordingly.	Noted. Feedback considered in the final drafts.
42	Chapter 5 Table 5.1: Unsure why *Cyclospora spp* have been included – this is not a protozoa of concern in Australia at present – only significant outbreak with Australian cases was in 2010 and was in passengers returning from an Asian cruise. Delete reference to *Cyclospora* unless inclusion can be justified (noting it may be relevant to include it in a later revision if it becomes a protozoa of concern within in Australian water supplies). There is existing user concern about the ADWG being too big and unwieldy, so some culling of content should take place where possible.	Not accepted. For consistency the reference to *Cyclospora* has been kept with the exception of *Blastocystis*, all protozoa with fact sheets have been included in the chapter updates. The fact sheet notes that for *Blastocystis* there is no evidence of waterborne transmission in Australia.
43	Chapter 5 Table 5.2: I am not sure what is meant by the term "Itinerant human activities" and suggest that it is replaced by a descriptor encapsulating recreational activities, camping etc. The column on "protection measures" is a little confusing as in some rows information is provided on protection measures in place to ensure maintenance of vulnerability status (classes 1 and 2) while in other rows information is provided on measures that could be used to improve protection and to perhaps improve vulnerability status (classes 3 and 4). Suggest that a consistent approach is adopted.	Accepted. Edits made to Table 5.2 to improve consistency based on advice from the enHealth Water Quality Expert Reference panel.
44	Chapter 5 Table 5.2: Protection measures are those in place but may also be introduced to improve the vulnerability assessment of a water sources. Suggest including something about this in the paragraph prior.	Accepted. Additional information on source protection measures provided under the Classification heading in Table 5.2.
45	Chapter 5 Table 5.2: The descriptors negligible, low level, minimal, moderate and high are used in this table with no definition. This may lead to inconsistent application of the vulnerability categories and disagreements. Suggest defining these in the footnotes.	Accepted. The table has been updated with less reliance on these terms.
46	Chapter 5 Table 5.2: Vulnerability class 2 – intensity of activity column includes criteria 'well-managed on-site sewage management' – this assessment is very difficult to make, and any assessment is unlikely to remain current – failure rate of on-site systems is very high. Perhaps consider amending Vulnerability Class 1 to say "Poor or no onsite sewage management systems…"	Accepted. Wording has been amended as suggested.
47	Chapter 5 Table 5.2: Footnotes includes that a large reservoir has been defined as being >1 GL, as well as having other characteristics. It can be assumed that a small reservoir is at least <1 GL. If a reservoir is >1 GL, but misses some characteristics of a protective reservoir it doesn't become small. Remove the statement "A small reservoir does not meet all the criteria for a large reservoir."	Accepted. The footnote text has been edited and other edits to table to focus on what makes a protected catchment/reservoir.

#	Comment	NHMRC Response
48	Chapter 5 Table 5.2: Table 5.2 needs editing. There are too many qualifying words used without explanation e.g. negligible, moderate, low intensity, medium (what is the difference between moderate and medium?). These could be reduced. It could also be beneficial to group the three columns on “intensity of activity”, “proximity to offtake” and “protection measures” under a unifying heading to reinforce the linkage between the information provided e.g. to make it clearer that “low levels of recreational activity” in the column on intensity are explained in part by the text in the column on proximity that recreational activities are excluded from the inner catchment area etc. Edit text accordingly.	Accepted. Extensive edits made to text in Table 5.2 to clarify requirements and improve readability.
49	Chapter 5 Table 5.5: Treatment targets for protozoa, bacteria and viruses given the source water type and E. coli results. There is no reference to the explanation detailed in the Technical Appendix for the reduction in protozoan LRV which takes into consideration viability and infectivity (0.5 or 1 LRV reduction). Add footnote in Table 5.5. to include explanation for derivation of LRV for protozoa (Cryptosporidium).	Accepted. Include in text of the "Assess Treatment Requirements".
50	Chapter 5 Table 5.6: Additional information could be included in Table 5.6 e.g. more detailed description of C.t values for the various forms of disinfection. Edit text accordingly.	Accepted. Edits made to C.t descriptions Table 5.6 based on advice from the enHealth Water Quality Expert Reference Panel.
51	Chapter 5: There is no reference to ‘Tier 2’ assessments, as outlined in the *WSAA Manual for the application of health-based targets for drinking water safety (2015).* Suggest reference to this methodology for determining LRVs.	Not accepted. The decision was made by the Working Group to remove reference to Tier 1 and Tier 2 assessments.
52	Chapter 5: The word ‘itinerant’ is used when ‘recreation/al’ is intended. Replace itinerant with recreation/al throughout the document.	Accepted. Itinerant has been replaced with recreation/al throughout the document.
53	Chapter 5: If not clear already, can the guidance specify that the sanitary surveys underpinning the health-based target assessments be reviewed every 3-5 years in addition to when there is a known change in the catchment? Edit accordingly.	Accepted. Edits made to text specifying that sanitary surveys should be reviewed regularly. No timeline is specified as the frequency will be dependent on the source and jurisdictional expectations.
54	Chapter 5: General Comment: It is likely that there will be wide interest in this chapter; the anticipation has built up through its long preparation. The chapter is written with a lot of scientific terms and highly technical information which can pose a barrier to readability and understanding. Efforts have been made in some places to explain terms, e.g. symbionts on page 29, and this should be expanded or at least ensuring the ADWG glossary includes all terms. Edit text accordingly.	Accepted. Extensive edits made to text to make more readable and accessible.
55	Chapter 5 and technical appendix: Generally supportive of both the Chapter and the Technical Appendix with the principles and structure sound. This includes being supportive of the derived targets. As previously discussed, the greatest challenge for implementation will be faced by operators of small-moderate sized supplies. This was a similar challenge faced in implementing the Framework. Need to emphasise the importance of getting started and not being overwhelmed by the new approach.	Noted. The importance of getting started included in the accompanying Q&A resource.
56	Chapter 5 and technical appendix: There is some room for technical editing as in places the test is too academic and in others it assumes a level of background knowledge that may not be shared by all readers. Examples are the section on “Meeting the Treatment Requirements” and Box 5.4. The Section on treatment requirements could be improved by including further discussion and explanation of	Accepted. Extensive edits made to text to make more readable and accessible.

#	Comment	NHMRC Response
	validation (reference to Table 5.6 is insufficient) and the term "Site specific validation" is likely to be mis-interpreted without inclusion of further explanation. The point being made in Box 5.4 about "Reservoirs and risk management" is not particularly clear and is hidden in the complexity of the discussion. Identifying caveats based on hydrodynamics of storage is reasonable but operators are mainly interested in how to determine LRVs attributable to storage in a relatively straightforward manner i.e. once minimum detentions have been determined what LRVs are reasonable. Cross-referencing to A1.6 could be useful but suggest that a short narrative to explain the LRVs presented in A1.6 would be useful. Edit text accordingly.	
57	Question and answer resource: Depending on changes that are incorporated it may be necessary to revisit the Q&As (e.g. Q9). In addition, in the answer to Q11 suggest including a little more information on the limitations of the methods used to determine Cryptosporidium concentrations (i.e. compared to infectivity). Edit text accordingly.	Accepted. Edits made based on feedback provided.
58	Question and answer resource: There is not a Q and A to provide explanation of HBTs – this might be important if the document might be used to help craft media statements. Insert Question – What are HBTs? https://www.who.int/water_sanitation _health/WHS_WWD2010_ health_targets_2010_8_en.pdf	Accepted. A question on what health-based targets are has been included using the suggested reference in the answer.
59	Question and answer resource Q11: Modify the question to *"why does the calculated LRVs for Cryptosporidium in the appendix differ by 1 log from those required in Chapter 5, for different categories of source water?"* Then rephrase the second part of the response to say *"….it may be prudent to add 0.5 log to the targets in Chapter 5"* since most people would be looking at the values in the chapter rather than the appendix. Edit text accordingly.	Accepted. Question 11 and answer has been edited accordingly.
60	Question and answer resource Q12: In the answer to Q12 it should be noted that humans are the predominant source of human infectious enteric viruses. Edit text accordingly.	Accepted. The Q&A resource was edited as suggested. The relevant text in Chapter 5 and technical appendix to match.
61	Question and answer resource 14: Unsure if there should be some discussion of why unheated water volumes are used instead of total water consumption. See comments relating to Section A7 below.	Noted. The comment on water volumes responded to below.
62	Question and answer resource Q18: This needs to be explicitly covered in Chapter 5 and not just left to the Q and As. See edit suggested in relation to section 5.4.3 of Chapter 5 outlined in table above.	Noted. The topic of classification for groundwater sources covered by edits in 5.4.3 "Vulnerability Classification".
63	Question and answer resource Q22: The question could include Table 5.5 as a reference as it is the same as Table A.4. Consider.	Not applicable - Q22 has been edited.
64	Question and answer resource Q22: It appears that the use of "vulnerability category" (1st sentence) and "vulnerability assessment" (2nd sentence) are used in the correct context. Change "vulnerability category" to source water category. Change "vulnerability assessment" to vulnerability classification.	Accepted. "vulnerability category" changed to "source water category". Changed "vulnerability" to "vulnerability classification assessment".

#	Comment	NHMRC Response
65	Question and answer resource Q5: More than consultation with Water Services Association of Australia. Revise to say NHMRC has consulted with stakeholders including xx regarding the implication of adopting the LRVs…	Accepted. The response to Q5 has been edited to better represent the key stakeholders consulted on the development of the guidance.
66	Question and answer resource Q7: The way that the answer is written is that one can expect additional guidance specifically related to LRVs in A1.6. For mine, A1.6 is more related to information about the considerations that can be applied to reservoirs and catchments when interpreting how LRVs may be applied. Might benefit from a rewording.	Accepted. Reworded to improve clarity.
67	Technical appendix section A5: The four dot points listed are slightly different to those listed in the AGWR. Suggest changing the dot points to: • Concentration in source water • Persistence in the environment and resistance to treatment • Infectivity • Pathogenicity	Not accepted. No edits made after further consultation with the enHealth Water Quality Expert Reference Panel.
68	Technical appendix section A7: Whilst it may be logical to some as to why unheated water volumes are used, it may not be clear to all. It may also beg the question as to if 1L is used in the HBT context, why is it not used in the context of deriving HBGV? Perhaps it just needs some commentary that the consumption of heated (boiled) water has rendered pathogens inactive and therefore need not be considered – whereas boiling water does not remove chemical contamination.	Noted. Additional text included to explain why unheated water is used for the health-based targets context.
69	Technical appendix section A7: It is stated that the reference exposure volume is 1 L per person per day which excludes heated water and other sources of drinks including soft drinks, cordial and alcohol. The justification for this is not clear – in regards to hot taps used for tea/coffee – what is known about the temperature reached for these – is boiling point reached? In relation to cordial – the source is surely drinking water, and in relation to manufactured beverages the starting point for these is that potable water must be used to manufacture these. What consideration has there been to consumption in the shower or when brushing teeth or food preparation? The Australian government recommends the following consumption volumes for drinking water (i.e. > 2 L): https://www.healthdirect.gov.au/drinking-water-and-your-health. This makes reference to the NHMRC Nutrient Reference Values for Australia and New Zealand drinking water). Furthermore the 1 L is less than the minimum requirement in an emergency context. This should not be up to the regulator as this is a population wide exposure scenario. It is preferential that this is resolved in finalising the guidance and the LRVs updated accordingly in the technical appendix and guidance. I refer to ABS 2011-12 data (which I note is 10 years old and it would be beneficial to have more recent data. Notwithstanding, according to the graphs from data – if the 90thile is adopted for all age groups, then the 1 L is not appropriate. Review the 1 L critical assumption to ensure that consumers are adequately protected. FISANZ should be brought into these conversations if not already. Derivation of a consumption volume should take into consideration increased temperatures and health promotion drivers to drink more water.	Not accepted. After further consultation the Committee agreed that it is most appropriate to use 1L for consumption similar to other guidelines
70	Technical appendix Box A1: The example calculation at bottom of box does not reflect formula expressed in top half of box and the section, generally, is difficult to follow. Suggest updated version be clearer, as this is the only opportunity to communicate the calculations behind DALYs to a non-health practitioner audience.	Accepted. Edits made to Box A.1 to make it easier to follow the calculations behind the DALYs and to make the order of the formulas consistent.

#	Comment	NHMRC Response
71	Technical appendix Box A1: Copying the calculation formula into a calculator like wolfram alpha does not yield the same result as calculated in Box A.1 Wolfram Alpha produced result of 0.0576. Re-calculate and re-format parenthesis and fractions to make it clearer.	Accepted. The formula has been checked and reformatted to give the correct result.
72	Technical appendix Box A1: The given basic formula given is YLD = I x DW x L, but the given calculation uses the order of YLD = DW x L x I. Make the order consistent between formula and the given calculation example so that it is easier to follow for new readers.	Accepted. The formula has been reordered for consistency.
73	Technical appendix Figure A4: The graph is difficult to understand. Suggest adopting a higher resolution and different colours for the different organisms shown in the graph.	Not applicable. Figure A.4 was removed from the appendix after further consultation with the enHealth Water Quality Expert Reference panel.
74	Technical appendix multiple sections: Throughout document, unusual structure; some sections seem out of place. For example, A6 comes before the selection of reference pathogens and A12 introduces a fundamental concept at the end of the document. Consider moving sections to more appropriate locations in the document.	Not accepted. Selection of reference pathogen is in A5 which is before A6 Level of reference pathogen contamination in Australia source waters.
75	Technical appendix Table A8: Calculations aren't provided for arriving at the LRVs listed. As this is a technical appendix, suggest including equation for calculating LRVs.	Accepted. The calculations are included in the table.

2022 EnHealth consultation on final guidance

The following feedback was provided by the enHealth Water Quality Expert Reference Panel in response to the final version of the guidance provided for review in March 2022.

Table 4. 2022 enHealth comments on the final guidance

#	Water Quality Expert Reference Panel Comments	Outcome
1	Using unheated water volumes instead of total water consumption and the rationale of using 1L assumption value and whether this value is protective of health, particularly in the context of Australia and changing climate. Members noted: • the value is based on the WHO QMRA document and Mons et al. 2007 paper which recommends using a mean of cold water of 1L, rather than a median or other percentile figure • the rationale that the data is left skewed, and considering how much conservatism is applied to the model (e.g. treatment and concentrations) • text has been added to acknowledge there are jurisdictions where water consumption is higher (e.g. Northern Territory), and the assumption can be adjusted • using either 1L or 2L will essentially leads to the same outcome with rounding (under other conditions check with the relevant health authority or regulator).	Accepted. Edits agreed for current version of guidance. Recommend considering review of assumptions as part of the rolling review of the Guidelines.
2	Small drinking water providers will struggle to comply with several recommendations in the guidance regarding the expectations of assigning as category 4 or to undertake a QRMA, due to limited resources and capacity. Discussed concerns about providing support to small service providers and the practicality for jurisdictions of making this mandatory for these providers. Members noted text has been included in in Box 5.6 around this issue of small service providers.	Accepted. Addition of statement to clarify expectation of drinking water service provider regarding QMRA; they need to ensure their operations are such that they can meet the safety targets identified by any existing relevant QMRA.
3	Suggestion to Improve discussion on ground water vulnerability classification. Members noted several edits have been made to improve this issue and provide guidance to understand surface water recharge risks and the protected nature of the ground water sources.	Accepted. Response agreed.
4	Define or refer to a definition of a small water supply as this may vary between different jurisdictions. Members noted text has been added to indicate small water supplies are those supplying fewer than 1000 people consistent with Chapter 4 of the Guidelines.	Accepted. Agreed to minor wording changes to better explain small water supplies.
5	Decision by the Working Group to remove reference to tier 1 and tier 2 assessment. Instead, the focus is on site specific assessment. Members noted there was an effort across the board to remove this terminology, and members agreed to the removal of reference to tier 1 and tier 2 from the guidance.	Accepted. Agreed to minor edits to direct to use available data.

#	Water Quality Expert Reference Panel Comments	Outcome
	Suggest adapting sentence in in the appendix which provides that if a service provider has their own data, it can be used in discussion with the appropriate health regulator.	
6	Include text that reminds water suppliers that they should achieve a disinfection residual throughout their network wherever possible. Members noted the maintenance of residual disinfection is a concern for all categories; text after the dot points has been included based on information sheet 1.3. Provides a reminder that a residual should be kept in distribution system, there is an expectation around residual disinfection included in the text now.	Accepted. Agreed to inclusion of general wording on maintaining residual disinfection.
7	Technical Appendix, Table A.8, Calculations are not provided for arriving at the LRVs listed. There was a decision made by the Working Group to leave it out to stop people from trying to do their own calculations where they may not have the skillset to do it. Members noted that they would prefer to have the formula for LRVs included in the chapter, there is evidence is that it will not get used improperly and has been included in the guidelines for water recycling. Suggest adding as a footnote in the appendix so that people know how the calculation was done, should include for transparency.	Accepted. Agreed to include formula.
8	Softening on the assessment of source waters used to supply small drinking water systems particularly where there is only limited data available. Members discussed difficulties softening language when referring to binaries (e.g. talking about having to either go for a conservative level category allocation or have the data to prove otherwise). Text has been re-drafted where appropriate to balance softening of text and maintaining key message. Members discussed different definitions of small water supply that exist between jurisdictions and the difficulties around management and assistance provided to small suppliers (e.g. providing generic risk management plans and giving catchment specific guidance so that small utilities don't have to go through this process themselves). Discussed some concerns that the Guidelines do not provide enough help for small suppliers because that is where there are currently lot of issues. Members noted that the definition of small water supply is not only about the size of the community and supply system, but also considers the capacity of the council. Discussed the possibility/opportunity to re-develop the community water planner work, noting that additional funding would be required to progress this piece of work. Change "demonstrated" to "discussed with" in the text.	Accepted. Agreed with revised wording, noting that many jurisdictions will be using their own approach for small water suppliers. Re-development of the Community Water Planner to be considered as part of the rolling revision of the Guidelines, noting that funding would be required for this work.
9	Edits made to the text in "vulnerability Classification" to provide high-level instruction for classifying a water source.	Accepted. Edits agreed.
10	Suggestion to define terms n*egligible, low level*, *minimal, moderate* and *high* used in Table 5.2. Discussed challenges in setting definitions for the variety of water sources used in Australia. Members noted that the table has been updated since and there is less reliance on these terms. Discussed around vulnerability class 1 and class 2 classifications and agreement to remove "inner" and instead refer to "catchment area"; noted there are instances where "inner" should be retained to distinguish between classes.	Accepted. Minor edits agreed.

#	Water Quality Expert Reference Panel Comments	Outcome
11	Suggestion to include problems caused by Crustacea and molluscs. Members noted this would be followed up with WQERP for further literature and considered in the rolling review of the Guidelines where there is supporting evidence.	Accepted. Agreed to consider as part of the rolling revision of the Guidelines.
12	Review guidance in relation to hot water systems in Australia regarding *Legionella* control (e.g. should enHealth guidance of 60ºC be adopted?) Members noted that numbers have been updated to reflect enHealth guidance and strengthened language around what QMRA should and shouldn't be used for.	Accepted. Edits agreed.
13	Suggested edits regarding microbial band allocation. Members noted this topic has been discussed in the Working Group with the decision to retain text which suggests two years of data directs water utilities to the relevant regulator for site specific issues.	Accepted. Edits agreed.
14	Inclusion of WaterRA work on sanitary surveys for source water classification for unprotected groundwater. Members noted NHMRC has received a copy of the WaterRA Guide to Sanitary Surveys and Operational Monitoring in Catchments and will include a reference in the chapter, noting this is paid accessible document.	Accepted. Edits agreed.
15	Discussion about text that could be viewed as doubting commercial lab methods. Members noted this level of practical guidance is out of scope for the guideline reviews. Discussed feedback received through Working Group around the limitations of some of the laboratory methods, Members noted it is not the role of the Guidelines to get into the complications of lab methods. Discussion about the confidence in the studies that have been undertaken to inform the infectivity assumptions. Suggest modifying paragraph to include a general statement that the reduction based on infectivity can be varied depending on local circumstances and should be discussed with local regulator; remove reference to the Committee.	Accepted. Minor edits to the wording agreed.
16	Suggested amendments to the supporting information on chloramination in Chapter 5 and factsheets. Members noted the information supporting chloramination as effective control measure is consistent with the chloramination factsheet in the Guidelines, and that amending the factsheet and information based on the content should be based on an appropriate review process which includes the latest research.	Accepted. Agreed to consider in rolling review of the Guidelines.
17	Suggested amendments to the supporting information on *Naegleria fowleri* in the Chapter and factsheets. Members noted that the temperature range quoted is from the *Naegleria fowleri* Part V factsheet, and that amending the factsheet and the information based on the content should be based on an appropriate review process.	Accepted. Agreed to consider in rolling review of the Guidelines.
18	Suggested minor corrections/revisions: • Update Table 8.3 with the Gibney calculations with the new burden of disease data from 2015 • In footnotes of Figure A3.2, subscript required for the log reference • In Box 5.5. vulnerability "assessment" should be changes to "classification"; for consistency insert "allocation" after the word "monitoring band" • Remove reference to draft enHealth 2022 document, and instead refer directly to Deere and Khan ref.	Accepted. Edits agreed.

Appendix B – Public Consultation Summary Reports

Background

The National Health and Medical Research Council (NHMRC) is responsible for the *Australian Drinking Water Guidelines (2011) (*the Guidelines*)*. The Guidelines are the accepted authoritative reference to the Australian community and the water supply industry on what defines safe, good quality drinking water, how it can be achieved and how it can be assured. The Guidelines undergo a rolling revision to ensure they represent the latest and best scientific evidence on good quality drinking water.

Chapter 5 of the Guidelines contains guidance on the microbial characteristics of water quality. It describes the microorganisms found in drinking water that can be harmful to health and discusses the risk of disease from waterborne pathogens. It also discusses 'nuisance organisms' that may affect the taste, odour or appearance of water but do not cause disease.

Chapter 5 has been revised to align with current international best practice on managing the microbial safety of drinking water. The key update is the introduction of guidance on microbial health-based targets into the Guidelines, including a quantitative definition of microbiological safety. The updates to the Guidelines will also provide regulators, drinking water suppliers and other users with additional information on assessing source water risk and setting appropriate treatment targets.

The inclusion of microbial health-based targets is a substantial change from the current guidance and is expected to have significant implications for the water industry.

Consultation process

NHMRC conducted public consultation on two separate occasions (2016 and 2018). For each public consultation stakeholders were invited under paragraph 13(d) of the NHMRC Act to make submissions to NHMRC about the draft guidance presented. The aim of these public consultations was to seek stakeholder feedback on the draft guidance, including the proposed approach for setting health-based targets for the microbial safety of drinking water.

The first round of public consultation occurred in 2016 after the Water Quality Advisory Committee (the Committee) had drafted the guidance. NHMRC Council considered the draft guidance at its 208th session on 14 July 2016 and recommended that the NHMRC CEO release it for public consultation. The CEO approved the release of the draft guidance for public consultation on 16 August 2016. Public consultation was held from 5 September 2016 to 4 November 2016. NHMRC collaborated with the Committee and Health-Based Targets Working Group (the Working Group) to ensure due consideration was given to the matters raised during public consultation.

The second round of public consultation occurred in 2018 once the draft guidance had been revised to incorporate public comments from the first round. NHMRC Council considered the draft guidance at its 213th session on 21 March 2018 and recommended that the NHMRC CEO release it for public consultation. The CEO

approved the release of the draft guidance for public consultation on 16 April 2018. Public comment was sought from 30 April 2018 to 30 June 2018. NHMRC collaborated with the Committee and the Working Group to ensure due consideration was given to the matters raised during public consultation.

2016 Public Consultation Report

Public consultation was held between 5 September 2016 and 4 November 2016. Submissions were accepted through submission on the NHMRC website or by email.

The questions asked during the 2016 public consultation were as follows:

1. Do you have any comments specific to the text proposed for Chapter 5.7?
2. Do you have any comments specific to the text in appendices A5.1, A5.2, & A5.3?
3. Is the draft text relevant, accurate and easy to understand?
4. The approach presented in the draft framework is intended to be a tool for water suppliers to manage and improve their water quality. The process is intended to be flexible, with smaller or less-resourced water suppliers able to apply default treatment technologies based on an understanding of their source water. Larger, more technically advanced suppliers may choose to use monitoring results specific to their water sources to apply more system-specific approaches. Is this practical, and is the intent clear in the draft framework?
5. In addition to the text, NHMRC seeks feedback on the following: For chemical risk assessment in the development of drinking water guidelines, it is assumed that an adult consumes two litres of water per day. As approximately half of this water is consumed after boiling (in cooking, or tea and coffee) it may be appropriate to use a smaller volume, one litre per day, as the default value for microbial risk assessment. Would you support NHMRC using a default water consumption value of one litre per adult per day for microbial risk assessment? Do you have any evidence to support your view?

Submissions

NHMRC received 32 public consultation submissions from various individuals and organisations. Stakeholders included water utilities, small council utilities, regulators, water associations and citizens. High level details of respondents are listed below where permission has been given to do so. Full submissions from respondents who have given permission to publish their comments are available in **Appendix C**.

- Michael Lawrence
- Melbourne Water
- Hilltops Council
- Veolia Australia and New Zealand
- Australian Water Association
- Townsville City Council
- SA Health
- Tasleem Hasan
- Water Services Association of Australia (WSAA)
- Nambucca Shire Council
- SA Water
- Power and Water Corporation, Northern Territory
- Water Corporation, Western Australia
- Department of Health, Western Australia.

Key issues and responses to 2016 public comments

The public consultation submissions raised a number of key issues that were given due regard by NHMRC and the Committee. The Working Group considered that that several of these issues were catchment-specific and should be treated on a case-by-case basis. The Committee also advised that water suppliers should consult the appropriate health authority or drinking water regulator for their jurisdiction. Key issues and the Committee's responses are summarised in **Table 5**.

Note that comments on issues unrelated to the scope of the public consultation were not considered as part of this process. Other minor edits such as text clarifications and writing style were actioned where accepted.

Full submissions are available in **Appendix C** where permission has been given to do so.

Note that some revisions undertaken to address comments from the 2016 public consultation may have been superseded by revisions undertaken following the 2018 public consultation.

Table 5. Summary of key issues from 2016 public consultation

#	Summary of comments	NHMRC/Committee response
	Health-based targets	
1	Concerns that the health-based targets may be seen as a Guideline Value.	Noted. The Committee agreed that the health outcome target of 10^{-6} Disability Adjusted Life Years (DALYs) per person per year (pppy) is a benchmark value. The Committee strengthened the text to reflect that this is a benchmark rather than a pass/fail guideline value. For utilities that do not currently meet the health outcome target of 10^{-6} DALYs pppy, the health-based targets framework describes a water safety continuum, where the utility can plan improvements to its operation in order to work towards the goal of safer water and best practice.
2	Whether a utility's customers, (when considering issues such as the financial impact of achieving the benchmark of a microbial target 10^{-6} DALY pppy), should be able to determine whether they accept a lower microbial target.	Not accepted. The Committee considered the intention of the microbial health-based target framework, which is for utilities/suppliers to improve water quality along a continuum towards the benchmark of 10^{-6} DALYs pppy and to validate improvements made. The Committee does not endorse the suggestion of lowering the target even if some consumers seem willing to drink poor quality water. Members agreed to keep the target at 10^{-6} DALYs pppy, noting that it is a guideline not a standard and reiterating that the utility should work with the relevant health authority or drinking water regulator to develop and implement improvement plans.
3	References in the target to "Safe" water should be changed to be consistent with the idea of a 'tolerable risk'. Alternatively, the target could be seen as the maximum treatment that any utility should apply.	Not accepted. The Committee considered that the aim of the health-based targets is to provide safe drinking water. Framing the text around the concept of tolerable risk would unnecessarily complicate the message. The guiding principles of the Guidelines emphasise the importance of not degrading water quality up to the guideline value by reducing levels of treatment. Some cross-referencing to that guiding principle has been added to the microbial quality chapter. For utilities that do not currently meet the health outcome target of 10^{-6} DALYs pppy, the framework describes a water safety continuum, where the utility can plan improvements to its operation in order to work towards the goal of safer water and best practice.
	Application of the microbial health-based targets to drinking water supplies	
4	Changing minimum treatment target to treatment target.	Accepted. The Committee agreed to standardise terminology to 'treatment target'.
5	Terminology - LRV credits and LRV targets Binning systems Use of binning vs categories Define C.t	Accepted. The Committee agreed to use the terms $\log_{10}$ credit and category. C.t value is defined in the disinfection information sheets and will be cross referenced in Chapter 5.

#	Summary of comments	NHMRC/Committee response
6	Short term increases in microbial challenge and how this is accounted for in an annualised risk.	Noted. The Committee considered that failing to achieve the target in the short term is not the same as breaching a guideline value. The defined treatment targets use an arithmetic average of the pathogen concentration accounting for expected variability in the concentration based on existing datasets (for *Cryptosporidium*). For more extreme events, it is the responsibility of utilities to ensure adherence with their water safety management plan and liaise with the relevant health authority or drinking water regulator.
	Water safety continuum	
7	Urgency of action Exponential decline in risk as move towards the target Terminology on continuum Starting point 10^{-2} vs 10^{-3}	Accepted. The Committee considered that the water safety continuum diagram should start at 10^{-3}. The Committee agreed to the addition of a graph demonstrating the exponential decline in risk when moving towards the target.
	Minimum treatment requirements	
8	Information on "pumpbacks" is no longer included in this revision of the framework. Some guidance on classification for schemes with discretionary pumping would be helpful to differentiate these to non-discretionary pumped schemes.	Not accepted. The Committee considered that as "pumpbacks" are site specific they should be considered on a case-by-case basis after discussion with the relevant health authority or drinking water regulator.
9	Catchment to consumer approach – concerns regarding recontamination of water in the reticulation system.	Noted. The Committee considered that recontamination of water in the reticulation system is beyond the scope of the microbial health-based targets, which is aimed specifically at defining treatment requirements based on source water quality.
10	Increasing storage detention times to reduce risk.	Noted. The Committee agreed that storage detention times can be effectively used to reduce risk. Log_{10} reductions cannot however be nationally generalised. The achievable Log_{10} reductions are site-specific and should be considered on a case-by-case basis in consultation with the relevant health authority or drinking water regulator.
	Vulnerability assessment	
11	Consider the binning categories too harsh and concerns that they may over-estimate results.	Not accepted. The Committee advised that default binning categories need to be conservative. If there is scientific evidence to suggest that the allocated category is too harsh for a specific site, a case can be made to the relevant health authority or drinking water regulator to consider re-categorisation.
12	Effect of storms, bush fires and other extreme events on microbial indicator assessment.	Noted. The Committee advised that extreme events should be investigated in relation to the site-specific risk management plan and any grace period is up to the supplier to discuss with the relevant health authority or drinking water regulator.
13	The automatic assignment of a catchment to Category 4 where there is any recreational use of the water should be reconsidered and risk assigned appropriate to the actual activity. Recreational uses pose a wide range of risks.	Noted. The Committee considered that all recreational water activity with access to the source water catchment whether land based (e.g bushwalking) or water based is high risk. All recreational activity needs to be considered the same level of risk when assigning binning categories.
14	More flexibility in the classification of source water catchments including the accounting for well-operated selective raw water extraction or the use of off-stream storages.	Noted. The Committee considered that using selective raw water extraction or the use of off-stream storage is site specific, and risk should be considered on a case-by-case basis and discussed with the relevant health authority or drinking water regulator.

#	Summary of comments	NHMRC/Committee response
15	Suggestion to use source water classification or category instead of the terms *bin* and *binning system*.	Not Accepted. The Committee agreed to use the term binning category.
16	Lack of detail on sanitary survey, consider work of Baker and Ferguson.	Accepted. The paper Baker, D. L., C. M. Ferguson, P. Chier, M. Warnecke and A. Watkinson (2016). "Standardised survey method for identifying catchment risks to water quality." Journal of Water and Health **14**(3): 349-368 has now been referenced and provides details about the conduct of the vulnerability assessment.
17	Provide LRVs for large rivers.	Noted. The Committee considered that all rivers are likely be initially categorised as binning category 4. If there is reason to conclude that this is too conservative, then a site-specific assessment is encouraged in consultation with the relevant health authority or drinking water regulator.
	Microbial indicator assessment	
18	Impact of environmental *E.coli* 'blooms' on *E.coli* monitoring and use of molecular techniques to verify results.	Noted. The Committee considered that currently there is insufficient evidence for the use of molecular techniques for *E. coli*. WQAC is aware of ongoing research on *E. coli* 'blooms' and the characterisation of 'bloom' strains.
19	The use of the term typical *E.coli.*	Not accepted. The Committee agreed that maximum *E. coli* should be used throughout the documents instead of typical *E. coli.*
20	The use of maximum *E.coli* as opposed to using the 98th percentile value in an *E.coli* dataset.	Not accepted. The Committee advised that maximum *E. coli* should be used unless the dataset is robust enough to use the 95th percentile. Water suppliers should consider explanation for anomalies and consult relevant health authority or drinking water regulator (as required).
21	How to deal with temporal variations in *E.coli* loading or run off turbidity, such as water quality deterioration due to periodic large scale flooding or periodic cyclones or bushfire and cyclone and bushfire aftermath that may affect a catchment or river basin.	Noted. Major events such as large-scale flooding or cyclones or bushfire aftermath are out of scope of the health-based targets in the Guidelines. Water suppliers should refer to their incident management plan and consult the relevant health authority or drinking water regulator.
22	Whether testing for thermotolerant coliform bacteria can be an acceptable alternative when *E.coli* data is not available.	Partially accepted. The Committee considered that thermotolerant coliforms can only be used if *E. coli* data are not available pending subsequent substitution of thermotolerant coliform monitoring with *E. coli* monitoring within a reasonable timeframe.
23	Concerns about default category 4 classification in the absence of *E. coli* monitoring data.	Noted. The Committee agreed that in the absence of *E. coli* monitoring data the safest and only approach was to default to binning Category 4.

#	Summary of comments	NHMRC/Committee response
24	Justification of *E. coli* bands needs strengthening.	Noted. The *E. coli* bands (categories) and associated recommended treatment requirements were based on those presented in WHO (2003) (citing EC (1975)). The same four categories were used with the same numerical values in the ADWG draft as the WHO and EC documents. These numerical values were checked against evidence from Australian data and found to be reasonable (summarised in Deere *et al.* 2014) and were adopted by WSAA (2015). One change made was that the WHO (2003) document referred to 'thermotolerant coliforms' whereas the ADWG and more recent documents refer to *E. coli.* In addition, the WHO (2003) guidance was vague with respect to its recommended treatment requirements whereas the ADWG and WSAA (2015) documents are much more explicit. The same broad approach was presented in the Guidelines for Drinking Water Quality (WHO 1997 and 2011) but in the more recent guidelines example numerical values were removed and the need to develop such values locally was implied. Therefore, we consider that states and even water utilities at the local level should be able to develop their own categories if so desired and justified. Hence, what we have presented is guiding and illustrative only, albeit retaining consistency with historical WHO, WSAA and EC guidance, and the final text will make that clear to endorse the use of alternative values by specific jurisdictions.
	Quantitative Microbial Risk Assessment (QMRA) and specific pathogen testing	
25	Calculations for QMRA and concerns that's QMRA may result in a worse category Correction of P_{ill} from 0.16 to 0.14	Noted. The document has been amended to include updated QMRA calculations and a revised table.
26	Consider dose response data from Messner *et al* 2014.	Accepted. The QMRA section has been amended and a review of studies undertaken to determine the best studies to inform the QMRA calculations. An updated appendix outlines the approach taken.
27	Comments related to *Cryptosporidium*: Should there be a requirement for 100 data points for crypto? Clarity around *Cryptosporidium* species used in calculations	Noted. The number of samples for QMRA needs to be determined on a case-by-case basis. The calculations are based on total infectious *Cryptosporidium* species.
28	Minimum treatment requirements in relation to *Cryptosporidium* and whether an additional 2-3 log removal for *Cryptosporidium* in Category 4 catchments is required where *Cryptosporidium* has not been detected for many years.	Noted. The Committee discussed that a lack of water borne disease outbreaks does not mean that a minimum treatment requirement is not required. Catchment specific data should be used to determine the LRV target. The purpose of the health-based targets is to drive down levels of endemic disease. The lack of evidence of outbreaks does not mean that endemic disease levels are acceptable since there can be of the order 3 $\log_{10}$ margin between endemic disease targets and outbreak levels.
29	Concerns about specific pathogen monitoring due to testing limitations and prohibitive cost.	Noted. The Committee noted that specific pathogen data is not a pre-requisite to meet the health-based targets and that the framework contains the option to use a vulnerability assessment either with or without *E. coli* testing**.**
	Other pathogens	
30	Clarification that health-based targets equates microbiological risk with the occurrence of faecal originated pathogens and not other pathogens such as *Naegleria*.	Noted. The Committee noted this comment and have strengthened the wording to reflect that the health-based target is focused on faecal originated pathogens and exclude other pathogens such as *Naegleria* and *Legionella*.
	Clearer messaging for small water suppliers	

#	Summary of comments	NHMRC/Committee response
31	Important to identify flexibility and that implementation of HBT does not require pathogen monitoring or even additional *E. coli* monitoring. There needs to be a clear message to operators of small systems that this is not an onerous new impost but that it is intended to provide a useful tool in assessing safety of systems and prioritising improvements.	Accepted. The Committee noted this comment and additional text has been added to clarify purpose of health-based targets.
32	Concerns that specified treatment technologies for small or remote drinking water supplies are conservative when assessing source water for categorisation to compensate for a lack of data to support a full risk assessment. This guidance will result in potentially higher than necessary treatment requirements, resulting in inflated operational and infrastructure expenditure.	Not accepted. The Committee considered that in the absence of *E. coli* monitoring data the default option has to be conservative to ensure the water is adequately treated to protect public health.
33	Guidance should be included on how very small communities or private water suppliers are expected to implement the requirements outlined in the draft framework text. The guidelines should be modified to allow utilities to substantiate a deviation from a given approach or value, where they have evidence to do so.	Noted. The Committee considered that the specified treatment technologies for small or remote drinking water supplies is a last resort option where water suppliers do not have the resources to undertake *E. coli* monitoring. All utilities should have a water safety management plan and deviations from this plan should be discussed with the relevant health authority or drinking water regulator.
	Run of river catchments	
34	The proposed catchment categories appear to focus on supply systems with reservoirs and are difficult to interpret for supply systems that rely on large run of river catchments.	Noted. The Committee advised that unless microbial monitoring data is available, catchments will default to binning category 4 regardless of catchment type. The onus is on the water supplier to provide catchment specific data to justify the reclassification of that individual catchment.
35	The proposed Framework makes no consideration in regard to water storage and selective pumping.	Noted. The Committee acknowledged that more guidance for considering the benefits of water storage on pathogen reduction may be warranted, but there is currently insufficient evidence to create a special category. WQAC advised that the default position should be no LRV credits unless the water utility can provide catchment specific evidence to the regulator to support selective pumping and/or off river storage as a treatment method.
36	Little recognition of the proximity and intensity of the activity e.g. sewage treatment works relative to the source water offtake.	Noted. The Committee considered that there is insufficient evidence to generalise across the nation. If there is evidence to show that certain activities are not compromising source water quality due to distance, then this should be discussed with the relevant health authority or drinking water regulator.
37	There are no credits given for environmental land and water inactivation of pathogen infectivity.	Noted. The Committee acknowledged that natural systems may make a difference, but there is currently insufficient evidence to support this. The committee advised that the default position should be no LRV credits unless the water utility can provide catchment specific evidence to the relevant health authority or drinking water regulator to support inactivation of pathogens.
38	Solar UV disinfection needs to be taken into account by the health-based targets model.	Noted. The Committee considered that the default position should be no LRV credits for solar UV unless the water utility can provide catchment specific evidence to the relevant health authority or drinking water regulator.

