Administrative Report
Updated guidance on radiological water quality

Contents

Summary

The National Health and Medical Research Council (NHMRC) has collaborated with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) to update sections of the *Australian Drinking Water Guidelines (2011)* (the Guidelines) relating to radiological water quality (the guidance). The updated guidance covers radiological aspects of Chapters 7 and 10, Information Sheet 2.2 and the factsheets on radium, alpha and beta radionuclides, radon-222 and uranium. Information and terminology have been updated to reflect current best practice in radiation protection and radiation measurement. The updated guidance will be published in the relevant sections of the Guidelines. The review of guidance relating to non-radiological aspects of drinking water quality (e.g. chemical toxicity) was out of scope of this update of the Guidelines. 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 Act). NHMRC maintains the *Australian Drinking Water Guidelines (*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.

ARPANSA is the Australian Government's primary authority on radiation protection and nuclear safety. It regulates Commonwealth entities using radiation, with the objective of protecting people and the environment from the harmful effects of radiation. ARPANSA undertakes research, provides services and promotes national uniformity and the implementation of international best practice across all jurisdictions.

In 2017 ARPANSA published a *Guide for Radiation Protection in Existing Exposure Situations* (the Guide). The Guide is part of the Radiation Protection Series and provides advice on approaches to protect the public from exposure to radionuclides in existing exposure situations. The ARPANSA Radiation Protection Series publications are based on international standards and guidance including publications from the International Commission on Radiological Protection (ICRP), the International Commission on Non-Ionizing Radiation Protection, the International Atomic Energy Agency (IAEA) and the World Health Organization (WHO). ARPANSA has adopted an exposure level based on an annual effective dose of 1 millisievert per year (mSv/year), which is consistent with the current guideline value (now referred to as a reference level) in the Guidelines.

Development of guidance

While reviewing the existing radiological water quality information in the Guidelines, ARPANSA identified a need for additional information to assist drinking water regulators, particularly with regard to the:

- screening of water supplies
- assessment of dose to critical population groups
- occurrence and levels of naturally occurring radionuclides in groundwater
- need for clarification, amendment and correction of existing information.

In 2016 ARPANSA recommended that the radiological water quality advice in the Guidelines be reviewed to incorporate the latest terminology and information provided by the ARPANSA Guide and to align with international best practice. ARPANSA offered to provide scientific input and advice to NHMRC on the review and has been updating relevant sections of the Guidelines since 2017.

ARPANSA has updated relevant sections of the Guidelines to ensure the Guidelines align with international best practice on radiation management and protection. The updates will also provide regulators and other users of the Guidelines with additional information on radiological quality of drinking water. ARPANSA have used the Guide and other international guidance to update Chapters 7 and 10, Information Sheet 2.2 and the factsheets on radium, alpha and beta radionuclides, radon-222 and uranium.

The following major changes were made to the Guidelines:

- updates to terminology to reflect current practice. Guideline dose, practices and interventions are now reflected as reference level, exposure situations and protective measures.
- an operational dose level of 0.3 mSv/year replaces the operational dose level of 0.5 mSv/year.
- amendments to operational flowcharts to correct existing errors and reflect the new operational dose level.

Additional information was included to strengthen and clarify radiation protection principles and applications in the Australian context. There has been no change to the 1 mSv/year guideline value or to the screening levels for gross alpha gross beta activity concentration. A Review Report developed by ARPANSA to explain the review process and evidence base for the updates is provided at **Appendix A**.

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

Figure 1: Overview of guideline development process

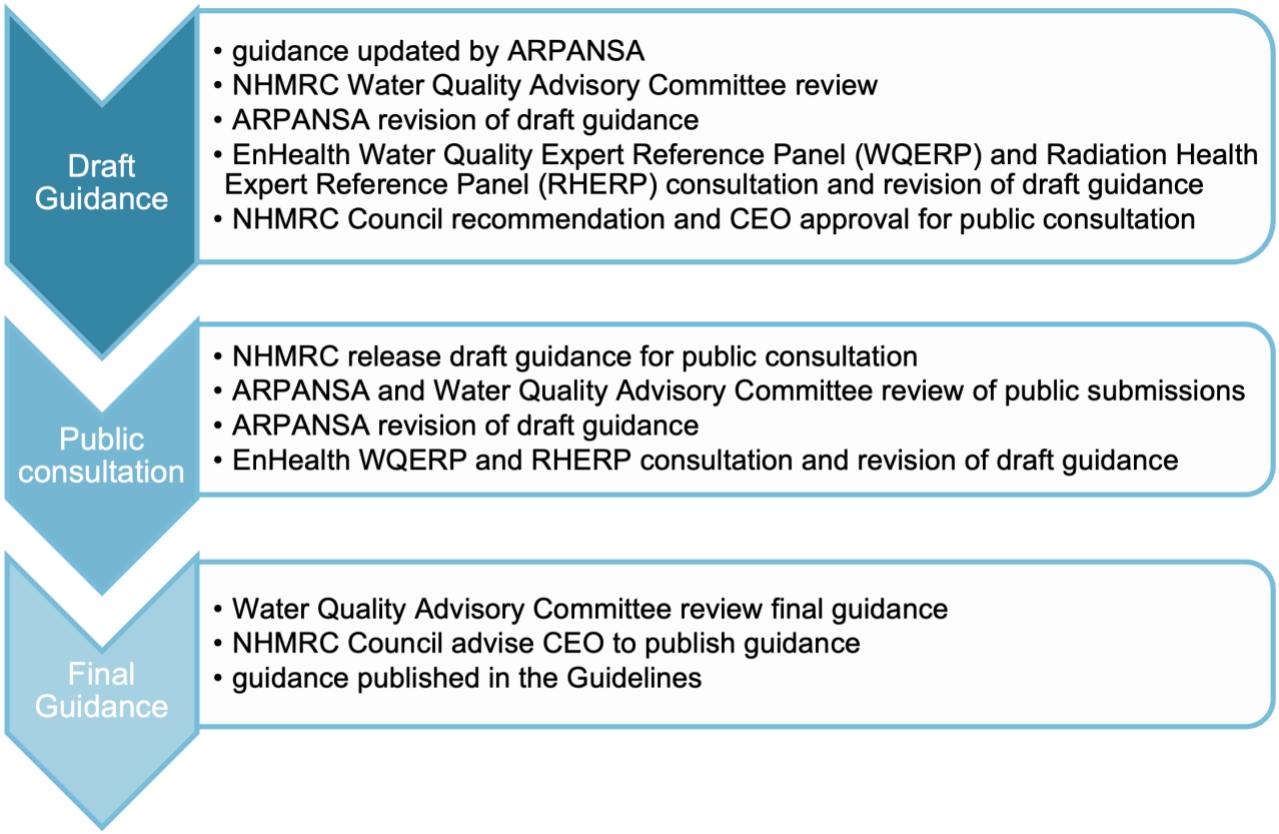

Table 1: Timeline of updated radiological water quality guidance development	Date
ARPANSA – sought support from NHMRC to review guidance	December 2016
Water Quality Advisory Committee (WQAC) meeting – noted proposal by ARPANSA	6 February 2017
NHMRC accepts offer to conduct review and update of guidance	29 March 2017
NHMRC and ARPANSA finalised scope and process for review	February 2018
WQAC meeting – review progress update	3 April 2018
WQAC meeting – members reviewed updates and review report	5 March 2019
ARPANSA revised guidance to address WQAC feedback	April - May 2019
WQAC meeting – members reviewed revised guidance	5 June 2019
NHMRC and ARPANSA meeting regarding literature review process and documentation of methods	2 September 2019
WQAC meeting – members reviewed revised Guidance	25 November 2019
Out of session WQAC advice to seek feedback on Guidance from enHealth	12 December 2019
EnHealth WQERP and RHERP consultation	January 2020
ARPANSA – revised drafts to address enHealth feedback (**see Appendix B**)	February - March 2020
WQAC meeting – reviewed and discussed enHealth feedback and revised guidance, advice to finalise guidance for NHMRC Council	27 March 2020
NHMRC Council – out of session advice to CEO to release draft guidance for public consultation	27 May 2020
NHMRC CEO – approved to release draft guidance for public consultation	24 June 2020
Public consultation opened	29 June 2020
Public consultation closed	12 August 2020
ARPANSA – revised guidance to address public consultation feedback (**see Appendix C**)	August – October 2020
WQAC meeting – discussed public submissions and responses	27 October 2020
EnHealth WQERP and RHERP consultation on revised guidance (**see Appendix B**)	November 2020
ARPANSA – meeting with RHERP to discuss jurisdictional feedback	17 December 2020

Table 1: Timeline of updated radiological water quality guidance development	Date
ARPANSA – revised Information Sheet 2.2 to address jurisdictional feedback	January - March 2021
WQAC meeting – reviewed revised guidance and recommended clarifying issues before finalising guidance	13 May 2021
WQAC meeting – discussed concerns with ARPANSA	19 May 2021
ARPANSA and WQAC revised guidance to address WQAC feedback	20-24 May 2021
WQAC – out of session advice to finalise guidance for NHMRC Council	24 May 2021
NHMRC Council – recommended the CEO publish the guidance in the Guidelines	17 June 2021 (223rd session)
NHMRC CEO – approved publication of guidance as part of the Guidelines	22 December 2021

* WQAC – Water Quality Advisory Committee

** WQERP – Water Quality Expert Reference Panel

*** RHERP – Radiation Health Expert Reference Panel

Water Quality Advisory Committee feedback

Members of the Water Quality Advisory Committee provided feedback on several iterations of the draft guidance before public consultation and final publication. ARPANSA addressed these comments and made revisions to the guidance where appropriate.

Key issues raised by the Water Quality Advisory Committee on draft guidance before public consultation included:

- the need for further clarification and guidance regarding screening levels for drinking water and differences between international guidance
- suggestions for cross-referencing to improve clarity of updated guidance, remove duplication and align updated sections throughout the Guidelines
- the need to summarise key changes in practice for end users
- the need to provide more details on the methods used to review the evidence
- minor amendments to improve plain language and consistency in terminology with the rest of the Guidelines.

Members sought clarification on a number of key issues after public consultation and before the guidance was finalised including:

- the differences between WHO and Australian advice, including screening, operational and reference values and their derivations

- the differences between WHO and Australian cancer risk estimates for radiation exposure that underpin the different advice.

Several members raised concerns about the 1 mSv/year and the basis for this guideline value compared to the WHO individual dose criterion of 0.1 mSv/year. Members discussed possible issues of perception that Australian guidelines values are significantly higher than WHO and other international guidelines. Some members also expressed concerns that the differences in terminology/nomenclature used in the updated guidance compared to those currently used in the Guidelines may cause confusion.

On 19 May 2021 ARPANSA met with the Water Quality Advisory Committee to clarify:

- ARPANSA's role in providing a framework and setting standards for health protection, including the 1 mSv/year reference level
- the recent review and endorsement of the 1 mSv/year reference level by Australian jurisdictions who apply the standards
- the difference between operational screening levels and reference levels, and the way these are applied
- the methodology applied for deriving radiation exposure guideline values.

ARPANSA also noted that further information on the derivation of the reference level and operational screening values will be drafted and published in an upcoming journal article. The guidance was amended to provide additional clarification on these issues and address member concerns. The Water Quality Advisory Committee advised NHMRC to finalise the guidance for NHMRC Council out of session on 24 May 2021.

EnHealth consultation

The Environmental Health Standing Committee (enHealth) Water Quality and Radiation Health Expert Reference Panels reviewed the draft guidance before and after public consultation, commenting on issues such as the terminology used, the applicability of changes to the specific dose criteria and other minor edits to improve clarity and accuracy. Panel membership includes jurisdictional representatives working in the field of drinking water quality, radiation safety and human health who can provide feedback on the feasibility and accuracy of NHMRC advice.

Following public consultation, several members of the enHealth Radiation Health Expert Reference Panel reiterated their concerns about the change in operational dose value from 0.5 to 0.3 mSv/year. Staff from ARPANSA met with the Radiation Health Expert Reference Panel on 17 December 2020 to explain the reasoning behind the change in operational dose value. It was emphasised that:

- The operational dose is not a regulatory limit, it is an advisory screening value that is used to provide an early warning system to water suppliers and encourage further monitoring.
- The operational dose does not require regulation, protective measures or remediation.
- The guidance is currently worded as a soft recommendation: as written in the text and flow charts in Information Sheet 2.2, when the operational dose is exceeded, the water manager

should *consider the need for increasing the frequency of monitoring in consultation with the appropriate regulator*.

- It more accurately reflects the existing screening value of 0.5 Becquerel per litre (Bq/L), which equates to 0.35 mSv/year. The 0.3 mSv/year value is a more conservative rounding proposed by ARPANSA. The 0.5 mSv/year value appears to be arbitrary and there is currently no clear justification for this operational dose in the Guidelines.
- The 0.3 mSv/year operational dose is more conservative but more accurately reflects the uncertainty in assumptions during calculations. A more conservative value is also supported to account for variations in exposures of different population groups (particularly vulnerable groups such as children) as well as different consumption rates and exposure levels in groundwater around Australia.
- Keeping the current 0.5 mSv/year operational dose may require an increase to the existing screening value of 0.5 Bq/L to keep the calculations consistent. This would result in a change in practice and would require consultation with industry as it would have a significant financial impact on stakeholders.
- Public submissions from the water supply industry indicated no concern with the implementation of the updated guidance.

