Australian Government
Australian Radiation Protection and Nuclear Safety Agency

arpansa

Updating the Australian Drinking Water Guidelines:

Changes made and lessons learned in updating the radiological guidance

Liesel Green, Fiona Charalambous, Julia Carpenter,
Rick Tinker and Arne Biesiekierski

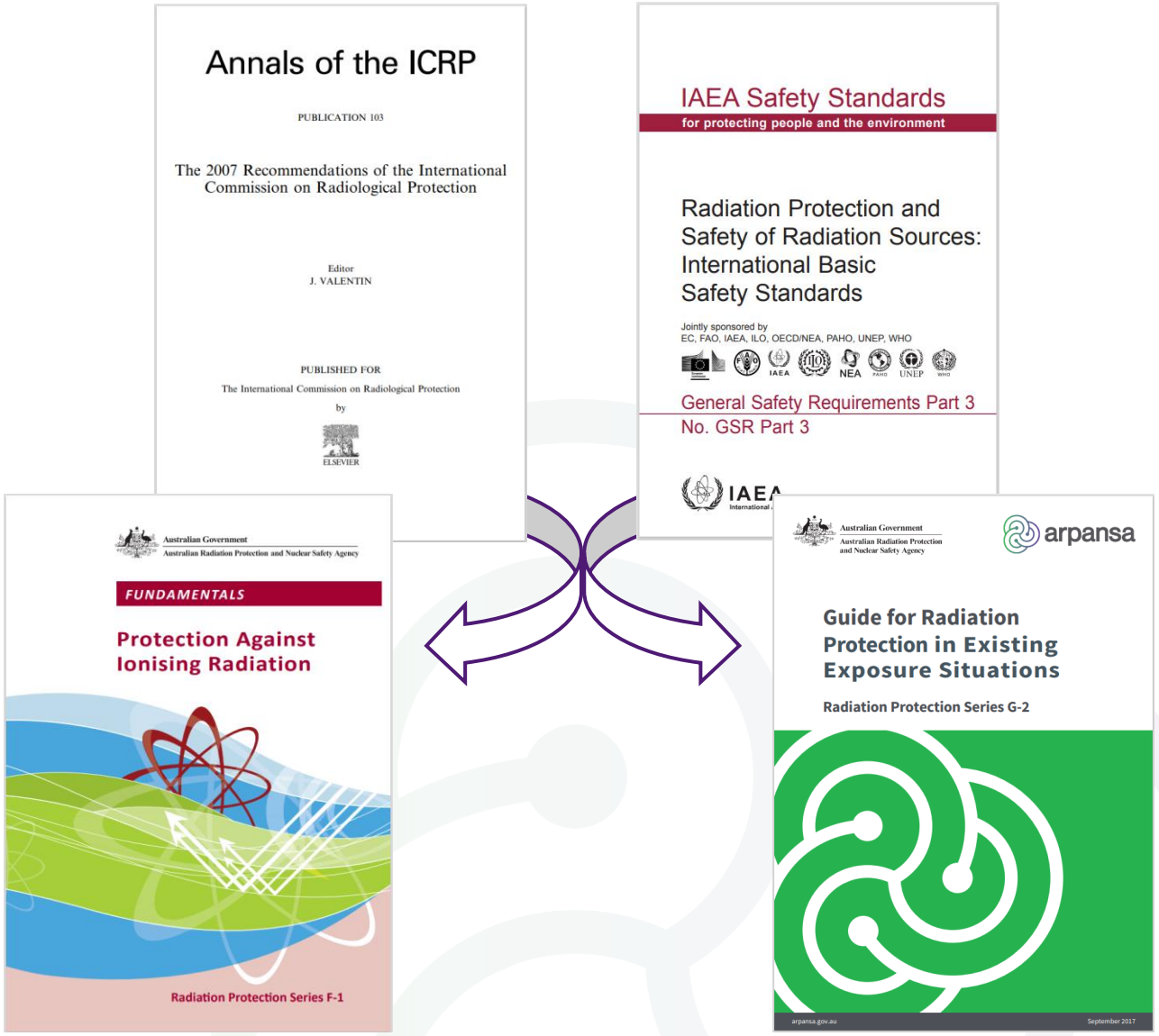
ARPANSA would like to respectfully acknowledge the Traditional Owners and Custodians of Country throughout Australia and their continuing connection to land, waters and community. We would like to pay our respect to them and their cultures, and Elders past and present.

ARPANSA's role

As the Australian Government's primary authority on radiation protection and nuclear safety, ARPANSA seeks to promote radiological safety of the nation.