#	Summary of comments	NHMRC/Committee response
	Ocean catchments	
39	No consideration of ocean-based catchments.	Noted. The Committee discussed that the desalination process has many barriers in place, and effective removal of salt is a good indicator for removal of pathogens. The chapter has been updated to reflect a wider range of catchment types and includes boxed text on ocean-based catchments.
	Groundwater catchments	
40	Concerns regarding no treatment requirements for protected ground water and risk of waterborne illness.	Noted. The Committee considered that the default position is to deem all groundwater unprotected unless the water utility provides the relevant health authority or drinking water regulator with acceptable data to demonstrate protection.
41	Concerns regarding the inclusion of a separate category for protected groundwater.	Noted. The Committee agreed that there should be a separate category for secure groundwater but cautioned that untreated water should not be permitted to be supplied regardless of how secure the groundwater source is as a default category. The committee considered that groundwater should be assessed on a case-by-case basis in consultation with the relevant health authority or drinking water regulator.
42	No mention of aquifer recharge systems (storm water or recycled water) as something that should be taken into account when undertaking a vulnerability assessment of a groundwater source.	Accepted. The Committee agreed to cross-reference the *Australian Guidelines for Water Recycling* and the CSIRO Aquifer recharge guidelines.
43	Clarification of the definition of groundwater not under the influence of surface water in relation to depth.	Accepted. The Committee noted this comment and has amended the text on groundwater document.
44	Concern about age and condition of aquifers and difficulty in analysing subterranean water in relation to categorisation of groundwater.	Noted. The Committee considered that groundwater should be assessed on a case-by-case basis in consultation with the relevant health authority or drinking water regulator.
45	There should be a requirement for ongoing *E. coli* monitoring for groundwater.	Accepted. The Committee agreed that there should be an ongoing requirement to monitor groundwater for *E. coli*.
	Indicative LRV credits for common water treatment processes	
	Filtrations	
46	Concerns regarding inclusion of combined filtration as opposed to encouraging individual filters.	Accepted. The Committee agreed to amend text to reflect preference for monitoring of individual filters.

#	Summary of comments	NHMRC/Committee response
47	The filtration processes have 3 tiers of credits based on given individual filtrate turbidity targets, ≤0.15 NTU, ≤0.2 NTU and ≤0.3 NTU (for 95% of the month, and not >0.5 NTU for 15 consecutive minutes), however no LRVs at all are given if turbidity is greater than these values. Disinfection is compromised when turbidity is >1 NTU, therefore a sliding scale of LRV credits should be considered for 0.1 - 1 NTU. Another consideration is the percentiles provided in the draft framework. Currently credit is only given if a target is met 95% of the month, however reduced LRV could be given if the percentiles are slightly reduced. A sliding scale between 75% and 100% would achieve this.	Noted. The cited guidance provided by WHO (2011) set out an objective of 0.3 NTU or below for individual filtered water effluent turbidity to control *Cryptosporidium*. This is consistent with United States Environmental Protection Agency (USEPA) and WSAA guidance. It is important to understand that the relationship between turbidity and protozoa removal is not linear so that a 'sliding scale' cannot simply be presented. More importantly, there is a step change in protozoa removal capability above the individual filtered water effluent turbidity of ≈0.5 NTU for conventional media filtration plants which was the basis for setting a 0.5 NTU maximum value in the Guidelines and WSAA documents. The Committee agreed with these conclusions and considered that the evidence did not support a sliding scale stretching beyond 0.5 NTU and that above 0.5 NTU protozoan removal is too unreliable to be credible. The text has been amended to cross reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA and the relevant primary literature.
48	Currently to claim 2.5 LRV for protozoa via direct filtration the individual turbidity and combined turbidity targets are the same at ≤0.3 NTU. We suggest that the combined target is reduced to 0.2 NTU similar to the WSAA guidelines unless there is a good reason otherwise. This comment also applies to claiming 3 LRV for protozoa via conventional filtration.	Noted. The document has been amended to cross-reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA guidance.
49	Clarify definition of slow sand filtration.	Noted. The document has been amended to cross-reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA guidance.
50	Concern that media filtration is granted up to 4 LRV while a blanket requirement of ≤0.15 NTU is required, whereas membranes are capped at 3 LRV and require additional MIT testing. Turbidity is not a good indicator of particle breakthrough.	Noted. The document has been amended to cross-reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA.
51	Guidance on how to measure turbidity, calibration/validation/verification and frequencies of each would be useful in this document.	Noted. The document has been amended to cross reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA guidance.
52	LRV credits for other commonly used barriers such as bank and bed infiltration and reverse osmosis and desalination.	Noted. The document has been amended to cross reference other documents including the WSAA Health Based Targets Manual, WaterVal and USEPA.
	Disinfection	
53	Concerns about table A5.4.2 including: - Inconsistency in LRV listed for bacteria LRV of 2 vs 4.0? - C.t. values inconsistent with disinfection information sheets.	Noted. The revised document cross references the information sheets.

#	Summary of comments	NHMRC/Committee response
	Non treatment barriers	
54	Concerns that no LRV credits for non- treatment barriers in contrast to the *Australian Guidelines for Water Recycling.*	Noted. The Committee considered that it is difficult to provide guidance on non- treatment barriers for drinking water. Water suppliers should discuss this with the relevant health authority or drinking water regulator on a case-by-case basis.
	Validation of barrier performance	
55	This section needs to be reworded. The Victorian Department of Health Validation Guide provides useful background information that could be used to introduce validation (pages 35). Could also cite the WaterVal framework in discussing methodology. http://waterval.com.au/wpcontent/uploads/2016/02/ValidationProtocolTemplate.pdf.	Noted. The document has been updated to include reference to WaterVal and the WSAA HBT Manual, USEPA (various guidelines), Californian Department of Public Health (various guidelines), German DVGW (various guidelines) documents and The Victorian Department of Health Validation Guidelines. The Committee decided that the updated text in the Guidelines should reference other validation guidelines, as well as the existing Element 9 text of the Framework for Management of Drinking Water Quality within the Guidelines, rather than providing its own additional set of guidelines.
56	Concern that the document is silent on the procedure for pre-validated treatment technology. Some discussion on this would be useful.	Accepted. The Committee noted this comment and agreed that adding specific mention of pre-validated technology is a good idea.
	One litre per day, as the default value for microbial risk assessment	
57	Concerns about the assumption of 1 litre per adult per day for microbial risk assessment.	Noted. The Committee discussed and agreed that the default water consumption for microbial risk assessment should be 1 litre per adult per day. This is consistent with WHO guidelines, the *Australian Guidelines for Water Recycling* and with data from the Australian Bureau of Statistics, Australian Health Survey which reports the average amount of plain water consumed by adult Australians as 1064 ml per day. The Committee noted that consumption levels may be greater in different areas of Australia, for example, in tropical regions, and that jurisdictions should be able to consider their own circumstances when deciding how to implement the microbial health-based targets.
	Cost of implementation	
58	Concerns about the cost of implementing microbial health-based targets.	Noted. The Committee noted that health-based targets will enable water utilities to demonstrate due diligence. The health-based targets have a flexible approach and if water utilises are currently implementing the Guidelines, additional costs should be minimal.

2018 Public Consultation Report

Public consultation was held between 30 April 2018 to 30 June 2018. Submissions were accepted through submission on the NHMRC website or by email.

The questions asked during the 2018 public consultation were as follows:

1. Do you have any comments on the overall approach to assessing and managing microbial risk in source water outlined in section 5.3?
2. The treatment targets as log reduction values (LRVs) in table 5.6 were derived using Australian data and the assumptions are outlined in the technical appendix. Do you have any specific comments on these values and /or how they were derived?
3. These targets are consistent with the ADWG framework for managing drinking water. Do you foresee any major difficulties in the implementation of these proposed treatment targets? If so, what are they and how could they be resolved?
4. Do you have any comments on the following sections:

    4a: section 5.5 on opportunistic pathogens
    4b: section 5.6 on cyanobacteria
    4c: section 5.7 on nuisance organisms
5. Is the approach as articulated in the technical appendix clear? If not, how could it be made clearer?
6. Please provide any other feedback on the chapter and technical appendix.

Submissions

NHMRC received 35 public consultation submissions representing a diversity of industry, government agencies and independent sources. High level details of respondents are listed below where permission has been given to do so. Full submissions from respondents who have given permission to publish their comments are available in **Appendix C**. Redactions have been made to remove personal information or other information upon request.

- Murray Darling Basin Authority
- Amutharaj Mahendrarajah
- Water Quality Unit SA Health
- Department of Health Western Australia
- Central Highlands Region Water Corporation
- Seqwater
- VicWater

- Queensland Water Directorate
- Bligh Tanner Pty Ltd
- MidCoast Water Services
- Coliban Water
- Water Services Association of Australia
- Melbourne Water
- Parkes Shire Council
- Department of Natural Resources, Mines and Energy (QLD)
- Water Research Australia Ltd
- Viridis Consultants Pty Ltd
- Karen Pither
- Central NSW Council (Centroc)
- Clarence Valley Council
- Department of Health and Human Services Victoria
- NSW Water Directorate/ Local Government NSW
- Water NSW.

Key issues and responses to 2018 public submissions

The public consultation submissions raised a number of concerns and suggestions for improvement that were taken into careful consideration by NHMRC and the Committee. From the 35 submissions received during the public consultation period there were over 530 individual comments or points of feedback that needed to be considered. Key issues and responses including amendments to the guidance by NHMRC with input from the Committee are summarised in **Table 6** below. Other minor edits such as text clarifications and writing style have been actioned where accepted.

Full submissions are available in **Appendix C** where permission has been given to do so.

Note that comments on issues unrelated to the public consultation questions were not considered as part of this process.

Table 6. Summary of key issues from 2018 public consultation

#	Key issue	NHMRC/Committee response
1	The revisions to Chapter 5 of the Guidelines must continue to support and emphasise the importance of drinking water source protection and health-based targets should not be seen as a licence to degrade the quality of a drinking water supply to that level.	Accepted. Edits made to text to emphasise that the introduction of health-based targets should not take focus away from the Guiding principles (see Guidelines Section 1.1) and implementation of all 12 Elements of the framework for safe drinking water. The guidance states the focus should be maintained on selecting the best source water, catchment protection, multiple barriers, and management of critical control points.
2	Clearer Ground Water guidance is required, including further detail on source vulnerability assessment and classification and assessment of bore security.	Accepted. Edits were made to draft to improve more guidance on source vulnerability assessment and classification. Further edits have been included to clarify factors which lead to vulnerabilities in ground water sources and the need for timely evidence on bore security. Note: The Committee did not support the feedback regarding including a special vulnerability class for groundwater. The Committee agreed to remove the protected groundwater category following the 2016 public consultation where several stakeholders expressed concerns about classification of protected groundwater.
3	Further guidance and clarification on QMRA application and assumptions is required. Particularly when to use QMRA or Semi-qualitative risk assessment and site specific requirements for conducting a QMRA.	Accepted. Edits made to section '5.3 Assessing microbial risk' and technical appendix to clarify the purpose of QMRA and its application The amendments highlight that the purpose of QMRA is for answering quantitative questions such as: "*What is microbially safe?*" and "*How much treatment is required to achieve microbial safety?*" The current guidance focuses on site-specific assessment in consultation with the relevant health authority or drinking water regulator. As further evidence becomes available the Committee may consider including case studies on the use of QMRA as part of the rolling review program for the Guidelines. Note. Some comments related to detailed practical application of QMRA were not accepted. For further detail on practical application of QMRA relevant references to WHO, Health Canada and USEPA have been included.
4	What is the Timeline for implementation of the revised guidelines including the LRVs in Chapter 5?	NHMRC has consulted with WSAA and the Environmental Health Standing Committee (enHealth) Water Quality Expert Reference Panel to discuss implications to water suppliers. It is expected that implementing health-based targets into drinking water management, particularly for small water suppliers, will take time. The timeline for adoption in each jurisdiction will be dependent on the requirements set by the relevant health authority or drinking water regulator.
5	Why have the LRVs changed from those used originally by WSAA 2015?	NHMRC's approach uses the best available Australian data at the time of drafting and uses different assumptions to 2015 WSAA Health Based Targets Manual. The final LRVs are derived from recent publicly available literature. While there are many high quality industry documents available, these documents are not always available to NHMRC, the Committee or users of the Guidelines. Only publicly available scientific evidence that can be reviewed and endorsed can be used to inform NHMRC guidance. NHMRC has been in consultation with WSAA in development of the advice to discuss implications for water suppliers.

#	Key issue	NHMRC/Committee response
6	Clarification is needed on the requirements and expectations for site specific validation of LRVs.	Accepted. Site specific validation is critical to ensure that the treatment process is performing as expected. Edits were made to text to clarify the general expectations of for site specific validation of treatment process to achieve LRVs. However, providing detailed in information on the process for site specific validation of achieving required LRVs is out of scope of the Guidelines. A reference to Chapter 9.8 '*Validation of Barrier Performance*' has been included in the revised text in case further guidance on validation is required.
7	The intent of was to provide LRVs for existing treatment processes. For this reason turbidity targets had been developed in Australia. Clarification on filter turbidity targets for LRV validation is required.	Partially Accepted. Table 5.6 provides guidance on validated filter turbidity targets and LRV credits. Text is included that directs readers to the Turbidity Fact Sheet for further information on filtration and turbidity targets for pathogen removal. Detailed implementation is out of scope of the Guidelines. Stakeholders should refer to operational guidance documents for detailed operational targets such as turbidity targets.
8	Explanation is required for the selection of a 0 LRV requirement for viruses in Category 1 sources.	Accepted. A note has been included under table 5.5 stating that fully protected Category 1 water sources do not have humans in the catchment. An LRV target of zero is set as humans are the predominant host for enteric viruses.
9	Why is an unsuitable source water vulnerability class not included in the revisions?	NHMRC made a considered decision on the advice of the Committee not to include an unsuitable source water vulnerability class in the most recent revisions. Given the issues of water supply in some areas of Australia experiencing drought no water source is out of the question.
10	Are drinking water sources other than surface water and groundwater covered?	The revisions to Chapter 5 do not consider ocean catchments, roof water or storm water, greywater and sewage catchments. The Framework for management of drinking water quality in the Guidelines covers the general approach of monitoring and maintaining integrity of any water source.
11	More guidance is required on the classification of drinking water sources in the absence of E. coli data, especially for smaller water suppliers.	Not accepted. The guidance outlines that in the absence of data, the guiding principle is to use a precautionary approach. The text acknowledges that this approach may result in a conservative classification until a robust data set is available. Site-specific considerations and departure from the Guidelines should be discussed with the health authority or drinking water regulator.
12	From the revisions to Chapter 5 it is unclear whether the HBT is intended to protect from endemic illness or outbreaks. An example is the recommendation to use the maximum *E. coli* value from available monitoring data (likely to be indicative of an outbreak rather than an endemic risk).	Partially Accepted. Additional information has been included to clarify the intention of health-based targets. NHMRC on the advice of the Committee have retained maximum *E. coli* because the level of treatment is related to the level of contamination in the source water. On the other hand, preventing outbreaks is about implementing the framework and the multiple barrier approach (failure analysis). Additional information is provided on using a 95th percentile value where sufficient *E. coli* data are available.
13	The datasets used in the calculation of these LRVs do not represent tropical catchments – how can this provide nationally consistent guidance?	In the absence of unpublished data on tropical catchments in Australia, the guidance is conservative so it can be applied nationally with reasonable confidence that it will be protective of public health. NHMRC and the Committee have agreed that the evidence used in this revision of the Guidelines must be publicly available and peer-reviewed. guidance on tropical catchments can be developed in future revisions of the Guidelines should evidence become available. The guidance encourages discussions with relevant health authority or drinking water regulator so that any exceptions are appropriately covered.

#	Key issue	NHMRC/Committee response
14	The validation requirements for claiming LRVs for reservoirs requires greater clarification.	Accepted. Edits made to Box 5.4 to provide additional guidance on reservoirs and pathogen risk management. However, it is out of scope to provide detailed information on implementation and additional references to other sources of detailed and practical guidance are provided.
15	Concerns regarding cost implications resulting from the need to invest in capital upgrades to meet HBTs.	Feedback from many submissions noted that the requirements of HBTs will probably result in the need for costly capital upgrades to water treatment infrastructure. The guidance outlines that water utilities should engage with the relevant health authority or drinking water regulator to guide decisions about the existing safety of drinking water supplies.

Appendix C – Public Consultation Submissions

The following public consultation submissions are reported in full without alteration where permission has been given to do so. Personal information has been removed except for the names of those individuals who submitted public submissions. Names of individuals who have responded on behalf of an agency/organisation have been removed. Redactions have been made to remove additional information upon request.

2016 Consultation Submissions

2016 Consultation Questions

1. Do you have any comments specific to the text proposed for Chapter 5.7?
2. Do you have any comments specific to the text in appendices A5.1, A5.2, & A5.3?
3. Is the draft text relevant, accurate and easy to understand?
4. The approach presented in the draft framework is intended to be a tool for water suppliers to manage and improve their water quality. The process is intended to be flexible, with smaller or less-resourced water suppliers able to apply default treatment technologies based on an understanding of their source water. Larger, more technically advanced suppliers may choose to use monitoring results specific to their water sources to apply more system-specific approaches. Is this practical and is the intent clear in the draft framework.
5. In addition to the text, NHMRC seeks feedback on the following: For chemical risk assessment in the development of drinking water guidelines, it is assumed that an adult consumes two litres of water per day. As approximately half of this water is consumed after boiling (in cooking, or tea and coffee) it may be appropriate to use a smaller volume, one litre per day, as the default value for microbial risk assessment. Would you support NHMRC using a default water consumption value of one litre per adult per day for microbial risk assessment? Do you have any evidence to support your view?

Table 7. **2016 Consultation Submissions**

#	Organisation	Q	Comments Received
1	Individual Michael Lawrence	1	The concept of a health based target framework is generally supported in that it provides more specific advice regarding the assessment and ongoing improvement of water treatment plants. However, in so doing, the many lagging water suppliers within Australia are potentially being left even further behind. The ADWG does not clearly articulate the way forward for them. I note that there are a number of substantial and severe inconsistencies with this proposed amendment and the rest of the ADWG, and further inconsistencies when cross comparing with the framework for managing recycled water. These inconsistencies must be resolved prior to consideration of implementation as they otherwise conflict dramatically. Specific comments 1) Page 5: greater than 104 DALYs pppy. "Public notification should also be considered in consultation with the relevant health regulator." This comment, and the statement regarding continued periods of poor performance provide strong guidance for WTPs that have a significant shortfall. However, where a WTP falls outside the tabulated results there is no guidance provided. There are many WTPs that will not meet any of the targets in Table A5.4.1. Guidance should be provided for water treatment plants that achieve less than the minimum requirements for log credit stated in this table, for example, a significant number of treatment plants only monitor turbidity once per day (grab samples) for turbidity off the filters – that is they do not have online turbidity monitoring. There are recommendations buried in the ADWG regarding the desirability for continual online monitoring but there is no specific explicit statement in the ADWG that online continuous monitoring of turbidity is required to protect public health. Explicit statements are required to raise the standard of the lowest quality water treatment plants. I note that Richard Walkers article http://dx.doi.org/10.21139/wej.2016.008 states that a turbidity >0.5 NTU receives no log reduction credit. If this can be stated in the supporting paper, why cannot such a statement be made explicitly in the ADWG? A statement of this type needs to be included in the HBT framework to educate water managers (and councillors who approve asset improvement budgets) about what is, and what is not acceptable. Possible solution: The ADWG should explicitly state minimum monitoring requirements (e.g. online continuous monitoring of turbidity) clearly and succinctly. 2) Table 5.7.3 states no treatment is required for protected groundwater. Disinfection should be a minimum requirement for all drinking water schemes. Not disinfecting a public water supply is in conflict with the multibarrier approach generally advocated by the ADWG (e.g. the only barrier is system integrity). The recent example from Havelock North in New Zealand demonstrates that even if you have data that shows that the groundwater is protected (50 years old) that there are feasible and likely routes of contamination. There are also examples of confirmed Salmonella outbreaks in Queensland (3 since 2005) where supposedly protected artesian and subartesian water supplies resulted in outbreaks. References to publicly available information provided below. http://www.abc.net.au/news/20120420/salmonellafoundinoutbacktownswater/3962638 http://www.waterra.com.au/publications/latestnews/2012/salmonellaoutbreakinromaqueensland/ OzFoodNet Annual Report 2005 Queensland 6) Inclusion of HBTs will require a thorough review of other aspects of the ADWG to ensure consistency. The factsheet for Protozoa will need to be updated immediately (P312 refers to optimum filter performance of 0.2 NTU – and adoption of HBTs means that the benchmark has been changed). Other related factsheets and sections should also be reviewed to ensure sufficient cross-referencing and internal consistency.
			3) How representative of all Australian conditions is Table A5.2.3? Previous versions of Table A5.2.3 that were presented in NHMRC consultation meetings were based on data exclusively from water service providers south of a line between Brisbane and Perth. Is the dataset used more extensive than that, and appropriately representative of all climate types in Australia? Data that is appropriate to South Eastern Australia may not necessarily be (in my opinion, is not) relevant to the dry or wet tropical regions of Australia. For example, completely protected catchments in the Wet Tropics World Heritage Area of Far North Queensland commonly have E. coli results above 20 MPN – this appears to be temperature related (E. coli being an indicator of recent mammalian faecal contamination) rather than human pathogenic risk related – e.g. there are many animals in the catchment, and the temperature appears to allow for increased survival of E. coli. But as this is likely zoonotic, the human pathogen risk is not necessarily related. These catchments are more inaccessible and equally or more protected than the Melbourne water supply catchment, with a lower surrounding population density, yet end up in a higher category. As a subnote to this comment – the referenced article is general in nature and does not provide any of the data/ data analysis that would allow a more thorough discussion of the relevance of this table to tropical areas. Possible Solution: provide a reference to a scientifically peer reviewed publication that includes the source data that was used in generating this table so that providers can more accurately assess the relevance to their own scheme and can justify differences in the assessment on this basis. 4) Log Reduction Credits: The AGWR Phase 2 guidelines Table 4.9 provide indicative guidance of >6 log reduction of cryptosporidium for microfiltration and ultrafiltration, yet the proposed values for HBTs in Table A4.5.1 only allows 3 Log. It appears incongruous that WTPs with direct filtration operating at <0.15 NTU for 95% of the month can be credited with

#	Organisation	Q	Comments Received
			3.5 log protozoan reduction, yet micro and ultrafiltration can only be credited with a maximum 3 log reduction credit. In practice an MF membrane should be easily achieving <0.1 NTU, so should get a greater credit than direct filtration. Again it is noted that 4log reduction can be claimed under most recycled water scenarios (limited to 4 log by regulation) when the CCP demonstrates integrity through both indirect and direct integrity testing. References to other international guidelines (published in 2003 2006) are not necessarily appropriate as the limited literature that they refer to is becoming outdated, and a more thorough consideration and evaluation of the current source literature is advised prior to formalising specific log reduction values. Reference of this document to the WSAA 2015 position paper is effectively circular, and does not justify the selection of these values. Possible Solutions: a) provide robust scientific references that can validate the log reduction credits that can be assigned as a default to particular treatment trains under particular conditions. b) lower the log reduction credits for protozoa for direct filtration and conventional filtration or, c) increase the log reduction credits for MF and UF to the maximum allowable 4log when membrane integrity testing requirements are met. 5) Table A5.2.3 – Band 4 states "not suitable" if E. coli is > 20 000/ 100mL. This is where the ADWG begins to intersect with the AGWR. The statement "not suitable" is patently not true – it is feasible to use the AGWR Phase 2 to consider treating raw sewage (Table 3.6 in AGWR Phase 1 states raw sewage contains 100,000 10 billion E. coli/ 100mL) through multiple barriers for augmentation of drinking water supplies, so why can water supplies with high E. coli counts not be used with appropriate treatment? Possible Solution: instead of "not suitable" consider this as the trigger for requiring the application of AGWR Phase 2 requirements. This does not then implicitly preclude the use of recycled water as a future drinking water source.
		3	**Is the draft text relevant, accurate and easy to understand?:** The draft conveys some complex information and is difficult for non-scientists to grasp. Nonetheless, it is probably as simple as can be. **Is this practical, and is the intent clear in the draft framework?:** In practice, the majority of providers will use the catchment binning and default treatment technologies as the default, so these should be as robust as possible. Providers are only likely to use a more extensive process if the default demonstrates a shortfall where additional monitoring may allow the shortfall to be reduced without additional barriers. i.e. if you are well short, simply spend the money on a new barrier, but if you are 1.5 log short, testing the veracity of the assumptions may be the better first step. The flexibility probably allows better resourced providers to justify delaying changing practices, whilst the underresourced providers may use a shortfall as a trigger to consider whether the continued provision of a town drinking water supply is feasible. **Do you have any evidence to support your view?:** No I do not support this change. I do not have scientific evidence at hand, but my reasoning follows: There are already many assumptions that are being made (catchment load, viability, treatment effectiveness, pathogenicitiy etc) does reducing the exposure factor really make a difference? In reality, pathogens impact young children, the elderly and immunocompromised more than the general population so the safety factor of inclusion of a larger potential exposure is warranted, as the consequence to these groups is potentially catastrophic.
2	Melbourne Water	1	Melbourne Water has specific comments on the test proposed. These comments are included in a compilation response that will be submitted by the Water Services Association of Australia (WSAA). Melbourne Water supports the introduction of Health Based Targets into the Australian Drinking Water Guidelines and has been a part of the WSAA working group that developed the supporting documentation and also trialled the concept. Melbourne Water believes the introduction of healthbased targets provides the water industry with a defensible benchmark for microbial safety that the current guidance in ADWG does not provide. It allows for healthbased investment in drinking water supplies and satisfies the health regulator that microbial risks have been addressed and are managed appropriately.
3	Hilltops Council	1	Nil
		2	Nil
		3	**Is the draft text relevant, accurate and easy to understand?:** yes

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			Is this practical, and is the intent clear in the draft framework?: In practical terms, the draft framework does not differentiate clearly where water suppliers to tap is multiple. ie a bulk water authority provides the treated potable water and distributed in bulk form via pipe line to a meter point. A local government or other water authority takes this water from this distribution point, and distributes it through its pipeline network. (the whole network of bulk and local authority pipe lines are interconnect and are one effectively...). The other point is the possible outcomes from the MHB targets on small treatment and distribute systems....say for populations of 200 to 1000 people.. the target results could indicate a lot of infrastructure upgrading required to improve the overall water quality... this in part should be addressed in the drinking water management plans of that system... but if the standard was higher... there could be a higher cost over all involved to reach that standard. This point is a more of an awareness of the cause /effect. **Do you have any evidence to support your view?:** I would support this view... however with the ongoing health education everywhere this figure could rise... perhaps a study/survey should be completed to confirm this figure.
4	Veolia Australia and New Zealand	1	Section 5.7, Overview: No observable risks to current desalination activities. 2. Section 5.7.3, Microbial health-based targets for drinking water supplies: No observable risks to current desalination activities. 3. Section 5.7.4, Determining minimum treatment requirements for drinking water supplies: A sanitary survey will need to be conducted on the seawater off take and surrounding areas. Without conducting additional pathogen assessments or QRMA, degree of confidence in sanitary survey will depend on any available catchment to tap, off take or environmental impact assessments. Further comments regarding sanitary surveys are outlined in relevant sections/appendices below. Anticipated that documented requirements for meeting and maintaining catchment HBTs can be adapted to existing drinking water or HACCP management and validation plans. 4. Section 5.7.4 A), Binning system based on system specific sanity surveys and E. coli monitoring data: Further comments regarding binning classification and treatment requirements are outlined in relevant sections/appendices below. Note: Deere et al (2014), treatment of Australian source waters to meet healthbased targets, did not appear to take into consideration or comment on oceanbased catchments or opportunities to tailor Australian guidelines. 5. Section 5.7.4 B), Binning system based on sanitary survey and system specific pathogen data: Under current available information and gaps in available HBT scoring, it is anticipated that this is may be the only viable option to accurately assess desalination catchments. Pathogen assessment would require the 'accurate' monitoring of Cryptosporidium, Campylobacter and cultivable viruses (rep. Norovirus). 6. Section 5.7.5, Specified treatment technologies for small or remote drinking water supplies: No comment, given size of existing plants. 7. Section 5.7.6, Operational monitoring: Anticipated that desalination projects will update drinking water/HACCP management, validation and other relevant operational plan to accommodate HBT monitoring updates.
		2	8. Appendix 5.1, Healthbased targets – calculation of LRV targets from pathogen data: Note: step 3 in calculating the LRV target from system specific data doesn't appear to specify whether maximum, average, percentile, etc. of pathogen data should be used to calculate DALYd. 9. Appendix 5.2 A), Sanitary Survey: Anticipated that using general GIS, available catchment information, etc. a preliminary sanitary survey can be conducted. Without valid information/literature references, degree of pathogen source and impacts is assumed. 10. Appendix 5.2 B), Vulnerability Assessment: Even if relevant information can be obtained from desalination catchment sanity survey, it is noted that current desalination catchments, can't suitably fall into any specific table A5.2.1 category. The only available option, under current draft HBT assessment, is that the conservative grouping of category 4 is required. Under this scenario there are still inconsistencies in the row associated with activities that occur in the inner or outer catchment (i.e. beach/ocean). Reference (1) indicates large reservoirs (full ~1GL) will provide a storage barrier sufficient to achieve several Log10 reductions in pathogens. It is anticipated that further information will be sought to add this additional LRV claim. Quantification will only be available subject to literature review or potential future research project(s). 11. Appendix 5.2 C), Microbial Indicator Assessment: Desalination source water E. coli monitoring is historically and currently only monthly. For valid assessment of E. coli data, the draft recommends ≥100 data points. This increases the risk of incorporating historical outliers can't be reinterpreted or accuracy/validity confirmed, due to historic nature. Increased source water e. coli monitoring may have to be implemented. It is anticipated that outside of outlier confirmation, desalination catchments will sit in either a band 1 or 2. 12. Appendix 5.2 D), Combining vulnerability and microbial risk assessments to confirm source water category: Utilising table A5.2.3 it is likely that Veolia operated and maintained desalination off takes will receive either an Anomalous or Category 4 Source (Amber). This has meant that, if draft is implemented, further investigation into scoring will be required. It is predicted that due to the nature of current desalination catchments it is highly unlikely that these can align with Table A5.2.1, predetermined,

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			catchment scores and some level of cost will be required to verify catchment category or LRV requirements. The only way to potentially avoid this would be to reinterpret desalination catchment data and/or assessments (from design documentation, available catchment assessments, etc.) to somehow fit in the table. 13. Appendix 5.3, Source Water Assessment for Groundwater: o No comment, given source. 14. Appendix 5.4, Default LRV credits for common water treatment processes: Unless table A5.2.1 can be interpreted differently, a pathogen/QRMA assessment is conducted, or regulatory health body consulted, it is anticipated under this current draft framework that desalination will need to achieve/monitor a category 4 LRV, as a conservative approach. If required, would investigate re/validation of catchment, chlorine Ct, RO, media filters, etc. in order to claim these relevant LRV. Further validation will be required on RO and catchment given it is not specified in the draft HBT framework. Information contained within current NatVal research projects is anticipated to be the base for claiming relevant LRV. Anticipated that short, medium and long term water quality improvement plans may be required if current plant processes can't meet required LRV claim.
		3	Unless desalination catchments can be suitable scored within the final ADWG HBT revision, overall potential operational and subsequent maintenance risks are: 1. Potential increased to catchment E. coli monitoring (client cost, accuracy of rescoring within current table, etc.) 2. Potential requirement to conduct a pathogen assessment to accurately categorise individual desalination catchments (client cost, accuracy, etc.); 3. Potential requirement to conduct a QRMA to accurately categorise individual desalination catchments (large client cost, accuracy, etc.); 4. Potential requirement to procure, install, operate and maintain validation/verification monitoring equipment (individual turbidity analysers on Tugun multimedia filters, replacement of existing RO cartridge filters with validated ones, etc.)(major cost, increased maintenance/controls, etc.) 5. During implementation of the above, potential not to meet required LRV and fall into a µDALY shortfall category that requires rapid response internally and from client (increased cost, regulatory impacts, etc.) 6. Post implementation, over conservative scoring may lead to highly stringent operating bandwidths resulting in continuity of supply issues.
5	Australian Water Association	1	The Australian Water Association is pleased to provide support for the text as proposed for Chapter 5.7 for Microbial health based target for drinking water supplies. From a regulatory perspective, this is a pleasing step towards water treatment under a national risk management framework. This is also a step towards ensuring remote and rural communities and their regulators can have confidence in the provision of cleaner, safer drinking water. The recent Australia's Water Outlook survey reflects levels of concerns from both communities and industries regarding investment and water quality disparities.
		2	In reference to A5.1 as increasing demands from a growing population and competing priorities with agriculture and commercial activities, the competing priorities on scaleable source water (catchment, developer, household levels) and impacts for Australia's water security will be paramount.
		3	Yes, the flowchart (Fig 5.7.2) inclusion is very useful, particularly mapping out the decision points and element links. **Is this practical, and is the intent clear in the draft framework?:** Yes, The key point raised on p8, access, lack of data and resourcing to undertake individual assessments is critical and varies across each State and Territory. In addition the statement on p7 that improvement plans must be developed in concert/consultation with relevant state and territory health regulators is essential. **Do you have any evidence to support your view?:** Whilst not a specific evidenced response, the Australian Water Association is utilising the Community Water Planner tool in the Son La Province as it will specifically assist managers of remote and rural community water supplies in Vietnam with water safety plans to manage microbiological, physical, chemical and radiological water quality risks in accordance with the WHO Guidelines for Drinking Water. The default water consumption value to 1 litre per day for microbial risk assessment would appear valid, however this is an unassessed observation only.
6	Townsville City Council		Statement of health guideline value The statement made in Section 5.7.2 of the framework is a definitive statement of a health guideline value: The microbial HBT that applies to Australian drinking water supplies is 106 Disability Adjusted Life Years (DALYs) per person per year (pppy). In section 5.7.3 however the following statement is made: The microbial HBT of 106 DALYs pppy should be applied to drinking water supplies as an operational benchmark, rather than a pass/ fail guideline value. The draft framework therefore is unclear on the status of the HBT. If it is set as a definitive health guideline value as per Section 5.7.2 and included with the guideline values in the Australian Drinking Water Guideline (ADWG), then Townsville City Council will not able to comply with the ADWGs and its Drinking Water Quality Management Plan (DWQMP) as it shifts from being a target to inform a practical improvement program to a compliance measure, which may be hard

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			to achieve in the short term, as guideline values are mandated in Queensland through regulatory notices. It is proposed that it is stated explicitly that 106 DALYs pppy is an operational benchmark and will not be included with the guideline values. E.coli as faecal indicator Townsville have not in the past routinely tested for E.coli in their raw water supplies instead using thermotolerant coliforms as an indication of bacterial raw water quality. The explanation note below table 5.7.1 states: "**Source waters from which no E.coli monitoring data is available may be categorised as Category 4 as a precautionary measure whilst such data is collected." If this clarification note is used, all of Townsville's water sources will be deemed Cat 4, irrespective of the sanitary survey outcome. Whilst it is appreciated that the precautionary principle should be used, the use of thermotolerant coliforms as a substitute for E.coli data should be conservative enough as per WHO Guidelines for Drinking Water Quality fourth edition: "Verification of the microbial quality of drinking water typically includes testing for Escherichia coli as an indicator of faecal pollution. In practice, testing for thermotolerant coliform bacteria can be an acceptable alternative in many circumstances". "For microbial water quality, verification is likely to be based on the analysis of faecal indicator microorganisms, with the organism of choice being Escherichia coli or, alternatively, thermotolerant coliforms" It is proposed that a clarification note is added: "Thermotolerant coliforms can be used for this categorisation if E.coli data are not available." Inactivation of bacteria by chlorine Table A5.7.3 – Indicative treatment technologies for different catchment types gives an LRV of 4.0 for chlorination as per USEPA (2006, 2010), New Zealand (2008) and Canadian Guidelines (2011, 2012). However a C.t value is not included. It is proposed that a C.t value of: C.t>15mg/L min. Feed water turbidity <1.0 NTU is included in a footnote to the table. Further to this Table A5.4.2 Pathogen inactivation by disinfection table assigns a bacterial LRV of 2 for chlorination: C.t for E.coli at 1015oC, pH 610< 1mg.min/L However the note under the table states: Most Australian suppliers use chlorine as their disinfectant of choice. Whilst the table above provides C.t values for various LRV credits, most suppliers target a C.t value of at least 15mg/L.min, which is consistent with the World Health Organisation's recommendation that effective disinfection can generally be achieved by maintaining a free chlorine concentration of 0.5 mg/L for 30 minutes (WHO, 2011). An LRV for this C.t value is not included in the table or statement, even though it is understood that this C.t is what most Australian supplier's target. WHO (1996) recommend that the Ct for free chlorine should be >15mg/L min to achieve at least 4 log reduction of viruses. The data published by the USEPA (2003) confirms that the WHO (1996) requirement of a free chlorine Ct >15mg/L min will achieve greater than 4 log reduction of viruses for pH 69 and at all water temperatures, with some margin of safety. The reduction of bacteria has been conservatively assumed to be the same as for virus reduction. It is proposed that the table (or statement) include a bacterial LRV of 4.0 for chlorination when: C.t>15mg/L min. Feed water turbidity <1.0 NTU This will also align table A5.7.3 3.
		2	As above
		3	The draft text is relevant and accurate. It is easier to understand when used in conjunction with the Water Services Association of Australia (WSAA) (2015). Drinking Water Source Assessment and Treatment Requirements: Manual for the application of health based treatment targets. Townsville City Council had worked through the manual prior to the release of the draft framework. This helped in the understanding of the methodology to be followed. It must be noted that at Townsville the framework was worked through by water quality scientists and engineers. **Is this practical, and is the intent clear in the draft framework?:** This is a practical approach and the intent is clear in the draft framework. However as stated above I think it needs to be made clear that there are set Ct values for log reduction value for bacteria, as stated in question 1. **Do you have any evidence to support your view?:** I would support NHMRC using 1 litre per person today as you are the expert medical body. However I would ask the question if this default consumption value is relevant to living in a tropical climate such as parts of North Queensland and the NT where it would be expected that more "unboiled" water would be consumed on a daily basis.
7	Water Quality Section, Public Health Services, SA Health	1	1. The opening paragraphs are too general and repeat information provided elsewhere in the guidelines (General principles Chapter 3, 4 and Section 5.2. If this was a standalone text this might be a reasonable approach but it is part of the larger guideline document. 2. It would be much better if the opening paragraphs were more direct in explaining the need for numerical targets and the advantages provided. This is generally included in the following two sets of dot points but should be provided as the lead statement. It is also important to identify flexibility and that implementation of