To clarify this issue further, ARPANSA has edited Information Sheet 2.2 to ensure that the intention of the 0.3 mSv/year operational dose value is clear in its relation to use as a screening dose value. No further comment has been received by members of the Radiation Health Expert Reference Panel on the draft guidance.

ARPANSA and the Water Quality Advisory Committee have considered jurisdictional feedback and revised the updated sections where appropriate (see **Appendix B**).

Public consultation

On 27 March 2020, the Water Quality Advisory Committee agreed for the updated draft guidance to progress to NHMRC Council for approval for public consultation. NHMRC Council members considered the draft guidance out of session, and on 27 May 2020 agreed to advise NHMRC's CEO to release it for public consultation. The CEO agreed for the draft guidance to be released for public consultation on 24 June 2020.

Public consultation was conducted between 29 June 2020 and 12 August 2020. NHMRC worked with ARPANSA and the Water Quality Advisory Committee to ensure due consideration was given to the issues raised during public consultation. It was noted that comments seeking additional review of chemical aspects of uranium were out of scope of this update, which focuses on radiological water quality. Any non-radiological changes to the chemical factsheet, and the health-based guideline value for uranium, will be considered when they are reviewed alongside other prioritised factsheets in late 2021.

A summary of this process, including the issues raised and how these were dealt with to finalise the guidance is provided in the public consultation summary report provided at **Appendix C**. Full submissions are available at **Appendix D** where permission has been given to publish.

Contributors

The NHMRC Water Quality Advisory Committee oversaw the development of the Guidance. The substantive work of the Water Quality Advisory Committee on this project was undertaken during 2019-2021. Committee membership during this term is outlined below.

2018-2021 Water Quality Advisory Committee

- 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 NSW
- 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 Waters (Former member) (Observer), Department of Agriculture, Water and the Environment
- Mr Adam Lovell (Observer), Water Services Association of Australia.

ARPANSA Project Team

The ARPANSA Monitoring and Emergency Response Section reviewed the radiological water quality advice and drafted updates to the Guidance.

NHMRC Project Team

The project was managed by the Water Team in the NHMRC Public Health section.

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). 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 Water Quality Advisory Committee and a summary of their disclosed interests at the time of publication of the Guidance are available on the NHMRC website at https://www.nhmrc.gov.au/health-advice/water-quality-and-health/water-quality-advisory-committee-wqac.

Project Funding

The project was funded by NHMRC with in-kind contributions and expertise provided by ARPANSA.

Appendix A – ARPANSA Review Report

Australian Drinking Water Guidelines (2011) (the Guidelines) Review Report

Review of the guidance documents relating to radiological quality of drinking water

Summary

The National Health and Medical Research Council (NHMRC), in collaboration with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), has reviewed the *Australian Drinking Water Guidelines* (the Guidelines) relating to the radiological quality of drinking water. Information and terminology have been updated to reflect current best practice in radiation protection and radiation measurement. Australian specific studies and data on radionuclides in drinking water have been included. There have been no changes to the screening levels and the guideline value (now referred to as a reference level).

Background

The National Health and Medical Research Council (NHMRC) is responsible for the Guidelines. The Guidelines provide guidance to water regulators and suppliers on monitoring and managing drinking water quality. The Guidelines provide details on the framework for Management of Drinking Water Quality (the Framework), a preventive management approach that encompasses all steps in water production from catchment to consumer, and aims to assure safe, good quality drinking water. The Guidelines are used by state and territory health departments, local health authorities and water utilities.

The Guidelines undergo a rolling revision to ensure they represent the latest scientific evidence on good quality drinking water. Updates are subject to approval by NHMRC Council subject to NHMRC seeking feedback from the Environmental Health Standing Committee (enHealth) Water Quality Expert Reference Panel and Radiation Health Expert Reference Panel regarding proposed changes to the Guidelines. Once approved by NHMRC Council a public consultation phase commences.

The current guidelines relating to the radiological quality of drinking water were last revised in 2004. In 2017 ARPANSA began working with NHMRC on the review of the Guidance on the radiological water quality in the Guidelines. The review covered the relevant chapters on radiation protection in the Guidelines in order to update the information, incorporate current international recommendations and provide additional information for regulators and users of the guidelines.

About ARPANSA

ARPANSA is the Australian Government's primary authority on radiation protection and nuclear safety. ARPANSA regulates Commonwealth entities using radiation with the objective of protecting people and the environment from the harmful effect of radiation. ARPANSA undertakes research, provides services, and promotes national uniformity and the implementation of international best practice across all jurisdictions.

Reason for Review

In 2017, ARPANSA in consultation with the Radiation Health Committee, published a guide for the protection of the public from the exposure to radionuclides in existing exposure situations. This *Guide for Radiation Protection in Existing Exposure Situations* describes an approach to be used

within Australia and is based on the recommendations of the International Atomic Energy Agency (IAEA) *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3 (GSR Part 3)* and of the International Commission on Radiological Protection (ICRP) *The 2007 Recommendations of the International Commission on Radiological Protection (ICRP Publication 103).*

The IAEA standard requires authorities to set reference values for exposure from radionuclides present in commodities (including food and water). Based on these recommendations, the ARPANSA guide has adopted a reference level based on an annual effective dose of 1 mSv/year for existing situations. Although the reference level is consistent with the guideline value and screening values in the current Guidelines, the Guidelines need to align with the latest terminology and evidence provided by the ARPANSA guide, the IAEA standards, the ICRP and the World Health Organization's (WHO) *Guidelines for Drinking-water Quality.*

ARPANSA identified a need for additional information to assist regulators, particularly with regard to the:

- screening of water supplies
- assessment of dose to population groups
- occurrence and levels of naturally occurring radionuclides in groundwater
- need for clarification, amendment and correction of existing information

Purpose of the Project

The project was planned to review the following chapters and documents in the Guidelines:

- Chapter 7
- Related content in Chapter 10.
- Information Sheet 2.2
- Radium factsheet
- Radionuclides (other beta and gamma–emitting). Note that this factsheet has been renamed to: "Specific alpha and beta radionuclides factsheet".
- Radon-222 factsheet
- A subsection of the Uranium factsheet (Radiological aspects)

Out of scope for this review was the chemical information in the uranium factsheet. The health-based guideline value for uranium in drinking water is limited by the chemical toxicity of the element, where the chemical toxicity limit of 0.02 mg/L is more than 100 times more restrictive than the radiological reference level of 1 mSv/yr. Review of the uranium factsheet should be conducted as part of a review of health-based guideline values for chemical factsheets.

Review of International Bodies

Based on the requirements placed on the CEO of ARPANSA, the CEO must take into account codes, standards, recommendations and guides that are produced by the ICRP, IAEA, WHO and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). The publications produced by these organisations reflect international consensus on what constitutes a

high level of safety for protecting people and the environment from the harmful effects of radiation. More information about these organisations is provided below.

International Commission of Radiological Protection (ICRP)

The ICRP is an independent, international, non-governmental organization, with the mission to provide recommendations and guidance on radiological protection concerning ionising radiation. The ICRP recommendations have gained broad acceptance and been implemented into international and national frameworks for management of radiation risks. ARPANSA contributes to the work of the ICRP by providing Australian representation on various technical working groups. The ICRP has a Constitution and a Code of Ethics that is available on their website and can be found here. At the beginning of every publication the ICRP produces, the revision process is specified.

ICRP Publications

International Atomic Energy Agency (IAEA)

The IAEA is the world's centre for cooperation in the nuclear field. The Agency works with its Member States (including Australia) to promote the safe, secure and peaceful use of nuclear (and radiation) technologies. The IAEA Safety Standards provide a framework comprising Safety Fundamentals, Safety Requirements and Safety Guides. The IAEA also produces Nuclear Security Guidance and Technical Documents, and publishes the International Nuclear Safety Group (INSAG) Reports. The IAEA's Safety Standards Committees have a Terms of Reference which explains the function, membership, working methods and resources of the Committees. This information can be obtained here.

All IAEA publications are developed by an open and transparent process for gathering, synthesising and integrating the knowledge and experience gained from the actual use of nuclear or radiation technologies and from the application of the safety standards and security guidance, including knowledge of emerging trends and issues of regulatory importance. ARPANSA, on behalf of Australia, plays an active role in the development of IAEA standards and guidance. ARPANSA contributes to the work of the IAEA as a member state and in various safety standards committees. At the beginning of every publication the IAEA produces, the revision process is specified in detail.

IAEA publications

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

UNSCEAR reports yearly to the United Nations General Assembly on levels and effects of exposure to ionising radiation, and associated risks to the health of people and the environment. Governments and organisations throughout the world rely on UNSCEAR's scientific evaluations as the basis for estimating radiation risks and for establishing protective measures. Australia is one of 27 UN Member States that participate in UNSCEAR's work. ARPANSA contributes to the work of UNSCEAR with its Chief Radiation Health Scientist as the current Chair of UNSCEAR. ARPANSA also has Australian representatives on various working committees. UNSCEAR has governing principles which can be obtained here. At the beginning of every publication that UNSCEAR produces, the revision process is specified. In the UNSCEAR 2017 Report, ANNEX A details the principles and criteria for ensuring the quality of the committee's reviews of epidemiological studies of radiation exposure and ANNEX B provides information on the epidemiological studies of cancer risk due to low-dose-rate radiation from environmental sources.

UNSCEAR Publications

World Health Organization (WHO)

The WHO is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, including shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends. It publishes guidelines and recommendations on health policies and clinical interventions. In terms of radiation protection, the WHO publishes guidelines on indoor radon, radiation in drinking water and radionuclides in food. There are also publications on radiation emergencies and information on the radiation accidents in Chernobyl and Fukushima. ARPANSA contributes to the work of WHO as a regional collaborating centre and in various working groups. WHO has ethical principles that can be obtained here. At the beginning of every publication that WHO produces, the revision process is specified in detail.

WHO Publications

Review of best practice approaches in radiation protection

ARPANSA has reviewed the references relating to the health effects of radionuclides, the determination of dose and any recommendations relating to the limitation of radiological dose. The review included updates to measurement techniques for radionuclides to ensure that the most up to date references were provided in the Guidelines. Appropriate scientific journals and technical reports were reviewed to obtain Australian data for levels of specific radionuclides in drinking water.

In addition to the use of ARPANSA documents on radiation protection, the review included current publications of standards, recommendations, guides and reports from relevant organisations.

Changes to the Guidelines

The following major changes were made:

- Updating of the system of radiation protection with change to terminology to reflect current state. Guideline dose, practices and interventions are now reflected as reference level, exposure situations and protective measures.
- An operational dose level of 0.3 mSv/year replaces the operational dose level of 0.5 mSv/year. This reflects the use of gross alpha/beta screening levels, where water that meets the screening levels will result in an annual dose that is approximately one third of the reference level of 1 mSv/year, when attributing Ra-226 to gross alpha and Ra-228 to gross beta. The operational dose level is in line with recommendations from the ICRP (1999) and the role of dose constraints in optimisation. Update of information on health considerations.
- Amendment to the flowchart to correct existing errors and reflect the new operational dose level.

Additional information that has included to strengthen and clarify radiation protection principles and applications in the Australian context. This includes information on:

- The Australian reference levels and Australian screening levels for drinking water.
- The application of the guidelines in specific circumstances for Australia
- Remedial measures which includes information on the treatment of drinking water
- Naturally occurring radionuclides and the decay series for uranium and thorium
- Expected doses to the public from the consumption of surface water
- Australian levels of radionuclides in drinking waters
- What is required if the screening values are exceeded
- Additional methods of analysis for radionuclides
- The dose contribution due to K-40

References in the documents reflect current versions of the literature, and are listed at the end of each document.

Review Process

The revised guidance was quality checked by relevant experts at ARPANSA and were reviewed by the NHMRC Water Quality Advisory Committee and the enHealth Water Quality Expert Reference Panel and Radiation Health Expert Reference Panel.

Major References to this Review Report

ARPANSA (Australian Radiation Protection and Nuclear Safety Agency) (2017). *Guide for Radiation Protection in Existing Exposure Situations* (RPS G-2).

IAEA (International Atomic Energy Agency) (2014). *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards. General Safety Requirements Part 3* (GSR Part 3).

ICRP (International Commission on Radiological Protection) (1999). *Protection of the Public in Situations of Prolonged Radiation Exposure.* ICRP Publication 82. Ann. ICRP 29 (1-2).

ICRP (International Commission on Radiological Protection) (2007). *The 2007 Recommendations of the International Commission on Radiological Protection.* ICRP Publication 103.

WHO (World Health Organization) (2011). *Guidelines for Drinking-water Quality*, 4th Edition.