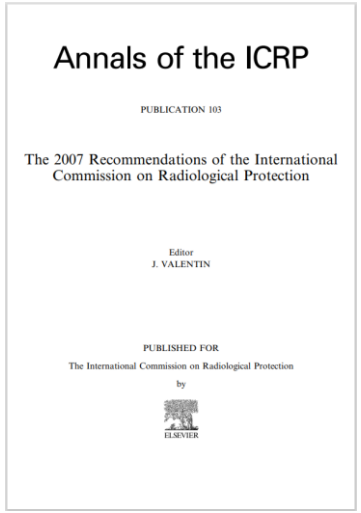
This is achieved in part through:

- implementation of international best practice into the Australian regulatory environment through Codes, Guides and Standards
- provision of advice and assistance to other state and Commonwealth entities on radiological matters.



The motivations

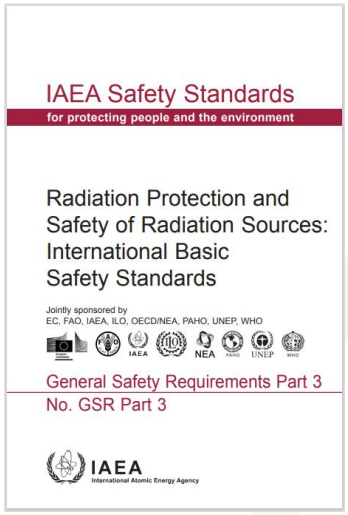
"Best practice" changes with time!



2007

ICRP publishes Publication 103

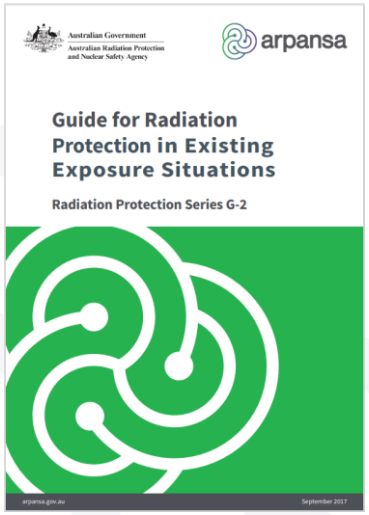
Introduces concept of Planned, Existing, and Emergency Exposures



2014

IAEA publishes GSR Part 3

Implements classes of exposures into IAEA guidance, and requires members to establish specific reference levels to achieve a 1 mSv effective dose



2017

ARPANSA publishes RPS G-2

Incorporating international best practice and modernising Australian guidance

The motivations

In process of preparing RPS G-2, ARPANSA compared existing national guidance around radiological exposure to information in ICRP, IAEA, WHO, and ARPANSA documentation.

On reviewing 2011 *Australian Drinking Water Guidelines* (ADWG), identified need for additional information, particularly on:

- screening of water supplies
- assessment of dose to the critical population groups
- occurrence and levels of naturally occurring radionuclides in groundwater
- need for clarification, amendment and correction of existing information
- basis for 1 mSv/year and an explanation of the indicative dose criterion (IDC) as applied by the WHO.

Opportunity to advise and collaborate with another Commonwealth entity on radiological matters!

The stakeholders

ADWG overseen by the *National Health and Medical Research Council* (NHMRC), so ARPANSA contacted NHMRC with offer to contribute resourcing and lead review with State, Territory, and relevant technical experts.

NHMRC accepted assistance, noting that review of the ADWG must also be reviewed by the *Water Quality Advisory Committee* (WQAC).

Australian Government
Australian Radiation Protection and Nuclear Safety Agency

21 December 2016 Ref No. Z1638633

Prof Anne Kelso
Chief Executive Officer
National Health and Medical Research Council
GPO Box 1421
Canberra ACT 2601

Dear Anne,

RE: National Health and M

Australian Government
National Health and Medical Research Council

NHMRC

GPO Box 1421 | Canberra ACT 2601
16 Marcus Clarke Street, Canberra City ACT 2600
T. 13 000 NHMRC (13 000 64672) or +61 2 6217 9000
F. +61 2 6217 9100
E. nhmrc@nhmrc.gov.au
ABN 88 601 010 284
www.nhmrc.gov.au

- 5 APR 2017

Dr Carl Magnus-Larsson
Chief Executive Officer
Australian Radiation Protection
and Nuclear Safety Agency
PO Box 655
Miranda
NSW 1490

Dear Dr Magnus-Larsson

Re: Australian Drinking Water Guidelines

As this relates to environmental health matters, two expert panels under enHealth were also involved:

- *Water Quality Expert Reference Panel* (WQERP)
- *Radiation Health Expert Reference Panel* (RHERP)

