



Lead in plumbing products in contact with drinking water Final Regulation Impact Statement 2021

The Australian Building Codes Board has developed this Final Regulation Impact Statement, which accords with the requirements of Best Practice Regulation: *A Guide for Ministerial Councils and National Standard Setting Bodies*, as endorsed by the Council of Australian Governments in 2007. Its purpose is to inform interested parties and to assist the Australian Building Codes Board in its decision making on proposed amendments to the National Construction Code.

The Australian Building Codes Board

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Contents

Introduction	8
Problem.....	19
Objective	64
Options.....	64
Impact Analysis.....	70
Sensitivity Analysis	81
Unintended Consequences.....	83
Business compliance costs.....	94
Regulatory burden	97
Consultation	98
Conclusion	105
Implementation and Review.....	108
Attachment A	111
Attachment B	115
Attachment C	117
Table 1: Annual sales data of leaded copper alloy plumbing products in contact with drinking water	47
Table 2: Blood lead levels in Victorian adults (2009 to 2010)	53
Table 3: Blood lead levels in Victorian children (2009 to 2010)	54
Table 4: Blood lead levels exceeding 5 µg/dL in Victoria (new cases)	56
Table 5: Blood lead levels exceeding 5 µg/dL in Victoria 2016* to 2018 (non-occupational only)	56
Table 6: Blood lead levels exceeding 5 µg/dL in Queensland	57
Table 7: Blood lead levels exceeding 5 µg/dL in Queensland 2016 to 2019 (non-occupational only)	57
Table 8: Blood lead levels exceeding 5 µg/dL in Tasmania.....	57
Table 9: Blood lead levels exceeding 5 µg/dL in Tasmania 2016 to 2019 (non-occupational only)	57
Table 10: Blood lead levels exceeding 5 µg/dL in Western Australia	58
Table 11: Non-occupational risk factors for cases of recorded elevated blood lead levels ..	62
Table 12: Product categories and annual sales.....	71
Table 13: Incremental aggregate costs of Option 2	72
Table 14: Composition of the DALY rate in Australia attributable to lead exposure	74
Table 15: Total annual cost of lead exposure in Australia (2019)	75
Table 16: Present Value benefits of Option 2	78
Table 17: Present Value benefits of Option 2	79
Table 18: Sensitivity analysis of Option 2	81

Glossary

Term	Meaning
Accredited Testing Laboratory	An organisation accredited by the National Association of Testing Authorities (NATA) to undertake the relevant tests. or An organisation outside Australia accredited by an authority to undertake the relevant tests and is recognised by NATA through a mutual recognition agreement.
Deemed-to-Satisfy Provisions	Provisions which are deemed to satisfy the Performance Requirements.
Disability Adjusted Life Year	A summary measure of population health that accounts for both mortality and nonfatal health consequences.
Low Lead	A plumbing product or material in contact with drinking water calculated using a weighted average lead content of not more than 0.25%, verified in the form of either— <ol style="list-style-type: none">a test report provided by an Accredited Testing Laboratory, in accordance with NSF/ANSI 372;ora WaterMark licence if it includes compliance with NSF/ANSI 372.
Network Utility Operator	A person who undertakes the piped distribution of drinking water or non-drinking water for supply or is the operator of a sewerage system or a stormwater drainage system.
Performance Requirement	A requirement which states the level of performance which a Performance Solution or Deemed-to-Satisfy Solution must meet.
Performance Solution	A method of complying with the Performance Requirements other than by a Deemed-to-Satisfy Solution.
WaterMark Certification Scheme	The ABCB scheme for certifying and authorising plumbing and drainage products.
Weighted average	Calculated across the wetted surface area of a pipe, pipe fitting and plumbing fixture.
Wetted surface area	Calculated by the total sum of diameter (D) in contact with drinking water.

Acronyms and Abbreviations

Abbreviation	Full Name
ABCB	Australian Building Codes Board
ADWG	Australian Drinking Water Guidelines
Ai Group	Australian Industry Group
ANSI	American National Standards Institute
ARIMA	Australia Metal Recycling Industry Association
AS	Australian Standard
AS/NZS	Australian and New Zealand Standard
AWQC	Australian Water Quality Centre
CDA	Copper Development Association Incorporated, US
CHO	Chief Health Officer
COAG	Council of Australian Governments
DALY	Disability Adjusted Life Year
dL	Deciliter
DTS	Deemed-to-Satisfy
EPA	Environmental Protection Agency (US)
FAO	Food and Agriculture Organisation
FPAA	Fire Protection Association Australia
GBD	Global Burden of Disease
HIA	Housing Industry Association
ICAA	International Copper Association Australia
IGA	Intergovernmental Agreement
IHME	Institute of Health Metrics and Evaluation
IRCC	Inter-jurisdictional Regulatory Collaboration Committee
JAS-ANZ	Joint Accreditation System of Australia and New Zealand
MCLG	Maximum Contamination Level Goal
NCC	National Construction Code
NHMRC	National Health and Medical Research Council
NUO	Network Utility Operator
OBPR	Office of Best Practice Regulation
pH	Potential of Hydrogen
PCA	Plumbing Code of Australia

Abbreviation	Full Name
PCC	Plumbing Code Committee
PCH	Perth Children's Hospital
PIPA	Plastics Industry Pipe Association of Australia Limited
PPI Group	Plumbing Products Industry Group
PVC	Polyvinyl Chloride
QBCC	Queensland Building and Construction Commission
RIS	Regulation Impact Statement
TMV	Thermostatic Mixing Valve
µg/mg	Micrograms
VSLY	Value of Statistical Life Year
WHO	World Health Organisation
WMCS	WaterMark Certification Scheme
WMCAB	WaterMark Conformity Assessment Body
WSAA	Water Services Association of Australia

Introduction

The use of lead (Pb) in the manufacture of plumbing products has been common practice for many centuries. It is most commonly found in copper alloys, such as brass and bronze, where a small amount of lead is added to provide malleability. These alloys are frequently used as components of plumbing products in contact with drinking water.