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			HBTs does not require pathogen monitoring or even additional E.coli monitoring (in many/most cases). There needs to be a clear message to operators of small systems that this is not an onerous new impost but that it is intended to provide a useful tool in assessing safety of systems and prioritizing improvements (where needed). Suggest including a statement that systems with well designed RMPs are expected to meet the targets. There is nothing substantial about small water supplies until 5.7.5 which is too late. 3. Minor point. Do the words “for drinking water supplies” or “to drinking water supplies” need to appear in most headings? This is the Australian Drinking Water Guidelines 4. There is no Section 5.7.1 5. The titles of 5.7 and 5.7.2 are identical 6. The opening paragraph to Section 5.7.2 should note that the risk that is low enough to be considered acceptable will be below levels that can be practically measured by standard epidemiological methods. This is in line with public expectations that drinking water should not cause demonstrable illness. The opening 2 sentences say the same thing in two different ways. This is a bit waffly. 7. The third paragraph should cite (Health Canada 2012a) 8. Page 3, 2nd paragraph below the Box should end with “this step is discussed in Section 5.7.4". 9. Page 3, 3rd paragraph below the Box. Expression could be improved and corrected “required treatment barriers” are not “measured in terms of LRV credits”. Treatment barriers provide LRVs subject to meeting operational criteria. A better way of describing this step is that treatment barriers are selected that in combination can achieve the required LRV targets. As a general comment I do not support the term “LRV credits” in the way it is used in this document. Barriers achieve LRVs by meeting operational criteria (critical limits). The term “credits” suggests the LRVs are something based on trust or are awarded rather than being achieved. 10. Section 5.7.3 2nd paragraph. Greater precision would be good. “the benchmark microbial HBT is 10^{-6} DALYs pppy" 11. Figure 5.1 should be narrowed in range. Suggest starting at 10^{-3} DALYs pppy. Also suggest changing the label to DALYs pppy as the acronym has already been introduced. Note that the Figure only works if the document is printed in colour 12. Section 5.7.3 4th paragraph. Figure 7.1 and the water continuum do not include any direction on urgency. This concept needs to be introduced 13. “benchmark of 106 DALYs”. Here and elsewhere delete “benchmark” – it is redundant. It has already been established that 106 DALYs is the benchmark 14. Section 5.7.3 5th paragraph. Provides an illustration of why “log credit” is a flawed term. The shortfall is between the target LRV and the LRVs achievable by existing treatment processes. 15. Section 5.7.3 page 5 1st paragraph. A shortfall of 1 log does not equate to a DALY of 105pppy. The shortfall means that DALYs will increase to 105 pppy 16. Section 5.7.3 page 5 dot point 3.Should briefly introduce the term C.t and provide units. 17. Section 5.7.3 page 5 last paragraph. Again not good uses of “LRV credit”. Suggest “Extended periods of poor performance where achieved LRVs are well below….” and “Consistent LRVs from appropriate performance…” 18. Section 5.7.4 Page 5, The final sentence ends in …..”is shown in Figure 5.7.2”, the next sentence on Page 7 starts with “The process detailed in Figure 5.7.2’. Suggest rewording to improve flow of text. “The first step is to carry out a sanitary survey…” 19. Figure 5.7.2. The second step mentions “binning” for the first time. Suggest that an explanation for the term is provided (comments during earlier consultation expressed misgivings over this term) 20. In Figure 5.7.2 and the related discussion on page 7 suggest changing the wording about specific pathogen testing. Don’t agree that it should be presented as a refining step or options to be pursued if the original source water category needs to be refined or confirmed. As discussed on page 7 it is about adding precision (at

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			a cost) Suggest rewording the options to indicate at the start that both are based on specific pathogen data with B applying a binning system to determine LRVs and C applying QMRA to calculate LRVs. The words “using system specific pathogen data” should be included in the “OR” Box. 21. There is some inconsistency between Figure 5.7.2 and the discussion on page 7. For example, Figure 5.7.2 does not include the key step of identifying required treatment barriers (per earlier discussion on pages 1 and 3). Page 7 while discussing the various source water assessment options does not identify that the aim is to identify minimum LRVs although it does note that the outcome “is a determination of the minimum treatment requirements to…meet the microbial HBT”. Suggest rewording to improve clarity and alignment of the process descriptions in the Figure and supporting text. The meaning of “review operational data and confirm actual performance” could be clarified. I can guess what is meant but would a non-expert understand? The relevant text on page 7 is not much better. The aim of this step in established systems should be to: o review all existing treatment processes, identify expected/validated LRVs and confirm compliance with operational limits. Achievable LRVs for combined treatment processes should be determined. This leads to the next step of determining residual risk and the need for improvement. The recommendation on page 7 of assessing treatment performance as per performance monitoring requirements in Chapter 10 is too broad. Which part of Chapter 10? The Links to Framework box identifies residual risk determination as being part of Element 11. It should be Element 3 (see page 31 of the ADWG). Identifying improvement is also discussed briefly in element 3 as well. The text in the Step 5 Box in Figure 5.7.2 is not consistent with Figure 5.7.1. The concept of considering additional monitoring to reduce uncertainty is not discussed on Page 6 and needs to be. Not clear of the intended outcome; if the original answer is a removal shortfall of 2 Logs how does reduced uncertainty help. Is it possible that increased monitoring could reinforce or question the original assessment? Also not clear how additional monitoring fits under the heading of “implement improvements”. A short discussion on the alternative improvement strategies would be useful. Page 7, Paragraph 3. Repetition in text – use of the word particular. … “prior to applying a particular methodology to a particular drinking water supply. Page 7 Paragraph 6. Again not a fan of “minimum treatment requirements are expressed as the LRV credit that need to be achieved…”. Changing this to “minimum treatment requirements are expressed as the LRVs that need to be achieved…” is clearer. Page 7 Paragraph 7. Similar issue with credit. “Default LRVs for protozoa…” is clearer than “Default LRV credits for protozoa…” Page 7. Paragraphs 8 & 9. The second and third last sentences at the bottom of the page begin with “ If there is a shortfall”. Suggest that the second the last sentence is reworded to improve flow . Suggest: “A water quality improvement plan needs to be developed (Step 5, Figure 5.7.2) to address the shortfall”. 22. Figure 5.7.2 and page 7 appear to be limited to existing systems. Need to describe how HBTs are applied when designing systems 23. Page 8. Text about small systems needs to be moved to the head of Section 5.7.3 24. Page 8 Part A. See earlier comment about the need to explain the meaning of the term “Binning” 25. Page 8 Part A paragraph 2. If there is a first step there needs to be a second step. Should add the word "microbial" before "hazards" 26. Page 8. Paragraph 4. Some repetition in text. Suggest removing: “of the catchment area”…” and consists of a detailed catchment survey”…as this has been described in sentences above. Suggest rewording to read “The sanitary survey may be qualitative, semiquantitative, or occasionally quantitative. Details on how to conduct the sanitary survey can be found in Appendix A5.2.” 27. Table 5.7.1 does not match easily with Table A5.2.1 and A5.2.2. Could be better if the third column included the term E.coli Bands (on this note is the term E.coli Range better?). The greatest uncertainty with this Table is assigning the E.coli Bands from WHO to the 4 Categories. The linking of LRV requirements with source water type has been done by others (in particular NZ) but linking of the E.coli Bands with the source water categories is less well established. I understand that there is supporting data but not sure that it has been published (the WSAA trials). It would be useful if a more detailed discussion justifying the linkage could be provided (perhaps in Appendix 5.2 with a crossreference added here). In addition it looks odd that Category 2 with moderate protection and Category 3 with poor levels of protection produce the same levels of E.coli contamination. This also needs to be explained. 28. Table 5.7.2. The LRVs for Cryptosporidium are based on a Pill of 0.16 (0.2x0.8) if a Pill of 0.014 (0.2x0.7) (as discussed below in the comments for A5.1) is used the LRVs should be 3 (rounded down from 3.2), 3.5 (range 3.24.2 average 3.7 rounded to the nearest half log 3.5), 4.5 (range 4.25.2 average 4.7 rounded to the nearest half log i.e. 4.5), 5.5 (range 5.26.2 average 5.7 rounded to the nearest half log i.e 5.5) 6.0 (6.2 rounded to the nearest half log). If rounding to the nearest half log is not used the LRVs for Campylobacter and Norovirus will need to be adjusted.

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			29. The superficial mismatch between Table 5.7.2 (using ranges of pathogen concentrations) and Table A5.1.3 (using specific pathogen concentrations) should be explained as this has the potential to cause confusion. Need to explain where the numbers in Table 5.7.2 came from (i.e. see Appendix A5.1). Consider amending use of <0.1 for pathogen concentrations for the fully protected source waters. It is not completely clear why <0.01 in a protected source produces different LRV targets than <0.01 in unprotected source waters. Also not clear why <0.01 Campylobacter requires a 0 LRV in protected groundwater, 4LRV in protected surface water (while <0.01 viruses and Crypto require 0LRVs) and 3 LRV in unprotected source waters. 30. Page 10 1st paragraph. The reference to maximum concentrations of organisms is inconsistent with column 1 in Table 5.7.2 which talks about average numbers. The LRV for Cryptosporidium should be 4.5 based on the discussion above. 31. Page 10, Paragraph 2. Repetition in text in use of considerable. "…Note that considerable numbers of samples, at considerable cost…" 32. Page 10, Paragraph 2. "Note that considerable numbers of samples, at considerable cost, are often required in order to gather sufficient data to cover the required range of pathogens, the extent of time and the variety of events required for representative results. At least dozens of samples over several years are required to provide a reasonable baseline on top of which event based samples are also required." The precision of this sentence could be improved ("considerable samples" or "at least dozens of samples", "extent of time" "over several years"). Could probably combine these sentences by making some choices (considerable or dozens of samples) and refining them (not a fan of dozens in this context). 33. Section 5.7.5. Suggest focusing on Small or Remote Drinking Water Supplies in the title (i.e. delete specified treatment technologies). Should there be a statement included that application of specified technologies will provide a reasonable level of confidence that safe water is produced. The last sentence on page 11 is missing something ("active in applying preventative" ?) 34. Table 5.7.3. Not clear why the LRVs are repeated in this Table. Same information is presented in Table 5.7.1 35. Section 5.7.6. The opening sentence could be clearer. Perhaps it might be better to start with an indication that targeted operational monitoring programs are required to support implementation of microbial HBTs.
			A5.1 Tables A5.1.1 and A5.1.2. The low dose approximation for Campylobacter should be Pinf = (α/β).d . The exact Beta Poisson Pinf = (α/(α+β).d is not required. While it has only a little impact on the later calculations approximate beta poisson is used in the Australian Guidelines for Water Recycling and the WHO text on QMRA During final drafting of this paper the probability of illness given infection for Cryptosporidium was decreased from 0.8 to 0.7 but other figures have not been adjusted accordingly. The probability of illness per organism for Cryptosporidium should be 0.014 (0.2x0.7). In Table A5.1.2 DALYd should be 4.2 x103 and the mean concentration/L should be 5.8x106. The units for Disease Burden (i.e. per illness or per case) should be included. It is suggested that the dose response for Norovirus could be updated using the parameters published in Messner et al (2014) Risk Analysis 34: 18201829 (α=0.0044, β=0.0022). The Messner et al dose response is being considered for inclusion in the Australian Guidelines for Water Recycling and the WHO Potable Reuse Guidance Table A5.1.3. Using the updated probability of illness for Cryptosporidium the LRVs should be 2.2, 3.2, 4.2, 5.2 and 6.2 (see also the comments on Table 5.7.2). Should the LRVs in this Table be rounded to the nearest half log? Page 17. Second paragraph. Not clear why the second paragraph refers to maximum concentrations. These are not used in the Table and the rationale is not consistent with the recommendation to use averages to calculate LRVs (see page 18). The LRV for Cryptosporidium should be changed based on the discussion above. Page 17 (ii) First paragraph. Not sure about the term "sufficiently viable state". Are there gradations of viability for Cryptosporidium Page 17 (ii) Second paragraph. The statement that *C.hominis* and *C.parvum* (bovine) are the most likely cause of waterborne outbreaks should be supported by references (these are available) Page 18 (iii) First paragraph. Suggest deleting "in some circumstances". The sentence already notes that operating at elevated levels of protection "may" have cost implications A5.2 As raised in comments on Chapter 5.7 the justification of the E.coli bands needs strengthening. They are an essential component of system assessment and derivation of HBTs but justification of the linkage between the bands and source characterisation receives limited attention. The text in WHO (1996) is a good start and Deere et al showed some differences in E.coli concentrations depending on levels of catchment protection. It would be useful if the WHO assessment and the data from Deere et al could be compared more closely. Figure A5.2.1 Includes Boxes A, B, C, D and F but no E A5.3 The definitions of groundwater not under the influence of surface water are questioned. A depth to groundwater of 10 metres or to the bore pump of 15 metres appear to be low. A5.4 Page 30 (dot points). LRV credits are also provided for DAFF and Slow Sand Filtration Page 3031 Published data. Paragraphs 3 and 4. On reflection the text is too conservative. The advice for continuous monitoring of turbidity from individual filters is generally reasonable for large well resourced

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			treatment plants but should be softened for smaller plants. An explanation should be provided to explain why a lack of continuous monitoring is inconsistent with Elements 3 and 4. Not sure what is meant by "the upper bound of grab sample data". A clarification/explanation would be useful. Page 32. Table A5.4.2 show that LRVs that can be achieved and measured (again not a fan of LRV credits) (see also comment below). Page 34 Validation. This section needs to be reworded. The Victorian Department of Health Validation Guide provides useful background information that could be used to introduce validation (pages 35). Could also cite the WaterVal framework in discussing methodology. http://waterval.com.au/wpcontent/uploads/2016/02/ValidationProtocolTemplate.pdf. In terms of processes the advice to adopt defaults shown in Tables 5.4.1 and 5.4.2 should be clarified. The defaults for mediabased filtration processes are internationally recognised best practice (as shown) and should be adopted. Suggest including a sentence making it clear that application of new validation processes is not required for water treatment plants that have already adopted the USEPA based defaults. However, defaults should not be applied to new equipment/processes where prevalidated equipment is readily available e.g. membrane filters prevalidated for Cryptosporidium removals using the USEPA Membrane Filtration Guidance and UV light disinfection systems prevalidated for protozoa, virus and bacteria inactivation. Validation for disinfection systems relies on meeting the Cts (and specified temperatures, pH and turbidities where appropriate) specified in Table A5.4.2. In this case validation is based on establishing monitoring systems to measure Cts. If targets are met LRVs are achieved.
		3	The text is relevant and a very important addition to the ADWG. The inclusion of microbial HBTs is strongly supported and the text provides all of the information necessary to support both inclusion and implementation. However, the clarity and in some places accuracy could be improved to assist understanding of those who are not as deeply immersed in the subject as the authors. Engaging with operators of small community water supplies is particularly important. This group also needs to be reassured that microbial HBTs will not represent a major new impost. Is this practical, and is the intent clear in the draft framework?: The flexibility included in the tool essential for practical application. However, this feature could described more boldly at the start of the discussion. The point about limited imposts on small and remote supplies should be in the first paragraph in section 5.7 **Do you have any evidence to support your view?:** This issue has been discussed frequently in recent years. There are published assessments of drinking water consumption e.g. Microrisk Final Report Quantitative Microbial Risk Assessment in the Water Safety Plan April 2006 (which includes Australian data) and the USEPA Exposure Factors Handbook 2011. It is suggested that any review of drinking water consumption should include all aspects of the ADWG. In the meantime it is recommended that a volume of 2L per day should be used for microbial HBT. This is the more conservative position and has a limited impact on the targets (0.3log) calculated using specific pathogen data.
8	Individual Professional Tasleem Hasan	1	It states that the HBT should be applied as an operational benchmark, rather than a pass/fail value - which is a good approach. Hence the Water Safety continuum diagram wording should be more reflective of this, for example, it shouldn't read "SAFE" outright but instead could be "CONSIDERED SAFE", "MAY NEED TO IMPROVE OPERATIONS" etc. Page 7 last para, missing word – [If there "is" a shortfall,….] Overall, there is strong focus on catchment management and treatment side of things in this Chapter – there should be a link identified that the distribution system needs to be closed, it is suggested to maintain residual chlorine to prevent recontamination etc. The approach discussed will guide 'SAFE' water to leave the water treatment plant but it does not acknowledge that it may not be the same quality water that reaches the consumers. The integrated nature of drinking water management should be highlighted, from catchment to consumer. It can also be mentioned that the performance targets which are being presented can form the basis for assigning the CCP limits, based on the risk assessment and in consultation with the state regulator.
		2	No
		3	Comments as stated earlier in Q1. It is also not clear what is the indicative timeframe for short term and long term improvements? How long can a utility keep the improvement identified through this approach in the back banner? **Is this practical, and is the intent clear in the draft framework?:**

#	Organisation	Q	Comments Received
			5.7.5 Many small and rural remote areas do not have jurisdiction for catchment management. Is there another example for them to be put here? Without having the ability to control catchment activities, the catchment grading for them will mostly fall in Cat 3 or Cat 4, which means investments to put in treatments like UV (risk based of course). What about claiming LRV credits for detention in dams, or not abstracting water from source when its dirty? **Do you have any evidence to support your view?:** Yes, WHO Guidelines for Drinking Water uses 1 L also, Table 7.4. ABS stats although little out-dated (data from 2011-12) mentions average consumption as 1.064 L as average, although this may be higher for older adults. http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/4364.0.55.012~2011-12~Main%20Features~Water~10001 1 L may be okay okay if we want to be conservative can be 1.5 L.
9	Water Services Association of Australia		WSAA welcomes the opportunity to provide comments on the draft framework on microbial health based targets and has consulted with its members in providing the following feedback. WSAA has shown early leadership on this approach having developed a guidance manual some time ago. It is disappointing it has not been referenced more fully given so much of the text and approach has been drawn from the WSAA Manual. It could be beneficial to practitioners to understand that a microbial HBT is required to align microbial safety with chemical safety and that the DALY approach provides a common metric for disease burden for chemicals and microorganisms. It is not completely clear with the current wording that this was one of the key drivers for adopting a microbial HBT. This section, 5.7, should also be referenced in Section 3.2 as it forms part of the assessment of the drinking water supply system. Below are some more specific comments. PAGE NUMBER - 3. Box 5.7.1 - Disability Adjusted Life Years (DALYs) The last paragraph in the table refers to Norovirus. The example earlier in the box is about Cryptosporidium. Consider removing the paragraph as there is no introduction for the norovirus DALY. PAGE NUMBER - 5. 5.7.3 Application of the microbial health-based target to drinking water supplies. Dot points. For consistency the different levels of DALYs pppy should align to the terminology used in Figure 5.7.1 i.e. safe, improve operation, enhance control etc. PAGE NUMBER - 5. Last paragraph of section 5.7.3 The text does not address the issue of short term increases in microbial challenge. How this is accounted for in an annualised risk also needs some comment i.e. that this is an annualised risk and there will be times when the DALY is greater than or lower than 1. Also unsure if the reference to Figure 9.2 is correct. PAGE NUMBER - 7. 5.7.4 Determining minimum treatment requirements for drinking water supplies Minor typos - E.coli not italicised, last paragraph should read 'if there is a shortfall'. PAGE NUMBER - 9. Table 5.7.1 Bin classification and minimum treatment requirements The guidance in this section could be confusing as the concept of reference pathogens has not been introduced and the first part of the paragraph indicates that the utility needs to monitor for norovirus. The second part of the paragraphs refers to cultivable virus (to represent norovirus). More information is required to clarify which virus is to be measured. In Table 5.7.1 the columns for reference pathogens should run Bacteria, Viruses, Protozoa to be consistent with the current revision of the Guidelines for Water Recycling. It is questionable whether minimum treatment requirements should not include any treatment (even chlorination) for groundwater, particularly given the recent outbreak in Havelock North in New Zealand. Some clarification of the appropriate sampling site for the E. coli samples needs to be provided. It is also assumed in this Table that it is the maximum E. coli concentration that is being discussed. However, Table 5.7.1 indicates that it is the 'typical' E.coli concentration. This needs to be clarified. PAGE NUMBER - 10. Table 5.7.2 Minimum treatment requirements, expressed as LRV target This table confuses the issue of binning and is inconsistent with information and data presented in tables 5.7.1 and 5.7.3 so some clarification is required. The LRVs in Table 5.7.2 do not align with the data presented in Table 5.7.1 and was not included in the WSAA Health Based Targets manual. This could create confusion for utilities. It appears that the LRV target is greater when you do a full QMRA than when you use this binning approach. This seems counterintuitive as you would assume that to do the QMRA you would have greater degree of certainty on the pathogen concentrations and therefore the default LRVs in the bins would be more conservative. If you use an average of 1 orgs/L and use the QMRA approach the target LRVs are: P – 5.3 LRV B – 5 LRV V – 5 LRV These are all higher than the LRVs in the corresponding bin in Table 5.7.2. It is a similar outcome for the next bin if you did the same calculation with an average of 10 orgs/L. It is not clear if the binning system numbers are recovery adjusted values. The table also uses an LRV at the >10 value range for Crypto which exceeds that in Tables 5.7.1 & 5.7.3. and is slightly different to Table A5.1.3. Table 5.7.2 also contemplates only

#	Organisation	Q	Comments Received
			a 3.0 LRV requirement for an unprotected source water. Some clarification of this is required. While it is accepted that E. coli is being used as an indicator, the fact that 20,000 - 200,000 E. coli/L requires 5.5 LRV (Table 5.7.1) whereas only >10 /L Camplyobacter requires 6.0 LRV may create confusion. The binning system in Table 5.7.2 seems to only refer to Cryptosporidium concentrations and not to concentration bins for bacteria or viruses. Maybe a reference to Appendix A is needed. It is not clear where the concentrations for the reference pathogens is sourced from and maybe a reference to the Appendix is warranted. PAGE NUMBER - 10 (C) QMRA based on sanitary survey and system-specific pathogen data It is disappointing that the document does not include the requirement for 100 data points (or 12 positives) for the Cryptosporidium QMRA as in the WSAA HBT manual. The use of the phrase "At least dozens of samples are required" is ambiguous and does not represent good guidance. The requirement for 100 data points for E.Coli is articulated in Appendix 5.2 but this does not extend to Cryptosporidium. Suggest including the same data requirement for Cryptosporidium. PAGE NUMBER - 12 Table 5.7.3 Indicative specified treatment technologies for different catchment types The LRVs for unprotected source water could be as high as 6.5 from Table 5.7.2. The different maximum LRVS in the various tables needs to be explained or rationalised to avoid confusion. 5.7.6 Operational monitoring This section could include more guidance. PAGE NUMBER - 13 5.8 References Deere et al 2014 reference is not included (although is referred to in text). PAGE NUMBER - 17 Paragraph 2 - discusses the use of maximum concentrations of pathogens, while Table 5.7.2 uses average concentrations. The LRV targets specified in this paragraph may need to be checked as in doing QMRA calculations with the organism concentrations detailed in this paragraph results in different LRV targets to those specified. PAGE NUMBER - 18 Subsection (iii) There needs to be some indication on what an adequate dataset for Cryptosporidium would be to calculate the mean, as is done for E. Coli in A5.2. PAGE NUMBER - 25 (c) Microbial indicator Assessment Paragraph 1, last sentence under Data assessment: even-based samples should be included provided the treatment plant was supplying water. Paragraph 2 – should read In order to verify.
		2	GENERAL COMMENTS Appendix 5.1 needs to include a discussion on the concept of reference pathogens. The data in Table A5.1.3 is different to 5.7.2 which is confusing. Suggest removing both tables as they do not add to the information. The information in the paragraph starting "as an example of how this methodology would be applied…." is not clear and suggests that Norovirus was measured. If it was other culturable viruses, then this needs to be stated. The methods used also need to be included. The guidance is silent on how to deal with non-detections for calculating the arithmetic mean. PAGE NUMBER - 21 Table A5.2.1 Preliminary categories for drinking water sources Footnotes to the table should be reconsidered as footnote 1 states that a large reservoir provides a storage buffer sufficient to achieve several log reductions. The document does not provide a log reduction value for a reservoir, so this statement is at odds with the guidance. Also consider deleting the statement "A small reservoir does not meet the requirement for a large reservoir". PAGE NUMBERS - 30, 31 and 32 A5.4 Default LRV Credits for common water treatment processes Table A5.4.1 Pathogen Removal by filtration As with other tables in the document, the order of reference pathogens should be Bacteria, Viruses, Protozoa for consistency. The first row in the table for Direct Filtration includes a requirement for combined filtrate turbidity of <0.3 NTU. In the WSAA HBT Manual this is listed at <0.2 NTU. Can there be some description in the table of why it was selected as <0.3? Also, the WSAA Manual does not have provision for combined filtrate turbidity if claiming a 3.0 Log reduction of Cryptosporidium. The NHMRC inclusion is not as conservative as the WSAA approach and may result in utilities not moving to the ideal situation of individual filter turbidity monitoring. The requirement for all filter turbidities not to be exceeded for 15 consecutive minutes should be dependent on the polling interval of the measurement. Some guidance is required on this issue. In relation to the slow sand filtration reference in Table A5.4.1, a reference needs to be considered for the turbidity limit as it seems quite high. Allocate treatment credits for MF and UF processes – though generally well understood by industry, for completeness the document could define how MF and UF processes are defined (eg. by pore size ranges perhaps). Normally membrane turbidity is measured on the filtrate of the skid, not from individual modules. You could easily have systems with 20 + modules, you wouldn't expect 20+ turbidity analysers. In addition, membrane systems with lower turbidity limits should not get less protozoa LRV credit than a conventional filtration system.

#	Organisation	Q	Comments Received
			PAGE NUMBERS - 32 and 33 Table 5.4.2 Pathogen inactivation by disinfection Check typos – E.Coli This table appears overly complex. The table D1 in the WSAA HBT Manual was put together from a review of international LRVs and is more useful. The information presented in Table A5.4.2 suggests that only 2 log reduction can be claimed for bacterial inactivation for chlorination. This means that protected supplies, such as Melbourne Water's, would need to have treatment as well as disinfection. Up to 4 log should be achievable with each of the disinfection approaches. Only one line is included for chlorination – more information is required. Also UV light is only allocated a 2 log reduction for E.Coli. Suggest this table is reviewed and reflects the information in the WSAA Manual Table D1. In terms of the credits allocated to chlorination and chloramination specifically, we suggest the basis for credits (Keegan et al 2012) be reviewed. The WSAA HBT Manual gives values from the USEPA documents, work completed by SEQ water and refers to the WHO value of 15 mg/L.min. Other reference values that are sometimes quoted come from the Vic recycled water document. We believe the industry needs a final determination on which values to use, as all have different outcomes. WSAA's preference would be to use the USEPA values as the primary reference point as they have the most 'official' and accepted status and are validated over a good range of pH's/temperatures. Further to this, the values for chloramine should explicitly state that they are only valid if chlorine is added first in the disinfection sequence as stated in the original USEPA documents. The usual approach for chemical disinfection is to allocate the same credits for bacteria as viruses as a conservative estimate – so this can be considered here. Using a broader context, the ADWG document and the WSAA approach doesn't specifically allocate pathogen reduction credits for detention time in reservoirs or dilution effects through multiple storages. We suspect this is due to the difficulties in quantifying and validating reductions, but in certain circumstances it can provide a pathogen reduction step that is not captured in the current approach. By way of example, a treatment plant may draw off a terminal storage that is fed by a range of other sub-catchment storages. One of these sources may be a higher risk source (say Category 4), but it is getting stored in the terminal reservoir for some time and mixed/diluted with other lower risk sources. WSAA's understanding is that the current approach would not recognise this scenario as lowering the risk for the terminal reservoir, and it would be collectively rated as a Category 4 system. PAGE NUMBER – 34 Validation of barrier performance The document is silent on the procedure for pre-validated treatment technology. Some discussion on this would be useful. Paragraph 4: the statement microbial and/or chemical characteristics should be assessed in samples taken before, during or after the unit process to confirm needs further clarification. It is not clear what during the process means – it appears to be a temporal statement. It is also not clear if this requires actual challenge testing to determine the achievable log reduction if claiming something other than the default values. There may not be sufficient challenge on the process to do this. Some discussion of these considerations may be warranted.
		3	WSAA supports the introduction of Health-Based Targets and believes that it is a positive addition to the Australian Drinking Water Guidelines. The approach presented in the draft framework is intended to be a tool for water suppliers to manage and improve their water quality. The process is intended to be flexible, with smaller or less-resourced water suppliers able to apply default treatment technologies based on an understanding of their source water. Larger, more technically advanced suppliers may choose to use monitoring results specific to their water sources to apply more system-specific approaches. The draft text is confusing in places for those new to the concept. However, those in the industry who were involved in the substantial WSAA trial of the approach will be able to navigate the document. It is noted that the WSAA Manual for Application of Health-Based Treatment Targets is not referred to in the text, even though it is drawn on heavily for the guidance and assumptions. It is understood that there are limits to the amount of information that can be included in the drinking water guidelines so a link to the WSAA manual will be useful and maybe a reference in the section that includes the Good Practice Guide. In relation to Sanitary Survey Approach, there is not enough guidance in the document for surface water supplies that do not have a reservoir. Run of the river supplies are not discussed, even though there is a large number of supplies of this type, particularly in rural areas. Also there is no guidance for seawater as a source for desalination plants. The WSAA Manual terminology of Tier 1 and Tier 2 is preferred to the current wording. **Is this practical, and is the intent clear in the draft framework?:** Yes, with reference to comments above. **Do you have any evidence to support your view?:** 1.0L per day is the preferred volume for microbial risk. This is supported by the average unheated water consumption per day as described in the 2005 Microrisk report and adopted by WHO. For recycled water, 2L is appropriate where chemical risk is more significant. The use of 2L per day consumption of water in the LRV target calculation is arguable.

#	Organisation	Q	Comments Received
			• 1 litre as the average unheated water consumption per day based on WHO and the 2005 Microrisk report Estimation of the consumption of cold tap water for microbiological risk assessment. • The volume relevant to the microbial assessment is unheated water, unlike chemical assessments where heating does not reduce contaminant concentration • The HBT methodology uses average pathogen concentration so it makes sense that average unheated water consumption is used in the calculation (not an upper bound of 2 litres) • The average daily intake of unheated tap water has been shown in studies in Aust, NZ and US to approximate 1 litre • Using 2 litres makes sense for recycled water where chemical and microbial contaminants must be assessed concurrently. However, 2 litres is not appropriate for a standalone microbial assessment.
10	Nambucca Shire Council	1	No
		2	No
		3	Yes Is this practical, and is the intent clear in the draft framework?: The intent of the framework is clear. However, Council has concerns about the cost of complying with the proposed framework. It would most likely be driving a requirement for the vast majority of water authorities including us to install a filtration plant. Councils are currently required to prepare Risk Based Water Quality Management Plans and use them to identify critical control points in the system to ensure safe drinking water. The plans also help identify shortcomings in the system where there may be a need for additional treatment or monitoring. What problem is the framework looking to address? Not aware of any bad outbreaks of water contamination making people sick in Australia. Do you have any evidence to support your view?: One litre would appear to be reasonable however I have no evidence to support this view.
11	SA Water	1	Box 5.7.1 DALYs 1. Reference 2 is not cited 5.7.2 2. Table 5.7.2 (and 5.7.3, A5.1.1, A5.1.3, A5.1.3) mentions Cryptosporidium but there is no discussion relating to whether this relates to total Cryptosporidium, viable Cryptosporidium or only C. parvum or C. hominis (human infective). This is discussed later on page 17 but it should be noted at the first mention of Cryptosporidium (as a minimum there should be a note under each table pointing towards the discussion on page 17). 5.7.3 3. Table 5.7.3 provides recommendation for indicative specified treatment technologies for different source water types. However the recommendations for rows 3 and 4 do not align with the allowed credits from tables A5.4.1 and A5.4.2, for Bacteria. 4. Following an assessment of both source water challenge LRV and treatment LRV, it may arise that the treatment LRV exceeds the challenge resulting in a negative shortfall. While on the surface this may provide the Utility some breathing space, it may work in the opposite way, encouraging additional riskier practices to be permitted in the catchment or to promote the concept of switching off treatment barriers. Some words discouraging such practices appear to be warranted. 5. While SA Water is supportive of the approach to use a combination of catchment surveys and E.coli monitoring to assess source water challenge, it should be recognised that E.coli monitoring data can be impacted from anomalies resulting from environmental blooms. In such cases, molecular techniques that help identify and clarify real pathogenic risk should be encouraged. It would be useful if there was provision within the source water assessment for using other techniques to verify the survey or E coli results, such as the use of other faecal indicator organisms or faecal source tracking markers. Likewise, techniques such as reservoir modelling may help a Utility better understand pathogen fate before it reaches plant inlet. 6. Table 5.7.1 Column 3 relates bin classifications using 'Typical E.coli results'. However in Appendix A.5.2, data relating to 'Maximum E.coli' is requested. This appears inconsistent.

#	Organisation	Q	Comments Received
			A.5.3 7. There is no mention of aquifer recharge systems (storm water or recycled water) as something that should be taken into account when undertaking a vulnerability assessment of a groundwater source. A.5.4 8. Table A5.4.1, notes (1) and (2) – the definitions of direct filtration and conventional filtration refer to the presence and absence of sedimentation but should also mention dissolved air flotation. 9. It should be recognised that turbidity is generally an imperfect measure of membrane integrity and that routine (daily) MIT should be performed to confirm log reduction performance. 10. Validation processes are recommended and supported by SA Water. Does NHMRC acknowledge that routine MIT is an acceptable mechanism to determine the log credit associated with a membrane process, particularly when claiming up to 4 LRV (protozoa) for an individual barrier? 11. Table A5.4.2 seems more detailed than it needs to be. For instance, it may be confusing to the reader that a LRV of 2 is assigned in the Table A5.4.2 while in other tables within the document (Table 5.7.3), chlorination is deemed appropriate for an LRV of 4. Is it possible to provide a recommended CT target to achieve a Category's associated pathogen credits in a similar way to that stated in the WSAA Manual for the Application of Health-Based Treatment Targets (Release No.2)? 12. The Document references the Water Research Australia (2015a) Good Practice Guide to the Operation of Drinking Water Supply Systems for the Management of Microbial Risk. Does the NHMRC document recommend compliance with this Guide to claim the LRV credits listed in Table A5.4.1?
			Yes this has been a significant gap in understanding for the industry. **Is this practical, and is the intent clear in the draft framework?:** Yes **Do you have any evidence to support your view?:** 1 Litre per day seems reasonable.
12	Power and Water Corporation, Northern Territory		The inclusion of the additional bin "Protected Groundwater" requiring no treatment, is a major deviation from the WSAA Manual for the application of health based treatment targets; and allows a method of supply that does lead to appropriate distribution system management. The risks to contamination in the distribution system are well known (leaky tank roofs, pipe breaks etc.). In addition, opportunistic pathogens *Naegleria fowleri* and *Burkholderia pseudomallei* are present in some Australian drinking water supplies. The maintenance of a robust chlorination barrier, in addition to appropriate maintenance and inspection of tanks etc. is critical to protecting customers from these hazards. Section 5.7.6 is does not define the operational monitoring that would be necessary to safely manage a water supply without chlorination; while the rest of the document provides effective detail about monitoring necessary (including detailed performance criteria) to operate other treatment processes and claim the log reduction credits. In a supply without chlorination, effective management of distribution system integrity is an absolutely critical barrier to preventing re-contamination, yet no definition of appropriate practice exists in this Chapter. One of the fundamental advantages of the HBT approach is that it clearly specifies the practice that is necessary to meet the HBT; which is especially important for smaller utilities with less in-house expertise. A failure to clearly specify appropriate practice to supply water without a disinfection barrier, while allowing a water supplier to claim they have "Protected Groundwater"; is likely to lead to inconsistent application of the Guidelines. The WSAA Manual for the application of health based treatment targets was able to be silent on the issue of distribution system management as chlorination was the minimum requirement defined in the tool. It should also be noted that during the period of consultation performed by WSAA with WSAA members, no utility expressed a desire to include a "Protected Groundwater" category. Specifically, all members considered chlorination to be a minimum requirement for the supply of drinking water in Australia. If the bin "Protected Groundwater" remains in the ADWG, much more detailed criteria must be developed to ensure water suppliers are appropriately managing their systems. These criteria should be, at a minimum, as effective and elaborate as other criteria developed to appropriately manage treatment barrier performance. An alternative approach could be to remove the "Protected Groundwater" category, and to allow for provision for a water supplier to apply to a Health Regulator for an "exemption from chlorination" based upon meeting some of the performance criteria described above, such as demonstration of an uncontaminated water source, and provision of a distribution system management plan. Such a plan could be tailored to the size of the distribution system/supply in question.
		2	A5.3 - Microbial Indicator Assessment - Does not specify a minimum frequency for raw water monitoring. This could be unclear and prone to misuse, given above comments. A5.3 - Water Treatment - As described earlier, this section does not go into enough detail about appropriate distribution system management.