The teams

Radiation Health Committee (RHC)

2019 – 2021

- Roslyn Drummond (Chair)
- Carl-Magnus Larsson
  - Gillian Hirth
- Noel Cleaves
  - Glenn Riley
- Amanda Fortanier
  - Daniel Bellifemine
- Mark Carey
- Simon Critchley
- Stephen Newbery
- Hazel Upton
- Bradley Feldtman
- Penny Hill
- Joanna Wriedt
- Bruce Hocking

ARPANSA Project Team

- Liesel Green
- Fiona Charalambous
- Sandra Sdraulig
- Marcus Grzechnik
- Rick Tinker

NHMRC Project Team

- Tanja Farmer
- Jennifer Savenake
- Kristal Jackson
- Miranda Cumpston

Enhealth

- Water Quality Expert Reference Panel (WQERP)
- Radiation Health Expert Water Quality Panel (RHERP)

Water Quality Advisory Committee (WQAC)

2018 – 2021

- Fred Leusch (Chair)
- David Cunliffe
- Cameron Dalgleish
- Dan Deere
- Cynthia Joll
- Stuart Khan
- Susan Petterson
- Craig Simmons
- Carolyn Stanford
- Katrina Wall
- Nick Fletcher (Observer)
- Amy Lea (Observer)
- Marcus Waters (Observer)
- Adam Lovell (Observer)

The timeline

Proposal — *Dec 2016 – Feb 2018*

- ARPANSA propose revision
- NHMRC accepts proposal
- ARPANSA and NHMRC finalise scope

Draft Guidance — *Feb 2018 – Jun 2020*

- Updated guidance prepared by ARPANSA
- NHMRC WQAC reviewed guidance
- ARPANSA revised guidance
- Guidance sent out for EnHealth (WQERP and RHERP) consultation/revision
- NHMRC council gives recommendation/NHMRC CEO approves public consultation

Consult Public — *Jun 2020 – May 2021*

- NHMRC releases draft guidance for public consultation
- ARPANSA and WQAC review public submissions
- ARPANSA revised draft to address submissions
- WQERP and RHERP consulted and guidance revised

Final Review — *May 2021 – Dec 2021*

- WQAC completed final review
- NHMRC Council recommends publication
- NHMRC CEO approves publication

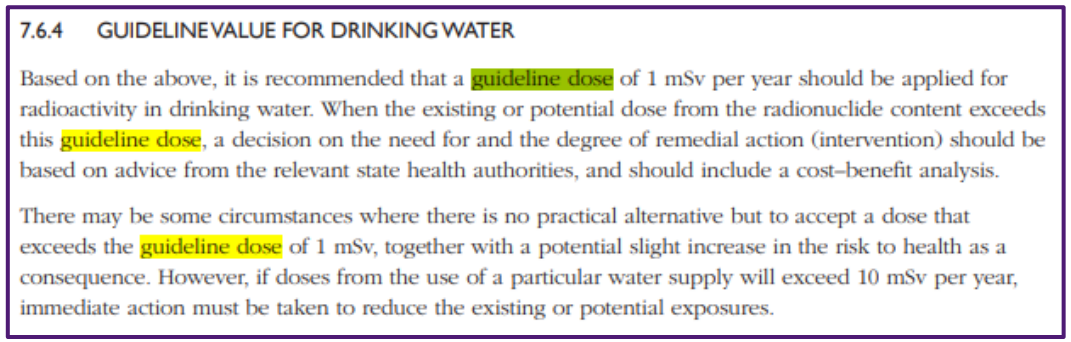
Publish — *Jan 2022*

The changes - terminology

So, what actually changed?

First off; **terminology!**
Many examples where ADWG used differing terms from international radiological best practice.

In particular “Guideline Dose” → “Reference Level”