A recent survey by the Australian Building Codes Board (ABCB) of the Australian plumbing industry indicated that of all the plumbing products in contact with drinking water only around 10% of the product was sold as 'low lead'.

The allowable amount of lead varies depending on the plumbing product and is regulated in Australia through both manufacturing standards and via the adoption of the Australian and New Zealand Standard (AS/NZS) 4020 *Testing of Products for Use in Contact with Drinking Water*. It is a requirement of the National Construction Code (NCC) Volume Three, that lead water levels not exceed 10 micrograms (μg) per litre (L) of water when tested in accordance with the Standard.¹ This requirement was first introduced in 1991 and has contributed to a measurable reduction of lead exposure from drinking water in Australia.

Lead has long been recognised as a cumulative toxicant and there is no blood lead level which is considered safe.² Once lead enters the blood, it is distributed to organs such as the brain, kidneys, liver and bones. At high lead exposure, lead has been known to cause coma, convulsion and death. The health impacts of lead are most profound in children under 4 years of age and pregnant women.

At blood lead levels which were previously considered safe, lead is now known to be associated with a spectrum of health consequences which include reduced intelligence quotient (IQ), behavioural changes (such as reduced attention span and increased antisocial behaviour), anaemia, hypertension, renal impairment, immunotoxicity and toxicity to reproductive organs. These effects are believed to be irreversible and have resulted in both the World Health Organisation (WHO) and the

¹ Australian/New Zealand Standard 4020 (2018) Table 2: Maximum Allowable Concentrations of Metals. Page 15. SAI Global.

² World Health Organisation (2018) Lead poisoning and health. ><https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health>< Accessed 4 June 2020.

independent statutory agency the National Health and Medical Research Council (NHMRC) encouraging governments to eliminate non-essential uses of lead.^{3,4}

People can be exposed to lead from ingestion of airborne dust, water, food and soil. The most common source of lead in drinking water is caused by lead leaching from plumbing products from within the premises.⁵

To mitigate the risk associated with lead exposure in Australia, drinking water is routinely tested for the presence of metals, including lead, by Network Utility Operators (NUOs). Such intervention is effective and Australian drinking water supplied to the premises is ranked in the top 15% for water quality in the world. Hence, where lead is present in drinking water in quantities above that permitted by AS/NZS 4020, the likely cause is plumbing products in contact with drinking water from within the property.

Background

Plumbing products in contact with drinking water have received negative attention for their potential to leach lead. In 2016, the Perth Children's Hospital (PCH) was found to have lead leaching from in-line fittings within the drinking water supply exceeding 10 µg/L. A study in New South Wales in the same year also found that 8% of 212 homes studied presented lead levels that exceeded 10 µg/L.⁶

Incidences of high lead levels in drinking water have resulted in the issuing of advice from the Environmental Health Standing Committee (enHealth), a standing committee made up of health representatives of states and territories and the Commonwealth that provides national advice on environmental health matters, that encouraged occupants to draw water each morning before use for a period of 30 seconds.⁷ Incidences also led to the ABCB undertaking a project to investigate options to address the issue, including the commissioning of a report in 2018 by Macquarie University, *Lead in Plumbing Products and Materials*, which evaluated the extent lead is used in the

³ World Health Organisation (2019) 'Lead'. >https://www.who.int/ipcs/assessment/public_health/lead/en/ Accessed 6 June 2020.

⁴ NHMRC (2015) 'Evidence on the effects of lead on human health' ><https://www.nhmrc.gov.au/about-us/publications/evidence-effects-lead-human-health> Accessed 6 June 2020.

⁵ US Environmental Protection Agency (2019) 'Basic Information about Lead in Drinking Water' ><https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water>< Accessed 2 August 2020.

⁶ Harvey, P. J., Handley, H. K., Taylor, M. P., (2016) 'Widespread copper and lead contamination of household drinking water, New South Wales, Australia'. *Environmental Research* 2016, 151. Pages 275-285. (Tests involved the sampling of first-draw water in the morning, when water had been in contact with fittings overnight.)

⁷ enHealth (2018) 'enHealth Guidance Statement Lead in drinking water from some plumbing products' [https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/\\$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf](https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf) . Accessed 5 July 2020.

manufacture of plumbing products and materials in contact with drinking water in Australia.⁸

In May 2019, a Lead in Plumbing Products Forum was convened by the ABCB with representatives of plumbing manufacturers, chairpersons of Standards Australia's technical committees responsible for the relevant product specifications, enHealth and plumbing suppliers and retailers. During the forum, participants considered the need to further reduce lead levels in plumbing products and a survey of attendees revealed that 92% agreed that lead content in plumbing products in contact with drinking water should be reduced.

Controlling lead content in drinking water

Current interventions that seek to reduce lead content in drinking water occur within a framework, which has been shown to be successful. These include:

- Water treatment by pH adjustment and other water treatment strategies to reduce lead solubility, which can reduce dissolved lead concentrations but not eliminate the problem.
- Water testing standards, such as AS/NZS 4020, which ensure a product's contribution of lead in drinking water does not exceed 10 µg/L.
- Placing limits on the maximum allowable lead levels within product specifications, which allow up to 6% lead content for some plumbing products in contact with drinking water.