Appendix B – EnHealth feedback on updated Guidance

The enHealth Water Quality Expert Reference Panel (WQERP) and Radiation Health Expert Reference Panel (RHERP) provided feedback on a number of iterations of the updated Guidance.

When responding to comments the following terms have been used:

Term	Definition
Accepted	The proposed change has been made to the text.
Partially accepted	Either: • the proposed change has been made, however the suggested text was modified • the proposed change is accepted but the text has been modified in a different clause/section or • only part of the proposed change was accepted or accepted with modifications
Not accepted	No changes were made to the text based on this comment.
Noted	Either: • no proposed change to the text was required to address the comment • the comment was outside the scope of the document or • noting a comment does not imply that neither ARPANSA nor Water Quality Advisory Committee endorses the comment.
Parked	To be addressed by NHMRC or reviewed following public consultation

First version of draft Guidance

The following feedback was provided by members of enHealth WQERP and RHERP in response to the first drafts of the updated Guidance provided for review in January 2020 prior to public consultation. Jurisdictions unable to provide comment during this consultation period indicated that they would provide comment during public consultation.

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
General comments		

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
1	Section 7.6.4 Guideline Values for Drinking Water states: *Therefore Australia has adopted a specific dose criteria of 0.3 mSv/year for the consumption of drinking water. This is in line with the recommendations of the ICRP (ICRP 1999) and the WHO (WHO 2018). The screening levels for gross alpha and gross beta, in Australia, have been set to meet the 0.3 mSv/year.* The reference is ICRP Publication 82 Protection of the Public in Situations of Prolonged Radiation Exposure. The criteria ICRP 82 applies to dose constraints in planned exposure situations and is not applicable or appropriate in existing exposure situations such as this. Other sections including 7.6.5, Chapter 10.3.7 and Info sheet 2.2 also make reference to this dose criteria. Presumably the relevant derived screening levels have been set to meet this criteria, though have not been through it to that detail. As such the document should be reverted to remove the dose criteria ahead of release for public consultation.	Partially accepted. To reduce confusion and impact on existing legislation, reference to "dose criteria" has been replaced with the original term used in the Australian Drinking Water Guidelines (ADWG), the "operational dose level". The operational dose of 0.3 mSv/year is set based on screening values for gross alpha and gross beta which remain unchanged from the current ADWG screening values. The operational dose level of 0.3 mSv/year provides a level of confidence that the guideline value of 1 mSv/year will not be exceeded. An assessment of the annual dose is performed when screening levels are exceeded. Where the annual dose is assessed to be below the operational dose level of 0.3 mSv/year, routine monitoring can be continued. Assessment of the dose to additional groups should be undertaken where the annual dose for the average group approaches 1 mSv/year. In this situation doses to some members of the population may exceed the guideline value of 1 mSv/year. When the annual dose of 1 mSv/year is exceed, optimisation should be considered in the form of remediation. The existing guidelines have an optimization level of 0.5 mSv/yr. The specific dose criteria is new wording but not a new concept to the ADWG. See table and figure IS2.2.1. The operational response stated that consultation should be held with the relevant health authority when the calculated dose lies between 0.5 and 1.0 mSv/yr. It is not clear if this aspect of the guidelines is applied in the current management of drinking water across all jurisdictions. It is up to the relevant health authorities or water regulators to make decisions on the implementation of the guidelines. The change from 0.5 to 0.3 is an update to reflect internationally referenced values for the dose criterion. ICPR 82 describes the internationally accepted guidance in prolonged exposure situations and includes commodities containing radioactive substances in A3. A29 page 78 states "The drinking of mineral water rich in primordial radionuclides is also a cause of additional prolonged exposure. ". Paragraph (k) of the Executive Summary in ICRP 82 "recommends that the maximum value of the dose constraint to be used in the optimisation of radiological protection for a single source should be less than 1 mSv in a year and that a value of no more than 0.3 mSv in a year would be appropriate."

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
		Verification of compliance in instances where doses lie between the operational dose level and the guideline value may require more intensive monitoring and assessment of exposed groups to ensure that the guideline value of 1 mSv/year is not exceeded. Text relating to the 0.3 mSv/year operational dose level (formerly dose criteria) has been deleted from Chapter 7. Further guidance on the 0.3 mSv/year operational dose level has been provided in IS2.2.
2	The consistency of terminology with guideline/reference values it remains the same at 1 mSv/year) though it is not entirely abandoned (The term "reference level" is used to align with the terminology used in the system of radiation protection for existing exposure situations.) There should be a description of why the assessment of radiological quality is different to other characteristics, so suggest the following be inserted into **Chapter 7 and Chapter 10.** For radiological characteristics, the most appropriate measure of water quality that could be regarded as a health-based guideline value is the annual effective dose to a person due to ingestion of radionuclides in the drinking water. However, the effective dose is not a directly measurable quantity, so assessment of water quality is based on the measurement of radionuclide concentration (screening) followed, if necessary, by the calculation of dose and its comparison to a reference level.	Accepted. The first statement is correct. In the system of radiological protection as described in the introduction of chapter 7, the terminology of guideline value is the equivalent of reference level. To reduce confusion and impact on existing legislation, reference to "reference level" has been replaced with the original term used in the ADWG, the "guideline value". The reference level will be defined in Chapter 7 with the continued use of the term guideline value throughout the ADWG. Text amended to include the suggested text provided by the QH RHERP/WQERP.
3	Concerns regarding the inclusion of Table 7.1 (detailed below)	Partially accepted. Anthropogenic values removed from the table of dose coefficients.
4	Section 1.3.2 ADWG has conflicting statements about the intent of the guideline value	Addressed in comment 2. Revised text taken from comment 2 describes the use of screening values, activity concentration and relation to dose and a health based guideline value.
5	Amendments to the content should be consistent with the existing concepts and content of the ADWG. For example, changes in the document refer to "health authority" or "drinking water regulator" undertaking the role assessing reported data to ensure levels have not been exceeded. This approach is not consistent with ADWG the 12-element framework, which has the water agency as responsible for implementing a risk-based approach to monitoring, reviewing data and reporting to health authorities if there is a threat to public health. Additionally, across Australia the regulatory framework for drinking water varies between states which influences the exact role and compliance processes of the "health authority" or "drinking water regulator" depending on the jurisdiction. Revisions made to radiological information in the ADWG needs to maintain consistency with the drinking water risk management principles and framework of the document, unless justifiable.	Noted. The role of assessing the reported data to ensure levels have not been exceeded can be found in section 1.3.2 of the ADWG is not in conflict with the statements given in Chapter 7. As stipulated in 1.3.2, "The amount by which and the duration for which any health-related guideline value can be exceeded without raising concerns for public health depends on the particular circumstances. Exceeding a guideline value should be a signal to investigate the cause and, if appropriate, to take remedial action. If the characteristic is health related, the relevant health authority should be consulted." Amendments required in the address of comments by the enHealth review will ensure that this is consistent with the radiological approach taken in the relevant sections throughout Chapter 7

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5.2	The introduction of "reference level" in place of "guideline value" in the proposed amendments is inconsistent with the terminology of the ADWG. With limited justification of the benefits from changing the terminology we suggest that "guideline value" remains unchanged to maintain consistency and avoid potential confusion.	Accepted. See response to comment 2. For clarity the following is added, "In the system of radiological protection a reference level is the equivalent of a guideline value…."
5.3	The revisions maintain the guideline value (stated as reference value) of 1 mSv/year. The introduction of the specific dose criteria of 0.3 mSv/year introduces ambiguity on the actual tolerable health threshold level for drinking water supplies. Furthermore, derivation of the specific dose of 0.3 mSv/year assumes that RA226 and RA228 are the dominant radionuclides, which may not be reflective of all water sources in Australia.	Partially accepted. See response to comment 1. Changes to the wording for the dose criteria to operational dose response will be made. The 0.3 mSv/year operational dose level has been justified based on the calculation of dose from the gross alpha gross beta screening levels. Studies of Australian drinking water indicate that radionuclides that dominate the contribution to dose are Radium-226 Radium-228. As these radionuclides also have the highest dose coefficients for ingestion the estimate provides a conservative approach. Wording amended in Chapter 7 to reflect this.
5.4	To reduce confusion, a single health guideline value should be adopted to protect public health. This is presently covered in the current version of ADWG, with the recommended screening level for gross alpha and gross beta activity concentrations. Based on the information provided we recommend that guideline value in table 10.7 in Chapter 10 remains unchanged.	Accepted. 5.4 See response to comment 2. Changed wording back to guideline value. Text amended to remove reference to the 0.3 mSv/year operational dose in Chapter 10, so that it is clear that the basis for screening is on the gross alpha gross beta measurement.
5.5	Further to the general comments provided above, specific feedback on proposed Chapter 7 amendments is provided in the attached document. The comments and feedback provided for Chapter 7 should be considered where appropriate in the other supporting documents and fact sheets provided for review.	Noted.
6	The language of radiation protection can be confusing. Those sections that talk about the system of radiation protection and reference levels need to be read and edited for scientific clarity and consistency. Parts of the discussion around radiation is too complex for the ADWG. Drafting of those sections could be improved if ARPANSA were involved and the draft sent to RHERP.	Accepted. The text has been simplified.
7	Do the ADWG find their way into regulation, and if so has a preliminary impact assessment been carried out?	Noted. Guideline values are referenced within at least one jurisdiction, other jurisdictions use a combination of approved risk management plans and/or may be detailed within operating licences. As no change has been made to screening levels for gross alpha and gross beta and the guideline value of 1 mSv/year it is considered that an impact assessment may not be required.
8	Being unfamiliar with the ADWG does it cover traditional owners accessing natural water as their primary source. In the N.T natural U and Th in water and concentrations from past mining practices are monitored by the Office of Supervising Scientist. Should the fact	Noted. The ADWG provide a framework for the management of supplied drinking water at the point of use. The OSS monitoring is a separate response to potential off-site releases from mining

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	sheets address this to provide comfort that the water is monitored and that the levels are extremely small	practises and does not constitute monitoring of supplied drinking water. The role of monitoring drinking water quality in the Northern Territory rests with Power and Water Corporation working closely with the NT Department of Health.
Specific comments Chapter 7		
9	By far the largest: No need to change this as it remains factual	Accepted. Wording amended
10	Reversion of sentence back to previous wording as it remains factual	Accepted. Wording amended – refer to Comment 9
11	7.2 dot point 1: preferred terminology material replacing species	Accepted. Text amended to use “material” instead of “species”
12	7.3 first para: Use of the phrase “not always detected” implies that the effects exist, whereas no evidence exists to support such. LNT is a MODEL only. Therefore should read effects are not detected in scientific studies	Accepted. Section amended to reflect the power of epidemiological studies at low levels of radiation exposure Text amended to “In accordance with the linear no threshold (LNT) model of radiation protection there is a theoretically possible increased risk of cancer and hereditary effects at very low radiation doses or for radiation delivered over a long period of time, these effects have not been detected through scientific studies.”
13	7.3 first para last sentence: True statement, but no indication of scale for the reader and introduces unnecessary anxiety.	Accepted. Text amended to remove information on dose levels not relevant to drinking water. See response to comment 12.
14	7.3: Second para and all dot points – recommended delete with the reasoning: No need to address dose ranges and scare people with tales of terror, as water ingestion doses are typically “very low doses” and certainly rarely in excess of a mSv or so. Third para recommended delete due to the above reasoning	Accepted. Text deleted– refer to Comment 13
15	7.4 first para: preferred terminology radionuclides replacing radioactive species	Accepted. Text amended
16	7.4 first para: small change to wording	Accepted. Text amended from “biological effects” to “biological interaction mechanisms”
17	7.4 third para: recommended delete paragraph reasoning: The respective source of radionuclides in water is immaterial.	Accepted. Paragraph deleted
18	7.5.1 fourth para: changes to the sentence including lifetime (50 years) with reasoning: The citing of the duration of calculations for CED is not relevant, given that the dose coefficients for children are not cited further on. Protection of populations acknowledges the fact that the dose to the critical group is an average dose received by the critical group.	Accepted. Paragraph deleted.
19	7.5.2 (Table 7.1) table be removed (or at least restricted to only the more significant radionuclides – U & Th series). 7.5.2 (Table 7.1) Fission products and other radionuclides: Information Sheet 2.2 says anthropogenic radionuclides may be present though in very low concentrations. The fact	Partially accepted. Removal of anthropogenic radionuclides. Removal of the K-40 co-efficient and the note under table 7.1. Information sheet 2.2 for Radiological monitoring and assessment of performance reviewed in relation to information about K-40 and the