#	Organisation	Q	Comments Received
		3	Is this practical, and is the intent clear in the draft framework?: There is a very real risk that smaller or less-resourced water suppliers will read this document and see it as an excuse to cease operation of their chlorine disinfection systems, which are a big burden on operational resources (particularly in remote and regional areas). Such smaller operators are also the least likely to have the robust risk management framework necessary to manage the supply of undisinfected water. Do you have any evidence to support your view?: In warmer climates, it may be necessary to continue to use the higher value, where water consumption is greater. Otherwise, no comment.
13	Water Corporation, Western Australia	1	The advice that the microbial HBT should be applied to drinking water supplies as an operational benchmark rather than a pass/ fail guideline value is sound in view of the uncertainties & assumptions in the process The concept that when a water supply normally achieves the benchmark HBT, short term small magnitude adverse changes will not pose a significant risk to customers is an appropriate reflection of the multiple barrier principle The Corporation will work together with its Regulator the Department of Health to determine the impact of adoption of HBTs on its existing notification framework Specified treatment technologies for small or remote drinking water The expression 'fully protected' – does this cover catchment protection (ie – with appropriate land use, policy, etc) as well as physical protection in the case of groundwater – ie – confinement? Table 5.7.3 mentions 'shallow' groundwater while table 5.7.1 just talks about groundwater. Is this a deliberate variation or not? If not, which is correct? Shallow is a generalisation that may not equate perfectly to risk, but merely stating 'groundwater' is very broad. Table 5.7.1 & 5.7.3 talk about 'protected groundwater' & 'fully protected groundwater' having a zero minimum treatment requirement & not requiring chlorination. The Water Corporation does not agree with this element of the submission • Chlorination is 'good practice' regardless of the water supply • Ongoing proving that groundwater is protected/ fully protected is technically challenging and open to interpretation • A key learning from Incidents around the world is that chlorination should be a centrepiece of even low risk water supplies • Even protected/ fully protected groundwaters periodically have very low levels of E. coli, which would be problematic to deal with under this approach • Chlorine residuals provide an important barrier to contamination within the distribution system, even within small systems It is strongly recommended that the Bin Classification 'Not Applicable' be deleted and protected/ fully protected groundwaters be rolled into the Category 1 Bin. This commentary is also relevant to page 29 – 'no treatment' is discussed. This should read'no treatment beyond standard disinfection'
		2	Vulnerability Assessment for Groundwater Section A5.3 does not provide significant guidance on how to deal with fractured rock aquifers. These may never have a confining layer above the aquifer but will typically satisfy all other characteristics. Should the utility interpret the characteristics independently – ie – all must be satisfied (= treatment for fractured rock aquifers) or should the utility take the view that if the other characteristics can be satisfied, one (the confining layer) can be 'missed'? Seawater It is noted that the document does not address seawater as a source water. The Corporation relies on seawater as an increasingly important source for its customers so would like guidance on how this water source should be considered in a HBT context. At face value there is a mismatch between typical E. coli levels (low, although it is understood that there are challenges with the use of this indicator in Seawater) and the level of protection that can be applied to seawater. In addition RO is absent from the table in A5.4. It is expected that the same HBT principles can be applied to seawater and that typical salt-removal treatment will also remove sufficient pathogens from seawater, as long as it is not routinely contaminated with untreated sewage. Naegleria fowleri This is a critical water quality parameter for management of water quality in WA. It is recognised that it is primarily not a 'source' issue however, its inclusion in Table A5.4.2 would be beneficial to understand LRV's that can be obtained and Ct required. Good Practice Operation Although this is touched on for water treatment plants on Page 34, the Water Corporation feels that this important element of water treatment operation to achieve the required pathogen removal performance should be a more central component of the HBT approach. Utilities should actively understand and seek to continuously improve toward the achievement of the 'Good Practice Guide'
		3	Yes Is this practical, and is the intent clear in the draft framework?:

#	Organisation	Q	Comments Received
			Yes Do you have any evidence to support your view?: Nil
14	Department of Health WA		Microbial health-based target for drinking water Section 5.7 clearly equates microbiological risk with the occurrence of faecal originated pathogens. A contextualising sentence needs to be added to this section explaining that this process does not apply to other forms of microbiological risk that may affect water, such as thermophilic amoeba such as Naegleria fowleri, all of which can be very significant in the context of surface water in hotter climates. Thus regardless of the HBT approach for faecal originated pathogens, water suppliers should be advised to also consider the risk from thermophilic amoeba when determining the overall level of risk posed by a catchment and the overall level of protection supplied by various barriers (in particular, chlorination or the lack thereof). This is also particularly relevant to small remote water supplies in inland or northern Australia. The same could readily apply to risk from cyanobacteria, unless that risk is characterised as chemical toxicological in nature. Further, please also add information about how the concept of HBT's and bin classification of catchments is relevant to the ocean as a source for seawater desalination. The "banking" or storage of water in reservoirs (including the banking of ground water or desalinated ocean water, or water pumped from other reservoirs) by water service providers (e.g. Water Corporation in Western Australia) may affect the raw water sampling at the off-take point recommended in the fact sheet and indication of level of microbial contamination. That is, the water stored in a surface water storage may not entirely be raw water that originated from the surrounding land catchment to that storage, but treated drinking water pumped up from the metropolitan area in winter and stored for delivery next summer. Whilst the risk assessment is up to the individual water supplier, suggest adding language that clarifies how such circumstances be taken into account so that the risk to the reservoir is not underestimated. For example, should there be sampling and assessments at the feeder streams where they enter the reservoir as well as at or instead of the water body or water body outlet? Page 1, section 5.7 refers twice to "a tolerably low level of risk to the consumer" and to "a tolerably low level of microbial risk for drinking water", but from then on this terminology is no longer used, and the language reverts to "acceptable risk" or drinking water being "acceptably" safe. Elsewhere, ADWG does not use language such as tolerable risk or tolerably low risk, with the use of language in Chapter 3 and the 12 element framework being about "acceptable levels" of risk. Suggest that consistent terminology be applied throughout this new text to align it with the main language in chapter 3. Page 1, section 5.7 – bottom 3 dot points describes the implementation of the framework but this does not include a dot point for improvements via source protection to reduce risks – which is mentioned later on in the document (e.g. in the second dot point on page 5 'Improved catchment and reservoir management'. Page 3, Box 5.7.1 Disability Adjusted Life Years (DALYs) In this box the DALY per 1000 cases is calculated for an Australian example using Cryptosporidium causes. The calculation is presented and then immediately followed by a statement about 'Norovirus'. Suggest text added to more clearly delineate these as two separate examples. Also 6, Figure 5.7.2 on page 6: summary of the process for drinking water supplies to meet the microbial HBT of 10-6 DALYs pppy. It is suggested to add a foot note to the word 'binning system' and explain what this means under the flow chart or refer to the relevant section. This section categorises source water into Category 1 to 4 catchments, based on the findings of the vulnerability assessment (Table A5.2.1, p. 21). This is heavily based on the level of human and livestock activity in a catchment area. What happens, if a catchment is assigned to Category one (protected catchment), but there is another water quality concern (e.g. mining related - and not human or not stock related)? Suggest clarifying how this would be considered. In relation to the category of source water type in TableA5.2.1, suggest adding contextualising information for category 2 (I.e. a third dot point in the right hand column) about circumstances where, whilst the water may originate from a category 1 ground water catchment, the lack of suitable protection at the bore or well head renders it category 2. That is, in remote areas the water resource under the ground may very well be well protected and free of faecal contamination, but the bore, pump, casing and fencing infrastructure to bring it to the surface is in poor condition and introduces risks. At the moment, the Table does imply that category 2 describes the overall uniform nature of the catchment, not some specific risk at the offtake point of an otherwise pristine catchment. Further, section 5.3 (pages

#	Organisation	Q	Comments Received
			28 and 29) also does imply that the risks relating to ground water relate to the overall catchment, not the quality or otherwise of the bore infrastructure, so further comments here will be very useful. Section A5.2 (page 19 onwards) clearly implies that a catchment has a particular 'steady-state' characteristic that can be determined by applying the sanitary survey processes described therein. However, this section does not appear to discuss at any length how to deal with temporal variations in E. coli loading or runoff turbidity, such as water quality deterioration due to periodic large scale flooding or periodic cyclones or bushfire and cyclone and bushfire aftermath that may affect a catchment or river basin, even in sparsely settled areas of central and northern Australia. The section also appears to assume that whatever streams or rivers run through or supply water to a surface catchment do so year round i.e they do not completely dry up in summer, as is frequently the case in most of Western Australia. There is a small reference to extreme weather events in page 18, but more detailed advice should be supplied as to how to deal with these temporal matters, or explaining why they are less significant (if that is the case). [It is noted on page 20 that the categories proposed "have been adapted for Australian conditions".] Section A5.4 and also Table A5.4.1 on page 31/32 do not appear to provide any advice to water suppliers about LRV credits for reverse osmosis or desalination. Suggest this data is included, or explained why it is not relevant. [In WA, many remote water supplies are ground water disinfected only, or ground water with RO then disinfected i.e. RO is the treatment technology of choice. Whilst it is normally applied for chemistry reasons, it nevertheless is there and has significant benefits similar to the other filtration processes listed in Table A5.4.1. so advice about LRV's should be provided.
		2	Please refer to response under Q1 above
		3	Please refer to response under Q1 above **Is this practical, and is the intent clear in the draft framework?:** Please refer to response under Q1 above **Do you have any evidence to support your view?:** The proposal under Q5 is NOT supported, NHMRC should stick to the status quo default for assumed consumption for microbial risk assessment. Any question of changing this should be the subject of its own consultation process that considers detailed discussion of the significance of such a move, including published evidence and rationale. [As an aside, in hot areas of WA, many adults routinely drink well over two litres per day, and this is not in the form of tea or coffee, it is ordinary water. A number of remote outdoor work places also recommend that up to 10 litres consumption per day is desirable for OHS reasons. Again, this is not tea, coffee or otherwise boiled. In this context two litres may well be an underestimation of the exposure for that cohort.]

2018 Public Consultation Submissions

2018 Consultation Questions

1. Do you have any comments on the overall approach to assessing and managing microbial risk in source water outlined in section 5.3?
2. The treatment targets as log reduction values (LRVs) in table 5.6 were derived using Australian data and the assumptions are outlined in the technical appendix. Do you have any specific comments on these values and /or how they were derived?
3. These targets are consistent with the ADWG framework for managing drinking water. Do you foresee any major difficulties in the implementation of these proposed treatment targets? If so, what are they and how could they be resolved?
4. Do you have any comments on the following sections:
    - 4a: section 5.5 on opportunistic pathogens
    - 4b: section 5.6 on cyanobacteria
    - 4c: section 5.7 on nuisance organisms
5. Is the approach as articulated in the technical appendix clear? If not, how could it be made clearer?
6. Please provide any other feedback on the chapter and technical appendix.

Table 8. 2018 Consultation Submissions

#	Organisation	Q	Comments Received
1	Murray Darling Basin Authority		Email correspondence stating "*Please note that the MDBA accepts all of the proposed changes in the revised draft and has decided not to make a public submission on this occasion*".
2	Individual Water Professional Amutharaj Mahendrarajah	1	The LRVs requirements for each source water category are derived from the first principles using QMRA, which is good. However, the LRVs requirements are different to the LRVs specified in Table 4 of WSAA's Drinking Water Source Assessment and Treatment Requirements - Manual for Application of Health-Based Treatment Targets Release No. 2, 2015, which has already been adopted by most of the water utilities.
		2	The LRVs requirements for each source water category are derived from the first principles using QMRA, which is good. However, the LRVs requirements are different to the LRVs specified in Table 4 of WSAA's Drinking Water Source Assessment and Treatment Requirements - Manual for Application of Health-Based Treatment Targets Release No. 2, 2015, which has already been adopted by most of the water utilities.
		3	Although the targets are consistent with the ADWG framework, microbial risk is currently managed by monitoring indicator organism (E.coli) and ensuring treatment processes are operated optimally to ensure no E.coli is present in the drinking water. Therefore, it is necessary to undertake a gap analysis and identify potential gaps in meeting treatment targets. Then an action plan to be development with timelines to close the gaps. The major constraint to implement the targets would be the requirement specified in the Section 5.4.3.2 that the LRV should be validated on a site-specific basis. It is not clear whether the site specific validation means full scale validation of individual processes or challenge testing? It is not practical to undertake full scale validations in the plants that are operational and supplies drinking water to the communities. Undertaking challenge testing would also be extremely difficult. Ensuring operating conditions in accordance with the pre-validated conditions (i.e. processes that validated at factories/labs) or based on supplies or manufacturers' recommendations and best industry practice would be the practical means to ensure the achievement of LRVs rather than undertaking site specific validations.

#	Organisation	Q	Comments Received
		4a	None
		4b	None
		4c	None
		5	Highly technical. It is more beneficial to simplify the content to suit majority of the water professionals.
		6	Vulnerability assessment and microbial indicator assessment can be combined to give a simple classification of source water risk. This is the starting point to categorise the water source based on the level of contamination from enteric pathogens in a water source." This indicates that this assessment is only a starting point and further assessment may be required but there is no clear triggers mentioned when to undertake further assessment. Since the document place lots of weight on QMRA, it indirectly suggests the user that a QMRA need to be undertaken to confirm the classification. 5.4.2.2. Groundwater - Source water classification for unprotected groundwater In general guidance on assessment of groundwater is lacking. It is mentioned that "If the groundwater is not under the influence of direct faecal contamination of the aquifer, then the source water classification of the surface water catchment recharging the groundwater aquifer should be selected." Although the document says it a conservative approach, it is misleading, because there are number of physiochemical and biological processes occur during transportation and storage of water from catchment through to the acquirer to reduce to pathogen load/intensity in the groundwater. Adopting this approach may lead to unnecessary capital expenditure.
3	SA Health	1	The approach is reasonable and is supported. A few comments on content are provided. • Epidemiology: Page 3: "*However, it is limited both by being retrospective and insensitive, and is of limited value in identifying new risks or understanding sporadic cases of disease.*" Agree with the statement but a brief justification would be useful. Page 3: "*This is associated with the high cost of well statistically powered studies and the large numbers of people required to participate in these studies to detect small increases in illness.*" Suggest citing Eisenberg et al on sensitivity (Env Health Perspectives 114: 1199-1204: 2006) and using figures from the paper to illustrate the points being made. This would underpin later discussion on page 4 and in Figure 5.1. • Risk Assessment: RA estimates health outcomes from hazards that can be encountered from catchment to consumer not just in the catchment. Suggest that Disease surveillance should have a distinct subheading. Is disease surveillance a third approach? The statement on page 4 that "Existing disease surveillance systems are designed for early detection of waterborne disease outbreaks after they have occurred, not as preventive warning systems." Is correct but they are used to limit the size and persistence of outbreaks. • Page 4: "This contrasts with low income settings where waterborne diseases are common and endemic disease is measurable." Agreed that endemic disease can be measurable but surveillance systems in low income settings are typically inadequate. • Page 4: "Most waterborne disease outbreaks occur in water supplies that were not previously reported to have had waterborne. Disease outbreaks at those locations, but sometimes multiple outbreaks may occur at the same location over several years." Suggest rewording to improve clarity (or deleting). • Page 5: "It has long been suspected that endemic waterborne illness not associated with outbreaks (redundant) is an important but unrecognized risk (Frost et al. 1996) but is difficult to quantify because background cases of community gastroenteritis are too low". Background gastro is not particularly low. • Page 5: "Periods of hyper-endemic community disease or even short-lived hidden outbreaks may also occur and these too can still be below the formal outbreak levels that are detected by the health surveillance systems." Not sure that the term "hyper-endemic" is being used correctly (persistent/consistently high levels of endemic disease). Also not sure what is meant by "formal outbreak levels". The point is that a waterborne disease outbreak may not be detectable from the normal variation of community gastro frequencies.
		2	The approach described in the Technical Appendix to derive LRVs is supported. The only questions are the use of: • • maximum E.coli results rather than more traditional 90th or 95th%iles for determining source water categories. • • the single range of E.coli from 20-2000 per 100 mL for Categories 2 and 3 while two LRVs are provided for reference pathogens, protozoa and bacteria (is the gradation of Campylobacter concentrations different to E.coli?). Dividing E.coli concentrations in band 2 into two ranges of 20-200 and 200-2000 per 100mL

#	Organisation	Q	Comments Received
			seems more logical. This would be consistent with the statement on page 8 that peak concentrations of pathogens increase with increasing average E.coli concentrations. If it is decided to retain the single range suggest that a justification should be included.
		3	The introduction of HBTs represents a substantial change to the ADWG with large implications to how drinking water utilities operate and health agencies regulate. There will be some nervousness about the practical application and adoption of HBTs and while large utilities will have expertise to do this many medium and smaller utilities will not and will need help. Some of this will need to be provided by external sources but in places the presentation of HBTs could be made more user friendly. The existing content is very sparse and provides little supporting information. Such information could be particularly useful to operators of smaller drinking water supplies. There are three practical issues that may cause concern or present roadblocks: 1. the overall implementation/application of HBTs 2. use of Table 5.2 3. Validation Implementation The ADWG has traditionally focussed on "what to do" rather than "how to do". A similar approach has also been adopted in other guideline documents such as the Australian Guidelines for Water Recycling and is strongly supported as attempting to address both would lead to impossibly long documents (or set of documents). In addition there is a sound argument that descriptive "how to do" guidance should be developed by practitioners with hands on experience of operating or regulating drinking water systems. The latter has usually been taken up by others through preparation of guidance documents. Having said all of that cross-referencing of available guidance documents, where appropriate, is useful to users of the ADWG to link "what to do" with "how to do" elements. In this case a manual has been prepared by WSAA to support implementation of HBT, it is being used by a range of drinking water utilities and is in the public domain. One of the major contributors to the WSAA Manual was also an earlier contributor to the development of the HBT text and not surprisingly there is much common ground between the two documents such as the vulnerability assessment, the microbial indicator assessment and various category and band definitions. There are some differences with the principal one being the recalculation of log reduction targets in the ADWG. However, these do not change the mechanics of conducting system assessments. It is suggested that cross referencing could be included to sections of the WSAA Manual that deal with practical implementation of various components such as the vulnerability assessment which is currently presented as a fairly bare-bones summary in Table 5.2. Table 5.2 In addition to providing cross-referencing as discussed above it is suggested that a slightly broader discussion could be included to support Table 5.2 with particular reference to supporting flexible application within the categories. The Table should not be presented as being overly prescriptive. It should be noted that interpretation and application of Table 5.2 will require expert knowledge and use of scientific judgement. In some cases consultation with health authorities and regulators will be required. In some circumstances there may be other activities that need to be considered and assessed. Validation The concept of validation can cause confusion (and concern) and is likely to be a big issue. It is suggested: • that a definition needs to be included together with an explanation of the difference between achievable and validated LRVs. • the different mechanisms for achieving validation should be discussed e.g. use of published data (dual media etc), certification against established protocols (membranes, UV etc) and field testing (pilot plants or pre-commissioning). Given the technical nature of this discussion the details could best be placed in the Technical Appendix with a short summary placed in Chapter 5. • might want to discuss assessment of established versus greenfield sites • cross-references to Element 9 of the Framework and Chapt 9.8 be included.
		4a	Generally reasonable. Limited comments are provided. "The potential for the source water to be contaminated ….should be assessed". Probably best to assume except for Burkholderia which is geographically limited that all of the other organisms in Table 5.8 are present but typically in concentrations that are too low to represent a health concern (e.g. in SA N.fowleri has rarely been detected in River Murray water but all SA systems contaminated with Naegleria have the River Murray as a source (part or whole)). Page 27: In-premise plumbing systems. These systems can create conditions conducive for growth and survival of Legionella, mycobacteria and Pseudomonas.
		4b	Generally reasonable. Limited comments provided. Page 27: Blue green algae are similar to green algae in habitat and photosynthetic ability but less so for morphology. Rather than "plant nutrients" might be better to state "phosphorus and to a lesser extent nitrogen". Table 5.9 Suggest identifying symptoms for saxitoxins to be consistent with those listed for the other toxins. Page 28: Suggest referencing the Pilotto, Hobson Burch et al Aust NZ J Public Health 28: 220-4: 2004 on skin rashes (11-15% of subjects not reacting to negative controls).

#	Organisation	Q	Comments Received
		4c	Generally reasonable. Limited comments provided In the 5th paragraph could be worth noting that iron bacteria can also be responsible for deposits in groundwater leading to loss of flow and performance of bores. Aged activated carbon filters also provide a good substrate for fungi. 5.7.1 Should iron bacteria be included in this section. 5.7.4 Do iron and sulfur bacteria cause biodeterioration of plastic and rubber compounds etc?
		5	A2 Suggest rewording/combining these 2 sentences "The concentration of reference pathogens in source water is quantified and then based on water consumption volume and health impact data i.e burden of disease (infectivity, morbidity, mortality and disability-adjusted life year (DALY) weightings). The critical pathogen reduction level (as an LRV) is determined in order to meet the health outcome target." A4 Paragraph 1: might be worth indicating that there is insufficient data to calculate LRVs for all enteric pathogens Paragraph 2: is it worth noting that the cause of the outbreaks i.e Salmonella and Campylobacter in the drinking water outbreaks and Cryptosporidium in the swimming pools outbreaks were influenced by the source/characteristics of the water? Protozoa: could be worth noting that Giardia (and giardiasis) is more common than Cryptosporidium. Bacteria: suggest noting that Campylobacter is the leading cause of bacterial mediated GI disease and is responsible for the highest disease burden of any of the enteric pathogens (per Gibney et al 2014) Table A4: suggest adding a note to explain the differences in Adenovirus and Campylobacter concentrations for Categories 2 and 3. Existing note** indicates that the concentrations were calculated from the E.coli concentrations but they are the same for categories 2 and 3 (see related comment on Table 5.6) A5: The choice of 1064 mL for drinking water consumption is interesting. It is the average for all Australians including children. If use of an average volume is retained (see comment below) it might have been better to choose 1114 mL as the average adult exposure. In addition, was the use of a more conservative 90th or 95th%ile considered? Australian data published in the enHealth Australian Exposure Factor Guide indicates that the 95th%ile consumption is in excess of 2L per day for an adult. This is consistent with data from the US which showed that the mean adult consumption was 1.2L per day with a 90th%ile of 2.3L/day and a 95th%ile of 2.8 L/day. Metrics used by other national agencies (50th, 90th or 95th%ile) could be included to justify the choice used here. On a related issue whatever volume is used here should also be included in Chapter 6.3.3 (currently cites 2L). Future chemical guideline values should use the new volume. Box A.3 Could have been useful to show calculation of one of the values used in constructing Table A.8.
		6	Style and target audience: The general content of Chapter 5 is reasonable, but the style is inconsistent with the remainder of the Guidelines. In an effort to keep the text sharp and focused the Chapter seems to take a fairly academic approach. Other Chapters tend to present material more in the context of risks and issues of relevance for drinking water suppliers and health regulators. The introduction is very brief and perhaps surprisingly does not discuss the importance of microbiological water quality or the fact that the Chapter deals with how to produce microbially safe drinking water based on use of HBTs. This is a key component of the Chapter and should be introduced in Section 5.1. In the same vein, the introduction of the groups of microorganisms in Section 5.2 reads a bit like a text book. Not sure that the target audience will be greatly concerned about whether bacteria are unicellular micro-organisms and whether viruses are made-up of core nucleic acid (RNA or DNA) surrounded by a protein coat and in some cases a lipoprotein envelope etc? The current version of Chapter 5 is more descriptive and includes a stronger focus on organisms of interest/concern. Not certain that the new format and style meets the needs of the target audience. Suggest that this is reviewed. Suggest that the structure of Chapter 5 be reviewed. The current order is Section 5.2 description of micro-organisms followed by 5.3 risk assessment and then 5.4 which starts with a description of enteric microorganisms and then moves to risk assessment. The flow of this text is a little awkward (i.e., description, risk assessment, description, risk assessment). Perhaps the first half of Section 5.4 could follow 5.2 with Section 5.3 and the last half of Section 5.4 (e.g. 5.4.3) being combined. Alternatively, the description of micro-organisms including enterics (5.4.1 and 5.4.2), opportunistic (5.5), cyanobacteria (5.6) and nuisance organisms could form the first half of the Chapter followed by the discussion of risk management and HBTs. There are a number of examples where names of micro-organisms do not start with a capital letter and different conventions have been used for generic descriptors e.g. Cryptosporidium, Cryptosporidium spp. and Campylobacter sp. Suggest choosing one. There are also some typographical errors that should be checked/corrected e.g. on page 2: "The major helminth (worm parasites of humans listed by the World Health Organis(z)ation as being transmitted by water is(are) Dracunculus (WHO 2017)". Could be worth noting that WHO describes other helminths that could plausibly be transmitted by water. Specific comments: Section 5.2: Under viruses it could be useful to add a brief explanation of why "an agglomeration of different virus characteristics" is used (or at least add a cross-reference to A4). The discussion of Enteric pathogens and Opportunistic Pathogens both include summary guidance on management but similar guidance is not provided for cyanobacteria. Need to be consistent. Suggest deleting the management advice which is dealt with in more detail later in the Chapter. If retained here the advice on management of opportunistic pathogens should be revised to include discussion of avoiding stagnation etc.

#	Organisation	Q	Comments Received
			Section 5.4: Table 5.1: IBS, GB syndrome, HUS should be written in full. There is an inconsistency in describing organisms e.g Cryptosporidium spp, Giardia lamblia Section 5.4.2. Shouldn't the Framework also reduce endemic waterborne disease? Section 5.4.2.1. "Failure of faecal storage facilities, such as effluent storage ponds, may lead to high levels of discharge of enteric pathogens from land-based sources even outside of rain events" Faecal storage ponds are often designed to discharge wastewater after limited pathogen reduction. Suggest the following edit "In contrast, most health risks from chemicals are from chronic exposure above guideline values" (some chemicals such as copper cause acute impacts). The following sentence about arsenic needs to bring in fluctuations in concentrations in comparison to guideline values. It doesn't matter if there are fluctuations that never exceed the guideline. "the presence of pathogens and peak concentrations increase with increasing average *E. coli* concentrations". This has not been shown consistently (a reference to support the statement would be useful). Does it apply to all pathogens? "Limited published and extensive unpublished (often confidential utility-held) data" suggest deleting the words in brackets; they are not required. Suggest deleting the reference to confidential data elsewhere e.g Table A.3. Box 5.1 "the relevant party". I understand the need for a general term as not all States have formal health regulators but not sure that this is the term. Perhaps "drinking water regulator or health authority" with a footnote indicating whichever is appropriate. Could also note that the regulator and health authority can be different agencies (e.g. Qld). Box 5.1 suggest moving the sentence "Hence there is an important longer-term incentive to improve system understanding through microbial faecal indicator (E. coli) testing and better source water characterisation." to the end of the following paragraph. Vulnerability assessment: not clear why source water vulnerability categories are preliminary (page 9: paragraph 2). Table 5.2: Vulnerability Category 1. Under typical characteristics there doesn't seem to be any consideration of contamination of small animals and birds contaminating raw water storages. Under intensity of activity, controlling feral animals is a good aim but is it practical for all types e.g. rabbits. Vulnerability Category 2. Not sure what is meant by "low intensity recreation". Suggest adding a definition. What is the scientific basis for choosing 1GL as the critical volume for a storage reservoir? While "low density rural developments with well managed on-site sewage management systems." Is a laudable goal well-managed on-site systems are not the norm. Suggest rewording the discussion of water catchment areas. Category1 is essentially free from humans or ruminant livestock while category 2 allows for minor sources i.e. they are different (as opposed to being not dissimilar). Vulnerability Category 3. Suggest defining what is meant by "itinerant human habitation" and "planning overlays and other planning controls", Vulnerability Category 4. Suggest defining what is meant "intense land-based recreation" and the scope of "water-based recreation" (e.g. does it include secondary contact and/or primary contact?). The discussion of the Phase 2 Australian Guidelines for Water Recycling is likely to add confusion without any clear benefit. ii) Microbial indicator assessment. Should Table 9.4 (which is on testing of drinking water) be replaced with Table 9.2? The use of the maximum result is questioned. Environmental sampling results are notoriously variable and one outlier in 100 results could have very large impacts on categorization and hence treatment (and cost) requirements. Table 5.3. Suggest reversing the order of the last 2 columns Box 5.2 Last 2 sentences. The old common MF based test for *E. coli* only required one more step than the test for thermotolerant coliforms and it did not delay production of results by more than a few minutes but the reagents were problematic. Confirming source water category: Table 5.4. the footnote should probably state that an anomalous E. coli result means classification as a category 4. On page 17 it could be useful to explain how typing can show that a bloom is present i.e. evidence of single/limited species or previously identified environmental bloom species. Not clear how serial dilutions of source water and use of MF can be used to distinguish between blooms and sanitary *E. coli*. Suggest deleting the last sentence about using non-standard media. 5.4.2.2 Groundwater This section is a challenging read and in a different style from surrounding text. Suggest editing. It is also highly conservative. Validation of pathogen removal by aquifer treatment requires expensive case by case analysis (as described in the module on MAR in the Australian Guidelines for Water Recycling). Based on this groundwater will have very conservative vulnerability categories. How far away are recharging surface water catchments for groundwater bores used in central-west Australia? What role does 10-20 or more years of *E. coli* testing play in assessments? How is it proposed that small groundwater based drinking water supplies in remote parts of Australia (for example) meant to undertake these assessments? If they do not have the resources what will be the implication in terms of treatment and operation of schemes? 5.4.3.2 Treatment targets The description of treatment technologies on page 20 is close to specified technology per the GDWQ. Is it worth discussing this? In any event suggest adding further discussion (more than currently provided in paragraph 3) on supporting flexible approaches to treatment providing they can be demonstrated to meet required LRVs (could cross-reference to the technical Appendix). There is a little inconsistency in the description of disinfection in the 4 categories; category 1 includes chloroamination but the remaining three don't. On page 20 in paragraph 2 suggest rewording the bracketed words to: e.g. whether Cryptosporidium may represent a high enough risk to warrant filtration and/or UV barrier rather than merely a chlorination barrier. Page 20 paragraph 3. The discussion gets a little confusing: • It isn't completely clear whether the 4 treatment categories align with the 4 source water categories. This should be made clarified/strengthened. • Not sure that the sixth guiding principle deals with conservatism. • Also not sure that

#	Organisation	Q	Comments Received
			the conservative approach to applying categories needs to be repeated here. It is dealt with earlier. This section should focus on a description of treatment and treatment targets Should the order of the discussion be changed? The title of the Subsection is treatment targets yet the section commences with a discussion of treatment and doesn't introduce targets until paragraph 4 on page 20. Suggest that this could lead the discussion. Paragraph 5. Suggest removing this paragraph as the main points are covered in Technical Appendix A9. There is some additional information in this paragraph e.g. the international context but this could be incorporated into A9. The two references by Swaffer et al showing infectivity rates could be cited (Water Research 67:310-320:2014 and Water Research 138: 282-292: 2018); could also briefly discuss King et al (AEM 83 e03068-16: 2017) Page 21. Although unlikely given the conservatism of the default HBT approach should the possibility that pathogen data indicates a higher level of risk than the default be considered? The text "whether a lower category is sufficient to achieve safety" includes a disconnect. The point should be whether a lower category is sufficient to describe source water risks/vulnerability and whether lower treatment targets are sufficient to achieve safety. Water safety continuum The continuum provides more flexibility than just dealing with short term exceedances. The description that it forms the basis for short medium and long term improvement plans infers that exccedances may be for short, medium or longer terms. This is consistent with earlier versions of the draft HBT text. The continuum should also allow for flexible responses by regulators i.e. when would public notification be required? Based on Fig 5.2 and Box 5.5 notification would be required if DALYs were above 10-4 per person per year (the unsafe zone) but regulators will probably want to enter into discussions with drinking water suppliers at lower DALYs. This is an important issue and it could be useful to add a sentence or two in the 2nd paragraph of this section. It could also be useful to include discussion of consultation with the community in terms of willingness to pay to upgrade systems. Page 23. Agree strongly with the last sentence of paragraph 3. Could this be strengthened as it is a key point? Figure 5.3. I can understand why this was shown in this way as a linear-log presentation but when I looked at it my immediate thoughts (on face value) were that: • The reduction in case numbers from 10-5 to 10-6 DALYs is tiny and there seems little point in advancing from 10-5 to 10-6 DALYs pppy • Bacterial pathogens are almost a non-event I know that both of these are misperceptions but nonexperts may not. Suggest some discussion could be added to deal with these potential interpretations e.g. bringing in burden of disease per case to explain the Campylobacter curve. Box 5.5 "Supplies that meet the benchmark are also likely to have (but won't necessarily have) sufficient treatment barriers in place such that short-term small magnitude adverse changes in raw water quality, or short-term minor increases in source water challenge, will not pose a significant risk to consumers." Not clear of the value of the bracketed words. Assessment that a plant will achieve 10-6DALYs as an annualised average target should be a conservative judgement including use of 95th%iles in one or more calculations (e.g. pathogen challenge, validation). These should provide a buffer against impacts of short term small magnitude changes. Meeting the LRV target: In terms of the dot points on page 24. The second dot point is strictly correct but it could be read as meaning that all validation needs to be conducted on-site. The third dot point is misleading as validation of a process only applies to defined water quality windows. If an upstream barrier performs poorly on a consistent basis this will impact validation. However, when failure is intermittent the overall validation process is not affected but validation will not apply during the period of poor performance as water quality will be outside of the defined range used in validation testing (and will typically represent failure to comply with a critical limit) Table 5.7 Instead of using the unpublished AGWR as a source could use the similar Table from the published WHO Potable Reuse text. The basis for chlorination validation is scientifically outdated. There are much better data from the studies of Keegan et al and SEQ Water. The results from these studies have been published in the WaterVal validation protocol for chlorine and cited in the both the draft AGWR and the WHO Potable Reuse text. 5.4.3.3 Management of the Distribution System. Reference WHO 2004 has been superseded by WHO Water Safety in Distribution Systems 2014 Table 5.5 Exposure pathway for Aeromonas more likely to be dermal/wound (per Pseudomonas). Exposure for Legionella includes aspiration as well as inhalation
4	Department of Health WA	1	General Chapter 5 demonstrates the significant degree of research put into developing a risk assessment approach based on health-based targets and microDALY's for illnesses attributable to water borne enteric pathogens. Nonetheless, the quantity of text in this section does give the impression that enteric pathogens are by far the most important microbiological hazard applicable to drinking water, to the extent that the limited attention paid to other water borne pathogens (particularly Naegleria Fowleri) implies they are of less significance, or of significance in only very specific and isolated circumstances. There is no doubt that enteric pathogens are very significant, but the lack of detail about other water borne microbiological hazards in chapter 5 relevant to Australia is of concern. There is also a clear emphasis in this Chapter on measuring or quantifying the risk from a catchment, and providing the necessary water treatment interventions to suit. There is however, not sufficient attention paid in this chapter to actually improving the catchment itself to mitigate the risk. From a public health protection perspective, it is always preferable to use high quality source waters with minimal risk to begin with to ensure the risk of community illness remains low, rather than use of lower quality sources with increased treatment / management and added potential for failure. Messaging on selection and protection of drinking water sources should be prominently established and reiterated in this chapter, as well as in earlier chapters, to ensure that the introduction of treatment based targets do not inadvertently

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			encourage an attitude of relaxing source protection in lieu of increased treatment. Health based targets This draft Chapter 5 (and the technical Appendix) refers to health based targets of 1 microDALY pppy, various treatment targets and log reduction value targets, but it notably DOES NOT make any recommendations of the form that can be seen as ADWG outcomes, or seen as being parallel to health-related guideline values or any other performance measure. The language skirts around it, and implies that these are desirable targets, but there is no direct statement (in a box or elsewhere) that meeting a particular microDALY or log reduction target is a key ADWG recommendation. It should also be noted that the term DALY or microDALY appears nowhere else in ADWG (and notably not in Chapter 10). This means that there is no information in ADWG, either in this Chapter 5 or elsewhere in ADWG, to indicate whether health based targets of 1 microDALY pppy, various treatment targets and log reduction value targets are actually ADWG recommendations or guideline values or a performance measure, or just terms used as part of a recommended calculation process. This is important because if there is no indication in Chapter 5 that health based targets of 1 microDALY pppy, various treatment targets and log reduction value targets are actually ADWG recommendations or guideline values or a performance measure, then there is simply no need for any regulator that is not a health authority to get involved in this subject. A regulator with its regulatory hat on (be it a health authority or what appears to be described as an "other regulator") will normally be entitled to focus on the performance indicators set out in Chapter 10. There is no linkage provided between Chapter 5 and Chapter 10, nor is there any indication in Chapter 10 that Chapter 10 is inadequate for not referring to DALY's. It is recommended that the draft of Chapter 5 set out clearly whether meeting a particular target is or is not an ADWG requirement or recommendation for a water supply to be considered safe. (NB – burying information similar to this in one sentence in Box 5.5, without attribution, is not adequate clarity for this purpose.)
		2	Figure A.2 shows that one of the "*Model inputs and assumptions*" into the QMRA framework applied to quantify log reduction values for drinking water treatment is the "consumption volume of unheated water per person per day", with this concept expanded on in section A5. The text in section A5 does not explain or justify what this metric actually means or, more significantly, why this metric has been introduced into ADWG, a document which otherwise is based around the assumed total consumption of two litres per person per day. Whilst Figure A.2 is cited as being drawn from WHO 2016, it should be noted that Figure 9.1 of WHO 2016 does not explain what "unheated water" is, nor does any of the surrounding text elsewhere in WHO 2016 either. As a guess, the draft is referring to water that has not been boiled (common in some tropical countries for disinfection purposes, but hardly used in Australia) or used in cooking, or otherwise heated in the production of hot drinks such tea or coffee. But that is a guess. Detailed information needs to be set out here as to: • what "unheated water" is; • where this term has previously been used in the literature, with a citation that explains its origin (noting that the WHO 2016 citation does not do so) • why it is assumed to be one litre per person per day; • how numerically sensitive the QMRA log reduction values are to changes in this estimate (e.g. what would the log reduction value be if the unheated water consumption was significantly greater than one litre per person per day, as implied by the statement that unheated water consumption "may be higher in tropical and arid regions of Australia"). Given that it is acknowledged that it "may be higher in tropical and arid regions of Australia", and given that tropical and arid regions of Australia represent the vast majority of the continent, and also where the vast majority of small water supplies in this country are located, and given the significant level of scientific rigour applied elsewhere in this chapter, this appears to be very lax, to the point where a range of "unheated water" values around Australia's climate zones consumption will be needed for ADWG if ADWG is to meaningfully pursue this construct. It is not adequate for ADWG to simply introduce a health based targets approach and then state that "local circumstances should be discussed with the relevant party (e.g. a health authority or other regulator) and calculated on a case by case basis when implementing the microbial HBT", without providing a reasonable level of detail of mathematical and epidemiological advice for health authorities or water suppliers as to how those case by case approaches in tropical and arid regions should proceed.
		3	There are five main general difficulties, but none of these are insurmountable and should be able to be addressed by text in a revised chapter 5: The first difficulty is ensuring, as best as possible, that the methodology and treatment targets are not used to derive perverse outcomes, from the point of view of protecting public health, by downgrading an already highly protected water supply system or water supply catchment to a lower level of protection, on the basis of a mathematical model employed and recommend by ADWG. For example, the QMRA approach runs the risk of being used by parties to justify further access to recreational activities in water catchments or on water storage reservoirs themselves, where there already is enough water treatment to address the log reduction requirements. The second difficulty is that the focus on enteric pathogens from the catchment source in effect sidesteps the importance of risk from *Naegleria fowleri* in drinking water supplies. Managing risk from *Naegleria fowleri* (via managing thermophilic *Naegleria*) is often the governing determinant for water treatment technologies and distribution system residual management in WA. Focussing on enteric pathogens exclusively runs the risk of taking eyes off an equally important target of water safety as far as thermophilic *Naegleria* is concerned. Enteric pathogens are for the most part unable to replicate in the storage and

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			distribution systems, so applying the necessary log reductions at a particular point of the journey of the water is usually sufficient. This model does not apply to *Naegleria, Legionella*, cyanobacteria, *Pseudomonas, Aeromonas* and some others. A different paradigm of control is required for these replicating organisms. The third main difficulty is that chlorination is mentioned in Table 5.6, but that is really putting the water treatment plant cart before the conceptual horse. It should really be about disinfection with suitable C.t values, not "chlorination" specifically and certainly not without indicative chlorine residuals mentioned. Stating in the heading that these are "indicative" does not resolve this issue, the fact remains that a specific disinfection technology has been listed and others that are frequently used in Australia have not. In particular, large areas of WA rely on chloramination, some rely on UV disinfection, and there are significant numbers of reverse osmosis systems, none of which are mentioned in this table (in this regard suggest this may be solved by clarifying linkages between Table 5.6 and Table 5.7). The fourth difficulty is how such targets would be introduced for, or what they would mean for, smaller or remote community drinking water supplies, or how the epidemiological analysis and data gathering required would be carried out. Finally, the fifth difficulty is in ensuring that the concept of DALY's or microDALY's applied to risks of the supply of drinking water to aged care facilities does not yield perverse outcomes given that most of the recipients are likely to be over the age of 75 and thus any statistic derived from microDALY's may be less likely to value safety of drinking water at this age group. As mentioned above, none of these are insurmountable, but advice to counter these perceptions would be very useful in ADWG, and Chapter 5 is clearly the best place for it.
		4a	Noting the consultation cover statement that "Sections on enteric and opportunistic pathogens, cyanobacteria and nuisance organisms have also been updated", in summary these sections are either unchanged or have been simplified, which is not what is expected when the changes are described by the cover statement as an "update". The main deficiency in the new chapter 5 is that its focus on enteric pathogens seems to be at the expense of thermophilic *Naegleria*. It is difficult to see how an approach based on DALY's and microDALY's, in which 0 is perfect health and 1 is dead, can so comprehensively ignore a real risk in Australia of something that has an approximately 97% fatality rate, particularly of younger people, albeit being rare. *N. fowleri* in piped water systems has caused documented deaths in WA, SA, Arizona and Louisiana, with concerns now being expressed in Pakistan. A suspected death long ago in NSW was never conceded by the authorities. Recent cases of deaths from drinking water in Queensland have been from homestead bores, not piped supplies. The problem though, is that in any given year, or even decade, the incidence will most likely be zero. This problem appears to have its genesis in Section 5.2, where, compared to the original text in the extant section 5.3 of ADWG, it removes a large section of text about free-living amoeba, including the key paragraph of: "Cerebral infection by *Naegleria fowleri* is strictly waterborne and, although rare, is usually fatal. Since these amoebae are able to colonise piped water supplies, disinfection at the water source may not adequately control them unless the disinfectant pervades the whole distribution system." Thus the new draft of Chapter 5 has removed key information from ADWG that infection by *Naegleria fowleri* is waterborne and usually fatal, significantly downgrading the significance of controlling this organism in Australia. There is not sufficient information presented in the new section 5.5 to give the reader any clue that some of these opportunistic pathogens pose significant risks to human health, beyond identifying that these opportunistic pathogens are "of concern". For example, there is no information provided in or under Table 5.8 that PAM is usually fatal, especially for children. As with the comments on section 5.6 below, this scant level of detail (barely one page of under 400 words) sits uneasily with the lavish detail in section 5.4 about enteric pathogens (22 pages and 6600 words) and thus further gives the impression that managing these organisms, especially *Naegleria fowleri*, is not important relative to managing enteric pathogens. In particular, the statement in section 5.2 of: "Some pathogens that cause infections of the respiratory system, skin, eyes or other organ systems can theoretically be spread via drinking water. In practice the processes for managing enteric pathogen risks will incidentally control these pathogens as long as residual disinfection is maintained. Therefore these pathogens are not discussed further." … does not read like an adequate reason to not discuss significant opportunistic pathogens further, and in any case appears to be contradicted by the existence of section 5.5. Including the word "theoretically" in the statement that these pathogens "can theoretically be spread via drinking water" implies that this might only occur theoretically, but does not actually happen in real world scenarios, further downgrading their significance. The word "theoretically" must be deleted. Further, the above sentence is wrong in relation to residual disinfection that controls enteric pathogens being adequate to control amoeba. In many cases a free chlorine residual of 0.2 to 0.3 mg/L may well be adequate for a residual in the distribution to control E. coli, whereas for control of *Naegleria* a significantly greater minimum free chlorine residual of 0.5 to 1 mg/L is required. A redraft is required. This is particularly problematic because, if the new redraft is adopted, ADWG will have a Chapter 5 on Microbial Quality of Drinking Water that barely mentions *Naegleria,* which means that suddenly in Chapter 10 (Monitoring for specific characteristics in drinking water) the significant detail about *Naegleria*, how it can be controlled and suggested response mechanisms in that Chapter (extant pages 163 and 164 of ADWG) suddenly appears out of context and out of nowhere. The solution to this is to incorporate into Chapter 5 a level of detail about QMRA for *Naegleria fowleri* that is at least the equal of the level of detail (in terms of amount of text, tables and Figures, significant conclusions and epidemiological rigour) given to enteric pathogens. If this was

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			to proceed, the authors are referred to a conservative QMRA for N. fowleri in recreational waters in 2001, and it is now posted on Academia at: www.academia.edu/24352862/HEALTH_IMPACT_ASSESSMENT_OF_PATHOGENIC_NAEGLERIA_AT_A_CABLE_WATER_SKI_PARK_IN_PERTH_WESTERN_AUSTRALIA It is based on an amount of water of 10 mL entering the nose in a single episode of exposure of someone immersed in water. Whether this is a realistic estimate for the various household uses (other than ingestion) of drinking water is of course another matter. But some sort of estimate of that would be essential in carrying out a QMRA for *N. fowleri* in drinking water. Reference should also be made to: Miller H C et al, "Elimination of *Naegleria fowleri* from bulk water and biofilm in an operational drinking water distribution system", Water Research 110 (2017) 15-26, 2016, available from: http://www.sciencedirect.com/science/article/pii/S0043135416309125 As background information, please note a table below of typical water temperatures in remote WA where most of the water supplied is ground water with generally high temperatures Water temperature in degrees Celsius: Region of WA Average Range Kimberley 31.6 25 - 37.4 Pilbara 31.5 24.5 - 36.8 Goldfields 25.5 21 - 31 As an aside, in hot areas of WA, many adults routinely drink well over two litres per day, and this is not in the form of tea or coffee or other boiled beverages, it is ordinary water from the tap. A number of remote outdoor work places also recommend that up to 10 litres consumption per day is desirable for OHS reasons. In this context two litres may well be an underestimation of the exposure for that cohort. This means that any QMRA approach for an authoritative Australian guideline document should discuss in more detail the scenarios of water temperatures being around 30 C and significantly more than one litre per person per day of so-called "unheated water" being consumed.
		4b	Section 5.1 states that: "The principles and approach for assessing the contamination of source waters and management of those risks are set out in sections 5.4, 5.5 and 5.6." There is however nothing in section 5.6 (cyanobacteria) that matches this description about risk management, beyond an elementary listing of cyanobacteria and their behaviour. (Noting that the above sentence is somewhat misleading, insofar as section 5.4 devotes over 22 pages of detailed text and Tables to its subject, but 5.5 and 5.6 get barely one page each, with no significant new information of any kind in section 5.6.) Having established cyanobacteria as a source of risk in certain circumstances, section 5.6 needs to then include information setting out what the mitigation strategies and water treatment processes are that can effectively deal with blooms, or at least point to where this information can be found in Australian published research papers (e.g WaterRA papers), in a manner that brings in the concepts of QMRA that are applied to enteric pathogens. If it is not possible to develop a QMRA approach for cyanobacteria, then an alternative process needs to be set out. As a guide, it should be noted that the section 5.7 on nuisance organisms contains some of this information, making its absence from section 5.6 on cyanobacteria more conspicuous.
		4c	This section appears to be substantially unchanged from the extant Chapter 5, however section 5.5.6 of the extant Chapter 5 of ADWG (Nuisance invertebrates) appears to have been dropped. If there is a reason for dropping the extant section 5.5.6 then that should be indicated. Otherwise there appears to be no benefit in dropping the section on Nuisance invertebrates and thus it should be retained. Section 5.7.1 frequently utilises the term "symbiont". It is recommended that the opportunity be taken to redraft these sentences to make it clear, in simpler terms, what this means (in particular, clarifying what "While the mechanism of symbiont contribution to odours in waters is unknown" actually means.), or to provide a definition of "symbiont" that is useful for the typical reader of ADWG.
		5	There are a number of comments provided on the Appendix text, as below. Unheated water Please refer to comments above in relation to Question 2 about the need for explanation around the introduction of the concept of "unheated water". Risk assessment methodology One thing that comes through clearly in the technical appendix is that this methodology is very sophisticated and is very sensitive to the accuracy of the data inputs. This is of course unsurprising, as that applies to most methodologies, but most of the text in the technical appendix then casts doubt on the quality of relevant Australian data available, and emphasises the level of necessary assumptions made by the authors in their calculations throughout the appendix, to the point where it looks like the poor quality of the available data is casting significant doubt on the validity of this methodology to the real nature of Australian catchments. (For example, section A5 states "Unfortunately, no published data on concentrations of bacterial or viral agents in Australian surface waters have been identified for inclusion in this analysis".) That is, the outcomes generated under this approach appear to provide more insight into the nature of the assumptions made by the epidemiologists doing the work, than a new insight into the nature of risk from drinking water catchments in Australia. It would be useful to add a section that basically states that in order to proceed down the QMRA pathway to get an insight into source risk, one needs a certain minimum standard of real world data applicable to that catchment (and define what that standard of data is) to start with, and until that data is available, or if that data is not likely to be available, then different empirical risk assessment methods may yield better outcomes.