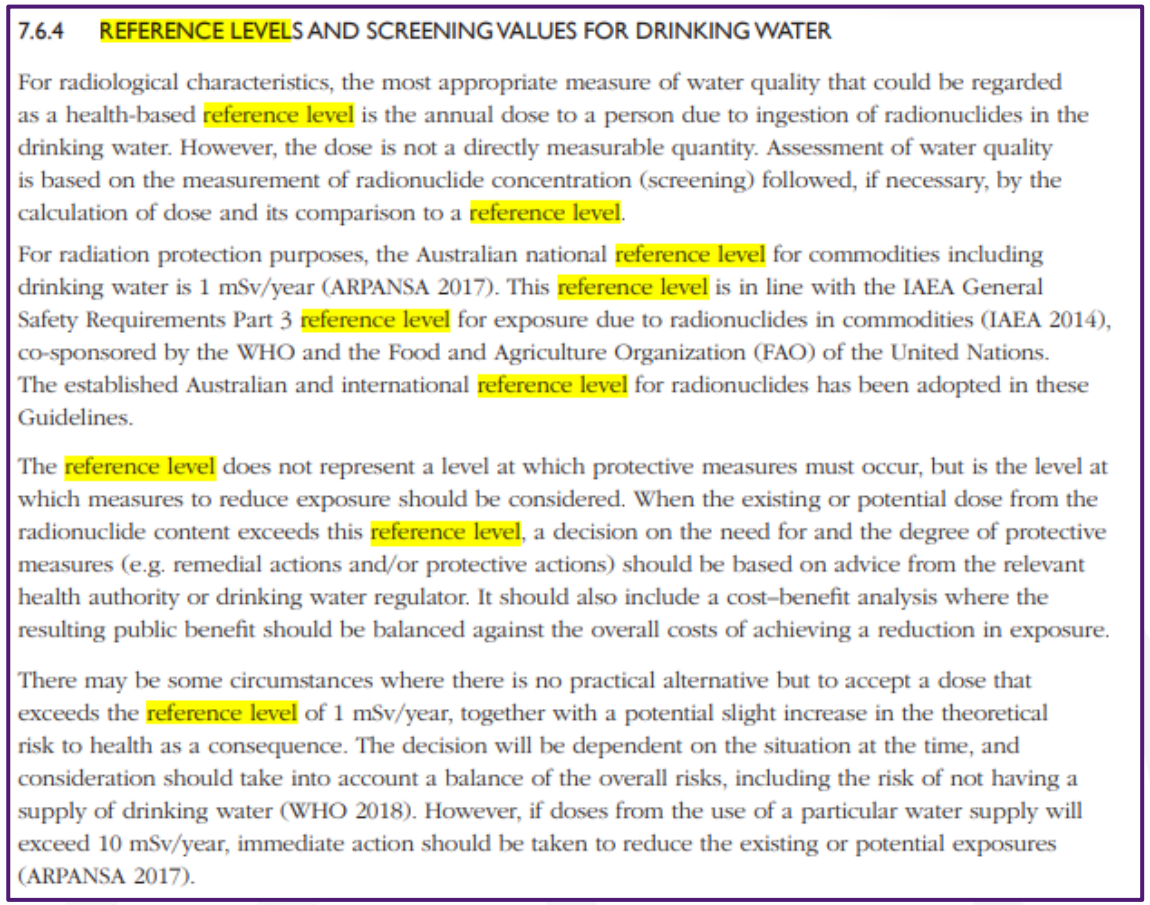


7.6.4 GUIDELINE VALUE FOR DRINKING WATER

Based on the above, it is recommended that a guideline dose of 1 mSv per year should be applied for radioactivity in drinking water. When the existing or potential dose from the radionuclide content exceeds this guideline dose, a decision on the need for and the degree of remedial action (intervention) should be based on advice from the relevant state health authorities, and should include a cost–benefit analysis.

There may be some circumstances where there is no practical alternative but to accept a dose that exceeds the guideline dose of 1 mSv, 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 per year, immediate action must be taken to reduce the existing or potential exposures.

Original



7.6.4 REFERENCE LEVELS AND SCREENING VALUES FOR DRINKING WATER

For radiological characteristics, the most appropriate measure of water quality that could be regarded as a health-based reference level is the annual dose to a person due to ingestion of radionuclides in the drinking water. However, the dose is not a directly measurable quantity. 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.

For radiation protection purposes, the Australian national reference level for commodities including drinking water is 1 mSv/year (ARPANSA 2017). This reference level is in line with the IAEA General Safety Requirements Part 3 reference level for exposure due to radionuclides in commodities (IAEA 2014), co-sponsored by the WHO and the Food and Agriculture Organization (FAO) of the United Nations. The established Australian and international reference level for radionuclides has been adopted in these Guidelines.

The reference level does not represent a level at which protective measures must occur, but is the level at which measures to reduce exposure should be considered. When the existing or potential dose from the radionuclide content exceeds this reference level, a decision on the need for and the degree of protective measures (e.g. remedial actions and/or protective actions) should be based on advice from the relevant health authority or drinking water regulator. It should also include a cost–benefit analysis where the resulting public benefit should be balanced against the overall costs of achieving a reduction in exposure.

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 theoretical risk to health as a consequence. The decision will be dependent on the situation at the time, and consideration should take into account a balance of the overall risks, including the risk of not having a supply of drinking water (WHO 2018). However, if doses from the use of a particular water supply will exceed 10 mSv/year, immediate action should be taken to reduce the existing or potential exposures (ARPANSA 2017).