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	sheet for specific alpha and beta emitting radionuclides says Sr-90 and Cs-137 are not detectable in drinking water. If any anthropogenic radionuclides are found, their dose coefficients can be found in ICRP and it would be preferable, in such circumstances, for related studies to be made in the context of the full ICRP text and not an isolated extract. Additionally, Section 7.6.2 discusses age specific dose coefficients which should (or would usually) be taken into consideration for non-adult groups. Wonder what is the value in presenting only selected age dose coefficients. Note under the table: insert body tissues for clarity – it is not the dose due to ingesting the drinking water	potential for doses from anthropogenic radionuclides incorporating a reference for ICRP dose coefficients.
20	7.5.3 – first sentence re inclusion of communities with the reasoning: Doses will differ between communities with different water supplies. Such is a fact	Accepted. Wording amended to include communities
21	7.5.3: Remove reference to natural uranium and thorium series in final sentence – the total dose will be due to natural and anthropogenic (if any) radionuclides	Not accepted. This needs to be unchanged in the context of the reference used. The study referenced did not include anthropogenic radionuclides.
22	Notes term guideline value is retained	Accepted. See comment 2
23	7.6 first dot point comment of 'Why it is proposed to move from a "guideline value" to a "reference level"? Most of the water quality targets are expressed as "guideline values". The introduction of the term "reference level", while strictly correct in a "best international radiation practice" is not consistent with the terminology adopted for other contaminants discussed in the ADWG.'	Accepted. Chapter 7 amended to include the definition of guideline values in relation to the international accepted term "reference level." See comment 2.
24	7.6 fourth dot point: …assure 'compliance'. Was it intended this word be 'assessment'?	Accepted. Wording amended combining dot 3 and 4 to "screening levels for gross alpha and gross beta analysis that optimise the effort required in demonstrating compliance with the guideline value"
25	7.6 fourth dot point: comments of The screening method does not assure compliance; it optimizes the compliance effort. And The screening method does not assure compliance; it optimizes the compliance effort. Suggested wording is: a simple screening method to optimize compliance determination efforts plus changes to wording	Accepted. See above.
26	7.6 fifth dot point and final paragraph changes to wording	Accepted. Insertion of "further"
27	7.6: final dot point – include the radon reference level	Not accepted. This would impact the regulatory requirements in jurisdictions such as QLD where specific reference to meeting guideline values exist within the Public Health Regulations Part 9 Division 1:50 and 52(6). Incorporation of radon may require a Preliminary Regulatory Impact Statement. The radon fact sheet will include further information on the justification for not including a routine monitoring requirement for radon.

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
28	7.6.1 first para and dot points: suggested to delete with reasoning While informative, this doesn't add anything to the ADWG.	Partially accepted. Wording revised according to comment 31 below.
29	7.6.1: para starting with 'In existing exposure' and dot points following, suggestion of deleting with the reasoning: 'While "radiation correct" this doesn't mesh well with the concepts for other contaminants in the ADWG, where no requirement for optimization exists below guideline values. It refers to planned exposures where it has just stated in the preceding paragraph that drinking water exposure is an existing exposure situation. This will confuse the reader significantly.'	Partially accepted. Wording revised; The system of radiation protection applies to all three exposure situations; planned, emergency and existing. The system of radiation protection and safety considers the following principles: justification, optimisation and dose. In existing exposure situations the principle of justification is applied in making the decision as to whether to take action to reduce the exposure. Once the decision to control an exposure has been made optimisation of doses to the exposed group is carried out. Optimisation of protection is intended for applications where the exposure is deemed justified in order to reduce exposures to a levels be kept as low as reasonably achievable, taking into consideration economic and societal factors. It is the intention that the operational dose level 0.3 mSv/year provides a basis for further assessing the exposed population. Optimisation of protection in this sense is ensuring that within the exposed population there are no individuals that may receive a dose for an extended period above the 1 mSv/year guideline level. Text relating to the 0.3 mSv/year operational dose level (formerly dose criteria) has been deleted from Chapter 7. Further guidance on the 0.3mSv/year operational dose level has been provided in IS2.2. See also response to comment 1.
30	7.6.1 last para: insertion of sentence "The levels considered acceptable for the planned exposure situation provide a basis for setting a level at which protective measures should be considered and may be required."	Not accepted. The inserted wording could infer that once the exposure is above 1mSv/year it becomes a planned exposure.
31	Chapter 7.6.1 System for Radiation Protection is too complex for this document. The discussion around planned exposure is not relevant to drinking water subject to contamination from past uncontrolled practices or natural sources of radiation. Maybe simplified: 'Australia implements a system of radiation protection in line with IAEA requirements. These are reflected in Radiation Protection Series documents published by ARPANSA and developed jointly with States and Territories. Exposure to radiation from drinking water meets the requirements of being an 'existing exposure' and is dealt with according Radiation Protection Series G-2 'Guide for Radiation protection in Existing Exposure Situations'.	Partially accepted. Amended text including suggested text and reference to the justification, optimisation and dose limitations in the system for radiation protection.

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32	Table 7.1 introduces too much complexity. Fission products and other radionuclides would most likely be the result of an emergency exposure situation not an existing exposure situation. Natural uranium and thorium are more likely to be present naturally or as the result of past mining practices.	Partially accepted. Naturally occurring radionuclides of the uranium and thorium series retained to give context to the formula provided in 7.6.2.
33	7.6.2 fifth and sixth para: comment of: 'How will this be applied in practical terms?' And 'Reconsider whether this inclusion is necessary. Protection of populations acknowledges the fact that the dose to the critical group is an average dose received by the critical group.'	Not accepted. This section provides information for the assessment of dose for groups other than the representative persons for whom the dose is calculated according to the example given in 7.6.2. It refers to cases where the calculated dose for the representative group - adults drinking two litres of water - is approaching the guideline value of 1 mSv/year. In this situation consideration of other patterns of consumption or specific age groups is recommended. This ensures a more rigorous assessment of doses to these groups if a decision on protective actions is required.
34	7.6.3 first para last sentence: suggestion of sentence restored as it provides factual context.	Accepted. Deleted text restored
35	7.6.3: second para: changes to wording and further wording altered to Wording altered to reflect the sense, "Clearly demonstrate" implies that there are effects which epidemiology can't find. LNT is a MODEL. Last sentence also suggested restored as it provides factual context.	Accepted. Text amended to include suggested wording.
36	7.6.3: description of fatal cancers: The description is inconsistent with other agents/ ICRP 103 para 66 'it is not appropriate, for the purposes of public health planning, to calculate the hypothetical number of cases of cancer or heritable disease that might be associated with very small radiation doses'	Accepted. References to cancer rates removed.
37	7.6.3 While the ADWG are a stand-alone document the description of cancer and calculations of such from low dose exposure needs to be re-written as we believe it is incorrect. Access to such expertise is via RHERP. There may be a danger in having an incomplete and possibly flawed discussion of this in the ADWG.	Accepted. See above
38	7.6.4 we note that here, guideline values is a general term that includes the reference level and screening levels	Partially accepted. See comment 2
39	7.6.4: insertion of first paragraph: This keeps the concept of guideline values while explaining that for radiological characteristic they are a set of parameters (reference level, screening level) applied in a particular process.	Accepted. Suggested wording accepted. "For radiological characteristics, the most appropriate measure of water quality that could be regarded as a health-based guideline value is the annual effective dose to a person due to ingestion of radionuclides in the drinking water. However, the effective dose is not a directly measurable quantity, so assessment of water quality is based on the measurement of radionuclide concentration (screening) followed, if necessary, by the calculation of dose and its comparison to a reference level."

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40	7.6.4 *Australian Reference level* - para 1*:* Discussion of cancer risk at low levels, The description is inconsistent with other agents, which are discussed in terms of safe levels.	Accepted. Text referring to lifetime cancer risk removed. See above comment 36.
41	7.6.4 altered wording on final sentence	Text related to cancer risks removed.
42	7.6.4 *Australian Reference level* - para 2: So in this sense, the "reference level" is consistent with the intent of a "guideline value", as described in Section 1.3.2.	Accepted. Refer to comment 2
43	Comment regarding health authority with Water regulators are not well versed in making health protective decisions concerning radiation.	Parked. Preferred wording from NHMRC is "health authority or drinking water regulator"
44	7.6.4 *Australian screening levels for drinking water:* The criteria in ICRP Publication 82 applies to dose constraints in planned exposure situations and is not applicable or appropriate in existing exposure situations such as this. The document should be reverted to remove the dose criteria.	Partially accepted. See response to comment 2
45	7.6.4 *Australian screening levels for drinking water* - Para 3: recommendation to DELETE all with reasoning of 'This explanation is unnecessary and offers a needless point of conflict for agitators. The material suggested effectively states that "Australia will not afford comparable protection that the WHO recommends because we live in a highly mineralized country". Merely saying that the WHO criteria is not appropriate is an inadequate defence of the position taken. The decision to use 1 mSv as a national reference value is one of policy i.e. for the Radiation Health Committee and/or enHealth. The reasoning for adopting a radiation "specific dose criteria" appears to be at variance with the establishment of criteria for the remaining contaminants for which guideline values are ascribed within this ADWG. '	Partially accepted. Wording in respect to WHO levels deleted. Information comparing the ADWG guideline level and the WHO Individual dose criterion may be considered for inclusion pending public consultation.
46	7.6.4 *Australian screening levels for drinking water* - Para 3: specific dose criteria ICRP existing exposure reference levels are identified in ICRP 103 as a range 1-20mSv.	Partially accepted. See response to comment 45.
47	7.6.4 – ARPANSA ***does not set national reference levels***. It publishes documents developed by S/T radiation regulators. For existing exposures RPS G-2 is a Guide. Under what legislation is the radiation reference level set in S/T?	Noted. See response to comment 7.
48	7.6.4 specific dose criteria. RPS G-2 existing exposures talk about reference levels. The ARPANSA review introduces specific dose criteria *'GSR Part 3 requires that when an existing exposure situation is identified, responsibilities for protection and safety are assigned and appropriate reference levels are established. Reference levels are used for optimisation of protection in existing exposure situations. For occupational exposure and public exposure in existing exposure situations, a reference level serves as a boundary condition in identifying the range of options for the purpose of optimisation in implementing protective actions. The reference level represents the level of dose or the level of risk above which it is judged to be inappropriate to plan to allow*	Accepted. See response to comment 2

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	exposures to occur, and below which the optimisation of protection and safety is implemented.'	
49	7.6.5 Application of Guideline Values: This section should point to where radon is dealt with and consider medical radionuclides	Not accepted. Additional information for radon is provided in the radon fact sheet. Medical radionuclides are not expected to constitute a health risk in drinking water if present at all. Man-made radionuclides are considered in the following section 7.6.5 APPLICATION OF THE REFERENCE LEVEL IN SPECIFIC CIRCUMSTANCES
50	7.6.5 Application of Guideline Values: The original wording of the material provided for comment is confusing and seems to mean that (1) after considering the national reference level an optimisation process should be applied for every water supply assessment (this includes a cost-benefit analysis; but (2) conflicts itself by advising optimization should be required at 0.3 mSv; and states that (3) Optimisation will reduce doses to below the national reference level of 1 mSv. At what point is consideration of optimization recommended? The use of the "specific dose criteria" is not helpful and should be deleted. The draft as provided for comment shifts the trigger point for a formal cost benefit analysis down from 1 mSv to 0.3 mSv. Such is unwarranted.	Accepted. Text amended to; "As stated in Section 7.6.3.4, a national guideline value of 1 mSv/year should be applied for doses resulting from the consumption of radioactivity in drinking water (ARPANSA 2017). It is recommended that the relevant health authority or drinking water regulator assess the reported radiological water quality data to determine that the guideline value has not been exceeded. If the guideline value has been exceeded the need for protective measures should be considered with all relevant stakeholders. More information about the assessment and operational response can be found in Information Sheet 2.2."
51	Suggestion of deletion in first sentence of 3rd para with and change to health authority reference as 'Water regulators are not well versed in making health protective decisions concerning radiation.'	Parked. Preferred wording from NHMRC is "health authority or drinking water regulator"
52	7.6.5 Application of Guideline Values – para 2: ICPR/0.3 mSv/year – see previous comment The criteria in ICRP Publication 82 applies to dose constraints in planned exposure situations and is not applicable or appropriate in existing exposure situations such as this. The document should be reverted to remove the dose criteria.	Partially accepted. See comment 1.
53	7.6.5 The 0.3 mSv/year, in this context, does not come from ICRP 1999. It is a specific dose criteria, lees than the reference level, adopted by Australia to set screening levels	Partially accepted. See comment 1.
54	7.6.5 para 3:If the screening levels are not exceeded, then doubt that the relevant health authority or drinking water regulator will be involved in assessing the water quality data.	Noted.
55	7.6.5 para 3 – rewording and comment of 'The assessment can only determine whether the specific dose criteria is exceeded, not ensure that it hasn't been.' And 'The specific dose constraint must not become a proxy reference level.' And 'Clarify what the further information is.'	Accepted. Text amended – deleted reference to 0.3 mSv/year operational dose level.
56	7.6.5 – para 4: The description of the optimisation process is not necessary. It is explained in a broader context in ICRP and Radiation Protection Series documents.	Accepted. Text deleted