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			Giardia and Cryptosporidium In relation to Giardia, section A4 states that: "Cryptosporidium is selected as the reference protozoan due to its resistance to chlorine disinfection, high infectivity, and the relatively large amount of data available for characterisation." However, Table A.1 and Table A.2 appear to give equal weight to Giardia and Cryptosporidium. It is suggested that section A4 provide more detail as to why Giardia was not designated as a reference pathogen. (Note that the heading for Table A.2 refers to it being about reported concentrations of reference pathogens.) Research Section A5 states: "Water utilities may hold data, but this is not generally available for analysis by third parties. Water utilities are strongly encouraged to publish existing data, which would improve the accuracy of QMRA for drinking water in future revisions." This plea by the authors reads like a conclusion in a published paper and sits uneasily in the context of being text within ADWG published by the NHMRC and deletion is suggested. The first sentence is mere speculation. The second sentence should provide information or advice provided to water utilities as to how to do this. Section numbering The Technical Appendix appears to have two section A5's: Page 6 - A5. Level of reference pathogen contamination in Australian source waters Page 9 - A5. Consumption volume of unheated water per person per day Section A3. This section states: "It is not possible to achieve zero health risk from the consumption of treated drinking water. Rather, a tolerable risk needs to be set as a health outcome target that can be considered to represent a target of safety." Elsewhere, ADWG does not use language such as tolerable risk, with the use of language in Chapter 3 and the 12 element framework being about "acceptable levels" of risk. Suggest that consistent terminology be applied throughout this new text to align it with the main language in chapter 3, thereby replacing "tolerable" with "acceptable" or "acceptable level of" in this sentence. Section A.9. Interpretation of calculated LRVs for practical treatment guidance This section states: "It may be that in certain situations even greater reduction would be appropriate (e.g. high ambient temperatures, long travel time of oocysts). In this situation the case to further reduce the LRV should be made directly to the relevant party (e.g. a health authority or other regulator)." This referral is not supported in the way it is written. This Appendix is the place for further technical detail as to what these situations are, why greater reduction would be appropriate, how such a case would be made, and advice should be provided in this section of ADWG to advise "the relevant party" on how to proceed here. Please note that, in practical terms, any "other regulator" that is not a health authority is not likely to have the public health or epidemiological knowledge to interpret such a case, so referring the case to a regulator in the absence of scientific advice or guidance to the regulator is a meaningless statement for ADWG to make. There is thus no reason for a regulator that is not a health authority to even become involved in any of this. If the other regulator is a health authority, then there is no criteria presented in ADWG that the health authority can use to determine if the case does or does not comply with ADWG. In light of the stated purpose of the technical appendix being to "provide full details of how the treatment targets were derived", this section should read: "It may be that in certain situations even greater reduction would be appropriate (e.g. high ambient temperatures, long travel time of oocysts).", then go on to provide about around two pages of detailed text and tables to guide water utilities and regulators through various plausible scenarios.
		6	Various – referrals The new draft of Chapter 5 makes seven references to referring to, discussing with or consulting with "the relevant party (e.g. a health authority or other regulator)". However, the clear context of Chapter 5 is about public health risk assessment, and in the main covers the disciplines of health risk management, epidemiology, statistics and QMRA. Notably, Chapter 5 does not cover matters such as customer acceptability, willingness to pay, financial or budgetary matters, rates and charges setting, supply of water to non-residential customers, abstraction volumes or licences, or asset management matters, all of which are of great interest to regulators that are not health authorities. In this light, referral to a "relevant party" that is NOT a health authority is puzzling in its purpose, as those entities do not cover the subject matter of Chapter 5. Nowhere else in ADWG is there such a stark referral to regulators that are not health authorities to implicitly make decisions about public health related matters, without guidance from ADWG as to how to do this. This draft is thus placing the onus on regulators that are not health authorities to make decisions about health-related matters. This is clearly inappropriate generally about public health risk management in Australia and also clearly inappropriate for a national guideline document about public health matters to encourage. It is recommended that ALL references in the new Chapter 5 and Technical Appendix to "the relevant party (e.g. a health authority or other regulator)" be reconsidered in the context of whether the matter in question is a public health matter or not and, if it is, which is usually the case in Chapter 5, then the only referral body should be a health authority, and even then with guidance. Section 5.2 The text in section 5.2 on bacteria, viruses, protozoa and helminths appears to be too simplistic when compared to the more detailed text in the extant Chapter 5.3 that has been jettisoned. It is recommended that the original section 5.3 be reviewed with a view to retaining it in the new chapter 5 unless there is a good reason to jettison it. For example, in the new section 5.2 there is a brief description of enteric protozoa, yet the entire set of paragraphs about free-living

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			protozoa from the extant Chapter 5 (page 72 of ADWG) is now missing. The new draft Chapter 5 MUST BE redrafted to recognise that *Naegleria fowleri* is waterborne, usually fatal to humans, and is a risk to drinking water quality safety in many parts of Australia. The text in section 5.2 also introduces new information about fungi. Whilst new information is always welcome in ADWG, this section states that: "Many of the fungi that have been isolated from treated drinking water are known to be pathogenic." And at the same time "Fungi are not considered a significant health risk in drinking water". These sentences are both within the one paragraph and appear contradictory, and unreferenced. It is recommended that this section on fungi be reviewed, with citation added to substantiate the claims made therein, in order to provide useful and practical information about fungi for water system managers. Box 5.1 – Small water supplies This box states (in part): "Where no E. coli water quality monitoring data are available, water sources should be allocated a conservative default category (category 4). If this selection is considered to be too conservative, the suitability of a less conservative category (3 or 2) should be demonstrated to the relevant party (e.g. a health authority or other regulator)." Direct allocation to category 4 merely on the basis of no historical E. coli water quality monitoring data is academically understandable, but is too onerous for small water supplies in Australia, many of which are in remote locations. The vulnerability assessment decision made by the water supplier into categories 1, 2, 3 or 4 based on Table 5.2 should be sufficient to proceed. Furthermore, this decision process by the water supplier should not automatically require ratification by a health authority or "other regulator". Recommend deletion of specific category numbers in the above para. Table 5.2 – heading Table 5.2 has a heading of "Vulnerability categories for drinking water sources". The context of the content of this table and its placement in section 5.4.2.1 means that it clearly relates to surface water sources. Suggest that for clarity the table heading is amended to "Vulnerability categories for drinking water sources for surface waters". This also means that Chapter 5 should have, in section 5.4.2.2, its own parallel Table of Vulnerability categories for drinking water sources for groundwater. Table 5.2 – Vulnerability assessment It is suggested that this Table 5.2, or the surrounding text, pay more attention to characteristics of catchments that are important yet ephemeral in nature. That is, catchment vulnerability should explore in more detail the behaviour of a catchment or vulnerability of a catchment to major environmental stresses, or "hazardous events" in the terminology of ADWG, such as sustained drought, intense bushfires destroying forest cover, intense rainfall events and their aftermath, including sustained overland flood events, many of which have the potential to mobilise microbiological hazards that are not otherwise an issue. Table 5.2 - inner catchment and outer catchment In relation to Table 5.2, this table introduces into ADWG the concept of the inner catchment and outer catchment. Whilst Table 5.2 uses these terms frequently, as if they are universally applicable to all catchments, it does not define the terms or explain them, apart from a remark in footnote 2 which of itself does not adequately explain what they are. Nor is there a glossary or definition of the concept of the inner catchment and outer catchment anywhere else in the 1200 or so pages of ADWG. Given that ADWG is a reference and authoritative document, please ensure that, if the concept of the "inner catchment" and "outer catchment" is central to Table 5.2 and thus to the new text of chapter 5, then a paragraph should be added to chapter 5 to explain what the inner catchment and outer catchment are, without the reader having to rely on prior external knowledge. For example, WA does not use the term "inner catchment", but uses the term "Reservoir protection zone", which means a buffer measured from the high water mark of a drinking water reservoir, inclusive of the reservoir (usually 2 kilometres). This is referred to as a prohibited zone under the WA Metropolitan Water Supply, Sewerage, and Drainage Act By-laws 1981. Thus it is suggested that the authors please verify that the terms "inner catchment" and "outer catchment" or suitable stated synonyms are in common use in every jurisdiction and regional area of Australia prior to inclusion unexplained in ADWG. Suggest the authors also, for example, explain how the concepts of the "inner catchment" and "outer catchment" apply to deep groundwater catchments (as there is no information in Table 5.2 to specifically state that they do not). Further, in relation to chemical contamination of groundwater, as covered in section 5.4.2.1, the current example text about arsenic levels appears to be overly dismissive. A statement acknowledging the significant levels of naturally occurring chemical contamination in some groundwater resources in Australia, and how these communities require significant treatment technology which will surpass any microbial-based treatment target, should be included, with a pointer to more detailed information in chapter 6 of ADWG. Please note that in some cases, especially in regional WA, the main health risk from drinking water from catchments can be chemical and also acute, in relation to naturally occurring high levels of nitrate in ground water. It is recommended that Chapter 5 is redrafted to acknowledge this. Table 5.2 – intensity of activity Table 5.2 provides a column about "Intensity of activity" that is designed to assist in allocating surface water catchments into vulnerability categories 1, 2, 3 or 4. However, when it comes to the aspects of "Human habitation", "Itinerant human activities" and "Stock animals", its sole advice is to subdivide this into "low", "moderate", and "high" (or "intense") levels or densities, for categories 2, 3 and 4 respectively. This categorisation is too vague to allow the reader to work out what the authors mean by "low", "moderate", and "high", so effectively provides no meaningful or quantifiable guidance. It is recommended that this part of the Table is redrafted to give the reader clearer advice as to how low is low, how moderate is moderate,

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			and how high is high, when it comes to densities of population, intensity of recreational activity, stocking densities on farms etc. For example, does "high population size and density" only refer to built up high rise inner areas of Sydney and Melbourne? Quite likely not, but advice would be appreciated. Medium population density from a capital city metropolitan perspective may be high density from a rural or regional water authority perspective. If it is not practicable to quantify these factors in this way, then their use as means to subdivide surface water catchments into categories 2, 3 and 4 is severely compromised to the point of being just guesswork by individuals. Table 5.2 – Protection measures Category 2 (moderately protected) catchments state: "Stock are fully fenced out of main feeder streams to the reservoir, and these streams are lined with vegetated buffer zones." Category 3 (poorly protected) and category 4 (unprotected) catchments both state: "Catchment management interventions include stream fencing, septic tank inspection and maintenance programs, stream frontage riparian buffers, planning overlays and other planning controls." All three of these catchment categories appear to have very similar criteria for stream fencing for stock, to the point where the criteria for categories 3 and 4 are identical. If this is intended so be it, but it is not clear how this criteria is useful if they are identical for categories 3 and 4 and very similar to category 2. Further, there appears to be no option for catchments where these features are absent. That is, what is the appropriate category for a catchment with NO stream fencing, NO septic tank inspection and maintenance programs, NO stream frontage riparian buffers, NO planning overlays or NO other planning controls? It is suggested that these criteria are reconsidered to ensure there is a meaningful difference between catchment categories in this Table. Section 5.4.2.1 (ii) Microbial indicator assessment (E. coli monitoring) This section opens with "Concentrations of the microbial indicator bacteria E. coli are measured at a raw water site representative of the inlet to the water treatment plant." The reason why it needs to specifically be measured from only one raw water site and specifically be "representative of the inlet to the water treatment plant" is not clear. Further down the page, it then states: "Source controls such as selective abstraction may need to be considered in discussion with the relevant party (e.g. a health authority or other regulator) as to whether event samples are used to set source category." This gives a very different message to "Concentrations of the microbial indicator bacteria E. coli are measured at a raw water site representative of the inlet to the water treatment plant." The context of this section is about data being representative of the condition or risks arising from the wider catchment, with sampling from or near the inlet to the water treatment plant merely a convenient way to measure this. It is entirely plausible that a clearer picture of catchment vulnerability would emerge by E. coli sampling at multiple sites, not just one. Further, measuring at a raw water site representative of the inlet to the water treatment plant does not allow for variation during the year when such a water treatment plant is turned off for seasonal reasons, for example when the raw water quality or raw water turbidity gets too bad. Thus sampling representative of the inlet to the water treatment plant may not give a true picture of the status of the catchment throughout the year, the aftermath of significant intense rain events or significant extended droughts when the catchment is not in use, or when that particular inlet to that water treatment plant is not in use. Suggest that this section be reviewed to clarify what message is being provided here. Table 5.3 and Table 5.4 These Tables posit a band of E. coli contamination of 20 to 2000, and one of 2001 to 20,000 E. coli per 100 mL. In terms of how results for E. coli are reported by analytical laboratories in Australia, is a reported result of "2001 E. coli per 100 mL" (being different to 2000 E. coli per 100 mL) actually plausible? Suggest that the third band does not commence with 2001 but commence with whatever is typically the next highest reporting number over 2000, which is usually defined by analytical laboratories in Australia as 2100 E. coli per 100 mL Section 5.4.3.2 – Treatment targets and Water Safety Continuum The section headed "Water Safety Continuum" refers to the health outcome target of 1 × 10-6 µDALY pppy. This looks like an error, insofar as the remainder of the Chapter refers to a health outcome target of 1 × 10-6 DALY pppy. Suggest review and deletion of the "µ" symbol after a 10-6. Box 5.5 states that if a drinking water supply achieves 10-6 DALYs pppy (1µDALY pppy) or less it is considered to be safe. The caveat "… from a microbiological point of view" (or similar words) needs to be added to the end of this sentence. NB – this is the only sentence in Chapter 5 that could be interpreted as a performance measure, yet it is buried within a Box – please refer to comments under Question 1 for why this is a significant problem. Section 5.4.3.2 states: "Only four categories are provided. Four categories may be considered insufficient for some unusual circumstances. However, it is not possible to nationally generalise additional categories." In the absence of any context or citation as to what its basis is, it is not self-evident why "it is not possible to nationally generalise additional categories". It is recommended that an explanation is provided as to why this is impossible. It is recommended that the new Chapter 5 include somewhere within its content (probably 5.4.2.2) a Box setting out a case study of what went wrong at Havelock North New Zealand (2016) in terms of errors in source protection, adequacy of treatment process and overall system risk management. Section 5.4.2.2 - Groundwater

#	Organisation	Q	Comments Received
			This section states that “Groundwater sources can become contaminated with enteric pathogens by a range of events including …leaky boreholes (resulting from a range of events).” Casually describing one of four water source failure modes as “leaky boreholes (resulting from a range of events)” is unacceptable in an authoritative Australian guideline document. This needs proper definition of “leaky”, whatever that means in this context, define “boreholes” that appear to be different to “bores” used elsewhere in ADWG, and set out what such “a range of events” may encompass, otherwise this text is too simplistic to be useful. This section also states: “If the water supply entity lacks the expertise and capability to reliably demonstrate such bore security then suitably qualified experts should be engaged.” This sentence is drafted too provocatively, especially given that water supply entity staff are the likely target audience of ADWG. This sentence (and the sentiment within it) is unnecessary and should be deleted. This section also states: “the performance of the aquifer in removing pathogens can be included as a treatment barrier for the purpose of risk mitigation if objective, credible scientific evidence can conclusively demonstrate and validate such performance.” If this is plausible, then typical log reduction credits should be able to be provided, but it is noted that the above sentence is written as a very high hurdle, and it remains unidentified how a “relevant party” would assess this. More generally, this section requires a Table of its own for vulnerability assessment for groundwater catchments, to parallel Table 5.2 for surface water catchments. Groundwater risk is essentially the extent of groundwater / surface interaction and a catchment assessment. To assess groundwater vulnerability there are two widely used models GOD and DRASTIC. The vulnerability assessment along with the catchment assessment will provide the groundwater risk category.
5	Central Highlands Region Water Corporation	1	No specific comments
		2	In our response, we refer to the WSAA Manual for the Application of Health Based Treatment Targets, Release No 2 (September 2015). 1. Treatment Targets Treatment targets for protozoa, bacteria and viruses in relation to the source water category classification are provided in Table 5.6. The basis for these Log Reduction Values (LRVs) is outlined in Appendix A and summarised in Section 5.4.3.2 – Treatment targets. These targets differ in a number of ways from the values provided in the WSAA HBT Manual as defined in Table 3 of Section 3.1.6 – Recommended minimum pathogen log reduction requirements. The basis for the derivation of these requirements are outlined in Appendix B of the WSAA HBT Manual. Notably, there is a 0.5 log additional protozoa removal requirement for category 2 and 3 sources compared to the WSAA recommendations. We suggest that the LRV targets in the ADWG be aligned with the WSAA HBT Manual as these are deemed to be adequate and sufficiently conservative to meet the µDALY target, and are supported by a significant body of evidence.
		3	2. Treatment Log Reduction Values Table 5.7 provides a list of indicative LRVs potentially attributable to treatment barriers, and these are quoted to be based on the Australian Guidelines for Water Recycling, 2018. The table lists both absolute values for ‘Achievable’ LRVs and a value range for ‘Validated’ LRVs. It is not clear how these values should be interpreted and applied by a water business, and we recommend that this table and associated text be revised to provide clarity on this aspect. This section of the manual also references a requirement to validate the performance of a treatment barrier on a site-specific basis. We consider that this validation requirement is impractical, as it is not feasible to validate LRVs for the vast majority of working water treatment plants via challenge testing or similar processes based on continuity of service and waste management considerations. It is also unnecessary, and prohibitively complex and costly. ‘Default’ treatment LRVs are a viable alternative, with ample evidence supporting their selection, as provided in the WSAA HBT Manual. Sections 5.2 and Appendix D of the WSAA HBT Manual outline a number of treatment processes and ‘default’ LRVs that can be used based on performance criteria for that treatment barrier – eg. turbidity and time criteria for media filtration processes. We consider that this is an appropriate approach and sufficiently conservative to meet the µDALY criteria, and the ADWG should align with this methodology. Also in reference to Table 5.7, we consider that the USEPA Ct values for free chlorine and chloramine should be adopted for the respective LRV values for chemical disinfection. The USEPA Ct values are internationally referenced and used in many regulatory jurisdictions. They are quoted extensively elsewhere in the existing ADWG. The current reference to a Ct of ≥ 15 mg.min/L for 4 log virus inactivation at a specific pH and temperature range is considered to be overly conservative when compared to the USEPA values.
		4a	No specific comments
		4b	No specific comments
		4c	No specific comments

#	Organisation	Q	Comments Received
		5	Provides useful background information to support the summary text in the draft Chapter 5
		6	3. Groundwater Source Assessments Section 5.4.2.2 addresses source risk classification of groundwater. There is a lack of detail and guidance surrounding this requirement and it is very conservative, assuming that the groundwater is unprotected unless demonstrated otherwise. The draft text does not address the criteria and standard of the evidence required to demonstrate the determination of 'protected' groundwater. A requirement appears to be placed on the water business to demonstrate aquifer security to the satisfaction of the health authority or other regulator with no guidance on this process for either the water business or the regulator. We consider it pertinent to include some further practical guidance in this section that can be used by the water industry. 4. Interpretation of the Water Safety Continuum Box 5.5 outlines sectors of the water safety continuum (from 'safe' through 'marginal' to 'unsafe') and recommended response actions. The banding is represented by DALYs per person per year (pppy). The use of DALY notation in this context is unclear and confusing. There is also no clear delineation between the sectors, and a system operating at say 10-5 DALYs pppy is either interpreted as being 'close' to or 'not close' to achieving the target. We recommend that the banding be expressed in terms of log shortfalls between targets and treatment performance. Additionally, there is inconsistency between this text and the interpretation provided in the WSAA HBT Manual from which the water safety continuum concept was adopted. We recommend that the interpretation in Section 6 of the WSAA HBT Manual regarding log shortfall banding and response recommendations be adopted in the ADWG.
6	Seqwater	1	Seqwater is supportive of the combined use of epidemiology and QMRA to inform the process for assessing and managing microbial risk in drinking water. This section could be improved by including a summary paragraph outlining at a high level how epidemiology and QMRA are combined.
		2	The broad approach taken to deriving the treatment targets identified in table 5.6 is supported by Seqwater. However, the methodology for determining the concentration range, and associated treatment target, for adenovirus and Campylobacter is highly conservative and is likely to overestimate the treatment requirement. A similar log reduction discounting approach from the QMRA value, to that applied to Cryptosporidium, should be considered for adenovirus and Campylobacter. The Cryptosporidium ranges in table A.4 are indicative 'average' concentrations. The adenovirus and Campylobacter values are calculated from 95th percentile values in sewage, based on the E. coli band concentration. Further discussion around the basis for utilising the different statistics and effect on the QMRA should be considered. The appendix could be improved by including further details of the assumptions ("… several significant assumptions…") made in determining the adenovirus and Campylobacter concentration ranges in table A.4. This should include, in particular, how the concentration ranges for Category 2 and 3 were differentiated. Box A.3 provides an example calculation for determining the log reduction for Cryptosporidium. Step 5 does not provide clear guidance on determining the required log reduction. Consideration should be given to including the additional step needed to solve the formula for the log reduction value. Section 5.4.2.2 identifies that unprotected ground water '…must be conservatively classified consistent with that of the surrounding and recharging surface water…'. It could therefore be classified as a category 4 source. Consideration should be given to including groundwater in the 'source water type' description for category 4 source in Table 5.6. The paragraph above table 5.3 identifies that where source waters regularly return results > 20 000 organisms per 100 mL they should be reconsidered as to whether they are a suitable source for drinking water. Further definition around the meaning of 'regularly' should be provided. Consideration should also be given as to why this is 'regularly' when Table 5.3 uses the maximum value in the data set. No justification is identified for why a cut off of 20 000 E.coli per 100 mL is identified for suitability. Consideration should be given for providing the basis for this cut-off.
		3	Seqwater considers there are two main difficulties in the implementation of the proposed treatment target. Its application to ground water systems and the need for site specific validation of treatment log reductions, particularly for conventional treatment processes. Ground Water: It is probable that many groundwater systems will appear anomalous based on the comparison of the source vulnerability and microbial indicator assessments. This is due to the surrounding and recharging surface water falling in to a category 3 or 4 source but E. coli not being detected (or rarely detected at low concentration)in the groundwater. Section 5.4.2.2 allows for the aquifer to be included as a treatment barrier but requires '…objective, credible scientific evidence…' to validate the claimed performance. This type of study is only likely to be applied to large schemes due to the complexity and cost involved in such studies. The additional treatment required to meet category 3 or 4 is complex in comparison to the level of treatment typically applied to ground water in Australia. The additional cost and risk of operating these higher levels of treatment should be considered in conjunction with the source water risk. This is particularly the case for category 4 systems where UV and chlorine disinfection will not satisfy the treatment requirement and additional process is required. This may also present difficulty in justifying such investment decisions to pricing regulators. Consideration should be given to the pragmatic approach to groundwater outlined in the WSAA Manual for the Application of Health-based

#	Organisation	Q	Comments Received
			Treatment Targets. The manual allowed the ground water source to be discounted by one category (i.e. Category 4 to 3 and 3 to 2) from that of the surrounding surface water if it could be demonstrated that it is not under the direct influence of surface water and the maximum E. coli concentration fitted band 1 (i.e. < 20 cfu/100mL). It is also suggested that text is included to identify the need to re-assess the ground water categorisation on a regular basis and certainly following significant change (e.g. significant geological event, flooding, drought). This is due to the inherent uncertainties in ground water assessment, largely due to only snapshots of particular parts of the aquifer being observed (e.g. bore drilling logs, ground water level monitoring). Validation of treatment log reductions: Section 5.4.3.2 identifies that 'The LRV should be validated on a site specific basis'. This is readily achieved for treatment technologies such as UV and membrane filtration where manufacturers provide 'pre-validated' systems, where the site specific component is demonstrating that the conditions are similar to those used in the validation testing. Similarly chlorine disinfection, ozone may be validated using recognised protocols (e.g. WaterVal). However, this is not the case for conventional treatment and is particularly problematic for existing WTPs. It is recognised that the actual pathogen reduction across conventional water treatment is variable and is dependent on a number of factors related to design, operation and environmental conditions. However, there is no robust accepted methodology for validation of conventional treatment. Validation of full scale treatment is also problematic for a number of reasons, including the need to batch sufficient surrogate to demonstrate the removal, covering the range of water quality conditions that may be experienced, full range of hydraulic conditions etc. Water Research Australia project 1079 identified some possible future surrogates for full scale validation of conventional treatment. However, further evaluation of the identified possible surrogates is required before robust surrogates and methodologies for validation can be developed. There also remains the complication of validating log reduction over the range of water quality, climatic and hydraulic conditions that may be experienced in an operating WTP. This is particularly problematic for existing WTPs, where it may not be possible to take the WTP offline to undertake validation studies. Use of pilot scale plants could be considered, but it is known that pilot scale does not fully replicate the conditions at full scale. Where a utility has multiple WTPs (e.g. Seqwater operates >30) undertaking pilot assessments at each site becomes logistically challenging and high cost. The literature consistently identifies that improved pathogen log reduction is achieved as conventional treatment is optimised. Filtered water turbidity is a typical online operational parameter used to measure the performance of conventional water treatment. This is also recognised internationally by e.g. USEPA, NZ Ministry of Health, where default pathogen log reduction credits are provided where specific filtered water turbidity performance values are achieved. This is typically as a per cent of time over a month and a maximum value that can not be exceeded for a short period of time. It is recognised that the log reductions specified for these turbidity performances may not always be achieved, but as performance increases the probability increases that pathogens are removed to acceptable levels. Consideration should be given to including default log reduction values based on filtered water turbidity performance, such as those identified in the WSAA Manual for the Application of Health-based Treatment Targets, USEPA Long-term 2 Enhanced Surface Water Treatment Rule, Drinking Water Standards for New Zealand
		4a	None
		4b	The section on cyanobacteria largely discusses free living cyanobacteria. However, benthic cyanobacteria have also been shown to produce cyanotoxin. The risk from benthic cyanobacteria is no easily identified via the conventional approach to management of cyanobacteria and rather direct toxin testing is likely to be required. Consideration should be given to including Anatoxin A in table 5.9 as it has been found in Australia. It is identified in section 5.6 that 'no human deaths have been recorded from ingesting the toxins directly produced by cyanobacteria…'. However, it is reported ny Campbell & Sargent (2004) that 1 death occurred in 2002 from consumption of, (suspected to be) anatoxin-a while recreating in a golf course pond in Milwaukee Wisconsin, USA. Consideration should be given as to whether it may be more appropriate to clarify that no human deaths from consumption of drinking water contaminated with toxins produced by cyanobacteria have been reported.
		4c	None
		5	The general approach to QMRA outlined in the technical appendix is clear. Specific comments on the technical appendix have been identified in question 2. Box A.3 provides an example calculation for determining the log reduction for Cryptosporidium. Step 5 does not provide clear guidance on determining the required log reduction. Consideration should be given to including the additional step needed to solve the formula for the log reduction value.

#	Organisation	Q	Comments Received
		6	Box 5.5 is designed to provide advice around what actions are required to achieve the Health Based Target based on where the water supply currently sits on the Water Safety Continuum. This box could be significantly improved by shifting the focus away from the type of improvement towards the urgency of improvement. For example, for greater than 10-4 DALYs pppy, immediate operational actions should be implemented to reduce the risk together with consideration of public notification, an interim upgrade (e.g. addition of UV disinfection, improved chemical dosing) should be implemented in the short-term (within 3 months) to further reduce the risk while planning is undertaken for an upgrade that will reduce the risk to less than 10-6 DALYs
7	VicWater	1	No comment provided in submission
		2	VicWater has been specifically requested to reiterate concerns regarding the proposed Log Reduction Values (LRVs). The source of the concerns is the draft text on pages 24 and 25, detailed under the heading 'Meeting the LRV target'. As currently drafted, the draft text lacks any information that would assist a water corporation in validating or determining LRVs required for its current treatment processes. This raises a number of questions, for example: - Do pre-validated treatment systems need to be revalidated, or will the pre-validated LRVs be acceptable? - Are LRVs that are published in recognised source documents, and accompanied with associated operational conditions, that need satisfied to "claim" the LRVs acceptable? Or, is the requirement going to be that every treatment process at every water treatment plant in Australia needs to undergo on-site validation? If the latter is the correct interpretation, that is, that water corporations will be required to validate pathogen log removal capabilities across entire treatment trains, this would be very costly exercise, with no clear methodology or process for achieving the desired outcome. VicWater requests that the NHMRC's Water Quality Advisory Committee clarify the text in this section to assist water corporations in understanding the requirements with respect to the validation of treatment processes, as well providing a mechanism for determining the LRVs for current treatment processes, without the need to undergo on-site or site-specific validation.
		3	If water corporations are required to validate pathogen log removal capabilities across entire treatment trains, this would be very costly exercise, with no clear methodology or process for achieving the desired outcome.
		4a	No comment provided in submission
		4b	No comment provided in submission
		4c	No comment provided in submission
		5	No comment provided in submission
		6	No comment provided in submission
8	Queensland Water Directorate	1	No
		2	No
		3	Yes
		4a	No
		4b	No
		4c	No
		5	Yes

#	Organisation	Q	Comments Received
		6	From submission 1/2 We support the introduction of microbial Health Based Targets into the ADWG. The P9 statement "*Small water suppliers are well placed to undertake a vulnerability assessment. This provides a useful tool for assessing safety of source waters and prioritising improvement.*" should be modified. The suggested replacement is simply: "*The vulnerability assessment is a useful tool for assessing safety of source waters and prioritising improvement.*" Rationale: While the statement is likely intended to point out the simplicity of the vulnerability assessment as a tool, a judgement on the capacity of small water providers is out of place in this document, and inaccurate in many instances. Some providers are simply not well placed to undertake an assessment, without assistance. The Queensland urban water sector has a number of significant issues to address in servicing small and remote communities, which it is progressing through regional collaboration. From Submission 2/2 (the same as above) We support the introduction of microbial Health Based Targets into the ADWG. The P9 statement "Small water suppliers are well placed to undertake a vulnerability assessment. This provides a useful tool for assessing safety of source waters and prioritising improvement." should be modified. The suggested replacement is simply: "*The vulnerability assessment is a useful tool for assessing safety of source waters and prioritising improvement.*" Rationale: While the statement is likely intended to point out the simplicity of the vulnerability assessment as a tool, a judgement on the capacity of small water providers is out of place in this document, and inaccurate in many instances. Some providers are simply not well placed to undertake an assessment, without assistance. The Queensland urban water sector has a number of significant issues to address in servicing small and remote communities, which it is progressing through regional collaboration.
9	Bligh Tanner Pty Ltd	1	The text and figure are not consistent in the approach: The text states that Figure 5.1 compares the differences between Epidemiology and QMRA. The figure caption states "Approaches to characterising risk of a drinking water source". The figure caption is written so broadly that it is incorrect as it suggests that only epidemiology and QMRA are appropriate. The current approach of qualitative risk assessment, which is also included in the text, should also be evaluated in this Figure, or the figure caption altered to reflect that the figure is only considering epidemiology and QMRA.
		2	The table has changed subtly but significantly from the previous version. There are a number of specific issues here that require discussion. The Category 1 requirement based only off Table 5.6 is now that a fully protected groundwater requires 4 log bacteria treatment - Appendix A9 states that this is to protect against local contamination e.g. birdlife. As currently written, this category also includes fully protected groundwater sources. This needs clarification (e.g. by inclusion of a Category 0 for not requiring treatment?). The 4 log bacterial reduction in groundwater is not necessary (for the reason stated). Source water categories do not exclude the possibility of contamination after the point of abstraction, and disinfection is warranted if there are any reservoirs/ potential points of contamination – but that is not the point of a source water assessment and the 4 log requirement should not apply to definitively safe sources. We do however support the ADWG requiring residual disinfection; we contend that an explicit requirement for residual disinfection in all drinking water supplies would actually have more of an impact in protecting consumers than the current proposed draft changes – and would almost certainly have prevented at least 2 proven Salmonella outbreaks in drinking water supplies in Roma Queensland and the Salmonella contamination event (not strictly classified as an outbreak) in the drinking water supply in Winton, Queensland. The source waters for these incidents are deep pumped GAB, and hot free flowing GAB water. Category 4 - the reduced requirement for Protozoa to 5 log undermines the concepts of the framework. A surface water source in an open unprotected catchment should have 2 robust barriers for protozoa in line with the principles of the ADWG. However, conventional treatment is expected to be able to validate (Table 5.7) 4 log reduction, leaving only a 1 log shortfall. When applied as an operational benchmark, reducing the shortfall from 10^-5 to 10^-6 will have negligible impact per 100 population (Figure 5.3) such that there is no driver to implement another barrier. Further, when read in conjunction with the technical appendix, there are arguments for reducing the 5 log requirement further. This means that the framework supports the status quo, e.g. single barriers for protozoa as the norm. That is, a provider with a known Cryposporidium risk can argue that a single barrier presents a safe supply. The ADWG needs to definitively state the treatment requirements. In our opinion, the QMRA, while theoretically sound, is not providing a robust defensible catchment risk applicable to all Australian catchments, as should reasonably be expected for the National guideline. As stated in the technical appendix, there is insufficient data about the presence of human pathogenic strains of Cryptosporidium in the studied catchments, their viability, and their infectivity. When coupled with a poor coverage of tropical and subtropical catchments, the outcome of the QMRA is not

#	Organisation	Q	Comments Received
			scientifically justified (not valid) for all Australian catchments. If the QMRA is not generally applicable as inferred in the technical appendix: "It may be that in certain situations even greater reduction would be appropriate (e.g. high ambient temperatures, long travel time of oocysts). In this situation the case to further reduce the LRV should be made directly to the relevant party (e.g. a health authority or other regulator). The LRVs for viruses and bacteria are point values selected from the range represented in Table A.8, by taking the upper limit and rounding to the nearest half log10." Then why introduce at this time?
		3	As above, the subtleties with the protozoan treatment requirement practically may not actually support the framework (e.g. it does not always support the guiding principal of ensuring multiple robust barriers). As to major difficulties - Yes - there are major difficulties based on the current draft. The approach is based on sound scientific principles and seeks (but fails) to provide a (complete) framework for water service providers to demonstrate that the risk they are passing on to their communities is low. The two key criticism of the draft are: 1) as stated above, the QMRA basis for the required LRVs is tenuous at best for most Australian catchments, and 2) it gives no practical guidance for a water provider to assess the performance of their treatment barriers. The previous draft of Chapter 5 included a second appendix that did allow providers to assess the performance of their barriers in a more robust manner. This has been removed from the current draft, and in our opinion this omission has completely gutted the framework of its significance for the lower capacity providers who do not meet current recommendations within the ADWG. If there is no specific guidance provided to validate treatment barriers included in the draft guidelines, then it is our strong position that the changes to Chapter 5 should not be adopted. A proposed solution would be to simultaneously amend Sections 3.9.2 and 9.8 of the ADWG, to ensure appropriate guidance is given for providers to validate the performance of their treatment barriers. It is our contention that in many parts of regional, rural and remote Australia, councils are operating water treatment plants that would not receive any log reduction credit based on their performance if assessed using the WSAA Health Based Target Manual that was the basis for the ADWG draft. For example, there are numerous treatment plants that do not have online turbidity meters, and do not monitor turbidity more than once daily. In these cases, it is obvious to us, as experts in the water industry, that there is no ability to demonstrate effective filtration, and if there is a Cryptosporidium risk, then it has to be assumed that there is insufficient treatment. Without specific guidance provided in the ADWG that would easily allow the Council/ operators to assess their own systems appropriately, the Council would have to rely on expert external advice. How is an elected Council (generally without specific technical skill in this area) to understand that the water treatment processes that have served them for decades without obvious and apparent health concerns are actually unsafe when they cannot go to the national guideline to understand their own situation? The only linkage in the draft that might suggest that there was an issue with specific treatment plants is the comment in Table 5.6 “(Assuming well designed, highly controlled, managed and monitored system)”. We understand what this means (e.g. by reference to the WSAA guidelines), but in our opinion, this has to be fully articulated for the proposed changes to add value to the current recommendations in the Guidelines. There is also nothing stated in the guidelines that limits the potential LRV credit provided to a particular barrier. This is a major oversight. In some jurisdictions for recycled water, a maximum limit of 4 LRV credit is applied for any particular barrier. The practical effect of this is that it absolutely requires multiple barriers. Nonetheless, this principle is not stated or applied – for example, in reference to RO treatment in ocean catchments, the text states that the multiple passes of RO would be expected to remove pathogens. This implies that a provider can (and should) apply multiple log reduction credits to what is actually a single barrier which can only be validated to a maximum of 1.5 log using salt rejection. Further it implies that generalised statements of expected performance are sufficient to demonstrate microbial safety. We do not believe that multiple layers of LRV credits should not be allowed for any barrier. For example, placing 2 UV units at 33 mJ/cm2 in series should not allow a provider to claim 8 log reduction of Cryptosporidium – as turbidity shielding in the first UV unit would similarly impact the second UV unit and undermines the guiding principle of multiple robust barriers. If the aim of the guidance is to actually improve the treatment of drinking water in Australia, and is not just an academic exercise, then the guidance should more explicitly state that multiple barriers are required for all identified pathogen risks. For an unprotected catchment, this would then require a second protozoan barrier. At present, the change from 5.5 log requirement to 5 log for protozoan pathogens and removal of the explicit filter performance default LRVs from the previous draft simply allows the status quo to remain. Given a 5 log requirement, as a provider will likely assess their conventional treatment as providing 4 log LRV, leaving an acceptable 1 log shortfall (e.g. this would not be a priority shortfall that needed immediate or short term rectification - which in a council scenario will mean that it will not be prioritised). There is either a current problem for water supplies in Australia (we believe that there is) that this framework is designed to rectify, or there isn’t. If there is general acceptance that conventional treatment alone is normally sufficient, then why are we complicating the issue with an incomplete framework that does not provide satisfactory guidance for all providers? If ultimately, the same outcome would be achieved by explicitly requiring a minimum 2 barriers (with specific performance criteria stated) for all pathogen types in surface water drinking water supplies, why not take this option?