Revised

The changes - terminology

Table IS2.2.1 *Summary of operational responses*

Dose level (mSv per year)	Response
< 0.5	1. Continue routine monitoring.
0.5-1	1. Consult with relevant health authorities. 2. Review frequency of ongoing sampling. 3. Evaluate operational options to reduce exposure.
>1-10	1. Consult with relevant health authorities. 2. Assess in detail possible remedial actions, taking into account potential cost-effectiveness of actions. 3. Implement appropriate remedial action on the basis of the cost-benefit evaluation.
> 10	1. Water not suitable for consumption on the basis of radioactivity levels. 2. Consult with relevant health authorities. 3. Immediate intervention is expected and remedial action must be taken to reduce doses to below the guideline value of 1.0 mSv.

Original

Table IS2.2.1 *Summary of operational responses*

Dose level (mSv per year)	Response
<0.3	1. Gross alpha and gross beta screening values (corrected for potassium-40) and/or the operational dose value are not exceeded. Continue routine monitoring.
0.3-1	1. Evaluate dose and if required, perform assessments based on local conditions. 2. Consider the need to increase the frequency of monitoring in agreement with the relevant health authorities or drinking water regulators based on if the operational dose value is exceeded.
1-10	1. Consult with relevant health authorities or drinking water regulators. 2. Assess in detail possible protective measures e.g. remedial/protective actions, taking into account potential cost-effectiveness of actions. 3. Implement appropriate remedial/protective measures on the basis of the cost-benefit evaluation.
> 10	1. Water not suitable for consumption on the basis of radioactivity levels. 2. Consult with relevant health authorities or drinking water regulators. 3. Intervention is expected and protective measures must be taken to reduce doses to below the reference level of 1 mSv/year.

Revised

Other terminology changes:

- “Practices and Interventions” → “Exposure situations”
- “Interventions” → “protective measures”

Not all proposed changes made it through!

E.g. Proposed “Operational dose level” → “Dose criteria”, reverted on RHERP feedback.

The changes - numbers

Revised the Operational Dose Level from 0.5 to 0.3 mSv/year.

In a “worst credible scenario”, where screening value of 0.5 Bq/L alpha is attributed to ^{226}Ra and 0.5 Bq/L beta to ^{228}Ra, reference person receives 0.35 mSv/year (0.1 mSv from ^{226}Ra and 0.25 mSv from ^{228}Ra).

Table IS2.2.1 *Summary of operational responses*

Dose level (mSv per year)	**Response**
< 0.5	1. Continue routine monitoring.
0.5-1	1. Consult with relevant health authorities. 2. Review frequency of ongoing sampling. 3. Evaluate operational options to reduce exposure.
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1-10	1. Consult with relevant health authorities or drinking water regulators. 2. Assess in detail possible protective measures e.g. remedial/protective actions, taking into account potential cost-effectiveness of actions. 3. Implement appropriate remedial/protective measures on the basis of the cost-benefit evaluation.
> 10	1. Water not suitable for consumption on the basis of radioactivity levels. 2. Consult with relevant health authorities or drinking water regulators. 3. Intervention is expected and protective measures must be taken to reduce doses to below the reference level of 1 mSv/year.

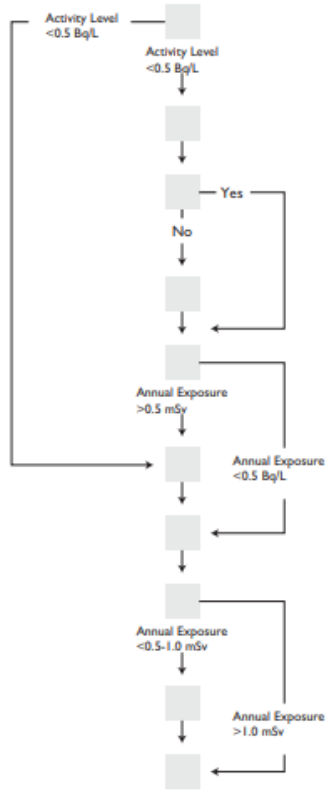
Revised

:. Would never normally reach 0.5 mSv/year without exceeding screening value, and screening value has not changed.

TL;DR? No functional change!