Despite the success of these interventions, researchers at the Macquarie University found that the most effective means in further reducing lead content in drinking water was interventions targeted at its source, through the use of low lead plumbing products and materials.⁹

Internationally, regulations pertaining to the use of lead in plumbing products in contact with drinking water have undergone reform in recent years. In 2014, USA federal legislation that was designed to substantially reduce the lead content of plumbing fixtures and fittings in contact with drinking water commenced. The prescribed

⁸ Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University, NSW, Australia. ISBN: 978-1-74138-468-0

⁹ For brass products, it is not possible to achieve zero percent lead due to small trace amounts in the raw materials.

legislation requires a maximum limit of 0.25% lead calculated across the wetted surface of a pipe, pipe fitting, plumbing fitting and fixture and 0.2% lead for solder and flux on newly manufactured or installed products.¹⁰ These new requirements resulted in a substantial reduction from the previously permissible maximum lead content of 8% and reflects the lowest lead level content which is technically achievable at this time. This was enacted as part of the response to the Maximum Contaminant Level Goal (MCLG) of zero being set by the (US) Environmental Protection Agency (EPA). Sweden¹¹ and Canada¹² have also recently reduced the permissible lead level in water below that of the Australian limit of 10 µg/L.

Water testing standards internationally have also improved, resulting in some stakeholders suggesting that the test methods used in Australia with respect to lead are now out-dated, inconsistent with international practice and do not reflect how lead enters the water supply.^{13,14} The test methods for lead within AS/NZS 4020 have not substantially changed since the introduction of the test in 1991.¹⁵

Many factors influence the variability of lead in water. These factors include; the materials used in the plumbing system; the age of the plumbing system and its complexity; introduced chemicals; water quality fluctuations (pH), water treatment strategies such as the use of corrosion inhibitors and behavioural factors, such as usage patterns, flow rates and stagnation. Some of these variables are not reflected in the AS/NZS 4020 testing regime.

The most critical factor influencing the level of lead in drinking water is the lead content in the plumbing product itself. Laboratory testing has shown that lead leaches from copper alloy plumbing products in contact with drinking water. The findings of a review of Australian and international literature by Macquarie University also demonstrates that lead is known to leach into drinking water from copper alloy plumbing products through a variety of factors influencing the passivation and release of lead into drinking water. This occurs through a long-term process known as dezincification and is

¹⁰ (US) Environmental Protection Agency, Use of Lead-Free Pipes, Fittings, Fixtures, Solder and Flux for Drinking Water (2017) ><https://www.epa.gov/dwstandardsregulations/use-lead-free-pipes-fittings-fixtures-solder-and-flux-drinking-water> Accessed 29 May 2019.

¹¹ Boverket's Building Regulations 2019 (Sweden), Chapter 6.62.

¹² Government of Canada, Guidelines for Canadian Drinking Water Quality: Guideline Technical Document – Lead.

¹³ Tallwood Rise Water Consulting (2020) Potential changes to AS/NZS 4020: Testing for lead leaching.

¹⁴ Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University.

¹⁵ Test methods originated in AS 3855 – 1991 which has now been withdrawn and replaced with AS/NZS 4020 (2018).

causing instances of non-compliance with the acceptable maximum set by Australian plumbing regulations. The short-term release of lead through the dissolution of a leaded film (a by-product of the manufacturing process) is also believed to be causing non-compliances in practice where plumbing products in contact with drinking water are not adequately rinsed after machining by the manufacturer.

Purpose and Scope

This Decision Regulation Impact Statement (RIS) considers whether reducing lead content in plumbing products in contact with drinking water can have a measurable impact on reducing the lead content in drinking water and blood lead levels, particularly in the vulnerable population.

The scope of this Decision RIS is focused on plumbing products in contact with drinking water from within the property only. Other plumbing products (i.e. products not in contact with water intended for drinking) and those used within the infrastructure of NUOs is not within scope of this analysis. NUO infrastructure is excluded on the basis that there is no evidence to indicate high levels of lead leaching into the drinking water supply up to the point of connection to the property. Other products reviewed and excluded on the basis of the low likelihood of water from these products being consumed for drinking purposes are also discussed.

The focus is on new products and does not include premature replacement of existing plumbing products.

Themes in responses to the Consultation RIS

The Consultation RIS was open for public comment between 7 December 2020 and 1 March 2021. Interested parties were encouraged to provide responses to the questions listed throughout the document and all responses have been taken into account in producing this Decision RIS.

The ABCB received 40 submissions in response to the Consultation RIS, comprising of individuals, plumbing practitioners, health specialists, government bodies, manufacturers and industry bodies.

Non-confidential responses can be accessed via the ABCB's [Consultation Hub](#).

Qualitative themes from consultation

Several important themes were identified from the responses to the Consultation RIS. These themes have been summarised below:

Quantification of the problem and areas of uncertainty

There was widespread agreement on the issue with 89% of respondents supporting the description of the nature of the problem and 71% of respondents supporting the description of the extent. While the outcomes of the existing available studies were recognised, some stakeholders questioned the validity of the studies being extrapolated across Australia and saw merit in a national study being conducted.

Broadly, there were two opposing views on how uncertainty should be treated by decision makers when deciding which option to implement.

One Australian manufacturer (Enware) felt that the information gaps were too significant to enable an informed decision. They advocated for more research and data collection on a national level to determine the true extent plumbing products in contact with drinking water contributed to the problem of lead exposure in Australia. This opinion was in part based on belief that moving to low lead products may result in product substitution, increasing bacterial contamination.

While the cited studies correctly identify copper and copper alloys as inhibiting the growth and colonisation of various waterborne opportunistic pathogens, the studies

fall short in concluding that products manufactured from other materials are unsafe and not fit-for-use, as currently deemed by the PCA. Such conclusion would warrant a much larger investigation into all plumbing products and materials and not only those containing lead.

Further, there will always be relative advantages and disadvantages between material types. Hence, differences should not automatically infer that a material is unsafe but rather reflect that there are trade-off considerations when selecting products of differing materials.