#	Organisation	Q	Comments Received
		4a	Why has Acanthamoeba been removed? It is currently included in the existing S5.3 of the ADWG.
		4b	There is emerging evidence that other cyanobacteria might be relevant in an Australian context. (Fabbro and others). Perhaps these emerging sources/ types of cyanotoxins should be acknowledged? Table 5.9 The restriction of the symptoms for Saxitoxin "No direct evidence of symptoms in humans from exposure to drinking water" should be removed. Saxitoxins are a known neurotoxin, and the factsheet states that "there was little evidence of human health impacts" and derives a health alert based upon a human LOAEL. That is, there are observable symptoms. In poorly treated water supplies, the missing information may prove critical.
		4c	No
		5	Section A9 justifies that the LRVs in A8 can be reduced by 1 log, (as in table 5.6), but states that there may be other reasons to lower them further, but that this case should be put to the relevant regulator. Some guidance should be provided as to what that case should be - e.g. if it needs to be supported with significant protozoan data, it may prove cheaper to just install UV than to provide robust evidence. This needs to be made clear as the equivocation on this point in the guidance provides a loophole and justification for retaining the status quo.
		6	Table 5.4: It is our understanding (personal communication), that the datasets used in the development of this table does not include catchments north of a line between Brisbane and Perth (as those providers were not included in the cited study). Wet tropic rainforests catchments typically have E. coli levels of 20-100 MPN/ 100mL, yet in many instances these catchments absolutely exclude human activity and agriculture completely. They represent the most protected catchments in the country, yet they are anomalous when applying the framework. Similarly the absence of these catchments in the development of the guidance may overemphasis the protozoan risk relative to the southern catchments. To what extent can we be confident that Deere (2014) is appropriate to apply to the Burdekin River catchment? This catchment is completely unprotected, with extensive but low intensity cattle grazing, yet E. coli levels above 20 MPN/ 100 mL are rare. Is the Cryptosporidium risk actually sufficient to require 5 log treatment? If there are exceptions to the applicability of the data to the majority of Australia (by area), is it appropriate to use this as a cross check of the first cut vulnerability assessment when in many cases it will simply need to be explained away and ignored? If the default position of “discuss with your regulator” is the recommendation of the change, then the proposed change will not result in nationally consistent guidance. Specific technical issues: Assessment of Groundwater Sources: The first 2 paragraphs indicate that a groundwater source that cannot be assured to be free of direct faecal contamination should be assessed consistently with the recharging water. The second paragraph states that even if the source is free of faecal contamination, that the source should still be assessed as per the recharging water, but that the performance of the aquifer in removing pathogens can be included as a treatment barrier IF objective, credible scientific evidence can conclusively demonstrate and validate the performance. What exactly would be required in terms of conclusive, objective and credible evidence? For example, how much E. coli data from the recharging source, and the bore water, and under what conditions? Would trace detections of other contaminants (such as PPCPs) be contrary evidence? It appears that learnings from Havelock North have led to this statement, but in the absence of any guidance, this appears to be unachievable for a provider to demonstrate appropriately. Ocean Catchments: Sea water is specifically excluded from consideration in the guidance. This seems to be a lazy response. While RO treatment should remove the pathogens, should this actually be assumed to be the case without proper evaluation? If it is the case, then why does a Category 4 catchment with RO treatment need to do any further evaluation as it would similarly expected that multiple RO passes would also remove all pathogens. The recommended methodology needs to be applied consistent across all water sources, and all treatment barriers. References to unpublished, unavailable draft documents: There are significant cross references to the draft AGWR 2018 guidance – we are unable to obtain the draft. This is not an appropriate reference for this framework and better justification is required from published sources. Section 5.4.3.2: This section currently states "(e.g. whether Cryptosporidium may be present in sufficient concentrations that it requires a filtration and/or UV barrier rather than merely a chlorination barrier)" The above statement is clearly incorrect. Chlorination is not a barrier to Cryptosporidium, and if Cryptosporidium is identified as present in any concentration (especially given the low sampling frequencies in the vast majority of catchments), then surely it requires an appropriate barrier to be in place? If the WSAA guidance for evaluating treatment requirements based of pathogen data is applied, this is certainly the case. Principles of validation: There is no guidance on the principles of validation of barriers provided in the draft guidance, and without this there is no point in making any change at all. If this framework is adopted, how is it applied? At present, the changes will benefit consultants more than providers as the interpretation of incomplete guidance will require outsourcing. This will likely be very good for our business, and exceptionally good for consultancies that promote QMRA as a tool – but will it benefit consumers? The information

#	Organisation	Q	Comments Received
			provided in Table 5.7 is not scientifically justified and is not sufficient to provide guidance to providers to assess their own barriers. For example, we have been unable to find any published scientific literature that justifies the stated 2 Log virus reduction from conventional treatment (2 log appears to be a default position that allows the 6 LRV arrived at via the conservative and highly uncertain QMRA process to be met by conventional treatment and chemical disinfection as resulting in an acceptable risk). In contrast, we are able to find validation data for virus reduction for specific microfiltration membranes, yet the validated virus reduction is 0. This is not appropriate, and a range for virus rejection my MF should be stated. Further, the table identifies UV as being validated for 4 log reduction of all pathogens, yet bacteria and protozoa at 186 mJ required for virus will be above 4 log. The 4 log limit appears to be the validation that is allowed in recycled water applications (e.g. California, Queensland, Victoria, WA) rather than the actual validated value. Conclusion: In principle, the framework makes sense, but the current draft does not provide a framework that is immediately implementable. Therefore, it is not supported without extensive revision. Until a provider can assess their catchment, and the effectiveness of their treatment barriers with the advice provided in the Australian Drinking Water Guidelines, without deferring to the whim of Regulators, or requiring engagement of expert consultants to apply, this appears to be a retrograde step.
10	Mid Coast Water Services	1	MidCoast Water Services welcomes the opportunity to make a submission on NHMRC's Australian Drinking Water Guidelines: Draft Chapter 5 Microbial Quality of Drinking Water (April 2018). MidCoast Water Services is a division of MidCoast Council. We are responsible for five water supply systems that deliver drinking water to a population of over 80 000 people. Our main water supply scheme is the Manning scheme, which serves 90% of our customers. Smaller water supply schemes operate at Tea Gardens, Bulahdelah, Stroud and Gloucester. Catchment types include surface water, run of the river, off river storage and groundwater. Treatment systems range from small conventional treatment plants to advanced plants including microfiltration, ozone and BAC. MidCoast Water Services (previously MidCoast Water) previously provided comments on the August 2016 draft 5.7 – Microbial health based targets. Outline of our position MidCoast Water Services supports, in principle, the concept of health based targets (HBT) to define microbial quality of drinking water; however we have concerns over the lack of detail and definitions surrounding HBT. We also have concerns about the lack of a regulation impact statement (including but not limited to financial impacts) to support the proposed implementation of HBT. Due to the lack of clear definition (e.g. validation and verification requirements) and the ultimate decision as to whether performance can be demonstrated conclusively resting with regulators, this may result in an inconsistent approach across Australia to the targets, therefore reducing effectiveness of the overall system. The determination of disability adjusted life years (DALY) and log reduction values (LRV) for specific treatment targets are very conservative, which may place undue pressure on water utilities to comply. This is likely to result in resources invested in extra treatment options (e.g. UV) rather than addressing other risks within water supply systems (e.g. reservoir integrity).
		2	The determination of disability adjusted life years (DALY) and log reduction values (LRV) for specific treatment targets are very conservative, which may place undue pressure on water utilities to comply. This is likely to result in resources invested in extra treatment options (e.g. UV) rather than addressing other risks within water supply systems (e.g. reservoir integrity). Details on LRV for ozone are not well defined, especially relating to protozoa. Ozone has been combined with BAC in Table 5.7. There are no details on the separation of these treatment options.
		3	Specific concerns 1. Source water assessment Methodology of source water assessment is not well defined, e.g. Table 5.2 works on worst case scenarios without considering alternate management practices (selective extraction and off river storages). For example, in Manning water supply, water is extracted from Manning River when quality meets criteria for turbidity and phosphorus, and stored in Bootawa Dam (inner catchment area protected). Using E. coli results for a two year period and assumptions of vulnerability assessments, Manning River may be classified as category 4, whereas Bootawa Dam may be classified as category 2. There is no clear direction for this type of situation. Definitions for groundwater assessment are not clear, e.g. definition of a shallow or deep aquifer. Is a multi-layered aquifer separated by an aquitard with low permeability, water age of 5 – 10 years and E. coli counts usually <1 orgs/100ml currently considered protected and therefore category 1? Using the current definitions it would be very difficult to prove that specific aquifers are 'protected'. 2. Validation There is limited information on the validation of treatment systems, leaving this open to interpretation with the ultimate decision resting with regulators. In the previous draft there were ranges of dose rates of various treatments provided for guidance. These are not included in this draft. 3. Verification There is limited information on the verification of treatment processes. These processes should be better defined to assist water utilities to comply with the proposed requirements. 4. Ozone credits Details on LRV for ozone are not well defined, especially relating to protozoa. Ozone has been combined with BAC in Table 5.7. There are no details on the separation of these treatment options. 5. Catchment management There is concern that the source water categorisation methodology does not support the Australian Drinking Water Guidelines 'catchment to tap' principle. The requirement to use maximum E. coli values (and event based monitoring) to help determine source water category will

#	Organisation	Q	Comments Received
			result in many catchments rated as category 4. Once it is rated as a category 4, there is little incentive to invest resources in catchment management. Practical support and funding options from regulators including realistic timeframes would assist in implementing these targets in the long term.
		4a	No comment provided in submission
		4b	No comment provided in submission
		4c	No comment provided in submission
		5	Information on validation and verification processes are not well defined. This could be made clearer by including ranges of dose rates of various treatment systems and more specific, clear direction for ongoing verification.
		6	MidCoast Water Services has viewed NSW Water Directorate's submission and agrees with concerns raised in that submission. We believe further refinement of the draft framework for microbial quality of drinking water is required to ensure it will deliver positive health outcomes in a practical, cost effective and achievable way. We have concerns around the lack of detail and definition in this draft and the lack of a regulation impact statement to support implementation.
11	Coliban Water	1	This submission is being made on behalf Coliban Water, a state-owned regional Victorian water corporation. The approach for managing microbial risk is theoretically sound, but, in and of itself, the current draft of Section 5.3 does not provide water corporations, such as Coliban Water, with much in the way of practical guidance in relation to managing microbial risk to drinking water supplies. Extending the scope of this response beyond section 5.3 of the draft text, the primary concern that Coliban Water has more generally is that Table 5.6 lists default log reductions (LRVs) for various classes of pathogens, but the rest of the chapter provides no practical way forward to achieving them, except by doing original validation work on each treatment process (i.e. Table 5.7 provides you no useful guidance on treatment requirements, and there are very few useful references provided in the Reference List to Chapter 5). To improve the usability of Chapter 5, it is recommended that NHMRC consider the following: - Replacing the current Table 5.7, with Tables A5.4.1 and 5.4.2 that appeared in the August 2016 draft HBT text (in that way, water utilities know what they have to do to achieve the required log reduction values) - Adding in something similar to the two dot points below into the list of dot points above Table 5.7: * The LRVs associated with pre-validated treatment units, particularly in the case of pre-validated UV units, can be accepted as representing the default LRVs, as long as the operational parameters to claim the pre-validated LRVs * For other treatment processes, LRVs that are published by recognised sources can be used as long as the operational conditions under which those LRVs proven can be consistently achieved - Referencing the Water Services Association of Australia's (WSAA's) Health- Based Targets Manual, as it is a water-industry accepted, and industry-developed source of advice on achieving microbial health-based targets. It should also be noted that all contributors to the WSAA HBT Manual are government-own water corporations, and the HBT Manual has also been run by state and territory regulatory agencies. Given that only government-own entities contributed to the production of the WSAA HBT Manual, it is seen as counterproductive to exclude it as a reference document for these same entities, given the pivotal role that the ADWG has as a definitive reference document for the Australian water industry
		2	The concern is that the LRVs listed in Table 5.6 are generally higher than in the values provided in the August 2016 draft HBT text, but the rationale for the changes to the LRVs is not that clearly articulated, primarily because the technical appendix is overly technical and not easy to follow. It does appear as if some of the underpinning assumptions have been drawn from the Australian Guidelines for Water Recycling, which is based on wastewater inputs, rather than non-wastewater inputs, which potentially overstates the risk profile for drinking water supplies. It is appreciated that there is limited Australian data from which to derive LRVs, but the derivation work undertaken for the August 2016 draft text, and for the WSAA HBT Manual, upon which that draft was based, was robust, so it is not entirely clear why higher values, and hence, more conservative values, were needed to manage microbial risks.
		3	As described in the response to Question 1 above, Table 5.6 lists default log reductions (LRVs) for various classes of pathogens, but the rest of the chapter provides no practical way forward to achieving them, except by doing original validation work on each treatment process (i.e. Table 5.7 provides you no useful guidance on treatment requirements, and there are very few useful references provided in the Reference List to Chapter 5). To improve the usability of Chapter 5, it is recommended that NHMRC consider the following: - Replacing the current Table 5.7, with Tables A5.4.1 and 5.4.2 that appeared in the August 2016 draft HBT text

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			(in that way, water utilities know what they have to do to achieve the required log reduction values) - Adding in something similar to the two dot points below into the list of dot points above Table 5.7: * The LRVs associated with pre-validated treatment units, particularly in the case of pre-validated UV units, can be accepted as representing the default LRVs, as long as the operational parameters to claim the pre-validated LRVs * For other treatment processes, LRVs that are published by recognised sources can be used as long as the operational conditions under which those LRVs proven can be consistently achieved - Referencing the Water Services Association of Australia's (WSAA's) Health-Based Targets Manual, as it is a water-industry accepted, and industry-developed source of advice on achieving microbial health-based targets.
		4a	Under the section headed source water contamination, section 5.5 states: "The potential for the source water to be contaminated with environmental pathogens of concern should be assessed. The next sentence states in part: "Opportunistic pathogens are naturally occurring environmental microorganisms...." The first sentence seems to be out of place here, as if opportunistic pathogens are naturally occurring, they cannot be source water contaminants (because they are naturally occurring). Under the section headed - In premise plumbing systems, a better reference than (WHO, 2017) is (WHO. 2007 - Water safety in buildings)
		4b	With regard to Table 5.9, it would be advisable to make sure the information in this table is consistent with relevant information that is contained in the Cyanobacteria Facts Sheets in Part V of the ADWG, particularly the summary Fact Sheet – Cyanobacteria and their toxins, and update either Chapter 5, or the Fact Sheets, accordingly.
		4c	In section 5.7.2, it states: "Blooms of algae and cyanobacteria may be controlled by judicious application of copper sulphate or other algaecide to the source water. However, care should be taken when doing so, since such applications can lead to the release of cyanotoxins from otherwise intact cells." It should be noted that many jurisdictions either prohibit, or tightly control, the use of algaecides, particularly, copper-based algaecides, and it may be useful to add a sentence that makes it clear that any decision to use an algaecide needs to be made in consultation with the relevant state-based agency or in accordance with state-based policy.
		5	It is not doubted that the technical appendix is technically correct, but it is written in a highly academic style, which makes it difficult to read and interpret. The questions that need to be asked with respect to the technical appendix are what additional value does the technical appendix provide with regard to helping water utilities provide safe drinking water, and what added value does provide to helping water utilities understand Chapter 5? The answer to the first question is probably very little. The answer to the second question is that its academic style inhibits easy interpretation, therefore limiting its value. A less complicated version of the technical appendix would be useful.
		6	General note - There is no Table 5.5, so the tables appear to be numbered incorrectly. On Page 1 there are the following two statements: "It describes disease causing microorganisms (pathogens) and toxigenic cyanobacteria found in drinking water" and "Microorganisms present in drinking water are grouped into the following five categories". It is more correct to say "that may be found in drinking water" or "may be present in drinking water", as if the drinking water is properly treated harmful organisms should not be present. Page 6, Table 5.1. Campylobacter spp and Salmonella spp should be place on separate lines, as the some of the symptoms listed against the combined group, such as IBS and GB Syndrome, only apply to Campylobacter spp and not Salmonella spp Box 5.1 should appear after Table 5.2, as Box 5.1 talks about source water categories that have yet to be described and fleshed out in the text. Box 5.2 - including theromotolerant coliforms results as part of the source water assessment is likely to overstate the microbial risk and lead to the misallocation of source water category. Need to rethink this approach Page 8 - The statement "Limited published and extensive unpublished (often confidential utility-held) data from Australian systems confirms these trends" is basically personal opinion/comment, which has no place in a guideline document, and it should be deleted. There are no legal requirements for water utilities to publish any data that they collect. Page 15 - The reference to Table 9.4 on page 15 is not the correct reference. Table 9.4 refers to the frequency of monitoring of E. coli in treated drinking water, not raw source water, which is what this section is about. Table 9.2 is a better reference than Table 9.4 Several spots - there are several references to AGWR 2018. Whilst the Australian Guidelines for Water Recycling (AGWR) are undergoing a limited review, that review has not been completed, to the best our knowledge, and the correct reference is AGWR 2008. Page 22 - After Table 5.6 and before the section titled Water Safety Continuum, the following text should be moved from the Technical Appendix and added into Chapter 5: "Defining the health outcome target It is not possible to achieve zero health risk from the consumption of treated drinking water. Rather, a tolerable risk needs to be set as a health outcome target that can be considered to represent a target of safety. The metric selected to define the health outcome target is the DALY. The DALY allows aggregation of health impacts to provide an overall measure of

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			burden of disease (Leder et al 2012). Box A.1 provides an overview of the DALYs. The microbial health outcome target that applies to Australian drinking water supplies is 10-6 Disability Adjusted Life Years (DALYs) per person per year (pppy) also referred to as 1 µDALY." The rationale for this is that the Water Safety Continuum mentions the health-based target, but there is no earlier introduction of what it is. It should be clearly stated what the microbial HBT is in Chapter 5, not hidden in an appendix. Figure 5.2 - it is appreciated that Figure 5.2 is mean to be illustrative, but the versions in the WSAA HBT Manual or in the August 2016 draft text, are clearer in illustrating how the water safety continuum process works. Box 5.5 - under dot point 1 - "(but won't necessarily have)" - This addition from the previous version draft text is not very helpful, because it implies that no drinking water supply system can ever be considered as being safe. Additionally, its inclusion adds no value to managing risks to drinking water quality. Box 5.5 – under dot point 2 - "However, if current system is already optimised, then an additional barrier may be warranted." - The 10-6-10-5 DALYs pppy range on the continuum puts you in the safe zone. The addition of this sentence from the previous version suggests that even in the safe zone further barriers may be required, which is contrary to the continuum approach, and suggests that < 10-6 DALYs pppy is a standard, rather than a target. Table 5.7 - Table 5.7 is confusing and unhelpful. The two columns of LRVs listed in Table 5.7 are confusing. There needs to be a better explanation about what is meant by achievable versus validated. It is not clear as to which column one should choose from. It is assumed that validated is the only relevant column, as, unless new validation information is produced, the achievable value can never be accepted. Strong consideration should be given to replacing the current Table 5.7, with Tables A5.4.1 and 5.4.2 that appeared in the August 2016 draft HBT text (in that way, water utilities know what they have to do to achieve the required log reduction values) If the current version of Table 5.7 is retained, then the information in the "basis for validation" column needs to bev checked against the vallidation section in Chapter 9, as well as the Information Sheets on disinfection, to ensure consistency across the ADWG. Table 5.7 should also include a row for direct filtration Section 5.4.3.3. Management of the distribution network - some additional contemporary references could be added: WHO 2014 – Water Safety in Distribution Systems AWWA 2017 – Manual of Water Supply Practices – M68 – Water Quality in Distribution Systems Correct reference is for the quoted WIOA document is Mosse and Deere (2009), although it is worth noting that a third edition was published by WIOA in 2016 Technical Appendix - contains the following statements - "Water utilities may hold data, but this is not generally available for analysis by third parties. Water utilities are strongly encouraged to publish existing data, which would improve the accuracy of QMRA for drinking water in future revisions." - this is largely personal opinion/comment, which has no place in a guideline document, and it should be deleted. There are no legal requirements for water utilities to publish any data that they collect.
12	Water Services Association of Australia (WSAA)	1	The Water Services Association of Australia (WSAA) welcomes the opportunity to provide a submission to the National Health and Medical Research Council (NHMRC) on its draft of Chapter 5 of the Australian Drinking Water Guidelines – Microbial Quality of Drinking Water. WSAA is the peak body that supports the Australian urban water industry. Our members provide water and sewerage services to over 20 million customers in Australia and New Zealand, and many of Australia's largest industrial and commercial enterprises. WSAA facilitates collaboration, knowledge sharing, networking and cooperation within the urban water industry. The collegiate approach of its members has led to industry-wide advances to national water issues. WSAA recognises the important role that the ADWG fulfils in providing guidance on good-practice management of drinking water quality and welcomes the inclusion of microbial Health Based Targets (HBTs) into the Guidelines. The water industry acknowledges the importance of microbial HBTs in the delivery of safe drinking water, as well as the value of the HBT methodology in demonstrating how drinking water safety has been achieved. This has been demonstrated through WSAA working with the government owned water corporations and state and territory regulatory agencies to develop the WSAA Health Based Targets Manual. Given the pivotal role that the ADWG has as a definitive reference document for the Australian water industry it is important that the WSAA Health Base Targets Manual and associated work be incorporated, more directly and clearly, in the updated guidelines. The HBT Manual was developed over a number of years to provide a pathway and support for the implementation to the HBTs by the Australian water industry and it will be a significant loss if that work is not utilised. More specifically with reference to the approach outlined in Section 5.3 of the draft text, our members request clarification around several items, these are outlined below. In addition, our have outlined several suggestions which would enable and support the practical application and implementation of microbial HBTs. 1. The outlined approach to validation is unclear. The draft text does not provide enough direction in the following areas:

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			• How a log removal value (LRV) for a process is to be determined. It is not clear if a single value, an average, or the worst case is used? • How does the LRV account for the variability of a process caused by operational variables, such as changes to source water quality? • Does the proposed approach to validation require the measurement of pathogen removal, or acceptable surrogates, directly at each plant, and for this measurement to be used as the basis for the plant's log removal rating? If so, this replaces the internationally accepted approach of assigning log credits to individual or component parts of the water treatment chain, based on operating these components within a specified operational envelope. 2. The validation approach is not practical to implement The validation of operational water treatment plants is impractical and uneconomical for the following reasons: • Validation is reliant on the presence of adequate concentrations of surrogates or pathogens to demonstrate the log reduction value and to be able to link it directly to operational parameters. However, source water for drinking water will not have adequate concentrations for this to be achieved. To address this spiking of surrogates or pathogens is required. • The spiking of source water with pathogens (or surrogates), to numbers adequate for log removal verification, will result in their presence in the final water. Under these conditions produce water will not be able to be supplied to customers. Subsequent disposal and cessation of supply will need to be managed. • While out of spec product water can go back to head of a plant, how long this can occur is dependent on the amount of storage in a system. This could range from hours to several days. In many situations, there may not be adequate storage in a system for validation studies to be undertaken and ensure adequate recovery time for the plant. • Due to the change in risk profile of the source water, operation of a filter post surrogate or pathogen challenge will require increased monitoring of the product water to ensure the safety of the final product. All these result in additional operational costs above the cost of undertaking a validation study, without necessarily providing greater assurance. There exists enough economically viable alternatives to in-situ validation to ensure that the operational parameters can be clearly defined. Examples are desk top or pilot plant scale validation. A rough estimate of costs is $20M for in-situ validation when a plant cannot supply to $2M for a pilot plant. These assumptions are based on the validation of the entire plant in-situ. In some situations, filters can be taken off line and individually validated. While this does not result in the complete cessation of supply, it does result in a reduction in the amount of water supplied and the additional post validation monitoring requirements. As economic alternatives to in-situ validation exist, full in-situ validation allows a utility to provide additional evidence to the regulator that the plant can achieve much greater log removal values than the conservative, desk top default values provided in the WSAA manual. In some scenarios this option may be more economically viable than adding to a treatment train. WSAA recommends: • Acknowledgment and reference to the WSAA Health Based Targets Manual as a recognised and legitimate source of advice for achieving the required LRVs, as detailed in draft Table 5.6 of the draft text. The description of the operational management of water treatment processes to achieve microbial HBTs provided in the WSAA HBT Manual is far more detailed than that of the draft text, and will provide suitable support material to the ADWG. In addition, the corresponding LRVs are more specific e.g. filtration LRVs based on clearly defined filtration performance targets. • Reviewing the implication and suggestion for in-situ full-scale testing of drinking water treatment plants for pathogen reduction. • Providing clear guidance on the process for assessing the inherent capability of the water treatment process • Clearly defining the validation requirements for LRVs attributable to treatment barriers, in line with the existing text on validation that appears in Chapter 9 of the ADWG. • More guidance or references on interpreting/evaluating data. Effective source water categorisation is key to this approach to microbial HBTs and ensuring that the required level of treatment is achieved. • Providing clearer guidance on whether the microbial HBTs can be met through desktop analysis (the two inferred methods in the draft text differ). • Stating clearly that improvement associated with the microbial HBTs be integrated with the continuous improvement paradigm established in the ADWG Risk Management Framework, as described in Chapter 3 of the ADWG (which is consistent with the 'water safety continuum' concept). • The finalised chapter be edited to accurately reflect contemporary microbiological and public health concepts.

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			• The finalised chapter better highlight that the use of site-specific QMRA is preferable to, and should override the use of, the generic LRVs required (as set out in draft Table 5.6), where sufficient data of suitable quality is available to the utility. 3. In addition, WSAA believes the microbial HBT guidance material would be strengthened by an outline of the procedure for its implementation, such as a high-level overview or flow chart WSAA notes that there is no Table 5.5. This appears to be a numbering error.
		2	Page 22 Section 5.4.2 Contamination Of source waters & enteric pathogens Treatment targets for protozoa, bacteria and viruses in relation to the source water category classification (provided in draft Table 5.6) differ from the values provided in the WSAA HBT Manual (see Table 3 of Section 3.1.6 of the WSAA HBT Manual – Recommended minimum pathogen log reduction requirements). The basis for the derivation of these requirements are outlined in Appendix B of the WSAA HBT Manual. Importantly, there is an additional 0.5 log protozoa removal requirement for Category 2 and 3 sources in the draft text for Chapter 5, compared to the WSAA recommendations. The basis for the Log Reduction Values (LRVs) in the WSAA HBT Manual is outlined in Appendix A of the HBT Manual and is summarised in Section 5.4.3.2 – Treatment targets. The LRV targets specified in the WSAA HBT Manual are supported by a significant body of evidence, which is referenced within the WSAA HBT Manual. WSAA members support and recommend that LRV targets in the ADWG be aligned with the LRV targets in WSAA HBT Manual, as these are adequate and sufficiently conservative to meet the microbial HBT target of 1µDALY/person/year.
		3	No comment provided in submission
		4a	No comment provided in submission
		4b	No comment provided in submission
		4c	No comment provided in submission
		5	WSAA questions the blanket 1-log reduction and basis by which the default LRVs have been derived. Clarity is sought. The mathematical notation style adopted in the Appendix does not lend itself to easy interpretation by water industry practitioners, and adds little value to the ADWG.
		6	It should be noted that the proposed amendments to Chapter 5 will create the need to undertake a series of consequential amendment to the existing text in Chapters 2 and 3, and Appendix I of the ADWG, to ensure consistency and alignment across the whole document. Page 2 Paragraph 1 Section 5.2 Microorganisms in drinking water WSAA members seek clarification on the “reference virus” described in Section 5.2. The wording suggests an agglomeration of different viruses/characteristics, but there is no detail on how these characteristics have been blended into a single reference virus. Page 5 paragraph 1 Section 5.2 Microorganisms in drinking water WSAA questions the reference to ‘42 outbreaks in recreational water’ and its relevance in a document focused on the provision of safe drinking water. While it is recognised that the reference illustrates that water-related outbreaks in Australia are almost never recorded in public drinking water supplies, the inclusion of this information sends a mixed signal and is of questionable relevance. Page 6 Section 5.4 Enteric pathogens Table 5.1 WSAA questions the relevance of the reference to the consumption of contaminated food under Hepatitis in Table 5.1 and suggests removing it. The Hepatitis risk only arises if pigs consume recycled water derived treated sewage, not treated drinking water. Page 7 Paragraph 4 Section 5.4.2 Contamination of source waters with enteric pathogens WSAA acknowledges that the breakdown of barriers can lead to waterborne disease outbreaks, but recommends, for the purposes of clarity, the inclusion of a statement that the scale and nature of the breakdown have a significant bearing on whether an outbreak occurs. Page 17 Section 5.4.2.2 Groundwater WSAA seek more detail and guidance around this requirement. Specifically: • the criteria and standard of the evidence required to demonstrate the determination of ‘protected’ groundwater, particularly in light of the findings of the Inquiry into the Havelock North waterborne disease outbreak in New Zealand • how a water business can demonstrate aquifer security to the satisfaction of the health authority or other regulator . Page 18 Section 5.4.3.1 Source water protection Regarding the statement “effective catchment management practices should provide the potential for the source classification to be reduced”- further

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			guidance on how this could be achieved should be provided. It should be aligned with the guidance provided in the WSAA HBT Manual. Page 20 Section 5.4.3.2 Treatment Targets The last paragraph on page 20 discusses the decision to down-rate the LRV for Cryptosporidium. For the derivation of LRV requirements, Cryptosporidium data from a Water Research Australia project, authored by Dan Deere, Susan Petterson et. al. was used. They cite average Cryptosporidium concentrations. Was the use of averages considered when calculating the new default LRVs listed in the draft Table 5.6? If this is the case then using the average rather than the maximum would remove some of the conservatism of the LRVs. It should also be noted that the text on page 20 is not consistent with the default LRVs presented in the August 2016 draft released by NHMRC. Specifically, the LRVs for Cryptosporidium have gone up for Categories 2 and 3, while there has been a decrease in the Cryptosporidium LRV for Category 4. Page 21 The text states: "If the source water categorisation and required LRV is considered by the water supplier to be too high for a specific site, it must be discussed with the relevant party (e.g. a health authority or other regulator) who will be the ultimate decision maker when deciding whether a lower category is sufficient to achieve safety. This should be undertaken with a more detailed site-specific assessment and may include application of QMRA including direct analysis of pathogen data (Box 5.4)". Will more information be provided on the detailed site-specific assessment and QMRA analysis, including pathogen data? Could this assessment and analysis be undertaken to provide a more robust support for the microbial HBT assessment? Is this similar, or equivalent, to the Tier 2 assessment from the previous draft text that was released in August 2016? It is worth noting that the technical guidance provided in the current draft is difficult to follow and its derivation is harder to understand, compared to the information on QMRA and its application as provided in the August 2016 draft text. Applying QMRA through system-specific pathogen monitoring to establish source water quality is a direct method for determining treatment requirements. However, this approach is not always practical. Further guidance on examples of when QMRA is useful would be helpful Pages 22-25 Table 5.6/5.7 Section 5.4.2 Contamination of source waters with enteric pathogens Clarification is sought on where membrane filtration fits in relation to the Indicative Specific Treatment Technologies column in Table 5.6 Regarding the headers on Table 5.6 (page 22) and Table 5.7 (page 25) – members would find reading of the table easier with the listing of pathogen groups in the same order in both Tables (preferred order would be protozoa, viruses, bacteria) Page 25 Section 5.4.2 Contamination of source waters with enteric pathogens Table 5.7. Indicative pathogen LRV potentially attributable to treatment barriers The two columns of LRVs listed in Table 5.7 are confusing. There needs to be a clear explanation about what is meant by achievable versus validated to clarify which column one should choose from. It is assumed that validated is the only relevant column, as, unless new validation information is produced the achievable value can never be accepted. Table 5.7 should also include a row for direct filtration. Sections 5.2 and Appendix D of the WSAA HBT Manual outline a number of treatment processes and 'default' LRVs that can be used based on performance criteria for that treatment barrier e.g. turbidity and time criteria for media filtration processes. WSAA members consider that this is an appropriate approach and sufficiently conservative to meet the 1µDALY/person/year criteria, and the ADWG should align with this methodology. In addition, members consider that the USEPA C.t values for free chlorine and chloramine be adopted for the respective LRV values for chemical disinfection. The USEPA C.t values are internationally-referenced and used in many regulatory jurisdictions. They are quoted extensively elsewhere in the existing ADWG. The current reference to a C.t of ≥ 15 mg.min/L for 4 log virus inactivation at a specific pH and temperature range is overly conservative when compared to the USEPA values. WSAA therefore recommended that: • Table 5.7 in the draft text of Chapter 5 be replaced with Tables A5.4.1 and A5.4.2 from 2016 draft HBT draft (in that way, water utilities know what they must do to achieve the required LRVs) • Add the following two dot points below into the list of dot points above Table 5.7: o The LRVs associated with pre-validated treatment units, particularly in the case of pre-validated UV units, can be accepted as representing the default LRVs, if the operational parameters to claim the prevalidated LRVs o For other treatment processes, LRVs that are published by recognised sources can be used if the operational conditions under which those LRVs have been proven can be consistently achieved. Page 26 Section 5.5 Opportunistic pathogens Table 5.8 The last line in section 5.2 states that pathogen risk caused by pathways other than ingestion will not be discussed further. Table 5.8 revisits this topic in last column of the table. It is suggested that amendments be made to improve consistency across the draft. This submission is a collation of comments from very experienced and senior water quality professionals across the country. These industry experts are responsible for the management, treatment and delivery of safe drinking water to Australia's urban community. ***This submission reflects a consensus view.***

#	Organisation	Q	Comments Received
13	Melbourne Water	1	Melbourne Water (MW) supports the inclusion of microbial health-based targets (HBTs) in the Australian Drinking Water Guidelines (ADWG) and provides this feedback on the Draft Chapter 5 Microbial Quality of Drinking Water and Draft Technical Appendix: Derivation of microbial treatment targets for enteric pathogens contained in this submission and recommends clarification of a number of items. MW supports the recommendations made in the WSAA submission and in addition provides organisationally specific comments relevant to managing and providing water from protected (vulnerability category 1) source waters. MW is committed to the adoption and implementation of HBTs to manage microbial risks in its water supply system and has adopted Health Based Targets and the 1µDALY (equivalent to 10^{-6} DALYs per person per year) in its 2017 Drinking Water Quality Strategy (MW 2017). Since adopting HBTs, MW has undertaken a preliminary Water Safety Assessment in line with the WSAA publication "A Manual for the Application of Health Based Treatment Targets", (WSAA manual hereafter). MW understands the need for succinct regulation however we feel that the current draft chapter 5 would be difficult to implement without further guidance. Based on our experiences of applying the WSAA manual we request that draft chapter 5 refer to this document to ensure practicability of HBT implementation. This is consistent with referral to other secondary documents such as the "Guidelines for legionella Control in the operation and maintenance of water distribution in health and aged care facilities (section 5.5)". The WSAA manual represents significant industry consultation, data collection and validation of approach over a period of almost 10 years and as such should be seen as a valuable resource by the NHMRC. The wording of section 5.3 should be reviewed and edited to ensure clarity and consistency throughout and adoption of the relevant rigorous scientific terminology. It would be helpful to include some description of and references to the body of work that has supported the adoption of 1µDALY. Specific comments are included in later sections however the most significant issues MW envisages are: 1. In situ validation – the original intent was to provide log credit for existing treatment processes to avoid full scale validation. This is particularly important for conventional filtration treatment plants where there is no internationally recognized approach to validate in situ. For this reason sophisticated turbidity targets were developed and trialled in more than 80 water supply systems around Australia and MW supports the use of these parameters rather than bespoke validation. For MW it would not currently be possible to undertake full scale validation of our 500ML/d conventional filtration plant given the lack of suitable protocols. 2. The E. coli band for vulnerability category 1 of less than 20 CFU per 100ml. Melbourne draws much of its drinking water from large protected catchments with negligible human contamination sources. We have undertaken source water and catchment characterization for more than 15 years. Our extensive water quality data set indicates that at times E. coli in water sources drawn from the most protected catchment can exceed 20 E. coli and not be environmental E. coli, i.e. E. coli originating from animals or birds. Some wording to support the results of individual organizations' risk assessment would be helpful. 3. Tier 1 and Tier 2 approach. The original approach in the WSAA manual was designed to avoid utilities having to collect pathogen data for a QMRA. The approach of Tier 1 and Tier 2 was clear and allowed utilities the flexibility to adopt the source water category and use the Tier 1 approach OR collect pathogen data to form a QMRA. This simple approach has not been adequately captured in the draft chapter 5. 4. The technical appendix is too complex and includes information that was not in the original WSAA document. Given the WSAA document has been the basis on which utilities in every state of Australia adopted HBTs, and there has been significant resources put into it, there would be value in aligning with this document to ensure consistency. Melbourne Water feels a reference for the values of two years in the Microbial Indicator Assessment and 100 samples should be provided. There may also be value in articulating what event sampling requirements may be, including reference events such as those based on Australian Rainfall and Runoff guidelines. Melbourne Water welcomes the inclusion of text relating to environmental blooms of E. coli. We feel that this section could be strengthened with the further information (here or in the appendices) on: • The data necessary required to make this conclusion • Potential issues with genotyping and amplification, i.e. high susceptibility to contamination and amplification of DNA from non-viable organisms • Indefinite results, i.e. %age similarity and no industry established standards
		2	The LRV treatment requirements in table 5.6 differ from previous versions and the WSAA manual with changes (increases) to most LRVs. The rationale for these increases is hard to infer from the technical appendices and the application of a 1 log discount for Cryptosporidium for Australian target values appearing to be somewhat arbitrary. It should be noted that Australian data and a significant body of evidence was used to generate the LRVs in the WSAA manual and that the LRVs (table 3) represent the worst case for each category. MW recommends the use of the LRVs from the WSAA manual. • Of particular relevance for Melbourne Water is the jump from 0 – 3 LRVs for protozoa LRV requirements between category 1 and 2 catchments.