The changes - graphical

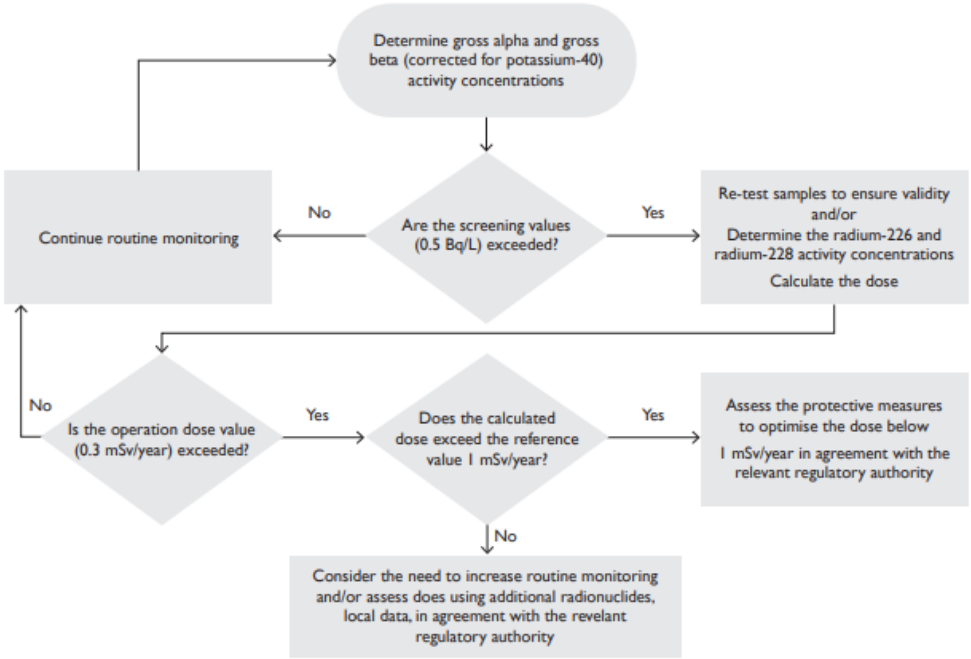
Figure IS2.2.1 *Flowchart showing how to determine whether the radiological quality of drinking water complies with the Guidelines*

Step	Activity	Process flow	Guidance note
1	Determine gross alpha and [gross beta excluding - K40].		
2	Retest for gross alpha and [gross beta excluding - K40] and determine Ra-226 and Ra-228 activity levels.		
3	Are all gross alpha and gross beta accounted for?		
4	Determine the activity levels of additional radionuclides.		
5	Calculate annual exposure.		
6	Complies with Guidelines. Continue rountine monitoring.		
7	Commence quarterly monitoring.		Monitoring includes steps 2 to 4.
8	Calculate annual exposure based on quarterly monitoring.		
9	Complies with ADWG. Continue monitoring at frequency agreed with health departement.		
10	Exceeds guideline. Consider intervention.		

Original

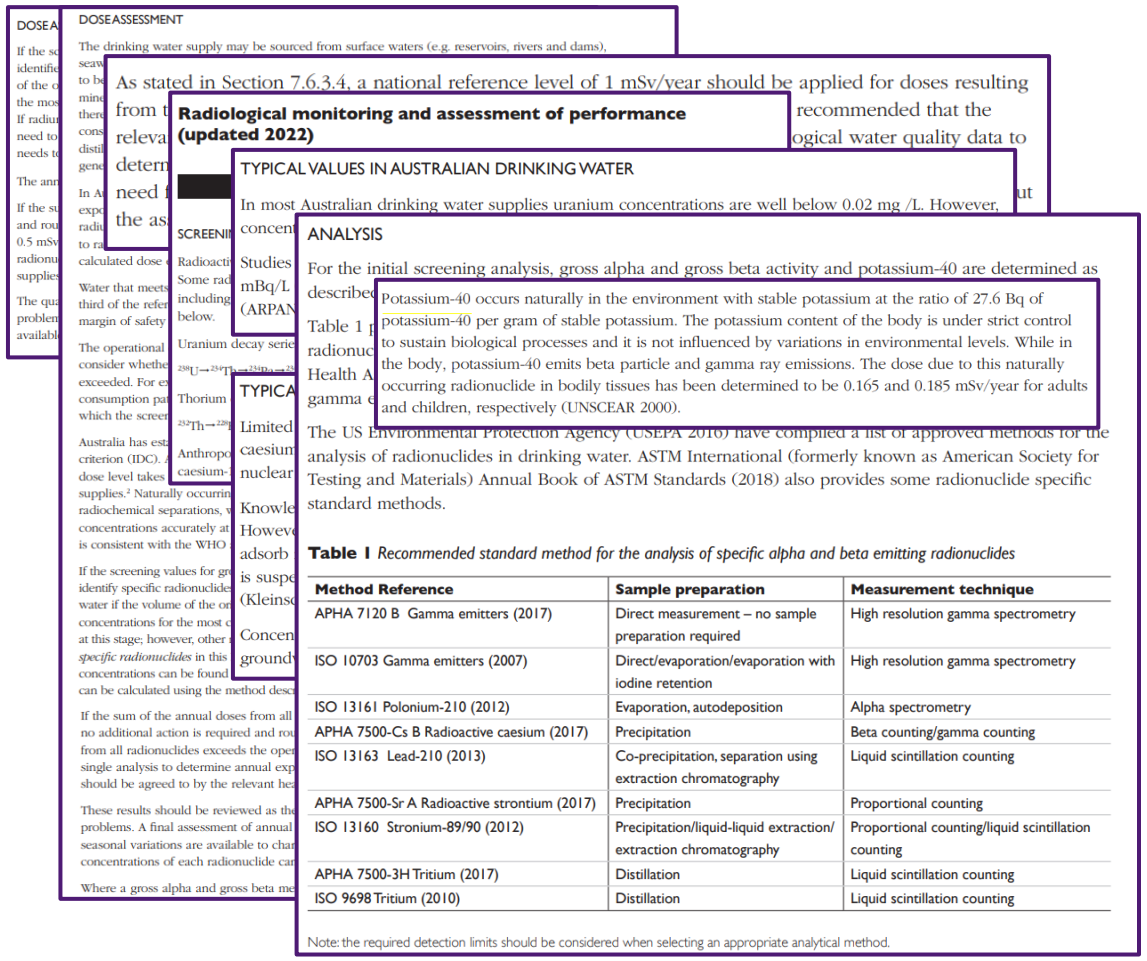
Condensed and clarified radiological assessment flowchart, correcting existing errors and implementing changes.