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	The relevant health authority or radiation regulator will be aware of this process and is best placed to perform the necessary assessments and determinations etc.	
57	7.6.5 – para 4: Agree. This goes to a more fundamental question of who the ADWG is intended for. The attempts to include everything for everybody has made the document unwieldly.	Partially accepted. From Chapter 1 Introduction "The ADWG are intended for use by the Australian community and all agencies with responsibilities associated with the supply of drinking water, including catchment and water resource managers, drinking water suppliers, water regulators and health authorities" Sections of the documents have been revised and simplified as given in the responses to other comments.
58	7.6.6 This section is not about the application of the reference level. It is about a management approach and the estimation of dose in specific circumstances. The text is better moved elsewhere. Paragraphs 1 & 2 to the end of Section 7.6.1. Paragraph 3 to the end of Section 7.6.2.	Accepted. Text moved as suggested.
59	7.6.6 (par 4) Section 3.6 of the ADWG deals with incidents and emergencies. The reference to the two particular emergency documents is not required. The relevant health authority or radiation regulator will take appropriate action and will be guided by these and other relevant documents. They are best placed to perform the necessary assessments and determinations etc. in the particular circumstance.	Not accepted. This information was requested in an earlier WQAC review. Text moved to 7.6.1.
60	7.6.6 - para 4: Agree. Including a specific reference like this creates an obligation to make sure the information stays up to date. ADWG would have to be amended every time these documents are updated.	Parked. RPS7 is now 2019 reference will be updated. Like the ADWG itself these documents undergo rolling revisions and the online source for the publication should be referenced using the URL or other means.
61	7.6.7 (remedial measures) reference to optimization removed. Consider removal of 7.6.7. The relevant Health authority or radiation regulator will most likely be involved in remedial measures and will be aware of the system of radiation protection.	Not accepted. See comment 57.
62	Again, this goes to the question of who the ADWG is for. the tendency to provide information intended to apply to regulators may give the impression that WSPs are able or expected to carry out the action.	Not accepted. See comment 57.
Specific comments Chapter 10		
63	Heading 10.7 – does not include radiological characteristics	Out of scope. Section 10.3.7 Microbial, Chemical and Physical characteristics were not reviewed in keeping with the existing format of the ADWG. Radiological aspects have not been added to the section in order
64	10.3.8 – suggestion of a separate radiological section since the approach is not quite the same as for other characteristics	Parked. ARPANSA's understanding of the review was that changes to the format and structure of the ADWG were not possible.

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65	Suggestion of changing guideline values to guidance on in table 10.7	Accepted. See comment 2.
66	Table 7 refers to the relevant regulatory authority. In all S/T radiation protection lives within Health Departments and the EPA. These organisations are not water regulators but have the expertise to interpret human health impacts from exposure.	Parked. Preferred wording from NHMRC is “health authority or drinking water regulator
67	Reference to ICPR in Screening of water supplies	Accepted. Reference to the operational dose level of 0.3 mSv/year will be removed in Table 10.7.
68	Reference level: Water regulators are not well versed in making health protective decisions concerning radiation	Parked. Preferred wording from NHMRC is “health authority or drinking water regulator
69	Screening water supplies: The use of the “specific dose criteria” is not helpful and should be deleted. The draft as provided for comment shifts the trigger point for a formal cost benefit analysis down from 1 mSv to 0.3 mSv. Such is unwarranted.	Accepted. See comment 69.
70	Derived reference level for Radon concentration – should be included as one of the parameters making up the set of guideline values	Not accepted. This would impact the regulatory requirements in QLD where specific reference to meeting guideline values exist within the Public Health Regulations Part 9 Division 1:50 and 52(6). Incorporation of radon in Table 10.7 may require a Preliminary Regulatory Impact Statement
71	Table 10.6 appears to be littered with inconsistencies in the presentation of data and units. Some examples: a. Microcystins are listed as 1.3 µg/L, which is equivalent to 0.0013 mg/L. Therefore it could be argued that any value using mg/L that contains that number of decimal points should be presented in µg/L? i. Vinyl chloride listed as 0.0003 mg/L; should this be 0.3 µg/L? ii. Heptachlor listed as 0.0003 mg/L; should this be 0.3 µg/L? iii. Hexachlorobutadiene listed as 0.0007 mg/L; should this be 0.7 µg/L? iv. Methiocarb listed as 0.007 mg/L; should this be 7 µg/L? b. I note that N-Nitrosodimethylamine and PAHs are listed in both ng/L and mg/L? c. So it may be worthwhile developing a protocol whereby the number of decimal places of a limit when presented in mg/L dictates if another unit of measurement should be presented. For mine, the bigger the number, the easier it is to read and avoid mistakes with translating the number of preceding zeros after the decimal point. If the group agrees with this, it may also be worthwhile having a brief description about units and the relationship between them. For example, people tend to panic when then see a large number, and often don’t appreciate the units. I often describe it to people by saying “a grain of sugar weights around 0.00625g (6.25mg or 6250ug)”. Then when they see that (for example) their water contains 0.5 µg/L of Pb, then they can see it in context! Maybe I’m making too much of this?	Noted. Out of scope for radiological update public consultation – can action as a separate update at a later date

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	d. The "note" used in Epichlorohydrin should be on the following line and not adjacent to the limit?	
Information Sheet 2.2		
72	Avoid discussion of dose in this section (Screening Water supplies) and re-enforce the role of screening assessment to form a point of reference for further investigation	Accepted. Text moved to section related to dose assessment.
73	Surface water: two references to "dose" here. What is this the dose from – ingesting the surface or groundwater directly, or ingesting a treated drinking water supply that uses surface or groundwater as a source?	Accepted. Text amended.
74	Surface water: The wording could be better here. Needs to indicate that if it is talking about treated water sourced from surface or ground, or to the raw water.	Accepted. Text amended
75	Is this meant to be "total" or "gross"? Total beta would include the contribution from ^{40}K.	Accepted. Text amended
76	The original wording provides a clearer explanation of good practice	Partially accepted. Text amended
77	ICRP publication and 0.3 mSv/year	Accepted. See comment 2.
78	The use of the "specific dose criteria" is not helpful and should be deleted. The draft as provided for comment shifts the trigger point for a formal cost benefit analysis down from 1 mSv to 0.3 mSv. Such is unwarranted	Accepted. See comment 2
79	Screening Water supplies: adding a 'target criteria' / specific dose criteria adds another level that may not add value	Accepted. See comment 2
80	Clarify the dose is from ingestion of radionuclides	Accepted. Text amended
81	The use of the "specific dose criteria" is not helpful and should be deleted. The draft as provided for comment shifts the trigger point for a formal cost benefit analysis down from 1 mSv to 0.3 mSv. Such is unwarranted. Health agencies should determine frequency of testing in conjunction with the water provider.	Accepted. See comment 2.
82	Dose assessment: Unlikely to be warranted at these dose levels (no acute impacts)	Accepted. See comment 2. If the screening levels are exceeded the dose assessment involves the calculation of dose from the dominant radium radionuclides. The current guidelines recommend a dose assessment if the screening values are exceeded. Clarification in the text.
83	Operational Response: Earlier text stated the gross alpha/beta is not to be used as a trigger for further action	Accepted. See comment 84. Exceeding the screening level triggers the need for further testing of specific radionuclides and calculation of dose. Whether the dose levels are required to be reported to health regulator is considered after the assessment.

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
84	The criteria in ICRP Publication 82 applies to dose constraints in planned exposure situations and is not applicable or appropriate in existing exposure situations such as this. The document should be reverted to remove the dose criteria.	Partially Accepted. See comment 2.
85	Superfluous as meeting the screening level test means no further work therefore no way to know whether the total annual dose at the "specific dose criteria" has been met. In any event, the "specific dose criteria" serves no real purpose in the context of other contaminants considered in the ADWG and should be removed.	Partially accepted. In situations where radium-226 and radium-228 radionuclides are tested in place of conducting gross alpha gross beta screening, the 0.3 mSv/year operational dose level can be used as a guide for where continued routine monitoring is recommended and further assessment is not required. Text amended to provide clarification.
86	Operational response – para 3: Optimisation is not catered for in the wider ADWG. Justification for the optimization of exposure from an existing exposure situation is not supported in this case. This aspect of the draft requirements for radionuclides introduces concepts that do not sit well with the remainder of the document. There is no need to optimize when the option to merely consider protective measures only seems to apply at doses above the 1 mSv reference level	Partially accepted. Text amended. See response to comment
87	Operational response – para 5: This implies that an annual dose greater than 1 mSv is unacceptable. However, Section 7.6.4 states: "There may be some circumstances where there is no practical alternative but to accept a dose that exceeds the reference level of 1 mSv/year, together with a potential slight increase in the risk to health as a consequence. However, if doses from the use of a particular water supply will exceed 10 mSv/year, immediate action must be taken to reduce the existing or potential exposures."	Not accepted. The text relating to this comment states "A total annual dose that exceeds 10 mSv is unacceptable for drinking water…" Text has been amended to remove decimal places on the guideline value of 1 mSv in the preceding paragraph to avoid confusion.
88	***Table IS2.2.1:*** If this table remains, there needs to be a supporting column that provides the rationale for the dose level ranges, health impacts, and the corresponding operational response Row 1: The assumption that the dose is less than 0.3 mSv per annum introduces the concept to public health decision makers that it <u>is</u> o.3 mSv, as the assumption in the document is that Ra226 and RA 228 are to blame. Such an assumption does not provide for supplies where Ra226 and Ra228 are not the dominant radionuclides. In any event the use of the "specific dose criteria" is not supported in this document. The use of the "specific dose criteria" is not helpful and should be deleted. The risk is that the draft as provided for comment shifts the trigger point for a formal cost benefit analysis down from 1 mSv to 0.3 mSv and requires regulatory intervention. This benefit of this outcome need to be carefully considered. Row 2: the use of the "specific dose criteria" is not helpful and should be deleted. Refer to comment above. Row 4: Regulatory authorities may not necessarily be health authorities, therefore use 'health authority'.	Partially accepted. Table IS2.2.1 reviewed in line with other comments.

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
	Row 4: The reference level is NOT a hard and fast limit. Protective measures would involve securing an alternative water supply as soon as feasible. To mandate that doses be immediately below the 1 mSv reference level from an alternative supply is extending the scope of the document too far. The wording establishes a pre-condition for regulatory failure in the event that a suitable alternative supply is unavailable. Row 4: These are guidelines, not black letter law.	
89	*Analytical methods for potassium-40:* To avoid confusion, this should be removed. This is the dose due to ^{40}K in bodily tissues – it is not a dose due to ingesting ^{40}K in drinking water.	Accepted. Wording with respect to potassium-40 removed
90	*Sampling frequency* – para 2: Approaching from which direction? If the screening level is not exceeded, then there is no requirement to be calculating the dose, so we won't know if it is approaching 0.3 mSv/year. If the screening level is exceeded and the calculated dose is less than 0.3 mSv/year, then the flowchart tells us to continue routine monitoring, and the paragraph above tells us the sampling frequency. **Consider removing this paragraph as it is not likely to come into effect.**	Accepted. Text amended to clarify. "Where screening is omitted in place of performing an analysis of specific radionuclides, the 0.3 mSv/year operational dose can be used to determine the case for continued routine monitoring."
91	*Sampling frequency* – para 2: The introduction of regulatory consultation at the "specific dose criteria" is inconsistent with the tone of the remainder of the contaminants assessed in the ADWG and is not supported. Refer to other comments regarding the removal of the "specific dose criteria".	Accepted. Text amended as above
92	*Reporting of results – para 3:* Remove text, it is the responsibility of water agencies to develop a risk management plan/process which would trigger the need to monitor and report to regulators if there is an exceedance of the guideline value or an elevated risk to public health. The role of regulator is to ensure the risk management frameworks are in place and action is taken when there is an elevated risk to public health.	Accepted. Paragraph removed
93	*Reporting of results – para 3:* The introduction of regulatory consultation at the "specific dose criteria" is inconsistent with the tone of the remainder of the contaminants assessed in the ADWG and is not supported. Refer to other comments regarding the removal of the "specific dose criteria".	Accepted. See response to comment 92.
94	It is not appropriate to derive screening levels from a 0.3mSv dose criteria	Partially accepted. The gross alpha gross beta screening levels which have not been changed in the review are set to achieve a level of confidence that the guideline level of 1 mSv/year will not be exceeded. They are not set on the basis of the 0.3 mSv/year. Clarification of the application of the 0.3 mSv/year operational dose will be improved throughout the text. See response to comment 1.