#	Organisation	Q	Comments Received
			• Indicative specified treatment is unclear and Melbourne Water recommends clarification, for example are there situations where a category 2 source water may be treated with UV and chlorine? • "Treatment technologies are assumed to be well designed, managed and monitored". This would be better expressed as meeting treatment targets such as turbidity and UV dose. MW recommends that the table from the WSA manual be adopted in place of draft chapter 5 table 5.6 to aid water authorities in being able to develop appropriate treatment trains to manage microbial risks identified by the vulnerability or microbial assessment.
		3	As previously noted MW notes a significant departure from the original intent of log credits vs. validation. MW feels that the statement that "The LRV should be validated on a site-specific basis" is not practicable, for example ADWG chapter 9 states that, "Validation testing of media filtration systems is a highly specialised and complex task". MW recommends the use of industry established operational thresholds such as turbidity, C. t /residual chlorine and UV dose or transmissivity. As previously noted MW does not support in situ validation however if guidance on validation from AGWR is to be adopted it should be noted that (p.96 AGWR) "Validation needs to be performed, or at least overseen in detail, by an independent and appropriately qualified professional or group of professionals". Reference is made to ADWG chapter 9 for guidance on monitoring. Given the complexity of monitoring required for validation this is unlikely to be sufficient.
		4a	No Comment Provided
		4b	No Comment Provided
		4c	No Comment Provided
		5	Melbourne Water does not feel that the technical appendix is clear, and it is inconsistent with a manual that has already been successfully tested at both pilot and trial scales. There is little reference to the technical appendices in draft chapter 5 to indicate where a reader may find further information or the basis for a threshold or standard. For example draft section 5.2 could point to appendix section A4 and so on.
		6	Melbourne Water feels that the box on hydrodynamic modelling uses vague terms such as 'high enough temperature'. This document should provide either a reference to more detailed guidelines or specifics such as events (including low probability events) and base dilution. The inclusion of the 'typical characteristics' column to table 5.2 is a welcome addition and aids in bringing all relevant information together. The table remains a little unclear in its terminology however, and some aspects appear to be inconsistent and contradictory, for example: • For a vulnerability category 1 human habitation can be negligible yet must be excluded from the catchment area. • Large storage is defined interchangeably as, a storage >1 GL and (Melbourne Water's preference) a storage where storage exceeds annual inflow. Many terms such as, negligible , minimal, moderate, formal settlement, inner and outer catchment, low level recreational activities etc. could do with further definition and ideally guidance for water authorities on proportionality and decision making. Given the importance of the vulnerability assessment, the technical appendices should have a section on this topic. MW also notes that this is an area for improvement in the WSAA manual and that a number of Water Research Australia (WRA) projects have been proposed to address this. MW also recommends that table 5.2 footnote 2 should include feeder streams as requiring a buffer of 2-3km as inputs directly to these may not be adequately attenuated prior to the offtake.
14	Parkes Shire Council	1	3.1. Category selection 3.1.1. Vulnerability assessment Council has concerns with the determination of category source selection in the Draft Chapter 5. Council's catchments have a small population, large catchment area and low-level intensity recreation typical of many areas west of the dividing range. There are limited faecal inputs in the inner catchment but no formal catchment protection. From the descriptions of the Source of microbial risk and the Intensity of activity columns in Table 5.2, these catchments would be Category 2 or 3 however from the Protection measures column the catchments would be in Category 4 as they do not have enforced regulation within inner catchment area.

<table>
<tr><th>#</th><th>Organisation</th><th>Q</th><th>Comments Received</th></tr>
<tr><td></td><td></td><td></td><td>If Council's sources are Category 4 due only to a lack of enforced regulation within inner catchment area, undertaking the microbial indicator assessment would not assist to determine if a Vulnerability Category 3 or 2 is more appropriate based on Table 5.4.

Council is concerned about the implications of requiring enforced regulation as a protection measure to be considered a Category 3 catchment. Greater consideration of the risk and required protection measures is necessary for low-density catchments such as those west of the Dividing Range.

Given the step-change in treatment technology between category 3 and 4 greater consideration should be given to the nuances in catchment categories, particularly for low density catchments.

3.1.2. Microbial indicator assessment

For Parkes Shire Council to undertake a microbial indicator assessment (i.e. raw water E. coli monitoring) across all of Parkes raw water sources according to the methodology provided in the Draft Chapter 5 would take a minimum of 10 years. This is due to the complexity of the raw water system and how the bores are used. For example, of the 8 bores only 1 or 2 are used at any time. The requirement for 100 sample points would take a significant period for all the individual raw water sources to obtain the required 2 years' worth of data. The estimated monitoring cost for this program alone is $100,000 or approximately $18 per connection.

Greater consideration should be given to the requirements for the number of microbial data points, particularly for water utilities with multiple raw water sources.

Council is concerned by advice that a default category 4 should be adopted by small water suppliers as this rating could undermine community confidence in the water supply system and the current ability of the new WTP to deliver safe water. To comply with Category 4 treatment requirements, an additional treatment process unit would need to be installed at the new Parkes WTP.</td></tr>
<tr><td></td><td></td><td>2</td><td>3.2 Cost Implications

A calculation of the LRV shortfall for Category 3 and Category 4 against current WTP treatment capability has been undertaken for Parkes new WTP (Table 31). Additional treatment would be required to meet Category 4 requirements. Indicative costs associate with installation of UV to meet the LRV shortfall associated with Category 4 are shown in Table 32.

Table 31. Difference between Parkes WTP achievable LRVs and Category LRV requirements
<table><tr><th>Parkes WTP</th><th>Protozoa</th><th>Virus</th><th>Bacteria</th></tr><tr><td>Category 3</td><td>0</td><td>1.5</td><td>3</td></tr><tr><td>Category 4</td><td>-1</td><td>0.5</td><td>2</td></tr></table>
Table 32. NPV cost estimate to upgrade Parkes WTP to Category 4
<table><tr><th>Parameter</th><th>Result</th><th>Comments</th></tr><tr><td>UV capital costs</td><td>$175,000</td><td>Capital and construction costs over a 20-year period</td></tr><tr><td>UV annual and maintenance operation costs</td><td>$145,000</td><td>Costs over a 20-year period</td></tr><tr><td>Total Costs</td><td>$320,000</td><td></td></tr></table></td></tr>
</table>

#	Organisation	Q	Comments Received
			The need for significant investment in infrastructure as a result of a default Category 4 assignment should be reassessed and further evidence provided to support the basis of such an investment
		3	3.3. Validation of systems The current draft Chapter 5 provides limited information on validation of systems in the context of health-based targets. Page 24 notes "The LRV should be validated on a site-specific basis". This requires further supporting detail. The role of desktop and field validation should be discussed and appropriate guidance for conducting validation should be identified. Challenge testing of regional and remote systems is unjustified. **Further clarification of how on-site validation should be undertaken should be provided**
		4	3.4. Default LRVs Default worst case LRVs are overly conservative for Cryptosporidium as stated in Section A.9 of the technical appendix. A reduction of 1 log10 has been used to determine the protozoan LRV requirement values (Table A.8 to Table A. 9). Currently the basis behind the level of conservativeness in the LRV has not been quantified. As the protozoa LRV value can significantly impact asset infrastructure costs (as discussed in section 3.2), further evidence should be provided around this conservatism. Details should also be included on what evidence would be required to further reduce the LRV requirement, as stated "It may be that in certain situations even greater reduction would be appropriate (e.g. high ambient temperatures, long travel time of oocysts). In this situation the case to further reduce the LRV should be made directly to the relevant party (e.g. a health authority or other regulator)" **Further evidence should be provided on the assumptions of using a reduction 1 LRV for protozoa and the evidence that would be required to further reduce this conservativeness by a water utility**
			4. Conclusions Parkes Shire Council have concerns reviewing the Draft Chapter 5 Microbial Quality of Drinking Water including: • Given the step-change in treatment technology between category 3 and 4 greater consideration should be given to the nuances in catchment categories, particularly for low density catchments. • Greater consideration should be given to the requirements for the number of microbial data points, particularly for water utilities with multiple raw water sources. • The need for significant investment in infrastructure as a result of a default Category 4 assignment should be reassessed and further evidence provided to support the basis of such an investment. • Further clarification of how on-site validation should be undertaken should be provided. • Further evidence should be provided on the assumptions of using a reduction 1 LRV for protozoa and the evidence that would be required to further reduce this conservativeness by a water utility. These concerns apply not just to Council's operation but are applicable to a broad number of utilities operating in Western NSW.
			While the addition of HBTs is useful, the current draft has some practical shortcomings, would be difficult to implement and could shift the focus away from the Framework for Management of Drinking Water Quality. I request that NHMRC consider the following when reviewing Chapter 5: • The Chapter needs to be very clear about the connections between the HBT and the relevant aspects of the Framework. Several agency comments also addressed the need to maintain the holistic approach recommended by the Guidelines, and to avoid undue emphasis on treatment. Attention to the HBT should not distract from other system management priorities, such as catchment management, and distribution system monitoring and maintenance. • The Chapter should be clear that a small shortfall in log reduction does not necessarily make a system unsafe. The role of the HBT in setting priorities should be emphasised. For example, supply systems that are close to the target will have the least urgency to take action.

#	Organisation	Q	Comments Received
			• The quantitative microbial risk assessment appears to determine levels of protection to reduce endemic disease risks. The distinction between preventing outbreaks and reducing endemic illness is important as it defines whether the protection addresses unusual incidents or continuous threats. This distinction is introduced on page 5. However, elsewhere it is unclear whether the HBT is intended to protect from endemic illness or outbreaks. An example is the recommendation to use the maximum E. coli value from monitoring (likely to be indicative of an outbreak rather than an endemic risk). • Consideration should be given to moving more of the technical aspects of the HBT to the Appendix. The revision of the Chapter needs editing to apply a plain English style.
15	Department of Natural Resources, Mines and Energy (Queensland)	1	The Water Supply Regulator within the Department of Natural Resources, Mines and Energy (Queensland) considers the use of epidemiology and risk assessment to determine microbial risk, as sound.
		2	The last paragraph on page 15 states 'source waters that regularly return *E. coli* concentrations >20,000 organisms per 100mL should be reconsidered as to whether it is a suitable source water for drinking water supplies'. Consideration should be given to providing some tighter definition around the term 'regularly'. A significant amount of groundwater in Queensland is sourced from deep artisan aquifers with water drawn at temperatures in excess of 50 degree Celsius. Consideration of temperature in reducing enteric pathogen concentration in ground water should be identified in the chapter.
		3	Drinking water services in Queensland are largely provided by local councils that vary considerably in size and remoteness. Implementation issues are likely to arise from the need for underpinning knowledge and skills within the local councils (i.e drinking water service providers) to validate the LRVs for their particular water supply scheme. Small drinking water service providers would not have the capacity to validate their LRVs. As an alternative, inclusion of default LRVs based on drinking water service providers achieving set process critical limits should be considered as this approach would alleviate the highly technical process of validating LRVs.
		4a	
		4b	
		4c	
		5	No comment
		6	Whilst the appendix is aimed for engineers and scientists, chapter 5 contains technical and scientific content that lacks pragmatism in terms of its application and frequently refers the drinking water service provider to a 'health authority or other regulator' to fill a gap in application. In Chapter 5 the drinking water service provider is advised to discuss the following matters with a health authority or other regulator: • Requirement for event sampling when abstraction of source water is used as a source control which in turn are used for determining source category • Lack of alternative source water if source water is considered not suitable for drinking water supplies based on E.coli monitoring data • E. coli monitoring data that are not aligned with the source water vulnerability assessment • When the drinking water service provider considers site specific matters and believes the required LRV is too high for the source category Furthermore, chapter 5 advises a drinking water service provider managing groundwater as their source water, demonstrate to a health authority or a regulator, their validation of their aquifer performance in terms of risk mitigation. By defaulting to a health authority or regulator to provide technical advice or approval, NH&MRC has made assumptions of the health authority or regulator capacity, capability and appropriateness and inadvertently guided drinking water service providers towards a regulatory framework that may not actually exist or be appropriate within their own jurisdiction. DNRME, as the regulator in Queensland does not believe it is the role of the NH&MRC to be outlining regulatory requirements within the ADWG. We also note the absence of simpler guidance that was provided

#	Organisation	Q	Comments Received
			in the 2016 draft microbial HBT framework with regard to specific treatment technologies for small or remote drinking water supplies. Although more conservative in approach, the inclusion of guidance for small and remote drinking water supplies would benefit a significant number of supplies within Queensland and would be consistent with the approach already available in the ADWG for other elements of safe drinking water provision e.g section 9.11 - monitoring advice for small remote or community-managed water supplies.
16	Water Research Australia [NHMRC has redacted information upon request]		Public - WaterRA Project #1091/16 - Management of potential contamination risks from pipeline repair or renewal works With reference to paragraph '5.4.3.3 Management of the distribution network' on page 26 WaterRA wishes to advise the NH&MRC of the recently completed project 'Management of potential contamination risks from pipeline repair or renewal works'. The project was funded by WaterRA, and undertaken by Atom Consulting, NSW. It aimed to identify areas for improvement in pipeline repair and renewal management practices. Methodology used in the project included: • Information review – national industry engagement session and desktop literature review • Identification of current management practices for pipe repair and renewal works of Australian water utilities - Mapped through case studies and an industry survey • Development of control framework - including evaluation and comparison of industry against proposed framework The project delivered a control framework developed for use by Australian water utilities, taking into account existing control strategies and utility-specific risks. Due to the varying controls used and degree of implementation currently being undertaken by water utilities across Australia, the developed framework aims to be flexible while allowing for areas of improvement to be identified based on individual utility risks. The Pipe Repair and Renewals Control Framework has been developed to align with the Australian Drinking Water Guidelines (ADWG 2011) Framework for the Management of Drinking Water Quality (the ADWG Framework). The Pipe Repair and Renewals Control Framework consists of a three-stage approach: 1. Define risk approach 2. Pipe break event 3. Evaluation and review WaterRA recommends that the Pipe Repair and Renewals Control Framework be referenced within paragraph 5.4.3.3 as it is publically available from the WaterRA website.
			Public - WaterRA Project #1059/12 - Bad tastes, odours and toxins in our drinking water reservoirs: are benthic cyanobacteria the culprits? In reference to paragraph 5.7.1 Organisms causing taste and odour problems, WaterRA wishes to advise the NH&MRC of recent research on benthic cyanobacteria. Recent research conducted in Australian drinking water reservoirs demonstrated that benthic cyanobacteria represent a significant source of toxins and taste and odour compounds (Chen et al., 2010; Seifert et al., 2007; Gaget et al., 2017a; Gaget et al., 2018a; Gaget et al., 2018b (in press)). A few benthic species detected to be toxigenic are producing hepatotoxins (Seifert et al., 2007; Gaget et al., 2017). Interestingly, Gaget and collaborators highlighted the production of anatoxin-a by benthic cyanobacterial species in Australia. The compound appears to be a different variant of anatoxin-a than that observed in pelagic species internationally. More work is needed to characterize this compound and its toxicity, but if confirmed, this represents the first report of anatoxin-a in Australia. It was demonstrated in these studies that the following species are toxigenic: - *Phormidium ambiguum*: cylindrospermopin (739 ng/mg d/w), deoxycylindrospermopsin (107 ng/mg d/w), - *Nostoc linckia*: microcystin (400 ng/mg d/w), - *Limnothrix mirabilis*: potential microcystin variant (not quantified due to lack of standard), - *Lyngbya wollei*: cylindrospermopsin (33 ng/mg d/w), deoxycylindrospermopsin (308 ng/mg d/w),

#	Organisation	Q	Comments Received
			- *Geitlerinema carotinosum*: anatoxin-a (not quantified due to lack of standard), - *Limnothrix sp.*: anatoxin-a (not quantified due to lack of standard). Similarly benthic genera/species were identified to produce geosmin and MIB in drinking water reservoirs (*Pseudoanabaena galeata*, Phormidium/Oxynema, Lyngbya). In Gaget et al., 2018b, it was demonstrated that 35% of the geosmin concentrations present in water can be explained by production by benthic cyanobacteria and actinobacteria. A current project conducted at the University of Adelaide, coordinated by WaterRA and involving 9 water utilities aims to screen for the distribution of benthic toxin and T&O producers around Australia. This project will also assess the production rate of these secondary metabolites by benthic cyanobacteria under various environmental conditions. This information will help authorities determining whether benthic cyanobacteria represent a real risk for water utilities and whether their monitoring needs to be included in current guidelines and regulations.
			Public - WaterRA Project #1022/12 - Cyanosurvey: A National update on toxic cyanobacteria and their distribution In reference to paragraph 5.7 Nuisance organisms, WaterRA wishes to advise the NH&MRC of a research project undertaken by WaterRA on cyanobacteria. The project (CyanoSurvey) conducted at the Australian Water Quality Centre (AWQC), coordinated by WaterRA and in collaboration with 15 water utilities, aimed to determine the diversity and distribution of toxigenic cyanobacteria in Australia. Results from this project highlighted that the monitoring method chosen to detect certain toxins has an impact on the positive detection and quantification of these toxins (Gaget et al., 2017). For microcystins, ELISA, PPIA and HPLC results generally correlated well, indicating that they all provided a response in proportion to the total microcystins present. However, the actual concentrations determined varied, with the PPIA quantification being on average only 60% of the ELISA result. This suggests that each assay is "seeing" the mixture of microcystins present differently, based on its detection mechanism. For cylindrospermopsin, the ELISA and LC-MS methods both produced comparable results, while PCR results correlated well with detection of CYN-producers by microscopy. However, the PSI assay was positive in many samples when no other measure indicated the presence of CYN. This may be due to the presence of the putative toxin limnothrixin as the assay is known to be sensitive to this novel cyanotoxin. If so, the present results suggest a widespread occurrence of the cyanobacteria responsible for its production. For PSTs, the ELISA appeared to underestimate the mass of PSTs present when more than one variant was present. This is probably due to poor cross-reactivity for the high proportion of C-toxins in most Australian *Dolichospermum circinale* samples. Therefore, chromatographic analyses remain the most reliable approach available for this group of toxins.
17	Viridis Consultants Pty Ltd	1	We often hear from utilities that there have been no reports of illness due to their water supply. Also, in one case where they requested details of Cryptosporidiosis in the local area from the health authority to justify not installing a barrier for protozoa. I think this section gives a good background on risk assessment. But, possibly there needs to be a clear conclusion, that for the purpose of the ADWG QMRA is the selected technique to determine HBTs.
		2	My only comment is in relation to Category 1. This is fine for normal circumstances, but for abnormal circumstances is it adequate, especially after recent events such as Havelock North. Where there is no filtration there is often very little monitoring of parameters such as turbidity that may indicate that there is an issue. Should there be a caveat that there needs to be some form of monitoring that would provide an alert of abnormal circumstances. Maybe, in certain circumstances there may be a need to undertake Crypto monitoring to demonstrate this category, especially if it is surface water. There is a large financial incentive to some for being in Cat 1.
		3	Box 5.1, default Cat 4 with no E. coli data, I agree in theory but practically how can this be implemented? The utilities without data are generally the smaller ones and don't have the resources to provide increased treatment capacities and the regulators would find it difficult to regulate. How about a Cat 3? In this instance they'd only be 1 log short of a Cat 4 and this would fall in the Enhance Control/Improve Operation on the Water Safety Continuum, if in fact it was Cat 4? Table 5.2 Vulnerability Assessment, there is a number of subjective terms used in this table, such as negligible, minimal, moderate, low, medium, high & intense. These require interpretation when applying this methodology and there is a significant potential for different interpretations. It is reliant on the use of E. coli monitoring to

#	Organisation	Q	Comments Received
			normalise the categories. Failing definitions, worked examples would be good. Table 5.2, .source water is typically low enough (<1 NTU) at the offtake....Should this be always low enough? Or could it say that disinfection should NEVER be compromised.
		4a	
		4b	
		4c	
		5	No comment
		6	In the Chapter possibly using Bands 1, 2 & 3, as well as Categories 1, 2, 3 & 4 could be a little confusing, especially in the matrix in Table 5.4. Band A, B & C might make it clearer.
18	Individual Karen Pither	1	The approach is sound, however the link between LRV's, validation and setting critical limits can be strengthened. As with experience with Table 3.4 in the AGWR, there is potential for Table 5.7 to be misused, and relied upon instead of undertaking validation. My understanding is that the ultimate goal of this section is for drinking water systems to establish a validated operational range that is proven to meet the required LRVs. It is a framework for setting appropriate critical limits, and identifying when a system is no longer achieving the LRV and taking action to prevent unsafe water being supplied. I feel that a little more elaboration about how this will translate and impact of operation will improve understanding.
		2	No comments
		3	At present, many drinking water service providers do not undertake online operational monitoring and there is not a great awareness of how the health based treatment targets framework relates to system operation and operational monitoring. For example, many schemes struggle to take a daily grab sample from combined filters, let alone individual filters. I think the the biggest difficulty will be the ability of many operators to take the next step and implement appropriate operational monitoring and setting critical limits based on the required LRV.
		4a	
		4b	
		4c	
		5	Yes
		6	None
19	Central NSW Council (Centroc)		2. Issues 2.1Original Draft Framework Submission In September 2016, the NHMRC initially proposed the inclusion of microbial health based targets (HBTs) in the Australian Drinking Water Guidelines (ADWG) and were seeking public comment on the draft framework. Centroc Water Utilities Alliance (CWUA) made a submission on the draft framework with key comments as follows. The CWUA membership supports overarching comments made in the submission by the NSW Water Directorate that the evidence on which the Draft Framework on microbial health based targets is based is currently insufficient to justify the potentially enormous infrastructure investment that would be required to meet the Framework.

#	Organisation	Q	Comments Received
			Specific concerns raised by the Water Directorate and supported by the CWUA were that: Typical catchments for western NSW were not well considered in the Deere et al (2014) paper on which the bin or category classification was based; No credits are given for environmental land and water inactivation of pathogen infectivity; There is little recognition of the proximity of the activity relative to the source water offtake, particularly for run of river systems. the investment required to comply with the framework, the amount of monitoring and data collection required, the discrepancy between catchment categorisation based on sanitary survey versus faecal indicators, and the insufficient data available to provide a complete HBT approach. Centroc had a number of additional concerns on the implications of the draft HBT framework being implemented. These included: Additionally, Centroc highlighted the desire to participate in a pilot project to investigate potential issues that HBT implementation may bring. There have been several additions and changes to the draft revised Chapter 5 (DRC5), in relation to the previous issues listed above. The following sections address these changes in relation to Centroc's existing concerns. 2.2 Investment Requirements The requirements as laid out in the draft HBT framework were expected to require significant capital investment in new infrastructure and improvements to existing facilities, as well as ongoing operational costs. Centroc requested additional evidence be provided to support the health benefits suggested, and to compare these against other health issues in regional communities. The Draft Technical Appendix: Derivation of microbial treatment targets for enteric pathogens contains much greater detail into the health outcome target, as well as prevalence rates for reference pathogens as well as the 'burden of disease' for these key pathogens. This serves as an improved point of comparison to other health issues; however, the concern on levels of investment still stands. To achieve the HBTs, each water supply system will require multiple capital and operational improvements. This will require millions of dollars for each water supply system. Centroc has more than 30 water supply systems between its member water authorities. The funding required to enable implementation of the new HBTs will easily run into the tens of millions of dollars for Centroc Councils. Additionally, Centroc Councils will require increased resources to implement the changes required. While many of our Councils are reasonably resourced and motivated, others will struggle to manage, provide sufficient expertise for, and program in such significant projects. In response to this consultation, CWUA member Parkes Shire Council has undertaken a review of the potential infrastructure investment required to implement HBTs, in a low-density catchment typical of those west of the Dividing Range. Notable is that in March 2018 Parkes opened its new water treatment plant which was designed to and meets the requirements of the 2011 Australian Drinking Water Guidelines in March 2018. Refer to Parkes Shire Council Submission to the NHMRC, ADWG Draft Chapter 5 Microbial Quality of Drinking Water. The NSW State Government has recently commenced the Safe and Secure Water Program which has proven popular and thus appears to be over-subscribed in the short term at least. It has also become clear that this process has significant uncertainty in funding allocation success and timing of funding for projects. Significant consideration will need to be given to an additional funding program with suitable support for water suppliers. 2.3 Data Collection and Monitoring Box 5.1. Small water suppliers (page 8) relates to the point of limited data and resources available to base a source water classification. The NHMRC suggest that where no E. coli water quality monitoring data are available, a category 4 rating is allocated by default. If a less conservative category (categories 3 or 2) is thought to be suitable by a supplier, this should be demonstrated to the health authority or regulator. This is intended to provide a longer-term incentive to improve system understanding through E. coli monitoring.

#	Organisation	Q	Comments Received
			NHMRC's position on this issue has not changed since the original draft Chapter 5, and the concern that this could easily result in higher than necessary treatment requirements and therefore inflated operational and infrastructure expenditure remains. We maintain that further support should be provided to water utilities that do not have the population to support greater data collection and monitoring. This would ensure an accurate assessment is able to be made and capital expenditure minimised. NHMRC should also provide more detailed guidance on the type of evidence required to demonstrate category 2 or 3 classification in the absence of E. coli data and who the relevant authorities will be evaluating this evidence. As it stands this is a rather vague statement that can have a significant financial and resourcing impact on small water authorities
20	Clarence Valley Council		Council notes that there have been several changes in response to submissions from the August 2016 draft, but further to Council's original submission to that draft dated 4 November 2016, Council still has some concerns regarding anomalies in the draft revision Chapter 5 compared with other sections of the Australian Drinking Water Guidelines (ADWG). Table 5.3 - Summary of E. coli bands for source water intended for drinking water Council thanks the committee for taking into account its previous concerns regarding how selective extraction is to be accounted for when determining the data set, and considers the recommended approach of discussing management of the dataset "with the relevant party (e.g. a health authority of other regulator)" is an appropriate way to address this issue as the selective extraction practice would normally be a site specific issue. However, Council concerns outlined in its previous submission regarding the "E.Coli number per 100mL" being specified as the "maximum value in dataset" when determining the E.Coli band have not been addressed in the revision. As outlined in Council's previous submission, this approach contrasts with the current ADWG philosophy of using the 98th percentile value in an E.Coli dataset in recognition that there are possible erroneous results from laboratory errors, sample contamination etc. and also does not provide any recognition of the size of the dataset. A single value in a data set with the minimum number of data points suggested on page 15 of the draft Guidelines (i.e. 100 data points) represents the 99th percentile value, but in a data set with 500 data points a single value represents the 99.8th percentile value. Requiring the use of the highest value in Table 5.3 effectively makes the guideline a "pass/fail" value, which contradicts the intent outlined on page 22 that the "microbial target should be applied as an operational benchmark rather than a pass/fail guideline value". Recommendation: That in Table 5.3, the "*E. coli* number per 100mL" requirement be changed to "(Maximum value in dataset where <100 data points; otherwise 98% value in dataset)"
			Table 5.4 - Confirmed source water category based on comparison of E. coli concentration with vulnerability assessment Council reiterates its previous concerns regarding categorisations which are shown as being "feasible" outcomes. While Council considers the comment on page 16 regarding "feasible" outcomes "Both the E. coli data and vulnerability assessment should be re-examined to better understand the reasons for the misalignment", the example then given is a suggested approach where the E.Coli indicates a higher level of microbial risk than inferred by the vulnerability assessment. There is no suggestion of the approach to be followed when the E.Coli indicates a lower level of microbial risk than inferred by the vulnerability assessment. For example, a maximum E.Coli result of 20 (whether it be the single value or 98th percentile value as suggested above) would currently "confirm" a Category 4 catchment classification as the result would not be assessed as being anomalous. Council is particularly concerned regarding this issue because a member of the NHMRC Water Quality Advisory Committee has verbally suggested to Council that the cause of an anomaly where E.Coli indicates a lower level of microbial risk than inferred by the vulnerability assessment is due to "insufficient sampling", notwithstanding that Council had over 250 data points compared with the minimum 100 data points in Table 2.3. The suggestion that the reason for anomalies is insufficient sampling is not considered by Council as "re-examining" to "better understand the reasons for the misalignment" as there is no guarantee that additional sampling would remove the anomaly. Recommendation:

#	Organisation	Q	Comments Received
			That the footnotes to Table 5.4 provide further guidance regarding the approach to be followed when the E.Coli sampling indicates a lower level of microbial risk than inferred by the vulnerability assessment.
			Treatment Targets We note that the Treatment Targets in Table 5.6 are based around achieving a health outcome target of 1 × 10-6 µDALY pppy. Section 1.1 of the ADWG (p2) states that when determining the quality of water to be supplied to consumers, the determination needs to consider "customer expectations and willingness and ability to pay" and subsequently comments (p4) that "excessive caution can have significant social and economic consequences…installing treatment processes that are not required could have a high financial cost and divert funds needed elsewhere". As outlined in Council's previous submission, the draft Chapter 5 does not take this key principle as outlined in the opening chapter of the ADWG into account. A utility's customers, when considering issues such as the financial impact of achieving the benchmark of a microbial target 10-6 DALY pppy, may consider a lower target as "acceptably safe". While it is understandable why public health professionals may desire a microbial target 10-6 DALY pppy, it is considered that a utility's customers should be able to determine whether they accept a lower microbial target. Council considers the Water Safety Continuum, and in particular Figure 5.2 and Box 5.5, provides information which enables the utility to make a determination of the appropriate DALY to adopt in terms of Section 1.1 of the ADWG which balances the quality of water to be supplied, customer expectation and willingness and ability to pay. Recommendations: 1. That the footnote marked with an asterix under Table 5.6 include a note which suggests the Utility make a determination in terms of Section 1.1 of the ADWG regarding the appropriate DALY to adopt, and also reference Figure 5.2 for determining appropriate reductions in the required LRVs should a lower DALY be adopted. 2. The following sentences be added as the second and third sentences in the first paragraph of "Water Safety Continuum": *Under Section 1.1, the Utility needs to determine the quality of water to be supplied to its customers, considering customer expectations and willingness and ability to pay. The Water Safety Continuum provides information on the potential health impact where Utilities adopt a lower health outcome target.*
21	Department of Health and Human Services – Victoria	1	The department is satisfied with the overall methodology to assessing microbial risk in section 5.3.
		2	The LRVs must be revised to reflect an appropriate consumption volume. The consumption volume of 1 litre per person per day is not considered protective across the population and therefore cannot be justified in this context. It is not appropriate to adopt a 'mean' or 'typical' consumption value for protecting the population from pathogenic microorganisms. In adopting a consumption volume, the following should be considered: • the value should be set conservatively (at least the 95the percentile) – after all we are aiming to manage microbial risks which result in acute and chronic harm. • consider the cumulative exposure scenarios beyond drinking, e.g. food preparation, brushing teeth, showering etc. • children and young adults would most likely consume cold water – not drink cups of tea or coffee, and would likely drink relatively larger volumes of water with active lifestyles. • there are campaigns across the Australia encouraging people to drink from the tap and move away from sugar-sweetened drinks, and also to adopt active lifestyles to reduce chronic disease – hence the driver is for people to drink more water. • warmer temperatures are likely to result in higher volumes of consumption. Amend appendices accordingly.

#	Organisation	Q	Comments Received
		3	The department doesn't foresee any major difficulties implementing the proposed treatment targets in Victoria. Victoria's Safe Drinking Water Regulations 2015 require that a risk management plan prepared by a water agency that operates and maintains a drinking water treatment process applied to untreated water must contain details of the methodology that is used by the water agency to quantify microbial hazards, including – (a) the extent to which pathogenic microorganisms are present in water that enters the drinking water treatment process; and (b) the extent to which the drinking water treatment process – (i) removes those pathogenic microorganisms from the water; or (ii) reduces the amount of these pathogenic microorganisms in the water. The department's Guidance on Risk Management Plans and supporting Appendix 2 Quantify microbial hazards provides guidance on how to comply with this regulation. These guidance notes are available for NHMRC to use as appropriate. Refer to https://www2.health.vic.gov.au/public-health/water/drinking-water-in-victoria/water-guidance-notes Section 5.4.3.2 states "*the LRV should be validated on a site-specific basis*". It's unclear whether this is implying that challenge testing be conducted at all sites to validate treatment processes. Further explanation regarding what this validation may entail should be included, including any relevant references. The principles of validation should be included in the chapter to assist with implementation.
		4a	Are there any residual risks from endotoxins following treatment that need to be discussed in this section? Consider inclusion of iron reducing bacteria and potential synergistic effects on legionella growth.
		4b	It is suggested that the scope this section should be extended to harmful algae and include planktonic and benthic cyanobacteria. Response to 4a equally applies.
		4c	Iron reducing bacteria should also be included for groundwater systems under main heading 5.7.Note that some of these organisms can be harmful to health, e.g. dinoflagellates.
		5	The technical appendix would benefit from being subjected to a thorough editing process; this may assist readability and clarity
		6	Section 5.1 must be prefaced with an overarching statement that microbial health based targets, as with any other health based target/values, 'should never be seen as a licence to degrade the quality of a drinking water supply to that level' (refer to section 1.3.2 of ADWG). Anecdotally, there is a perception by some that health based targets can be used to increase the inherent risk to source water (for example permitting recreation on and around water storages) or ease off on the multiple barrier approach. This is most certainly not the case and is a perverse outcome if this perception is perpetuated; increasing the inherent risk to public health. As Chapter 1 of the guideline states - a danger is that the fundamental principles vital to ensure safe drinking water quality become obscured in the detail. These fundamental principles should always be remembered. To this end, the introduction to this chapter must be clear on the purpose of microbial health based targets and reinforce the guiding principles in Chapter 1.1 underpinning the provision of safe drinking water including 'The greatest risks to consumers of drinking water are pathogenic microorganisms. Protection of water sources and treatment are of paramount importance and must never be compromised', the precautionary approach and multiple barriers. Suggest in the introduction in bold and italics insert words to this effect: ***The fundamental principles vital to ensure safe drinking water quality must always be at the forefront. These fundamental principles in Chapter 1 recognise that the greatest risks to consumers of drinking water are pathogenic microorganisms and therefore protection of water sources and treatment are of paramount importance and must never be compromised.***

#	Organisation	Q	Comments Received
			This chapter provides guidance on the quantification of microbial hazards in water and the associated performance targets for catchment controls and treatment processes to manage microbial risk. These microbial performance targets are underpinned by a tolerable burden of disease of 10^{-6} Disability Adjusted Life Years (DALYs) per person per year. ***This health based target must not be interpreted as a licence to degrade the quality of a drinking water supply or reduce the performance of individual barriers for economic or other benefits.*** ***The overall management of drinking water safety must be founded on the precautionary and multiple barrier principle. Health based targets are a tool to understand microbial risks in drinking water within these principles.*** **Appendix A.9** The statement that *the calculated LRVs for Cryptosporidium are most likely conservative* should be evidence-based and appropriately referenced. Further justification should be provided to support a 1 Log_{10} reduction for *Cryptosporidium*. The LRVs in the ADWG should be protective of human health and therefore set conservatively. Additionally, the referral of utilities to regulators in setting HBTs beyond 1 Log_{10} is problematic, leading to inconsistency in the application of HBTs. **General** The document would benefit from an edit and stylised for integration with the rest of ADWG. Guidance is lacking regarding review of treatment process performance to ensure that treatment targets are being achieved. Guidance should be included regarding potential prompts for review, such as source water changes, treatment validation, time periods, microbial assessment of source water and epidemiological evidence.
22	NSW Water Directorate/Local Government NSW	5	Outstanding matters of concern In the 2016 consultation period, both the NSW Water Directorate and LGNSW identified various issues with the draft Health Based Target (HBT) framework. While a few of these issues have been addressed in the 2018 draft, several concerns with the draft remain: Source water assessment Typical catchments for western NSW were not well represented in the Deere et. al. (2014) paper, on which the bin or category classification is based. Many water utilities west of the Great Dividing Range source water from run-of-river systems with extremely low population densities and low faecal inputs directly upstream of their offtake. However, the inner catchments are not specifically protected or enforced. Given the step-change in treatment technology between category 3 and 4, we believe greater consideration should be given to the nuances in catchment categories. **Conservative nature of the calculations** We note there is a level of conservatism in a number of the calculations. This may result in utilities with limited financial and human resources focussing their attention on the installation, operation and maintenance of UV at the expense of higher water quality risk aspects to consumers (e.g. reservoir recontamination, distribution system backflow). **Role of HBTs in a risk management approach** We are concerned that the focus on source water categorisation will reduce the emphasis on catchment protection as part of an overall risk management and multi-barrier approach. For example, once a source is assessed as category 4, there is pressure to open storages for recreation. **Validation of systems**

#	Organisation	Q	Comments Received
			The NSW Water Directorate's August 2016 submission noted there were no log reduction values (LRVs) attributable to filtration systems operating above 0.3 NTU (Nephelometric Turbidity Units). The current draft is limited in the information it provides on validation of systems in the context of HBTs. The statement on p24 "The LRV should be validated on a site-specific basis" requires further clarification on the role of desktop and field validation and should identify appropriate guidance for conducting validation. **Small water suppliers** Small water suppliers are likely to have limited data to confirm their source water category. The assumption these suppliers are category 4 could erode public confidence and may lead to the abandonment of small supply systems and result in poorer public health outcomes. It would be more appropriate that the vulnerability assessment category is used rather than automatically assuming the conservative category 4. The confidence of the assessment can then be improved through the collection of E. coli data. **Category 1 virus LRV target** There is a no explanation for why 0 LRV has been selected for virus for a category 1 source. **Cost/Benefit analysis** LGNSW argued in its August 2016 submission of the need to undertake a detailed cost benefit analysis to ascertain whether the proposed regime ultimately provides net benefits to society in general, and regional NSW in particular, and compares favourably with other potential beneficial action, health related or otherwise. At that time, the estimated capital investment required in regional NSW was suggested to be up to $1 billion. More recently, the NSW Department of Industry has conducted a high-level exercise to estimate the potential financial impact of achieving the proposed HBTs for regional town water supplies and it estimates the impact to be over $1.5 billion.
23	Water NSW		General Comment The present ADWG 2016 does not specify health-based treatment targets. This draft of Chapter 5 is an attempt to improve this shortcoming, and is welcomed by the water industry who aim to provide safe drinking water and a means of demonstrating this; and similarly by those who audit water treatment processes. To this end the water industry developed the Drinking Water Source Assessment and Treatment Requirements - Manual for the Application of Health-Based Treatment Targets (HBT Manual). It is our understanding that the HBT Manual has been widely adopted throughout Australia. While the basis of log removals for protozoa have been based on values accepted in many developed countries, it is known that the log credits for some treatments are variable and that typical values are used. Nonetheless, it is our understanding that this system, where implemented and monitored effectively, has reduced the risk of waterborne disease. We welcome the inclusion of HBT in the ADWG. However, the current draft is confusing and impractical. The validation approach used in the current draft is unclear. Does it require the removal of pathogens or acceptable surrogates to be measured at each plant and use this measurement as the basis for its log removal rating? This replaces the internationally accepted approach of assigning log credits for individual or component parts of the water treatment chain. The draft does not describe how a log removal value for a process is to be determined – does it use a single value, an average, a worst case – and how does it account for the variability of a process caused by operational variables such as source water quality? Not enough thought been given to the practicality of the measured removal approach. Individual water treatment plants cannot simply be taken off-line and tested. Isolation of treatment units also may not be feasible. There are issues of supply to consider, as well as the practicalities of obtaining approval to add potentially harmful material to the source water, and in the amounts needed to dose a steady-state system over a sufficient period to effectively measure the material at sufficient concentration in treated water to obtain statistically valid data. The approach more commonly used to assess treatment efficacy is to look at the inherent capability of the water treatment process (ie assess its theoretical log removal capability) and then establish control mechanisms to measure that the water treatment process is performing to specification. In terms of filtration for

#	Organisation	Q	Comments Received
			protozoa this is achieved by monitoring turbidity; for chemical disinfection this is achieved by c.t and residual disinfectant measurements; for UV disinfection this is achieved by reduction equivalent dose or transmissivity. The draft does not cover this aspect.
			Specific comments P2 para 1 – Which virus(es) used? If it is an agglomeration of different viruses/characteristics it is probably not valid to use the term "reference virus". P5 para 1 – Reference to 42 outbreaks in recreational water doesn't seem relevant to drinking water. P6 Table 5.1 – Hepatitis – suggest remove the comment about food, which is not relevant to waterborne disease. P7 para 4 – Breakdown of barriers can lead to waterborne disease; whether it also leads to outbreaks is merely a matter of scale. P12 Table 5.2 – Where do we recognise the benefits of source and offtake selection? P15 para 3 – It is important to cover a long period to capture sufficient data over a wide range of conditions, so 100 sample and 2 years is OK, but suggest weekly is overly prescriptive. Small supplies may have data at lower sampling frequency over many years, which would be equally valid. P15 para 3 – Statistical validity for the 100 samples is not demonstrated – i.e. what number of samples are required to have a low probability of a Type II error (inferring the status incorrectly). P15 para 3 – Or should we state that testing for enterrococci when unexpected numbers of E. coli are detected to confirm whether they are from faecal origin or environmental – as per p17. P15 para 3 - The microbial assessment should be based on a distribution, not a specific maximum value. For example, consider a dataset containing 256 values at the inlet to a WFP in a protected catchment with vulnerability Category 1, comprising routine (monthly) and event based data, where the maximum value is 2,000 orgs/100mL, but with a 95th normalised percentile of ~19 orgs/100mL. The use of a single data point (the maximum value - a potential outlier or anomalous result) to assess risk may require unnecessary major capital expenditure. The use of a maximum value to assess risk is creating potential bias in the risk assessment process – especially considering that one sample result can change the band (highly sensitive) whereas the bands are factorial (not particularly sensitive). P 17 para 2 – Serial dilution is a normal part of the membrane filtration process and so not necessary to specify here. Taking this detail out makes it easier to comprehend. P 19 Box 5.3 para 4 – Regular water quality monitoring and effective operation of Critical Control Points should also prevent pathogens entering supply. P 22 Table 5.6/P25 Table 5.7 headers – Confusion would be reduced by listing the pathogen groups in the same order in Tables 5.6 and 5.7 P22 Table 5.6 – Why do we need 4.0 LRV for bacteria in Category 1. P22 Table 5.6 – Where does membrane filtration fit in this table? P 25 Table 5.7 – The two sets of LRV columns are confusing. There needs to be a better explanation about what is meant by achievable vs validated. It is not clear as to which column one should choose from. P 25 Table 5.7 – There needs to be a row for direct filtration. P26 Table 5.8 – Last line in section 5.2 says that pathogen risk caused by pathways other than ingestion will not be discussed further; this appears to have been discussed further. P27 Note under Table 5.9 - Is it appropriate to refer to a propriety laboratory website in the ADWG?