Figure IS2.2.1 *Flowchart showing how to determine whether the radiological quality of drinking water complies with the Guidelines*



Revised

The changes - justification



DOSE ASSESSMENT

The drinking water supply may be sourced from surface waters (e.g. reservoirs, rivers and dams),

As stated in Section 7.6.3.4, a national reference level of 1 mSv/year should be applied for doses resulting

Radiological monitoring and assessment of performance (updated 2022)

TYPICAL VALUES IN AUSTRALIAN DRINKING WATER

In most Australian drinking water supplies uranium concentrations are well below 0.02 mg /L. However,

ANALYSIS

For the initial screening analysis, gross alpha and gross beta activity and potassium-40 are determined as

Potassium-40 occurs naturally in the environment with stable potassium at the ratio of 27.6 Bq of potassium-40 per gram of stable potassium. The potassium content of the body is under strict control to sustain biological processes and it is not influenced by variations in environmental levels. While in the body, potassium-40 emits beta particle and gamma ray emissions. The dose due to this naturally occurring radionuclide in bodily tissues has been determined to be 0.165 and 0.185 mSv/year for adults and children, respectively (UNSCEAR 2000).

The US Environmental Protection Agency (USEPA 2016) have compiled a list of approved methods for the analysis of radionuclides in drinking water. ASTM International (formerly known as American Society for Testing and Materials) Annual Book of ASTM Standards (2018) also provides some radionuclide specific standard methods.

Table 1 *Recommended standard method for the analysis of specific alpha and beta emitting radionuclides*

Method Reference	Sample preparation	Measurement technique
APHA 7120 B Gamma emitters (2017)	Direct measurement – no sample preparation required	High resolution gamma spectrometry
ISO 10703 Gamma emitters (2007)	Direct/evaporation/evaporation with iodine retention	High resolution gamma spectrometry
ISO 13161 Polonium-210 (2012)	Evaporation, autodeposition	Alpha spectrometry
APHA 7500-Cs B Radioactive caesium (2017)	Precipitation	Beta counting/gamma counting
ISO 13163 Lead-210 (2013)	Co-precipitation, separation using extraction chromatography	Liquid scintillation counting
APHA 7500-Sr A Radioactive strontium (2017)	Precipitation	Proportional counting
ISO 13160 Stronium-89/90 (2012)	Precipitation/liquid-liquid extraction/ extraction chromatography	Proportional counting/liquid scintillation counting
APHA 7500-3H Tritium (2017)	Distillation	Liquid scintillation counting
ISO 9698 Tritium (2010)	Distillation	Liquid scintillation counting

Note: the required detection limits should be considered when selecting an appropriate analytical method.

Updated and added extra information to strengthen and clarify principles and justifications that underpinned guidelines.