The alternative view, progressed in submissions from enHealth and the NHMRC, was to acknowledge the problem was occurring in Australia, however, due to differing rates, and the limitations of the existing data, the problem may not be capable of being further quantitatively defined. This opinion reflects a more strategic goal of health authorities, both domestically and internationally, to reduce exposure from all sources, thereby reducing the cumulative and irreversible effect of lead exposure on precautionary grounds.

Scope

There was broad acceptance of the scope of products considered by the Consultation RIS with 76% of respondents agreeing with the scope of the proposed requirements.

Exceptions were an individual, who advocated for including products manufactured from other materials, namely Polyvinyl Chloride (PVC). Health agencies (NHMRC and enHealth), advocated for products intended to be used for showering and/or bathing and other products to be captured by the existing definition of drinking water in the Australian Drinking Water Guidelines. The Water Services Association of Australia (WSAA) also advocated for the requirements to extend to the water utility infrastructure, citing the ease to which it could be implemented.

The Decision RIS retains the existing scope with the addition of water meters on the basis that:

- PVC products in contact with drinking water are currently not permitted to contain any amount of lead under existing Australian Standards referenced by the PCA.

- Products used for showering and/or bathing contribute to a very small increase in the risk of lead exposure. While some occupants may drink from the shower, the consumption is very low relative to consumption via other products. In this regard, greater importance is placed on ensuring that the scope of the new requirements is consistent with the model regulation from the US, with the goal of ensuring the availability of suitable product and consumer choice.
- The case to include NUO infrastructure is weakened by the evidence that water supplied to the meter is currently very low (up to 1 ug/L in most cases). This infrastructure is also outside the remit of the NCC and is regulated by the NUO. It was, however, recognised that water meters as the point of intersection between water utility infrastructure and plumbing within the premises should be included within the scope of the new requirements. As such, the impact analysis has been updated to reflect their inclusion in the Decision RIS.

The final scope of products was discussed and agreed with the ABCB's Plumbing Codes Committee (PCC) at its 2021 – Special meeting, in March.

Effectiveness and reliance on AS/NZS 4020

Two thirds of responses supported discontinuing an option examining changes to AS/NZS 4020 as an alternative regulatory option. Support was given for discontinuing the option on the basis that Option 2 by limiting the proportion of lead in the source material, was superior in addressing the problem at the source. That is, by significantly reducing lead from copper alloy plumbing products in contact with drinking water.

While proposed changes to AS/NZS 4020 have been discontinued from further evaluation by the Decision RIS, the following themes are noted from those submissions advocating for changes to AS/NZS 4020.

Changing the focus of AS/NZS 4020 from products to materials

Stakeholders with a working understanding of AS/NZS 4020 and its European equivalent (EN 15664) recognised the potential long-term benefits of moving towards a material-based test method for lead as opposed to the current product-based

approach in AS/NZS 4020. Among other benefits, this would allow for a register of compliant materials and suppliers to be created, making it easier to source compliant raw materials. In doing so, stakeholders recognised many of the methods used to test materials were not practical to apply to individual products for the reasons stated in the Consultation RIS, including the short-term costs associated with the additional time and resources required by manufacturers and testing authorities.

The Decision RIS notes the similarities in objectives of changing the focus of AS/NZS 4020 with those of Option 2. Given the similarities and potential unintended consequences on the testing requirements for other metals, the Decision RIS focuses instead on a regulatory option that delivers a higher net benefit to the broader community in its current form.

Changes to Testing Criteria

Of those who provided feedback on AS/NZS 4020, there was general consensus that the existing test methods could be changed to be more reflective of conditions in Australia and the range of variables and other factors influencing compliance with the Standard. This included reviewing test conditions, stagnation times and reducing the current maximum threshold for lead from 10 µg/L to a lower value.

The Decision RIS recognises calls for some changes to AS/NZS 4020 are strong, however, the details underlying the proposed improvements are not sufficiently resolved in order for the changes to be considered by decision makers via this RIS.

Following feedback received on the Consultation RIS, a review of AS/NZS 4020 should be investigated, noting that the test methods contained within the Standard have not undergone significant review since its introduction in 1991. It is envisaged that future changes to AS/NZS 4020 could support or complement proposed changes considered by this Decision RIS, subject to further development and consultation with industry and testing laboratories on the costs and benefits of any proposed changes.

Need for health-based guideline values for lead substitutes

The importance of ensuring that health-based guideline values are developed for all plausible lead substitutes prior to implementing Option 2 was raised by health agencies. Experience from the US shows that the most common substitutes for lead

brass have been silicon brass and bismuth brass. It is understood that no country currently has health-based guideline values for these substitutes. However, enHealth and the NHMRC acknowledged that the absence of a drinking water guideline value for any material, or leachable component of a material, does not imply that the product or material will be safe. This was particularly in regard to the use of bismuth, which they advised is one of the least understood elements in the periodic table.

As there are currently no threshold values in use internationally, the time required to develop these values should be taken into account by decision makers when determining which option to implement.

Given the concerns by the health agencies and the likely influence of the US market in Australia, the Decision RIS recommends work be undertaken with health authorities on what limits should be placed, if any, on the use of lead substitutes.

Implementation issues

Transition

Stakeholders accepted that Option 2 would have significant impact on the manufacture of copper alloy plumbing products in contact with drinking water, with most (85%) agreeing that a suitable transition period was required.

Opinions on the duration of the transition period required were mixed, with 47% recommending a three year transition and 38% recommending five years. Of those who advocated for the longer duration, most were manufacturers or industry groups with an in-depth understanding of the practical implications new requirements would have on domestic manufacturing and the time required to sell-off existing stock.