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
95	This is confusing – elsewhere we stress that 137Cs and 90Sr are not significant.	Accepted. Text amended.
96	If they are not detectable, they should not be mentioned as "significant" in the previous paragraph, and they need not be discussed in the later section on "Health Considerations"	Partially accepted. Text in this paragraph is retained as past events are not indicative of future potential contamination events. The later sections have been amended to remove Cs and Sr from health considerations.
97	Other agents are discussed in terms of safe levels.	Accepted. Text removed.
98	strontium-90 and caesium-137: Previous statements have said these two radionuclides are negligible and not detectable. There is no need to include this.	Accepted. Text amended and/or removed
99	Potassium-40: The dose due to this naturally occurring radionuclide in bodily tissues: Make it clear that the dose is due to 40K in the body, not from ingesting drinking water.	Accepted. Text amended
Fact Sheet: Radon		
100	Radon reference value: a "derived reference level" for radon concentration is set at 100 Bq/L. A derived reference level equivalent to only 5% of the national reference level seems overly conservative, and the rationale for this is not clear	Noted. The derived reference level for radon represents a conservative value to allow for the large inherent uncertainty of the transfer factor.
101	This terminology is not used elsewhere in the ADWG. There is no indication of how this derived reference level is to be applied (unlike there is for screening levels for gross alpha and beta, and the reference level for annual dose). There should be some guidance (even if it is somewhat subjective) about when the activity concentration of 222Rn needs to be determined. WHO recommends that it is prudent to measure radon concentration in drinking-water in circumstances where high radon concentration might be expected	Partially accepted. The terminology is further defined in the section DERIVED REFERENCE LEVEL FOR RADON. This text has been moved to after the GENERAL DESCRIPTION Additional text providing guidance on when consideration of radon monitoring is required has been added.
102	Discussion of liquid scintillation for Rn measurement: Consider other methodologies that are more practical than liquid scintillation (eg in-field radon monitors with flow through capability)	Partially accepted. Only Standard Methods of analysis were included in the text as these methods can be readily referenced. Text amended to include a reference for methods that utilise the range of equipment available for radon in air/water partitioning measurements.
103	3rd dot point under derived reference level for radon: not appropriate to use a level of dose as the basis for a guideline value for radon in drinking water: Agreed. The activity concentration is used a basis for a guideline value. As such it should be included in Chapter 7.6.4 which list the other two guideline values (reference level for annual effective dose, screening level for gross alpha and beta).	Not accepted. See response to comment 27 copied below. "This would impact the regulatory requirements in jurisdictions such as QLD where specific reference to meeting guideline values exist within the Public Health Regulations Part 9 Division 1:50 and 52(6)." The radon fact sheet will include further information on the justification for not including a routine monitoring requirement for radon."
Fact Sheet: Radium		

#	EnHealth WQERP and RHERP feedback (January 2020)	Action/ Water Quality Advisory Committee (WQAC) and ARPANSA response
104	Analysis: Either gross alpha or gross beta	Accepted. Text amended
105	Health Considerations para 4: If this is true for radionuclides in general (not just radium) then this statement is better placed in Chapter 7 at 7.6.3. Why not both.	Noted. The wording and reference Guseva Canu 2011 has already been included in 7.6.3.
Fact Sheet: Uranium		
106	Nil comments received	

Final Guidance

EnHealth WQERP and RHERP members provided the following comments on the final versions of the updated Guidance in December 2020.

#	WQERP/ RHERP Feedback	ARPANSA/ Water Quality Advisory Committee (WQAC) response
1	No further comments to make.	Noted.
2	No further comments.	Noted.
3	I understand that discussions have been held since 17 November involving ARPANSA and NSW, and I would support continued dialogue. Chapters 7 and 10 seem to have been updated broadly in line with our comments on the previous versions. I do have some queries on Info Sheet 2.2 Radiological monitoring and assessment of performance, where this does not capture my previous comments. *"Water that meets the screening values will therefore result in an annual dose of approximately one-third of the guideline value of 1 mSv. This value of approximately 0.3 mSv/year can be used as the operational dose value in the screening process. This is also consistent with the approach taken by the ICRP (ICRP 1999).* *The operational dose value of 0.3 mSv/year is a value where if exceeded, it may be reasonable to consider whether additional information is required to ensure the 1 mSv/year guideline value is met e.g. repeat testing, further specific radionuclide analysis and/or an assessment of consumption patterns. The 0.3 mSv/year operational dose value is also the point at which the screening value is generally exceeded, warranting further individual radionuclide analysis.* *The recommended screening values and operational dose value provide a good margin of safety against the guidance value of 1 mSv/year.*" 'Operational dose values' does not seem an appropriate concept for a radiological monitoring info sheet. A value of 0.3 mSv/y is not appropriate. There are clearly established international reference levels for existing exposure and NORM situations. If doses per annum are mentioned it should be those.	The issues raised by the reviewer were discussed at the RHERP meeting Dec 17 2020. This discussion is reflected in the minutes below: ***5. NHMRC Drinking Water Guidelines*** • *ARPANSA prepared a discussion paper to provide a better explanation around point 3 vs point 5, noting that it has been put forward that we use point 3 as it is roughly equivalent to a screening action.* • *ARPANSA noted that the process is addressed in the new draft, and that it is aligned with this is aligned with international approaches.* • *Tasmania was of the view that while there is some debate that change from 0.5 to 0.3 creates an expectation – they understand it to merely be a better translation rather than an overly impactful change.*

	The language "*additional information is required to ensure the 1 mSv/year guideline value is met*" is not appropriate. If the aim is determining whether the reference level is met, then I agree that uncertainties in monitoring may need to be accounted for. If this is the case then it should be expressed in those terms. Note that the requirement to justify intervention in existing exposure situations, means that uncertainty needs to account for the possibility of overestimating doses per year from monitoring and assessment. The terminology 'a good margin of safety' is not appropriate. With respect to safety, the origin of the 1 mSv/y value already defines a good safety margin.	**ARPANSA has edited Information Sheet 2.2 and used additional wording to ensure that the intention of the 0.3 mSv/year operational dose value is clear in its relation to use as a screening dose value.**
4	The NSW EPA has expressed similar concerns to those expressed by SA EPA regarding the proposed investigation value for radiation dose from drinking water of 0.3mSv per annum (reduced from 0.5mSv). In brief, an investigation value of 0.3mSv seems to have been derived from international standards appropriate for planned radiation exposure situations (where dose may be readily managed and mitigated) but not existing/background exposures, including drinking water. The practical effect is that the change may place an unwarranted burden on water authorities in additional monitoring, radionuclide testing and (potentially) treatment. (Our detailed concerns are in our submission to the public consultation). NSW EPA and NSW Radiation Advisory Council representatives met with ARPANSA on 18 November 2020, at which time ARPANSA committed to further consideration of the issues raised by NSW EPA and SA EPA at enHealth.	See response to 3
5	It is noted that the majority of the department's comments have either been accepted in full or partially as outlined in ARPANSA response at Attachment A. The main comment on the drafts provided relates to the introduction of the of "0.3 mSv/year operational dose value" previously referred to as the "specific dose criteria" in the draft revision of Information Sheet 2.2. As per the department's previous comments below, the introduction of the of the stricter 0.3 mSv/year operational dose value provides unnecessary ambiguity on the actual tolerable health threshold level for drinking water supplies. It would be appreciated to understand where this lands.	See response 3.
6	We note ARPANSA's responses to comments received during the public consultation process, and the comments from the RHERP members from SA and NSW, and have no further comment to make at this stage.	Noted

Appendix C – Public consultation summary report

Background

The *Australian Drinking Water Guidelines* 2011 (the Guidelines) have been developed by the National Health and Medical Research Council (NHMRC) and are designed to provide an 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.

The Guidelines contain information and guidance on the physical, microbial, chemical and radiological quality of drinking water. In 2016 the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) recommended that the radiological water quality advice in the Guidelines be reviewed to incorporate the latest terminology and information provided by the ARPANSA Guide and to align with international best practice. ARPANSA offered to provide scientific input and advice to the NHMRC on the review and has been updating relevant sections of the Guidelines since 2017.

The radiological water quality sections of the Guidelines that have been updated are:

- Chapter 7 – Radiological Quality of Drinking Water
- Chapter 10 – Monitoring for Specific Characteristics in Drinking Water (radiological aspects including Table 10.7)
- Information Sheet 2.2 – Radiological monitoring and assessment of performance
- Factsheet – Specific alpha and beta emitting radionuclides
- Factsheet – Radium (radium-226 and radium-228)
- Factsheet – Radon-222
- Factsheet – Uranium (radiological aspects)

Updates to the Guidelines include updated guidance on acceptable parameters and exceedance levels, as well as updated terminology and definitions.

NHMRC sought public comment on the draft guidance for inclusion in the Guidelines between 29 July 2020 and 12 August 2020. Stakeholders were invited under paragraph 13(d) of the *NHMRC Act 1992* to make submissions to NHMRC about the draft amendments. The aim of this public consultation was to seek stakeholder feedback on the draft updates to radiological water quality advice only.

Consultation Questions

The questions asked at public consultation were as follows:

1. Do you have any comments on the overall approach taken to update the radiological water quality advice?
2. Do you foresee any major difficulties in the implementation/ application of the updated guidance? If so, what are they and how could they be resolved?

Do you have any specific comments on the following updated sections of the Guidelines:

3. Chapter 7 – Radiological quality of drinking water
4. Chapter 10 – Monitoring for specific characteristics, Table 10.7
5. Information Sheet 2.2 – Radiological monitoring and assessment of performance
6. Factsheet – Specific alpha and beta emitting radionuclides
7. Factsheet – Radium
8. Factsheet – Radon-222
9. Factsheet – Uranium (Radiological aspects)

Submissions

NHMRC received ten public consultation submissions from professional organisations, government agencies and independent radiation protection experts. High level details of respondents are listed below where permission has been given to do so.

- Western Australian Department of Health
- Individual radiation expert
- NSW Environment Protection Authority
- The Australian Nuclear Science and Technology Organisation (ANSTO)
- Department of Agriculture, Water and the Environment (DAWE)
- Radiation Health, Western Australian Health
- Australasian Radiation Protection Society

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

Responses to public comments

The public consultation submissions raised a number of issues that were all given due regard and taken into careful consideration by ARPANSA and the Water Quality Advisory Committee. Key issues and responses including any resulting amendments to the guidance are summarised in the table below. Other minor edits such as text clarifications have been actioned accordingly.

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

When responding to comments the following terms have been used:

Term	Definition
Accepted	The proposed change has been made to the text.
Partially accepted	Either: • the proposed change has been made, however the suggested text was modified

Term	Definition
	or • the proposed change is accepted but the text has been modified in a different clause/section or • only part of the proposed change was accepted or accepted with modifications
Not accepted	No changes were made to the text based on this comment.
Noted	Either: • no proposed change to the text was required to address the comment or • the comment was outside the scope of the document noting a comment does not imply that the comment is endorsed.
NIL	Either • no comment received against the question or • the comment was not applicable to the question

Summary of key Issues

#	Key issue	Response
1	Concern about the use of mandatory and non-mandatory language to describe appropriate decision making.	Accepted. Language throughout the Guideline documents has appropriately been amended to reflect non-mandatory language as this publication is a Guideline.
2	Proposed adoption of an operational dose level of the 0.3 mSv/y is problematic, and 0.5mSv/y is a more appropriate operational dose level.	Not accepted. The 0.3 mSv is an operational dose level, exceeding the operational dose level does not infer that a regulatory response is required. Verification of compliance with the guideline value, in instances where doses lie between the operational dose level and the guideline value, may require more intensive monitoring and assessment of exposed groups to ensure that the guideline value of 1 mSv/year is not exceeded.
3	The change in operational dose level does not appear to be a correct application of the ICRP recommendations for the 0.3 mSv/y dose constraint.	Not accepted. ICRP 82 describes the internationally accepted guidance in prolonged exposure situations and includes commodities containing radioactive

#	Key issue	Response
	ICRP recommends this as a dose constraint for above background radiation exposure, mainly related to planned exposure situations. In the majority of cases drinking water does not a fit with the prolonged exposure situations being discussed in ICRP 82. Drinking water is largely related to existing exposure from background radiation sources. This level of extra safety is not required for drinking water because annual consumption does not increase proportionally to the number of drinking water sources used by a person.	substances in A3. A29 page 78 states "The drinking of mineral water rich in primordial radionuclides is also a cause of additional prolonged exposure. ". Paragraph (k) of the Executive Summary in ICRP 82 "recommends that the maximum value of the dose constraint to be used in the optimisation of radiological protection for a single source should be less than 1 mSv in a year and that a value of no more than 0.3 mSv in a year would be appropriate. The operational dose level of 0.3 mSv/year provides a level of confidence that the guideline value of 1 mSv/year will not be exceeded. An assessment of the annual dose is performed when screening levels are exceeded. Where the annual dose is assessed to be below the operational dose level of 0.3 mSv/year, routine monitoring can be continued. Assessment of the dose to additional groups should be undertaken where the annual dose for the average group approaches 1 mSv/year. In this situation doses to some members of the population may exceed the guideline value of 1 mSv/year. When the annual dose of 1 mSv/year is exceed, optimisation should be considered in the form of remediation. In the existing Guidelines the operational response stated that consultation should be held with the relevant health authority when the calculated dose lies between 0.5 and 1.0 mSv/yr. It is up to the relevant health authorities or water regulators to make decisions on the implementation of the guidelines. The change to 0.3 mSv/year is considered to have minimal impact in terms of the number of water sources across Australia. While drinking water is an existing exposure situation, it is also a situation where the opportunity to ameliorate exposure of the public to radioactivity can be provided through management practises such as blending and or other forms of water treatment.
4	The revised Guidelines is unlikely to result in intervention action at dose levels between 0.35 mSv/y and 0.5 mSv/y.	Noted. It is not the intention that an operational dose level 0.3 mSv/yr be used as a number for regulatory actions or interventions. The purpose is to monitor more closely supplies that may be approaching the guideline value of 1 mSv/year. The text has been modified to provide clarification in Information 2.2 and/or Chapter 7