This includes:

- increased explanation of dose assessment/screening values.
- expected doses to the public from the consumption of surface water
- guidance on application of guidelines in specific circumstances
- naturally occurring radionuclides and the decay series for uranium and thorium
- Australian levels of Radionuclides in drinking water
- additional methods of analysis for radionuclides
- and updated dose contributions due to K-40

The changes - justification

Also included new/updated material on protective and remedial measures to take when there are concerns about radioactivity.

This has already found application (More on this shortly)!

If either or both screening values are exceeded, specific radionuclide measurements should be undertaken to calculate the radiation dose associated with drinking the water. It should be emphasised that the screening values are conservative and should never be treated as a limit, guideline value or as an indicative water quality target. Screening values are intended only as a practical, cost effective means to ascertain if further assessment of the radiological quality of the water supply is needed.

7.6.6 REMEDIAL MEASURES

If remedial measures are contemplated, any strategy considered should first be justified (in the sense that it achieves a net benefit). Any decision that alters the radiation exposure situation should do more good than harm. This means that by reducing the existing exposure, it will achieve sufficient individual or societal benefit to offset the detriment it causes (ICRP 2007). Once the remedial action is justified, then protection should be optimised.

When source water contains unacceptably high concentrations of radionuclides, control options include the use of an alternative supply, controlled blending with another source or additional water treatment. Treatment plants with a combination of coagulation, sedimentation and sand filtration processes may remove up to 100% of the suspended radioactivity present in raw waters. Lime–soda ash softening plants can also remove practically all of the suspended radioactivity, depending on the radionuclide and on the proportion of radioactivity that might be associated with particulates.

A comprehensive review of the removal of dissolved radionuclides by water treatment processes has been undertaken (Brown et al. 2008).

The treatment of drinking water may result in materials with increased concentrations of radioactive material that may need to be managed in accordance with international best practice. Radioactive wastes arising from water treatment processes should be appropriately managed with the relevant health authorities or drinking water regulators.

The lessons

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

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	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
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
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."
5.2		
5.4	information provided we recommend that guideline value in table 10.7 in Chapter 10 remains unchanged.	basis for screening is on the gross alpha gross beta measurement.
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.

1) Different agencies can provide learning opportunities!

2) Terminology can be a major hurdle.

3) Vital to understand consultation process and identify all stakeholders early in the conversation!

Putting it all into practice…

10 June 2022
Mayor: Councillor John Medcalf OAM
General Manager: Greg Tory

FOR IMMEDIATE RELEASE

LACHLAN SHIRE COUNCIL
Wiradjuri Country

MEDIA RELEASE

LAKE CARGELLIGO AND MURRIN BRIDGE – DRINKING WATER

You may notice your drinking water tastes a bit different. This is because the water source has changed from Merri Abba Bores to Lake Cargelligo.

Drinking water from the Merri Abba Bores is tested regularly. Recent testing has found an increase in radiation levels above the Australian Drinking Water Guidelines (ADWG) screening levels.

This result does not mean the drinking water from the bores is unsafe. It means further investigation is needed.

This is why the water source has been changed. Lachlan Shire Council has stopped using the Merri Abba Bores for now and will use Lake Cargelligo instead.

Lachlan Shire Council, the Department of Planning and Environment and NSW Health are working together to look into this issue.

NSW Health spoke to experts in radiation protection who confirmed the level of radiation found in the drinking water is a very low risk to health. Everyone is exposed to radiation from radioactive materials that occur naturally in the environment. Some minerals which produce radiation are found in drinking water.

The community will be given more information as it becomes available.

If you have questions or need more information, please call 1300 066 055 to talk to your local Public Health Unit.

Lachlan Shire - The Heart of NSW
3 October 2022 ·

Lake Cargelligo water supply update
In June 2022, Council received the results of radiological testing of the drinking water at Murrin Bridge and Lake Cargelligo. The results showed a level of radioactivity that was above Australian Drinking Water Guidelines (ADWG) screening levels, and required further investigation. It should be noted that the ADWG screening levels are a trigger for further investigation and are not health-based guideline values.

Council advise the community that it has now been confirmed, following recent testing of drinking water in Murrin Bridge and Lake Cargelligo that levels of radioactivity are lower than the previous result and well below the ADWG screening levels.

Further investigation of the sample taken in early June shows there was an error in the laboratory analysis process and the results are no longer considered valid. The laboratory is completely confident in the results from the tests on the most recent samples.

It can be considered that the Merri Abba Bore water represents no health risk to the community if and when Council returns to this water source in the summer months.
If you have questions or need more information, please call Council on 02 6895 1900.

Of course, it's important to double check your results first!

Thank you

 ARPANSAGovernment

 ARPANSA

 ARPANSANews

 ARPANSA