Concerns were also raised by industry groups regarding the capacity of the testing laboratories, who also advocated for a five-year transition period on the basis of the significant volume of testing required. The current global pandemic and its impact on product and material supply chains was also identified as a barrier to implementation, with one stakeholder advocating for a five-year transition after travel restrictions had been removed.

Reasons supporting a shorter transition period included the ability to rely on NSF/ANSI 372 compliant imported products in the short-term. Emphasis was also

placed on the public safety outcomes derived from Option 2, with some suggesting that the move should be made as soon as possible to give recognition to the health benefits that would flow.

The Decision RIS considers the interaction of many factors on the transition period raised in responses received during consultation, noting decision makers need to balance the need of the industry with the goal of improving public safety outcomes. Given the length of transition required, consultation with industry following a decision would ensure achievable key milestones are transparent in the form of a formal implementation strategy.

Labelling

Following consultation, the need for labelling emerged as an important factor. Industry in particular felt that the assumed effectiveness of Option 2 would only be achieved if compliant products were readily identifiable by plumbing practitioners and consumers.

The Decision RIS discusses the need for labelling and the potential recognition of the US labelling requirements. This would enable a new product manufactured either in Australia or internationally to be deemed compliant with the proposed requirements until such time all products are certified and labelled in accordance with the WaterMark Certification Scheme (WMCS).

The need for labelling to provide plumbing practitioners with an indication of compliance status is valid for a transition period of three years. Over this time, it is expected that plumbing product suppliers would have a mix of products in stock, which would make differentiating compliant low lead products difficult. Similarly, practitioners may have difficulty confirming the compliance status of existing stock.

A transition period of five years is expected to negate the need for such labelling as it provides sufficient time for suppliers to run down existing stock. When the transition period concludes, a valid WaterMark licence would be expected to indicate conformance to the new low lead requirements and confirm the product is suitable for installation.

Problem

Nature of the Problem

The nature of the problem relates to the inclusion of lead in the manufacture of certain plumbing products in contact with drinking water. This results in a risk of lead leaching into the drinking water supply at higher levels than permitted under Australian Drinking Water Guidelines (ADWG) and international standards, with potential health consequences when drinking water is consumed.

The nature of the problem is influenced by three elements:

- The inclusion of lead in the manufacture of certain brass and other copper alloy plumbing products in contact with drinking water, primarily to facilitate the machining of products.
- The mechanisms of short-term and long-term release of lead into drinking water from certain leaded plumbing products, through surface films and dezincification.
- The health consequences of drinking water containing low levels of lead and its impact on the population, when consumed.

Lead in plumbing products in contact with drinking water

Lead is currently permitted in small proportions in the raw materials used to manufacture some plumbing products in contact with drinking water. It is used to improve a product's malleability and corrosive resistance properties, and is a particularly useful lubricant that assists in the machining of new products. In its most common form in plumbing products, lead is mixed with copper (Cu) and zinc (Zn) to form brass. It is also used in the manufacture of other copper alloys such as bronze.

A recent industry survey revealed that approximately 90% of copper alloy plumbing products sold in Australia contain lead to some extent. The exact lead content of products varies by component, although some products contain up to 6% lead as a proportion of raw material.¹⁶

¹⁶ Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University. Page 13.

The types of copper alloy products in contact with drinking water which contain lead include:

- Fittings
- Valves
- Fittings on stainless steel braided hoses
- Taps
- Mixers
- Water heaters
- Water dispensers (boiling and cooling units)
- Water meters.

Some products may contain lead, but are not within scope of this analysis.

These include:

- Residential fire sprinklers
- Fire-fighting equipment
- Irrigation
- Appliances, including washing machines and dishwashers
- Commercial boilers (associated with HVAC systems)
- Toilets
- Emergency deluge showers, eyewash and eye-face wash equipment
- Showers for bathing
- Recycled water systems (such as residential dual pipe reuse systems or dual reticulation systems).

These exclusions reflect the low likelihood of water from these products being consumed for drinking purposes.

The Consultation RIS asked stakeholders whether they agreed with the scope of the listed products and whether other products should be included or excluded from the proposed requirements.

The majority of respondents (76%) agreed with the listed scope of products. Those that did not agree, primarily advocated for an increase in scope to include:

- PVC products used for the collection of rainwater.
- Fire sprinkler systems.
- Shower heads, citing examples of where drinking has occurred while showering.
- Products associated with potable water sourced from rainwater.
- Water meters, citing examples of where high lead concentrations have been found to have leached from water meter components.
- NUO infrastructure (i.e. water main fittings).

The Plumbing Codes Committee, the ABCB's national plumbing technical advisory committee, endorsed the current scope for the Public Comment Draft of NCC 2022. Lead leaching occurs primarily due to two issues, the short-term release of lead through the incorrect rinsing of newly manufactured products and the long-term release of lead through the dezincification process. While lead is contained in plumbing products other than copper alloy products and materials, the dezincification process is an important factor in lead leaching. In the absence of this process, there is no evidence to indicate that lead leaching occurs from other new products and materials.

In the case of PVC pipes and fittings, lead is not permitted in the manufacture of these products in Australia. As such, the scope is deliberately limited to copper alloy products, where lead leaching has been found to occur.

In the case of fire sprinkler systems, each fire-fighting water service must be assigned a Hazard Rating and be isolated from the drinking water service by an appropriate backflow prevention device in accordance with B5.4 of the PCA. As such, existing requirements adequately safeguard against the risks associated with water backflow.

Water consumption when showering is very low relative to other sources of drinking water. This assessment is based on their relatively small contribution to consumption, and common practice to draw off comparatively larger volumes of water (i.e. flush the system) before entering a shower.

Varying the requirements for showering and/or bathing products in Australia would also create an inconsistency with the much larger US market, which could impact the pricing and availability of compliant products in the short-term until such time Australian specific products became available.