#	Key issue	Response
5	The impending change to dose factors will create confusion in the future due to the potential that the new dose factors will be significantly different to the dose factors proposed for the Guidelines. ICRP137 contains current dose factors, which have changed significantly from the previous dose factors used in the Guidelines. While ICRP137 contains dose factors for workers, it is noted that previously dose factors for ingestion where the same for both workers and the public.	Not accepted. The Guidelines use the current dose coefficients by ingestion for adult members of the public found in ICRP Publication 119 (2012). Changes to the dose coefficients in Table 7.1 can only be implemented once new dose coefficients for members of the public are published by the ICRP. It would not be correct to assume that the dose coefficients for workers will be the same as for member of the public. As the Guidelines are an electronic document with rolling revision, the changes can be easily adopted once the final coefficients are published. Additional text has been added to allow the use of the values in the table at 7.1, or the most recent published dose coefficients for intakes of radionuclides by members of the public.
6	Concern about potentially confusing messaging in stating that up to 0.35 mSv per annum is acceptable (Infosheet 2.2), via the gross alpha/beta screening. Yet there is a 0.3 mSv per annum dose constraint. This creates ambiguity, and may lead to misunderstanding by the public about safety and the implementation of the Guidelines to radiological water quality. This would be eliminated by retaining the existing 0.5 mSv per annum dose constraint.	Partially accepted. Text has been modified to clarify the relationship between screening and the operational dose level in Information Sheet 2.2. The value of 0.3 mSv/year refers to an operational dose. The operational dose level is proposed to value which if exceeded, it might be reasonable to consider whether additional information is required to ensure the 1 mSv/year guideline value is not exceeded. E.g. repeat testing, further specific radionuclide analysis and/or an assessment of consumption patterns. The 0.3 mSv/yr operational dose level is also the point at which the screening level is generally exceeded, warranting further individual radionuclide analysis.
7	Consideration could be given to the range of annual consumption in setting an operational dose level.	Noted. Consumption levels can be considered in the estimation of the annual dose and assessment against the guideline value of 1 mSv/year. However, it is not necessary for a more detailed evaluation of the dose unless the guideline value has the potential to be exceeded. The conservative operational dose level of 0.3 mSv/year can be used in situations, particularly for hot/arid regions of Australia, where consumption rates for drinking may be higher than average and where drinking water supplies tend also to be sourced from ground waters, which may have elevated radiological activity concentrations.
8	Use of radiation protection terminology should be reviewed. Terms such as “screening levels”, “reference levels” and “guidance levels” used interchangeably and inconsistently, and have different meanings in broader international standards. For example a Reference level	Accepted. Text in Chapter 7 has been modified to provide consistent use of terminology

#	Key issue	Response
	in an international context is when action is required, whereas the Chapter 7 talks about considering if action is required when the reference level/guideline value is exceeded. Terminology has also been duplicated with the existing terminology in the Guidelines. e.g. guideline value and reference value	The review is constrained by the need to work with the terminology used in the broader Guidelines when using the "screening levels" and "Guideline values".
9	Although the updated guidance makes clear that monitoring radioactivity in the water supply is needed, it does not make clear who is responsible for undertaking this monitoring. For example, should it be the responsibility of the water provider, water regulator, health authority, company discharging radionuclides to the environment in the vicinity of the water supply, etc. This lack of clarity could be a point of confusion or contention in the practical application of the guidance.	Noted. This information is covered in Part 1 Management of Drinking Water Quality (Chapters 2 to 4) and is not information included in the specific information for the Chapter 7 Radiological Quality of Drinking or the supporting information for the radiological quality of drinking water.
10	The latest document by the World Health Organization, “Management of radioactivity in drinking-water” (2018) is not mentioned in the text and in the references. It is suggested that the document is studied and the Guidelines are amended as appropriate (and if required), to reflect the latest WHO Guideline on the subject.	Noted. ARPANSA contributed in the peer review to the publication “Management of radioactivity in drinking-water” (2018). The document was developed primarily to facilitate of the development of national standards that take into consideration the local conditions including the technical, economic, environmental and societal circumstances
11	The age of members of the public to which the Guidelines apply may also need to be considered. Both IAEA Basic Safety Standards (2014) and the latest WHO publication mentioned above (2018) contain ingestion dose coefficients for different ages, with the ones for the age over 17 years being used in the Guidelines. It is understood that in most practical situations the factors for adults will be applicable. There are, however, cases such as water supply to a primary school and/or a child care centre – where these coefficients will not be appropriate.	Noted. The use of age specific dose coefficients along with the consideration of lifestyle and individual consumption patterns for drinking water is discussed in 7.6.2. A reference to the original source for the dose coefficients provided in Table III.2.D IAEA BSS GSR Part 3 (2014) is provided with the reference ICRP Publication 60 (2012). Due to the expected updates to the ICRP dose coefficients for members of the public, the preference is to maintain a single reference for the dose coefficients in Table 7.1
12	There could be some confusion in comparing the Guidelines’ recommended reference level of 1mSv/year to international standards. For example, the World Health Organization (WHO) drinking water guidelines adopt a more conservative approach, with the reference level being 0.1 mSv/year which represents 10% of the dose limits for members of the public, as recommended by the International Commission on Radiological Protection (ICRP).	Partially accepted. The WHO has adopted a 0.1 mSv/year is an individual dose criterion, which provides the basis for the development of individual guideline levels for individual radionuclides. The Guidelines take the approach that the dose should be below the 1 mSv/year reference level or guideline value recommended in the International Basic Safety Standards (IAEA, 2014) for the radiation dose due to the consumption of drinking water and adopted in ARPANSA RPS-G-2.

Appendix D – Public consultation submissions

The following public consultation submissions are reported in full without alteration where permission has been given to do so.

Public Consultation Questions

The questions asked at public consultation were as follows:

1. Do you have any comments on the overall approach taken to update the radiological water quality advice?
2. Do you foresee any major difficulties in the implementation/ application of the updated guidance? If so, what are they and how could they be resolved?

Do you have any specific comments on the following updated sections of the Guidelines:

3. Chapter 7 – Radiological quality of drinking water
4. Chapter 10 – Monitoring for specific characteristics, Table 10.7
5. Information Sheet 2.2 – Radiological monitoring and assessment of performance
6. Factsheet – Specific alpha and beta emitting radionuclides
7. Factsheet – Radium
8. Factsheet – Radon-222
9. Factsheet – Uranium (Radiological aspects)

#	Organisation	Q	Comments received
1	Department of Health Western Australia Government department – State / Territory	1	The overall approach is supported.
		2	No comment.
		3	The updated text is supported.
		4	The updated text is supported.
		5	The revisions are supported, subject to the following comment: The section "Dose Assessment" states that "the drinking water supply may be sourced from surface waters (e.g. reservoirs, rivers and dams) or from groundwaters", then proceeds to make arguments and provide examples in relation

#	Organisation	Q	Comments received
			to each case. No advice is provided for circumstances where drinking water is sourced from seawater desalination. This source is considerably more common in Australia than 20 years ago, particularly in Western Australia. It is recommend that information is provided in this section (and also Chapter 7 generally) providing advice in relation to drinking water sourced via seawater desalination.
		6	The updated text is supported, subject to clarifying: Under "GENERAL DESCRIPTION" the draft states: "Physical processes of weathering, recoil, decay, adsorption-desorption and precipitation during transport within aquifers will affect the radium content." In this sentence, please clarify what is meant by 'recoil'.
		7	The updated text is supported.
		8	The updated text is supported.
		9	The updated text is supported, subject to clarifying: Under "TYPICAL VALUES IN AUSTRALIAN DRINKING WATER" the draft states: "In most Australian drinking water supplies uranium concentrations are well below 20 µg/L. However, concentrations up to 120 µg/L have been recorded in some groundwater supplies in remote areas." For consistency with the remainder of this factsheet, and the Guidelines generally, please convert the 20 and 120 µg/L example data to mg/L.
2	Individual Radiation Protection Expert	1	N/A
		2	No
		3	Dear ladies and gentlemen, I would like to offer the comments on the revised version of the Australian Guidelines for the radiological quality of drinking water (ADWG), as follows. The issues that may need to be considered are: 1. The latest international document from the WHO appears not to have been taken into account in the review of the guideline, 2. An overall trend in the significant reduction in dose coefficients for the ingestion of radionuclides listed in the ADWG may need to be studied, 3. The age of members of the public to which ADWG apply may also need to be considered.

#	Organisation	Q	Comments received
			1. WHO 2018 document The latest document by the World Health Organisation, “Management of radioactivity in drinking-water” (2018) is not mentioned in the text and in the references. It is suggested that the document is studied and the ADWG is amended as appropriate (and if required), to reflect the latest WHO Guideline on the subject. 2. ICRP 2017 dose coefficients The second issue concerns ICRP 2012 dose coefficients that are used in the ADWG. There was a significant change in 2017 in these coefficients for workers and it is likely that these will also change for the members of the public in the near future, necessitating an additional review of the ADWG. • Table 7.1 in Chapter 7 quotes dose coefficients from “ICRP (2012)” for adult members of the public; • The ICRP Publication 137, ‘Occupational Intakes of Radionuclides: Part 3’ provides new ingestion dose coefficients for workers. However, it should be noted that a significant decrease has occurred in ingestion dose coefficients for workers, which is likely will be reflected in the coefficients for the members of the general public as well; most likely in the near future. The radionuclides listed in the Table 7.1 of the ADWG and corresponding decrease in the ICRP dose coefficients for ingestion (workers) are detailed below: • Uranium-238 and uranium-234 – 89% decrease, • Thorium-230 and radium-226 – 46% decrease, • Lead-210 and radium-228 – 49% decrease, • Polonium-210 – 25% decrease, • Thorium-232 – 36% decrease, • Thorium-228 – 56% decrease. 3. The age considered for members of the public Both IAEA Basic Safety Standards (2014) and the latest WHO publication mentioned above (2018) contain ingestion dose coefficients for different ages, with the ones for the age over 17 years being used in the ADWG. It is understood that in most practical situations the factors for adults will be applicable. There are, however, cases such as water supply to a primary school and/or a child care centre – where these coefficients will not be appropriate. A suggestion: As it is correctly stated in part 1.3.5 of the WHO (2018), the guidance levels don’t need to be adjusted for children. However, the different dose coefficients will need used in the dose assessments. It is unlikely that a specific part needs to be added to the ADWG, but it would be, in my opinion, appropriate to insert a reference to Table III.2.D of the IAEA Basic Safety Standards (2014) for these situations. Kind regards

#	Organisation	Q	Comments received
			Nick Tsurikov Calytrix Consulting Pty Ltd
		4	No comment
		5	No comment
		6	No comment
		7	No comment
		8	No comment
		9	No comment
3	NSW Environment Protection Authority Government department – State / Territory	1	1. The NSW Environment Protection Authority (EPA) administers the Radiation Control Act 1990 (NSW). The primary Object of the Act is: "to secure the protection of persons and the environment from exposure to ionising and harmful non-ionising radiation to the maximum extent that is reasonably practicable, taking into account social and economic factors and recognising the need for the use of radiation for beneficial purposes." Key observations 2. The EPA's primary concern about the draft Chapters is the proposed 0.3 mSv dose constraint, reduced from 0.5 mSv. 3. Section 7.6.5 of Chapter 78 of the ADWG is clear that the document only applies to natural sources or past practices that are not under control (abandoned mines) (existing exposure situations). 4. A current practice (planned exposure situation) would have to undertake a separate assessment of impact to water. This would then be the situation where a 0.3 mSv dose constraint should be applied, above the background dose. 5. The proposed 0.3 mSv dose constraint in the ADWG, recommended by ICRP Publication 82, is supposed to be above background. The EPA is concerned that this is a misapplication of that recommendation to a situation that includes background radiation. 6. Adoption of an operational dose level of 0.3 mSv/y is problematic. Drinking water, in general, is an existing exposure situation whereas the 1/3rd dose constraint concept is usually applied to planned exposure situations. 7. The draft has potentially confusing messaging in stating that up to 0.35 mSv per annum is acceptable (Infosheet 2.2), via the gross alpha/beta screening. Yet there is a 0.3 mSv per annum dose constraint. 8. This creates ambiguity, which would be eliminated by retaining the existing 0.5 mSv per annum dose constraint. 9. The dose constraint is justified by ICRP Publication 82, which is related to the previous recommendations of the ICRP (ICRP Publication 60). It would be preferable to adopt current recommendations and guidance based on ICRP