Appendix D – Declarations of interest

The declarations of interest of Committee and Working Group members at the time of their involvement in the development of the guidance are listed in the tables below.

Consideration of the declarations of interests of members of the Water Quality Advisory Committee during the period 2009-2012 were undertaken according to NHMRC committee policy at the time.

2013-2015 Water Quality Advisory Committee

Name/Position	Declaration of Interest
Dr David Cunliffe (Chair) Principal Water Quality Adviser, Public Health, Department of Health (South Australia)	• Published a number of journal articles on water supplies and quality. • Involved in the development of the South Australian Safe Drinking Water Act 2011 and Safe Drinking Water Regulations 2012. • Regularly presents on water quality issues at international meetings, Australian specialist workshops, meetings for state agencies, industry and public health interest groups. • Provides annual lectures to the University of South Australia on water quality standards and public health, and the University of Adelaide on water-borne infectious diseases. • Member of the World Health Organization (WHO) Drinking Water Quality Committee and the WHO Small Community Water Supply Management Network. • Member of the International Life Sciences Institute (ILSI) Water Reuse Project Core Group, and ILSI Europe.

Name/Position	Declaration of Interest
Mr Philip Callan Independent consultant	• Published journal articles and book chapters on drinking water quality and regulation. • Involved in the development of the World Health Organization's (WHO's) Water Sanitation and Health programs, and contributed to the 3rd and 4th editions of the WHO Guidelines for Drinking-water Quality. • Currently working on the 5th edition of the WHO Guidelines for Drinking-water Quality. • Individual member of the Australian Water Association. • Member of the Water Quality Research Australia's Regulatory Advisory Committee.
Adjunct A/Professor Sophie Dwyer PSM Executive Director, Health Protection, Queensland Health	• Responsible for water quality standards and related guidelines and publications within Queensland Health. • Involved in Queensland Health activities supporting the fluoridation of drinking water, and has general responsibility for drinking water quality and recreational water.

Name/Position	Declaration of Interest
Dr Andrew Humpage Senior Research Specialist (chemical contaminants) in the Source, Wastewater and Environment Research Group at the Australian Water Quality Centre, South Australia Water Corporation	• Manages research projects in the areas of cyanobacterial toxins, disinfection by-products and chemical contaminants of recycled waters. • Published numerous journal articles, book chapters and reports on water quality and toxicology. Also presented at various conferences, workshops and seminars on these topics. • Co-authored the Australian Drinking Water Guideline Fact Sheet on cyanobacterial toxins. • Currently on the Association of Analytical Communities (AOAC) Task Force on Marine and Freshwater Toxins. • Member of the Project Advisory Committee for Recycled Water for the Australian Recycled Water Centre of Excellence. • Affiliate Associate Professor at the Medical Schools of the University of Adelaide and Flinders University. • Chaired the Project Review Team for Water Quality Research Australia. • Steering Committee member for the National Water Commission projects on endocrine disruptors in water, as well as endocrine disrupting chemicals, pharmaceuticals and personal care products in waste water. • Member of the expert review panel for the WateReuse Foundation funded project on hormonally active compounds, pharmaceuticals and personal care products in water for reuse.
Dr Stuart Khan Centre for Water and Waste Technology, The University of New South Wales	• Published journal articles and guides on supporting direct potable water reuse in Australia, and recycled water quality. • Provided expert testimony at the NSW Inquiry into Coal Seam Gas (2011) as an individual, on the need to appropriately analyse and manage risks to water quality as part of the approvals process. • Lectures at the University of New South Wales on water and wastewater quality and analysis.

Name/Position	Declaration of Interest
Dr Frederic Leusch Senior Lecturer with the School of Environment, Griffith University. Program Leader for Water Quality and Diagnostics, the Smart Water Research Centre, Griffith University, Gold Coast Campus, Queensland Adjunct Lecturer, National Research Centre for Environment Toxicology, University of Queensland	• Published numerous research papers, conference publications, and a book that focusses on endocrine disruption and in vitro bioassays for water quality assessment. • Conducts research on the application of bioanalytical tools for water quality monitoring, endocrine disruption, and toxicogenomics analysis in the context of environmental pollution. Some current research projects are funded by Australian water suppliers. • Regularly attends conferences and presents the outcomes of research (which sometimes includes references to drinking water guidelines, particularly when dealing with micropollutants and bioanalytical results). • Has provided expert advice to Seqwater (local water supplier) on recycled water quality and micropollutants of emerging concern. • Contributed to a guide for determining, monitoring and achieving safe concentrations of chemicals in recycled water. • Member of the Project Review Team for Water Quality Research Australia. • Committee member of the Specialist Group on Assessment and Control of Hazardous Substances in Water of the International Water Association. • Secretary of the Society of Environmental Toxicology and Chemistry, Australasian regional chapter. • Australian Research Council Linkage grants include some water utilities in Australia (including Water Quality Research Australia) and regularly meets with industry partners.
Mr Adam Lovell Executive Director, Water Services Association of Australia (WSAA)	• Has strategic oversight of all WSAA's national priority issues relating to urban water services including regulation, productivity and research. • Is a non-executive director of the National Centre of Excellence for Desalination Australia, the United States Water Research Foundation, and the United States WateReuse Research Foundation. • Previously Deputy Chair of the Cooperative Research Centre (CRC) for Water Quality and Treatment, and a founding Board member of Water Quality Research Australia.
Professor Michael Moore Chair of the Board of Water Quality Research Australia Emeritus Professor, University of Queensland Honarary Professor, Smartwater, Griffith University Adjunct Professor at QUT and Sunshine Coast University	• Diverse range of publications on water quality. • Provides expert advice on fluoridation and other water quality issues. • Has given lectures and presentations to Water Quality Research Australia (WQRA), and contributed to fact sheets produced by WQRA. • Member of the Queensland Health Fluoridation Committee. • Other memberships and roles include: o Vice-president, Australasian College of Toxicology and Risk Assessment o Strategic Advisor, Toxicos, Pacific Environment Limited. o Strategic Advisor, Grains Research Development Corporation

Name/Position	Declaration of Interest
Mr David Sheehan Team Leader Water Regulation, Water Program, Health Protection Branch, Department of Health (Victoria)	• Oversees the administration of Victoria's *Safe Drinking Water Act 2003* and the *Safe Drinking Water Regulations 2005*. • Was involved in the review processes that led to the 2011 revision of the Australian Drinking Water Guidelines (ADWG). • Has given presentations on the 2011 ADWG and other water regulatory issues to water stakeholders, including industry, in Victoria. • Represents the Victorian Department of Health for Water Quality Research Australia (WQRA), and chairs the WQRA's Regulatory Advisory Committee. • Member of the World Health Organization's Drinking Water Quality Regulators Network (WHO RegNet). • Individual member of the Australian Water Association, the Water Industry Operators Association of Australia, and the American Water Works Association.
Professor Wayne Smith Director, Environmental Health Branch, New South Wales Health	• Regulatory role in relation to drinking water quality in NSW. • Contributed to the development of NSW Health Fact Sheets and Guidelines on water quality. • Published journal articles on drinking water quality in Bangladesh. • Attends Strategic Liaison Group meetings with Sydney Water and the Sydney Catchment Authority.
Mr Richard Walker Water Corporation, Western Australia	• Published and presented a range of papers in relation to water quality, including recreational activities in drinking water supplies, and the management of disinfection by-products. • Currently undertaking strategic water quality projects for the Water Corporation and the Water Services Association of Australia. • Was involved in the review processes that led to the 2011 revision of the Australian Drinking Water Guidelines (ADWG). • Participated in pilot studies associated with the Framework for Managing Drinking Water Quality (Chapter 2 of 2004 and 2011, ADWG). • Member of the Advisory Committee for Purity of Water, which is a peak body for the oversight of water quality in Western Australia and is responsible for advice to the Minister for Health.
Ms Carolyn Stanford (Consumer Representative from 2014) Standford Marketing	• Consultancy fees to Stanford Marketing from Goulburn-Murray Rural WaterCorp for marketing and communication services • Development of Goulburn – Murray Water publications • Development of various guidelines, standards, educational material or fact sheets for Coliban Water 1999 – 2005

Name/Position	Declaration of Interest
Mr Brian Bycroft (Observer until late 2013) Water Quality Policy Section, Aquatic Systems Policy, Water Reform, Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)	• Currently managing the review of the strategic directions of the National Water Quality Management Strategy. • Developing an Australian Government policy position on urban water quality, including use of recycled water. • Providing technical expertise to a review of the Australian and New Zealand Fresh and Marine Water Quality Guidelines. • Member of the Recycled Water Regulators' Forum, the Murray Darling Basin Water Quality Advisory Panel, and the Project Co-ordination Group for the Revision of Australian and New Zealand Guidelines for Fresh and Marine Water Quality.
Dr Chris Hepplewhite (Observer from late 2013) Assistant Director, Water Quality Policy and Wetlands Sections, Department of the Environment	• Works on Australian Government policy on Water Quality – National Water Quality Management Strategy, Australian Drinking Water Guidelines and Murray Darling Basin Plan. • Provision of water quality advice for the Environment Protection and Biodiversity Conservation Act referrals in relation to Ramsar wetlands. • Input into other Water Quality Programs – Coorong and Lower lakes and Acid Sulphate Soils.

2015-2018 Water Quality Advisory Committee

Name/Position	Area of Expertise	Declaration of Interest
A/Professor Frederic Leusch (Chair) School of Environment, Griffith University	Environmental toxicology; Chemical pollutants in the environment; Endocrine disruption; Bioanalytical tools in water quality assessment; Chemical risk assessment and guideline development	• Head of Discipline, Griffith University, Soil Water and Energy, School of Environment. • Associate Editor (environmental toxicology) for Chemosphere 2014 – present • Appointments: NHMRC's Fluoride Reference Group 2014 – present; Health and Environmental Sciences Institute – Animal Alternatives for EDC Testing Workgroup 2014 – present; Project Review Team – Water Research Australia 2012 – present; Board Member – SETAC 2015 – present: Gold Coast Commonwealth Games Independent Expert Panel – Water Quality and Monitoring Programme 2016 – present • Recipient of Australian Research Council Linkage Grants • Published numerous research papers, conference publications, reports and book chapters • Presentations at international and national conferences, seminars and workshops • Has provided expert advice to Californian and Australian water utilities on recycled water quality and micropollutants of emerging concern. • Conference organisation: Chair – SETAC Australasia Conference 2012; Co-Chair: Micro Pool & Ecohazard 2011; Organising Committee: EmCon & WiOW 2016 – Emerging

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		Contaminants and Micropollutants in the Environment; SETAC AP 2014; SETAC Australasia 2013; Discussion Leader – Disinfection By-Products Gordon Research Conference 2015 • Committees: Chair of Steering Committee – Bioanalytical Risk Assessment Validation and Experimentation – Australian Water Recycling of Excellence 2015 – present; European Commission Seventh Framework Programme – Demonstration of Promising Technologies to Address Emerging Pollutants in Water and Waste Water 2014 – 2015; Water Research Foundation – Screening Endocrine Activity of Disinfection By-Products 2010 – 2014 • Member of: Australasian College of Toxicology and Risk Assessment; International Water Association; Society of Environmental Toxicology and Chemistry
Dr Dan Deere **Independent Consultant** Water Futures, The University of New South Wales	Water quality and risk management; Data analysis, interpretation and modelling; Auditor	• Consultant: Visiting Fellow at The University of New South Wales – Water Futures • Committee member of: Seqwater Water Security Program Independent Review Panel; WSAA HBTs Working Group; NATA Cryptosporidium and Giardia Proficiency Testing Program; NATA Biological Accreditation Advisory Committee; NSW Health Cryptosporidium and Giardia Testing Independent Expert Panel; NSW Decentralised Systems Working Group • Past committees: NHMRC Drinking Water Guidelines Reference Group 2009 – 2011 • Member of: Australian Water Association; International Water Association; Water Research Australia • Taught numerous training events for local Government and Water Utilities in water quality and risk management • Expert witness on water quality protection for both governments and water utilities • Publications of numerous journals, book chapters and reports; also presentations at international and national conferences, seminars and workshops
Professor Stuart Khan Water Research Centre, The University of New South Wales	Trace chemical contaminants in water; Risk assessment and risk management	• Academic at the University of New South Wales – Water Research Centre • Consultant: undertook work for members of the Australian Water Industry • Committee/Advisory member of: WHO – Water Quality and Technical Advisory Group 2015 – present; Water Quality Research Australia – Project Quality Review Team 2012 – present; U.S. WateReuse – Technical Advisory

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		Committee 2015 – 2017; Gold Coast Commonwealth Games Independent Expert Panel – Water Quality and Monitoring Programme 2016 – present • Past Committee/Advisory member of: U.S. WateReuse Foundation – Project Advisory Committee 2010 – 2014; Australian Water Recycling Centre of Excellence – Project Advisory Committee 2011 – 2014; CSIRO and NSW Environmental Trust – Project Advisory Committee 2010 – 2013; South East Queensland Urban Water Security Research Alliance – Project Advisory Committee – Purified Recycled Water Project 2008 – 2012 • Journal Editorships: Associate Editor – Environmental Science – Water Research and Technology; Journal of Water Supply – Research Technology • Recipient of research grants from government and non-government agencies – including Australian Research Council and Water Research Australia • Publication of numerous journal articles, reports and book chapters; also presentations at international and national conferences, seminars and workshops • Member of: Australian Water Association; International Water Association; Engineers Australia
Professor Jochen Mueller National Research Centre for Environmental Toxicology, The University of Queensland Griffith University	Environmental chemistry and toxicology; Human bio-monitoring and molecular bio-markers	• Academic at University of Queensland – National Research Centre for Environmental Toxicology • Adjunct Professor at Griffith University – School of Atmospheric Science • ARC Future Fellowship until 2016 • Committee memberships: Chair – 32nd dioxin Symposium 2012 • Member of: Queensland Alliance for Environmental Health Science • Editorial boards: Chemosphere; Environmental Science and Pollution Research; Emerging Contaminants • Consultant: industry, government agencies and international meetings & programs including expert advice on PFAS. • Recipient of research grants – Australian Research Council and National Health and Medical Research Council, industry, government agencies including state governments and CSIRO, international organisations including WHO and UNEP • Publications of numerous journals, book chapters and reports; also presentations at international and national conferences, seminars and workshops

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Dr Joanne O'Toole School of Epidemiology and Preventative Medicine, Monash University	Water microbiologist; Water recycling; Health risk assessment; Laboratory accreditation	• Research Fellow at Monash University – School of Epidemiology and Preventive Medicine • Consultant: Water Research Australia and international workshops by Unilever 2014 • NHMRC Project Grant – Research Investigator – Improving access to water using Riverbank Technology Filtration • Water Research Australia funded project Management of environmental *E.coli* • Member of: International Water Association; Australian Society for Microbiology; Australasian Epidemiological Association • Publications of numerous journals and reports; also presentations at international and national conferences, seminars and workshops
A/Professor Susan Petterson School of Medicine, Griffith University Water & Health Pty Ltd Journal of Water and Health	Quantitative microbial risk assessment specialist; Risk assessment software tool development	• Associate Professor at Griffith University – School of Medicine • Director of Water & Health Pty Ltd • Editor: Journal of Health and Water (IWA Publishing) • Consultant to: Viega Plumbing on opportunistic pathogens; the City of Edmonton, Canada – on recreational water; expert testimony for AGL Macquarie on opportunistic pathogens • Consultant on projects: Global Water Pathogens Project; Public Health Agency of Sweden 2012 – present; Sydney Water Corporation 2012 – present; NSW Health 2012 – present; WHO 2009 – present • Past projects for: Government of Alberta, Canada 2013 – 2014; INTARES EU 2011 – 2014; Water Research Australia 2011 – 2013; Swedish Water and Wastewater Association – Stockholm Water Ltd 2011 • Publications on numerous journals and reports; also presentations at international and national conferences, seminars and workshops
Professor Craig Simmons **FTSE** National Centre for Groundwater Research and Training, School of the Environment, Flinders University	Groundwater hydrology; Hydrological, environmental, earth and applied engineering sciences	• Director – National Centre for Groundwater Research and Training • Mathew Flinders Distinguished Professor of Hydrogeology and Schultz Chair of the Environment – Flinders University; Fellow of the Australian Academy of Technological Sciences & Engineering; Adjunct Professor at The University of Western Australia • Committee member of: Alternate Deputy Chair – Statutory Independent Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development; Chair

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The University of Western Australia		– IESC Research Subcommittee; Deputy Chair of the ATSE's Water Forum; Chair – Roundtable for Oil and Gas Projects in South Australia; Member – Research Advisory Committee, Goyder Institute for Water Research South Australia; Member – Engineering and Medicine Roundtable on Unconvential Hydrocarbon Development, US National Academies of Sciences; Member – Agency reference Group, Office of Groundwater Impact Assessment, QLD; Member – Steering Committee, SA NRM research and Innovation Network • Member of: Australian Institute of Company Directors; National Groundwater Association of the U.S.A; International Association of Hydrogeologists; American Geophysical Union; Geological Society of America; Hydrological Society of South Australia • Editorial boards: Australian Journal of Water Resources; International Journal of Water Conservation Science and Engineering; International Journal of Environmental Modeling and Assessment; Groundwater; Journal of Hydrology; Vadose Zone Journal • Publications of numerous journal articles, book chapters and reports; presentations at international and national conferences, seminars and workshop
Ms Carolyn Stanford (Consumer Representative) Standford Marketing	Marketing and communication	• Consultancy fees to Stanford Marketing from Goulburn-Murray Rural WaterCorp for marketing and communication services • Development of Goulburn – Murray Water publications • Development of various guidelines, standards, educational material or fact sheets for Coliban Water 1999 – 2005
Mr Tim Hoar (Observer) Australian Department of Agriculture and Water Resources	Environmental policy, water infrastructure and project management	• Senior Policy Officer – National Water Policy – Department of Agriculture and Water Resources
Dr Nick Fletcher (Observer) Food Standards Australia New Zealand	Toxicology and risk assessment	• Manager Risk Assessment Chemical Safety and Nutrition, Food Standards Australia New Zealand • Senior Associate (Toxicology) Coffey Environments 2012-2013

2018-2021 Water Quality Advisory Committee

Name/Position	Area of Expertise	Declaration of Interest
Professor Frederic Leusch (Chair) School of Environment and Science, Griffith University	Environmental Toxicology; Chemical pollutants in the environment; Endocrine disruption; Bioanalytical tools in water quality assessment; Chemical risk assessment and guideline development.	• Deputy Head (Research), School of Environment and Science • Associate Editor (Toxicology) for Environmental Science and Technology (2020-present) • Associate Editor (environmental toxicology) for Chemosphere 2014 – 2018 • Appointments: Health and Environmental Sciences Institute –Animal Alternatives for EDC Testing Workgroup 2014 – present; Project Review Team – Water Research Australia 2012 – present; Board Member – SETAC 2015 – present. • Member of: Australasian College of Toxicology and Risk Assessment; International Water Association; Society of Environmental Toxicology and Chemistry. • Conference organisation: Chair – SETAC Australasia Conference 2012; Co-Chair: Micro Pool & Ecohazard 2011; Organising Committee: EmCon & WiOW 2016 – Emerging Contaminants and Micropollutants in the Environment; SETAC AP 2014; SETAC Australasia 2013; Discussion Leader – Disinfection By-Products Gordon Research Conference 2015. • Committees: Chair of Steering Committee – Bioanalytical Risk Assessment Validation and Experimentation – Australian Water Recycling of Excellence 2015 – present; NHMRC's Fluoride Reference Group 2014 – 2017; European Commission Seventh Framework Programme – Demonstration of Promising Technologies to Address Emerging Pollutants in Water and Waste Water 2014 – 2015; Water Research Foundation – Screening Endocrine Activity of Disinfection By-Products 2010 – 2014. • Involved in the Commonwealth Games Independent Expert Panel. • Has provided expert advice to Californian and Australian water utilities on recycled water quality and micropollutants of emerging concern. • Published numerous research papers, conference publications, reports and book chapters. • Presentations at international and national conferences, seminars and workshops. • ARC Linkage grants include many water utilities in Australia (including Water Quality Research Australia).
Ms Miranda Cumpston Monash University and University of Newcastle	Evidence-based public health and systematic review.	• As part of previous role with the Australian Clinical Trials Alliance undertook activities in collaboration with NHMRC and other partners, including public advocacy in relation to the conduct and funding of clinical trials in Australia.

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		• Editor at Cochrane Public Health, University of Newcastle, which receives infrastructure funding from NHMRC. • Editor of *Cochrane Handbook for Systematic Reviews of Interventions* and author of other publications that advocate for the use of systematic reviews in policy. • Received Australian Government Research Training Program (RTP) Scholarship to undertake a PhD in evidence synthesis methods at the Research Methodology Division, School of Public Health and Preventive Medicine, Monash University. • Employed by NHMRC between April and June 2018, contributing to the development of the NHMRC *Guidelines for Guidelines*. • Publications of numerous journal articles. • Guest lectures on evidence synthesis and clinical practice guideline development to Melbourne School of Professional and Continuing Education, University of Melbourne (various courses) in 2018 and 2019.
Dr David Cunliffe South Australian Department for Health and Wellbeing	Water regulator, microbiology, risk assessment.	• Principal water quality specialist with the SA Department for Health and Wellbeing. A regulator with over 35 years of experience dealing with public health aspects of drinking water, recycled water and recreational water. • Contributed to a range of national and international guidelines on drinking water quality, safe use of recycled water and recreational water quality. • Member of the NHMRC/ARMCANZ Drinking Water Review Coordinating Committee formed in 1998; later a member and then chair of the Water Quality Advisory Committee until the end of 2015. Chair of the working group that developed the Framework for Management of Drinking Water Quality. Member of the Joint Steering Committee for the development of the Australian Guidelines for Water Recycling and chair of the Health Risk and Drinking Water Augmentation working groups. • Member of WHO Water Quality Committees since 2001 and current chair of the WHO Drinking-Water Coordinating Committee. Attendance of meetings and associated expert working groups (e.g toxic cyanobacteria). Attendance at meetings on recreational use of water. Contributed to the 2nd, 3rd and 4th editions of the Guidelines for Drinking Water Quality and the Guidelines for Safe Use of Wastewater, Excreta and Greywater. Lead editor and scientific adviser for WHO texts on “Potable Reuse”, “Water Safety in Buildings” and “Water Safety in

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		Distribution Systems". Contributed to WHO texts on "Developing Drinking-water Quality Regulations and Standards" and "Legionella and the Prevention of Legionellosis". • Member of international expert panels on drinking water quality in Singapore and Hong Kong. • Published on drinking water quality, recycled water, desalination, and rainwater quality.
Mr Cameron Dalgleish Tasmanian Department of Health	Environmental science, water quality and risk management, auditing, public health.	• Health regulator for drinking water safety in Tasmania; administering legislation, policy and guidelines. Cover both drinking water quality and fluoridation with a working understanding of the implementation of the ADWG framework. • An environmental scientist specialising in water chemistry with 20 years' experience in the water industry. Previously worked across construction, natural resource conservation, environmental management and as a health regulator. • Member of the enHealth Water Quality Expert Reference Panel and the National Recycled Water Regulators Forum. • Secretariat of the Tasmanian Fluoridation Committee. • Publication of journal articles, reports, fact sheets, guidelines and presentations at national conferences, seminars and workshops. • Public Servant: State Water Officer, Department of Health Tasmania. Areas of expertise: environmental science, water quality and chemistry, risk management, auditing, public health.
Dr Dan Deere Independent Consultant Director Water Futures. Visiting Fellow; Water Futures, The University of New South Wales	Water Quality and Risk Management, water and recycled water auditing.	• Consultant – Water Futures Visiting Fellow – UNSW • Current projects for: University of Technology Institute for Sustainable Futures 2019 – present; Monash Medical School (DHHS): 2019 – present; University of Bristol, Kathmandu University and Haramaya University (funded by UK Aid): 2020-present; University of Adelaide, (for Seqwater): 2019 – present; University of Adelaide and Australis Consulting (for Central Coast Council): 2019 – present; University of New South Wales, Monash University and Natural Logic (for Water Research Australia): 2019 – present; New Zealand Ministry of Health and Department of Internal Affairs: 2019 – present; Hastings District Council and New Zealand Ministry District Health Board: 2017 – present; Hong Kong Water Supplies Department: 2017 – present; NT Government (Power Water with Department of Local Government, Housing and Community and Department of Health): 2018 – present; NSW Health: 2019 – present; Department of Health and Human Services, EPA and Department of

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		Environment, Land, Water and Planning: 2019 – present; Department of Health and Human Services, EPA and Department of Environment, Land, Water and Planning: 2019 – present; University of Queensland: 2009 – present. • Current major unfunded projects/activities: World Health Organization Guidelines for Safe Recreational Water Environments Working Group; National Health and Medical Research Council Guidelines for Managing Risks in Recreational Water, Water Quality Advisory Committee; COVID-19 technical support for multiple agencies in Australia and internationally on an as needs basis relating to general microbiology and WASH aspects. This to date has been in the US, UK, China, HK, Australia and NZ. • Additional minor funded activities past and present include peer reviews, training, workshop facilitation, regulatory audits of water suppliers for health departments, contributions to research projects and specific technical assessments and validation, with the work mostly related to microbial pathogens. • Occasionally undertakes work for members of the Australian Water Industry as a consultant. This includes Health Departments, Water Agencies and Water Utilities and related to water quality risk assessment and management and other aspects of water quality science. This also involves Water Research Australia: Drinking water catchment source assessment tool; Hong Kong Development Bureau and Department of Health: assessment of risks from using seawater for non-potable uses; NSW Health: support for councils to implement the ADWG Framework; Power Water (Northern Territory): Catchment source water assessments to identify pollution sources; Vic DHHS: Drinking water supply risk management plan regulatory audits for water utilities (funded by the utility but undertaken for DHHS); SA Health/SA Water: Drinking water supply risk management plan regulatory audit for SA Water; Queensland Health: Advising Qld councils on implementing Health-based Targets; NSW EPA and Sydney Water: QMRA relating to biosolids application as part of guideline revision; Vic EPA: QMRA relating to recreational water guidelines; NSW IPART: Drinking water supply risk management plan regulatory audits for water utilities (funded by the utility or IPART but undertaken for IPART); WHO: Western Pacific Regional Office Water Safety Plan Training of Trainers Program for AusAID (DFAT) and UK AID. • Occasionally provides expert witness statements in court for the interpretation of the Australian Drinking

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		Water Guidelines or Guidelines for Managing Risks in Recreational Water in relation to water quality protection. • Member of Seqwater Water Security Program - Independent Review Panel, NSW Health Cryptosporidium and Giardia Expert Panel, the Australian Water Association, the International Water Association and Water Research Australia. • Publications include numerous journals and technical reports and presented at international and national conferences, seminars, webinars and workshops. Focus is on providing practical guidance founded in objective, best available evidence for water quality management.
Professor Cynthia Joll Professor, Curtin Water Quality Research Centre, Curtin University	Analytical chemist with a focus on disinfection by-products, both in terms of formation, detection and analysis of the chemicals.	• 2006 – 2018, Deputy Director, Curtin Water Quality Research Centre, Curtin University. 2019 – Present, Professor within the Curtin Water Quality Research Group, Curtin University. The Curtin Water Quality Research Centre is a Strategic Research Alliance with the Water Corporation of WA. Curtin University is also a research member of Water Research Australia. • Chief Investigator on a current ARC Linkage project on nitrogen compounds in wastewater treatment. Chief Investigator on past ARC Linkage projects on disinfection by-products in drinking water systems with partner organisations Water Corporation of WA and Water Research Australia. Future applications to ARC for research support. • Publications of numerous journal articles, book chapters and reports.
Professor Stuart Khan Water Research Centre, The University of New South Wales Fellow, Australian Academy of Technological Sciences and Engineering (FTSE)	Trace Chemical Contaminants in Water; Risk Assessment and Risk Management; Environmental Engineer.	• Lectures at the University of New South Wales on topics closely related to the activities of the Water Quality Advisory Committee and the Recreational Water Quality Advisory Committee including water and wastewater quality and analysis. • Works closely with many Australian and international water industry participants including water utilities, health regulators, environment regulators and private consultants. • Committee/Advisory member of: Sydney Independent Metropolitan Water Advisory Panel; WHO – Water Quality and Technical Advisory Group 2015 – present; Water Quality Research Australia – Project Quality Review Team 2012 – present; U.S. WateReuse – Technical Advisory Committee 2015 – 2017; Gold Coast Commonwealth Games Independent Expert Panel – Water Quality and Monitoring Programme 2016 – present; the National Water Grid Advisory Body 2020 – present (The Advisory Body provides independent expert advice to the Australian Government via the Deputy Prime Minister on specific

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		water infrastructure policy, projects and investment priorities). • Member of: Australian Water Association; International Water Association; Engineers Australia. • Honorary (unpaid) role as an adviser to the Parramatta River Catchment Group. • Past Committee/Advisory member of: U.S. WateReuse Foundation – Project Advisory Committee 2010 – 2014; Australian Water Recycling Centre of Excellence – Project Advisory Committee 2011 – 2014; CSIRO and NSW Environmental Trust – Project Advisory Committee 2010 – 2013; South East Queensland Urban Water Security Research Alliance – Project Advisory Committee – Purified Recycled Water Project 2008 – 2012. • Consultant: undertook work for members of the Australian Water Industry in relation to water quality. • Provided expert opinion to Water Research Australia on PFAS chemicals. This includes contribution to a current water industry fact-sheet on these chemicals and their relevance to the water industry. In the past, made comments to the media regarding the safety and risks associated with PFAS in drinking water. • Journal Editorships: Associate Editor – Environmental Science – Water Research and Technology; Journal of Water Supply – Research Technology. • Participation in national and international academic and industry conferences. • Publication of numerous journal articles, reports and book chapters; also presentations at international and national conferences, seminars and workshops. • Recipient of research grants from government and non-government agencies – including Australian Research Council and Water Research Australia. Applications for NHMRC funding are much less frequent, but not excluded.
Associate Professor Susan Petterson Associate Professor, School of Medicine, Griffith University Director, Water & Health Pty Ltd Editor, Journal of Water and Health	Quantitative Microbial Risk Assessment Specialist and risk assessment software development.	• Associate Professor at School of Medicine, Griffith University. • Director of Water & Health Pty Ltd • Editor: Journal of Health and Water (IWA Publishing) • Consultant to: Viega Plumbing on opportunistic pathogens; the City of Edmonton, Canada – on recreational water; expert testimony for AGL Macquarie on opportunistic pathogens; NSW Health – in drinking water QMRA; Queensland Urban Utilities – applying QMRA to assess overflow impacts on recreational sites. • Advisor for WHO Water Sanitation Hygiene and Health on risk assessment and microbial aspects in water.

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		• Member of the independent peer review panel (human health) for Sydney Water. • Member of Sydney Independent Metropolitan Water Advisory Panel • Peer Review of QMRA undertaken for recreational water quality at Hunter Beaches for Hunter Water. • Current projects for: Global Water Pathogens Project; Public Health Agency of Sweden 2012 – present; Sydney Water Corporation 2012 – present; NSW Health 2012 – present; WHO 2009 – present. • Past projects for: Government of Alberta, Canada 2013 – 2014; INTARES EU 2011 – 2014; Water Research Australia 2011 – 2013; Swedish Water and Wastewater Association – Stockholm Water Ltd 2011. • Publications on numerous journals and reports; also presentations at international and national conferences, seminars and workshops. • IWES course presentation.
Professor Craig Simmons Fellow, Australian Academy of Technological Sciences and Engineering (FTSE) Executive Director for Maths, Chemistry, Physics and Earth Sciences at the Australian Research Council (secondment). National Centre for Groundwater Research and Training, School of the Environment, Flinders University Adjunct Professor, The University of Western Australia	Groundwater Hydrology, Hydrological, Environmental, Earth and Applied Engineering Sciences.	• Foundation Director at the National Centre for Groundwater Research and Training • Executive Director at the Australian Research Council • Matthew Flinders Distinguished Professor of Hydrogeology and Schultz Chair of the Environment – Flinders University; Fellow of the Australian Academy of Technological Sciences & Engineering; Adjunct Professor – The University of Western Australia. • Committee member of: Alternate Deputy Chair Statutory Independent Scientific Committee (IESC) on Coal Seam Gas and Large Coal Mining Development; Chair – IESC Research Subcommittee; Deputy Chair of the ATSE's Water Forum; Chair – Roundtable for Oil and Gas Projects in South Australia; Chair, Alligator Rivers Region Technical Committee; Member – Research Advisory Committee, Goyder Institute for Water Research South Australia; Member – Engineering and Medicine Roundtable on Unconventional Hydrocarbon Development, US National Academies of Sciences; Member – Agency reference Group, Office of Groundwater Impact Assessment, QLD; Member – Steering Committee, SA NRM research and Innovation Network. • Member of: Australian Institute of Company Directors; National Groundwater Association of the U.S.A; International Association of Hydrogeologists; American Geophysical Union; Geological Society of America; Hydrological Society of South Australia. • Editorial boards: Australian Journal of Water Resources; International Journal of Water Conservation Science and Engineering; International Journal of Environmental Modeling and Assessment;

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		Groundwater; Journal of Hydrology; Vadose Zone Journal. • Publications of numerous journal articles, book chapters and reports; presentations at international and national conferences, seminars and workshops. • Honorary Professor Australian National University.
Ms Carolyn Stanford (Consumer Representative) Stanford Marketing	Marketing and Communication	• Consultancy fees to Stanford Marketing from Goulburn-Murray Rural WaterCorp for marketing and communication services. • Development of Goulburn – Murray Water publications. • Development of various guidelines, standards, educational material or fact sheets for Coliban Water 1999 – 2005.
Dr Katrina Wall Water Unit Health Protection NSW Health	Health Regulation, water quality risk management and environmental microbiologist.	• Employed by NSW Health as Senior Project Officer in the Drinking Water Risk Management Water Unit, Environmental Health Branch since 2008. Provide water quality advice, policy and regulation for NSW. • Represented NSW on the enHealth Water Quality Expert Reference Panel 2016-2018, providing advice and national guidance on water quality and public health. • Represents NSW Health on the NSW Carp Advisory Group, 2017-current, provides advice and NSW policy position to the National Carp Control Program. • NSW sewage surveillance for SARS-CoV-2 steering committee member. • Corporate member of the International Water Association and WaterRA including participation in project advisory committees, and personal member of the Australian Water Association. • Member of the Project Advisory Committee to Water Research Australia project 1109 Health Based Targets guidance. • Published journal articles conference proceedings and reports, presented at international and national conferences, seminars and workshops. • Development of various guidelines, factsheets and educational materials on water quality. • PhD supported by AWWARF project 2618 Water quality improvements during ASR as part of the Bolivar ASR Project.
Dr Nick Fletcher (Observer) Food Standards Australia New Zealand	Toxicology and risk assessment.	• Member of: Joint FAO/WHO Expert Committee on Food Additives (JECFA) advisory panel; New Zealand Environmental Protection Agency Hazardous Substances and New Organisms Committee. • Manager Risk Assessment Chemical Safety and Nutrition, Food Standards Australia New Zealand.

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		• Senior Associate (Toxicology) Coffey Environments 2012-2013.
Ms Amy Lea (Observer) Department of Agriculture, Water and the Environment	National Water Policy and Reform.	• Australian Government national water quality policy.
Mr Adam Lovell (Observer) Water Services Association of Australia (WSAA)	Peak industry body representing the urban water industry.	• Water Services Association of Australia (WSAA) – Executive Director. • Global Water Research Coalition (GWRC) – Board Chair. The GWRC is a non-profit organisation that serves as a focal point for the global collaboration for research planning and execution on water and wastewater related issues.