The importance of the proposed requirements aligning with the model regulation from the US was emphasised by the Ai Group:

“Australia is a small market. If we transition to low lead levels for plumbing products for which this is not required in other countries (e.g. shower valves) then overseas manufacturers are unlikely to manufacture ‘low lead’ variants specifically for Australia. This will significantly limit the choice for Australian consumers.”

Hence, based on the very low risk from consuming water when showering or bathing and the inconsistency generated with the model regulation, these products have been excluded from the proposed requirements.

Products associated with potable water sourced from rainwater are included in the proposed scope. This has been better reflected in the final NCC provisions (see Attachment A). Waste fittings are not within scope of the proposed changes on the basis that they pose no risk to consumable drinking water.

The case to include NUO infrastructure made by WSAA is weakened by the evidence that water supplied to the meter is currently very low (up to 1µg/L in most cases). This infrastructure is also outside the remit of the NCC and is regulated by the NUO's. The Decision RIS recognises the potential for lead to leach from water meters, which are now included within the scope of the proposed requirements.

Lead leaching into drinking water

Lead release from copper alloy plumbing products in contact with drinking water can occur differently over the short and long term.

Short-term lead release

The short-term release of lead is the result of dissolution of machining film which forms immediately after the manufacture of some copper alloy products. The ABCB is not aware of any Australian specific studies on the rate of short-term release of lead in drinking water and such studies are limited internationally.

A US study in 2010, found that most lead in drinking water within the first 30 days is surface lead.¹⁷ Short-term release can continue to occur up to 3 months of operation.¹⁸ Applying monochloramine (NH₂Cl) as a disinfectant of products following manufacturing can reduce the likelihood of this film being present. A 0.5 µm thick lead film nearly completely dissolves in a NH₂Cl solution.¹⁹ Figure 1 shows the release of lead from a brass plumbing product in contact with drinking water from a study conducted in Germany in 2015.

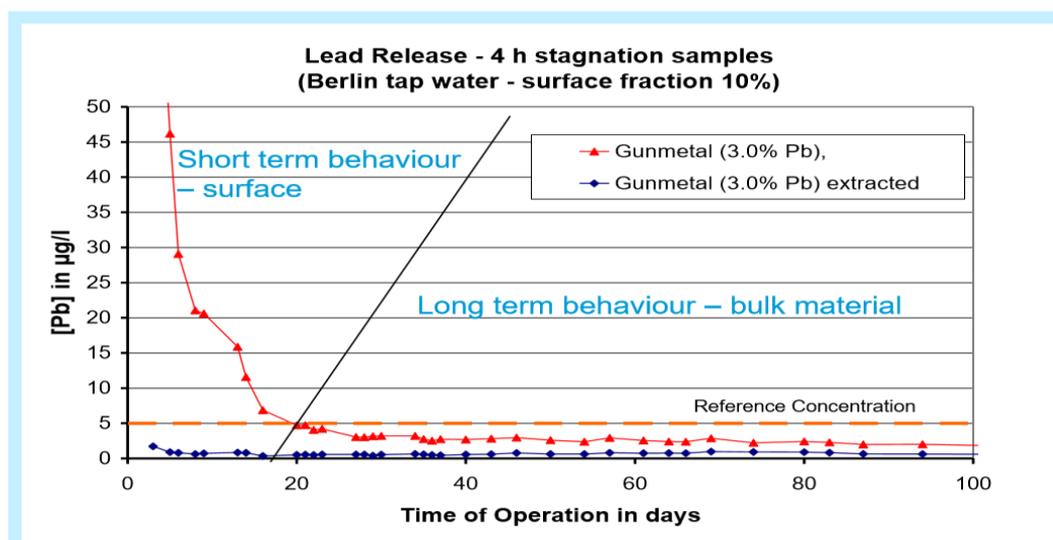
While Figure 1 provides visual representation of the short-term release of lead from a copper alloy product, it may not be representative for all plumbing products in Australia. This is because Australian Standards referenced in the WMCS typically do not permit the use of gunmetal brass, though its lead content is comparable to that found in red and yellow brass. The exact detail of the experimental conditions underpinning the figure is also unclear from the source document.

¹⁷ Efland C., Scardina P., Edwards M. (2010) Lead-contaminated water from brass plumbing devices in new buildings. J. Am. Water Works Assoc. Pages 102:66–76.

¹⁸ 4MS Joint Management Committee (2016). Acceptance of metallic materials used for products in contact with drinking water: 4MS Common Approach; Part A – Procedure for the acceptance Part B – 4MS Common Composition List-2nd Revision: 07.03.2016 Bundesministerium für Gesundheit (Deutschland).

¹⁹ Switzer, J. A., et al. (2006). "Evidence that monochloramine disinfectant could lead to elevated Pb levels in drinking water." Environmental Science and Technology 40(10): 33843387.

Figure 1: Lead released from copper alloy plumbing products in contact with drinking water²⁰



Source: Rapp (2015)

It is widely accepted within industry that the incorrect rinsing of a product can influence the lead content in drinking water. This has resulted in some stakeholders calling for prescriptive requirements to be included in product standards to ensure that there are clear and unambiguous methods prescribed for the correct rinsing of products.

There is no evidence that manufacturers lack the knowledge or incentive to correctly rinse products. Existing safeguards include WaterMark Conformity Assessment Bodies (WMCABs) reviewing AS/NZS 4020 testing of plumbing products at the initial manufacturing process stage, which would generally reveal a product's susceptibility to short term lead release. Independent AS/NZS 4020 testing of plumbing products is also reviewed by the WMCABs every five years, as part of WaterMark re-certification, or when there has been a change in the manufacturing process, materials, design or specification.