#	Organisation	Q	Comments received
			Publication 103. 10. ICRP 82 primarily discusses this dose constraint in terms of radioactive residues from past practices (TENORM, building materials). Situations where prolonged radiation exposure results from human activities. 11. In the majority of cases drinking water does not a fit with the prolonged exposure situations being discussed in ICRP 82. Drinking water radiation levels will rarely be the result of a practice; whereas Table 1 (Chapter 6, page 67 of ICRP 82) states that the 0.3 mSv per annum dose level is a dose constraint for practices as an “Additional Annual dose”. 12. There is also consideration of the utility of 1/3rd of the guideline value. The concept behind adopting a 1/3rd dose constraint is for extra safety in the case persons are exposed to multiple radiation sources. 13. This level of extra safety is not required for drinking water because annual consumption - hence dose - does not increase proportionally to the number of drinking water sources used by a person. 14. An operational dose level of 0.5 mSv/y is more appropriate: a. since that is consistent with the screening alpha beta activity level b. ICRP Publication 82 allows for dose constraints to be set between 0.3 mSv per year and 1 mSv per year c. Drinking water does not fit well with the types of practice discussed in ICRP Publication 82 d. The revised ADWG is unlikely to result in intervention action at dose levels between 0.35 mSv/y and 0.5 mSv/y 15. Consideration could be given to the range of annual consumption in setting an operational dose level.
		2	Please refer to our response to Question 1, which also addresses the question of implementation/application and potentially how to resolve.
		3	7.5 Table 7.1. Suggest using more current dose coefficients than those in ICRP 119, based on ICRP 60. ICRP 137 (2017) provides current dose coefficients for workers. The Ra-226 dose coefficient for ingestion for workers and the public in ICRP 119 is the same. The uranium series dose coefficients in ICRP 137 are all lower than those presented in table 7.1. Suggestion: Update to use current dose coefficients preferably related to ICRP 103. 7.6 Pre-amble. Dot point 3. The use of the term “Optimise the effort” should be reconsidered, as it risks creating confusion with the radiation protection principle of optimisation. The screening levels provide a relatively easy assessment of the radionuclide content of the water, compared to full radioassay. Suggestion: Reword along the lines that: The screening levels provide the ability to readily assess the suitably of a water source for use as drinking water. Is the third dot point detailed version of the second dot point? 7.6 Pre-amble Last sentence. Is it correct to state gross alpha/beta analysis is not time consuming? Methods are listed in Info sheet 2.2 that involve evaporation and other time-consuming steps. Certainly, these analysis methods are cost effective compared to full analysis for individual radionuclides. 7.5.1 First Paragraph. It would be preferable to have better definition of a Bq, which was technically correct. ARPANSA

#	Organisation	Q	Comments received
			RPS C-1 refers to nuclear transformations, which gives a better understanding of what is disintegrating. 7.5.1 Third paragraph, third sentence. This sentence could be simplified. Suggest ARPANSA RPS C-1 as a model. Suggestion: Effective dose is the sum, across the entire body, of the tissue or organ equivalent doses weighted to account for the sensitivity of each organ or tissue to radiation. 7.5.2 First sentence. Consistent use of radioisotope or radionuclide; Radionuclide is used in Table 7.1. Why mention 1 Bq? Why introduce the chemical form when it is not mentioned in relation to table 7.1? Suggest replacing the first sentence. Suggestion: The dose arising from the annual intake, in Bq, by ingestion of each radionuclide can be estimated using a dose coefficient. Dose coefficients can vary depending on the chemical form of the radionuclide and the pathway for exposure, i.e. ingestion or inhalation. Dose is used as a general term to mean effective dose (Sv). [then the rest of the paragraph as is] Consider moving the last sentence of 7.5.1 to this paragraph. 7.6.1 Second paragraph. The correct terminology is “System of Radiological Protection” rather than “system for radiation protection.”
		4	No comment
		5	See general comments
		6	General Description. The inclusion of the dose coefficient for Ra-224 is not particularly useful for the assumed target audience (persons without a background in radiation protection). First Paragraph. Ra-224 has negligible contribution to personal dose; just state this fact. Last Sentence. At least change/swap the order of the sentence to focus on Ra-224. E.g. Radium-224 … with a short half-life …etc. Suggestion: Radium-224 is generally not considered in assessments of radiological health effects due to its short half-life of 3.66 days and the [insignificant] contribution to radiation dose per unit of intake. Replace [insignificant]; subject to appropriate replacement. “Health Considerations”. A confusing section. Are we saying it is safe or not? Suggest putting the third paragraph at the beginning.
		7	Intro 3rd paragraph. In the case of groundwater being reticulated into an enclosed building, would monitoring for radon in the building atmosphere be more relevant? There seems to be easier ways to determine if radon is an issue in the situation proposed, than undertaking radon in water assay.
		8	See general comments

#	Organisation	Q	Comments received
		9	No comment
4	The Australian Nuclear Science and Technology Organisation (ANSTO) Government science agency	1	Overall, the revision is well written, clear and is in line with the best available science.
		2	ANSTO does not foresee any difficulties in the implementation and application of the updated guidance.
		3	- ANSTO anticipates there could be some confusion in comparing the ADWG's recommended reference level of 1mSv/year to international standards. For example, the World Health Organisation (WHO) drinking water guidelines adopt a more conservative approach, with the reference level being 0.1 mSv/year which represents 10% of the dose limits for members of the public, as recommended by the International Commission on Radiological Protection (ICRP). - One minor comment for Chapter 7 on page 5: The section Australian screening levels for drinking water states that "…the contribution of potassium-40 to beta activity is subtracted following a separate determination of total potassium", as it is a natural beta emitter. ANSTO suggests that an additional statement be included to further justify the exclusion of potassium-40, including specific reference to the method/s for compliance. Such a statement could be drafted along the lines of "stable potassium is well regulated biologically within the body and therefore internal concentrations of potassium remain fairly stable, regardless of the amount ingested. Therefore, the contribution of potassium-40 in drinking water to total beta activity dose can be considered negligible". An appropriate reference to literature could be provided, for example: https://dx.doi.org/10.2215%2FCJN.08580813
		4	As referenced in the response to Question 3, ANSTO suggests there is further discussion of the basis for which potassium-40 is excluded from the dose.
		5	ANSTO has no comments to make on this question.
		6	ANSTO suggests that it could be useful to include guidelines on the recommended minimum detection limits for both Ra-226 and Ra-228 analyses. At present, the ADWG recommends the determination of both radionuclides based on a measurement that 'exceed' specific limits. It would be useful to also include a minimum detection level, as it would provide insight into determining the types of analytical methods that are suitably sensitive to yield results close to or below the suggested detection limits. Previous collaborative research led by ANSTO investigated a range of techniques for this exact purpose (https://www.sciencedirect.com/science/article/pii/S0265931X16307214?via%3Dihub).
		7	ANSTO has no comments to make on this question.

#	Organisation	Q	Comments received
		8	ANSTO has no comments to make on this question.
		9	ANSTO has no comments to make on this question.
5	Supervising Scientist Branch - Department of Agriculture, Water and the Environment Government Department - Federal	1	No comment
		2	Although the updated guidance makes clear that monitoring radioactivity in the water supply is needed, it does not make clear who is responsible for undertaking this monitoring. For example, should it be the responsibility of the water provider, water regulator, health authority, company discharging radionuclides to the environment in the vicinity of the water supply, etc. This lack of clarity could be a point of confusion or contention in the practical application of the guidance.
		3	Minor technical issues are: Issue: "Radiological contamination of drinking water can result from: naturally occurring concentrations of radioactive material" (Section 7.2) Comment: If the radioactivity in drinking water is at naturally occurring concentrations, then is it actually 'contamination'? Issue: "Radiological contamination of drinking water can result from:…" (Section 7.2) Comment: A caveat that is missing here is that there needs to be an environmental transport pathway present for radionuclides to move from the source (e.g. a mineral sands mine or fertilizer production plant) to the water supply in order for the water supply to become contaminated by the source. If there is no transport pathway, then the source cannot contaminate the water supply. Issue: "…these effects have not been detected through scientific studies." (Section 7.3) Comment: Reference to an international report (ICRP or UNSCEAR) reviewing such studies would be useful to support the claim being made here. Issue: "Several different forms of radiation can be emitted by radionuclides (alpha particles, beta particles and positrons, gamma rays and x-rays)." (Section 7.4) Comment: X-rays are not emitted by the radioactive decay of a nucleus or 'radionuclides'. They are emitted by electrons moving between different energy states. Issue: "…human-made (i.e. anthropogenic) radionuclides are often controllable at the point at which they enter the water supply." (Section 7.6.1) Comment: Depending on the scale and environmental transport pathways, there may be multiple points of entry for radionuclides into the water supply across a broad area. This would make control at the point(s) of entry into the water supply difficult. Instead, radionuclides would be more controllable at the source or point of release from the source. Issue: "Additional doses that occur within these specific groups should be brought to the attention of the relevant

#	Organisation	Q	Comments received
			regulatory authority where a decision can be made on the requirement for further assessment." (Section 7.6.2) Comment: Some indication or quantification of what is meant by "additional doses" should be provided to aid the readers understanding of this sentence. How additional do the doses need to be to that of an adult who consumes 2L water/day before it should be brought to the attention of the relevant regulatory authority? For example, if the doses to these specific groups are additional to that of a typical adult but below the guideline value of 1 mSv/year, should it be brought to the attention of the relevant regulatory authority?
		4	No comment
		5	Minor technical issues are: Issue: "where Ac=actinium, Bi=bismuth, Pa=protactinium, Pb=lead, Po=polonium, Ra=radium, Rn=radon, Th=thorium, Tl=thallium, U=uranium" Comment: This can possibly be removed as these are all IUPAC standard chemical symbols. Issue: "In Australia, the presence of anthropogenic or human-made radionuclides in drinking water" Comment: The definition of anthropogenic is man-made, one of these terms can be removed.
		6	No comment
		7	To place the derived reference level for radon-222 of 100 Bq/L into context with the general guideline value of 1 mSv, the annual dose that would arise from 100 Bq/L of radon-222 in drinking water should be specified.
		8	No comment
		9	No comment
6	Radiation Health Government department – State / Territory	1	Approach is supported.
		2	No comment.
		3	Updated text supported. We believe it would be of benefit (either in this chapter or in Sheet 2.2) to raise the issue of managing any waste that might be produced from treatment facilities. Removing radionuclides, via treatment processes, from drinking water may result in a liquid or solid waste stream with increased concentrations of radioactive substances that may need to be managed as potentially low level radioactive waste. A note to raise the possibility of waste needing to be managed appropriately and that consultation with the relevant regulator may be required will be useful.
		4	Updated text is supported.

#	Organisation	Q	Comments received
		5	Revisions are supported.
		6	Text supported.
		7	Text supported.
		8	Text supported.
		9	Text supported.
7	Australasian Radiation Protection Society Non-government organisation	1	1. Use of radiation protection terminology should be reviewed. The documents refer to “screening levels”, reference levels and “guidance levels”. These terms are used interchangeably and inconsistently, and have different meanings in broader international standards. For example a Reference level in an international context si when action is required, whereas the Chapter 7 talks about considering if action is required when the reference level/guideline value is exceeded. 2. Current dose factors should be used. ICRP137 contains current dose factors, which have changed significantly from the previous dose factors used in the ADWG. While ICRP137 contains dose factors for workers, it is noted that previously dose factors for ingestion where the same for both workers and the public. 3. Recommend retaining the 0.5 mSv/y Operational level. a. The change in operational dose level does not appear to be a correct application of the ICRP recommendations for the 0.3 mSv/y dose constraint. ICRP recommends this as a dose constraint for above background radiation exposure, mainly related to planned exposure situations. Drinking water (in particular the ADWG) is largely related to existing exposure from background radiation sources. b. There is the potential for confusion as the screening level (alpha and beta activity) is assumed to be equivalent to 0.35 mSv/y, which is above the operational dose level of 0.3 mSv/y. c. It is noted that the screening level could be significantly different to 0.35 mSv/y depending on the validity of the assumption that all alpha and beta activity is due to Ra-226 and Ra228, respectively.
		2	Alignment with international radiation protection terminology is inconsistent and confusing, the terminology has also been duplicated with the existing ADWG terminology. e.g. Guideline value and reference value The impending change to dose factors will create confusion in the future due to the potential that the new dose factors will be significantly different to the dose factors proposed for the ADWG. Introduction of an Operational Dose Level (or dose constraint) below the assumed screening level, and also below the point where the there is a need to consider protective actions is confusing. This may lead to misunderstanding by the public about safety and the implementation of the ADWG to radiological water quality

#	Organisation	Q	Comments received
		3	The use of radiation protection terminology should be reviewed, as noted in general comments Dose constraints should be based on current ICRP guidance (e.g. ICRP137) Retain an operational dose level of 0.5 mSv per annum. Align various dose definitions with Radiation Protection Series definitions. ICRP have developed the "System for Radiological Protection"
		4	The retention of alpha/beta screening as a cheap assessment methodology is supported.
		5	It's not clear that the recommended actions in figure IS2.2.1 are consistent with chapter 7
		6	The section about health considerations is confusing. Is radium safe or not safe?
		7	N/A
		8	N/A
		9	N/A