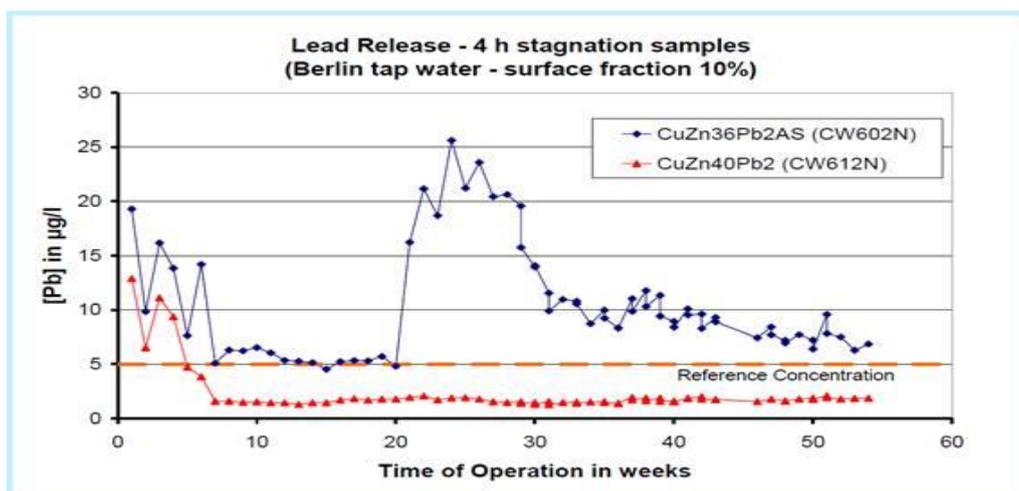
Despite these safeguards, there remains some concerns, as expressed by industry during consultation, regarding the short-term release of lead from incorrect rinsing procedures. These concerns will be referred to Standards Australia for the consideration of each relevant Standards Australia Technical Committee.

²⁰ Rapp, T. (2015) Materials and Products in Contact with Drinking Water Section II 3.4 Distribution of Drinking Water. Presentation notes available from: https://www.kupferinstitut.de/fileadmin/user_upload/kupferinstitut.de/de/Documents/techUnterstuetzung/4MS/2015/08_-_4MS_approach_for_metallic_materials_-_Rapp.pdf

Long-term lead release

The causes of long-term lead leaching into drinking water are well studied. With time, zinc in brass is preferentially lost relative to copper.²¹ This process is known as dezincification. The effect of dezincification is shown by Figure 2.

Figure 2: Effects of dezincification on lead releasing from the bulk alloy²²



Source: Rapp (2015)

The above figure shows the lead leaching rate of a common brass product over time.²³ After 20 weeks, lead is released at high levels as a direct result of dezincification; that is, lead leaching due to zinc being preferentially lost to copper within the bulk alloy containing lead.

During consultation, enHealth and the NHMRC highlighted that lead leaching from the bulk alloy can occur much earlier than 20 weeks, citing the recent examples of high lead concentrations being found in Australian drinking water.

The possibility of lead leaching from the bulk alloy prior to 20 weeks is not disputed and the findings of Rapp (2015) was included in the Consultation RIS as general explanation of the dezincification process only.

The rate of long-term lead release from certain copper alloy plumbing products is influenced by a number of factors, including:

²¹ Maynard, J. Mast, D. & Kwan, P. (2008) Kinetics of lead release from brass faucets and water meters.

²² Rapp, T. (2015) Materials and Products in Contact with Drinking Water Section II 3.4 Distribution of Drinking Water. Presentation notes available from:

https://www.kupferinstitut.de/fileadmin/user_upload/kupferinstitut.de/de/Documents/techUnterstuetzung/4MS/2015/08_-4MS_approach_for_metallic_materials_-_Rapp.pdf

²³ CW 602 is a common type of brass used in Australia.

- The surface characteristics of the product in contact with water. These characteristics will change over time dependant on the metal composition and water chemistry. The initial release of the surface lead film is followed by corrosion reactions which may produce a protective surface film or may lead to dezincification and continued release of lead from the body of the material.
- The presence of chlorine. High chlorine concentration usually increases metal release. However, these levels are not common or permitted by the ADWG.
- The velocity of the water within the plumbing system. Increased flow rates have been shown to speed up the dezincification process.
- The potential for galvanic corrosion where lead solder is used, however lead solder is no longer permitted in new plumbing work and as such, this source of lead is limited to existing plumbing work.

A report by the Water Industry Research Limited in the United Kingdom in 2016 on long-term testing of brass fittings found:

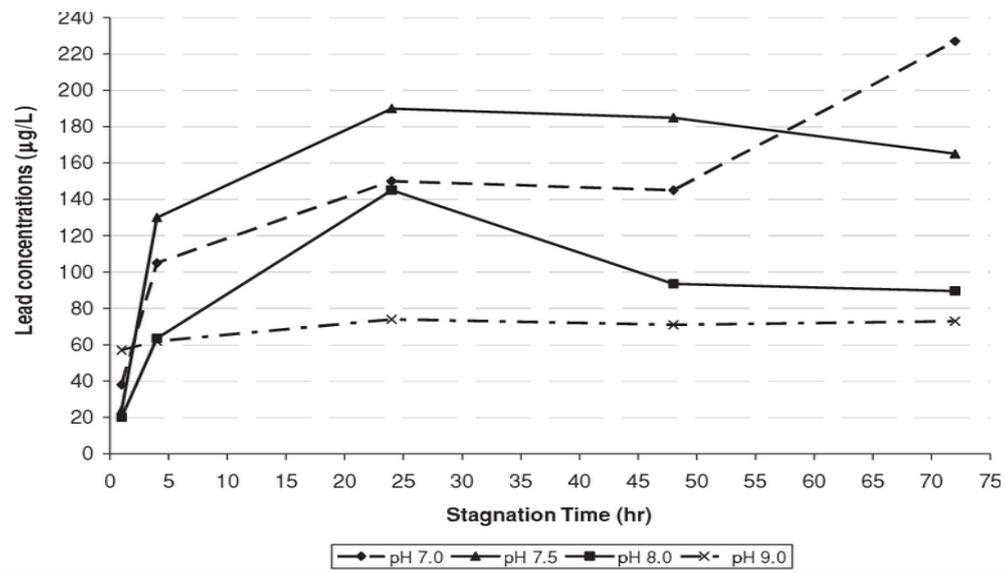
- The majority of copper alloy fittings exhibited a steady, but low, rate of metal leaching throughout the year.
- The yields of lead from combinations of some fittings had the potential to result in lead concentrations being higher than permitted in a random daytime sample. This occurred when stagnation was 8 hours or greater and when high lead content fittings were exposed to non-phosphate dosed waters.
- All low lead fittings tested showed significantly less lead and nickel leaching compared with their leaded copper alloy counterparts.
- Neither seasonal or stagnation temperatures appeared to significantly contribute to the leaching for the metals.

Parameters affecting lead release

The release of lead is known to be affected by stagnation time and the pH level of the water. The stagnation time that water is in contact with the surface has a significant effect on the concentration of lead in water. The lead concentration initially increases rapidly in stagnant water for at least 24 hours, but then slows until saturation, as shown in Figure 3. Stagnation times in household plumbing are usually less than 24 hours, which is within the timeframe of increasing lead release.

The degree of leaching is affected by the variations in water chemistry – particularly pH and alkalinity. This is also shown in Figure 3.

Figure 3: Lead leaching from stagnant water from a common brass plumbing product²⁴



Source: Tam & Elefsiniotis (2009)

The above figure indicates that lead leaching from plumbing products generally reaches its peak after 24 hours of stagnation for most water types and reaches a short-run equilibrium state thereafter.²⁵ The degree of leaching is largely affected by the variations in pH and alkalinity. At a pH around neutrality, an increase in alkalinity promotes metal dissolution, while for a pH of 9.0, the effect of alkalinity on leaching is marginal. The ADWG sets a pH regulatory target of 6.5 - 8.5. Less than 6.5, water may be corrosive, while above 8.5, scale (water hardness) and taste may be impacted.²⁶

It should be noted that the above figure is taken from a study which uses an alkalinity of 100 mg/L CaCO₃. This is above what is typically reported in Australian municipal water testing (which is typically 20-30 mg/L CaCO₃). At alkalinity levels of 20 mg/L CaCO₃, lead leaching is considerably lower relative to higher alkalinity values and as

²⁴ Tam, Y S, Elefsiniotis P. (2009) Corrosion control in water supply systems: Effect of pH, alkalinity, and orthophosphate on lead and copper leaching from brass plumbing. *Journal of Environmental Science and Health Part A*. (44), 1251-1260.

²⁵ Schock, M. R. Sheckel, K. G. DeSantis, M. Gerke, T. In *Mode of occurrence, treatment, and monitoring significance of tetravalent lead*, Water Quality Technology Conference, Quebec, Canada, 2005.

²⁶ Australian Drinking Water Guidelines (2011) Chapter 10. Page 188.

a consequence, the concentration of lead leaching will vary throughout Australia. Though stagnation will increase the rate of lead release across all alkalinity levels.

Baseline lead levels in Australian drinking water

Australian drinking water is of high quality. An Environmental Performance Index developed by Yale University ranks Australian drinking water 21 out of 180 countries, placing it in the top 15% of drinking water quality in the world.²⁷

The base level of lead in Australian drinking water, that is, the lead levels from the water source, including its transport through the NUO infrastructure, is very low. A Joint Monitoring Programme Report undertaken by the WHO and the United Nations International Children's Fund (UNICEF) in 2017, found that the proportion of the population using safely managed supplies of drinking water for Australian urban areas is 99%.²⁸ The compliance levels of rural supplies in Australia are not known due to the lack of aggregate data on a national level.

Drinking water in Australia is routinely tested for the presence of metals, including lead, to ensure continued compliance with the ADWG. NUO's conduct their own daily assessments of water quality, against the ADWG, and take action should levels cross thresholds. They report annually on these levels, and these reports are in turn assessed for compliance with the guidelines.²⁹ Corrosion inhibitors, such as zinc orthophosphates, can also be used. It is particularly effective at inhibiting lead leaching because it reduces lead solubility in waters of both low and high alkalinity. Zinc orthophosphate limits the release of lead, copper and iron from metal surfaces by forming a microscopic protective film on these surfaces, and through electrochemical passivation.³⁰ Though, the extent zinc orthophosphate is used by water utility operators vary.

In response to the Consultation RIS, a water testing consultant noted that it was rare in his experience for zinc orthophosphate to be used as a water treatment strategy by NUOs on the east coast of Australia and in his opinion, providers should not have to add orthophosphate to drinking water supplies if the issue was treated at its source.

²⁷ Yale University (2020) Environmental Performance Index. ><https://epi.envirocenter.yale.edu/epi-country-report/AUS>< Accessed 26 April 2020.

²⁸ Hasan, T. (2019) 'Determining safe drinking water'. Water e-Journal Vol 4 No 2 2019.

²⁹ Global Open Data Index (2016) Water Quality – Australia. ><https://index.okfn.org/place/au/water/> Accessed 21 April 2020.

³⁰ Australian Drinking Water Guidelines (2011) Page 1102.

Advice from WSAA following consultation also reveals the extent of zinc orthophosphate use varies by jurisdiction, though not common among NUO's.

Based on the available information, the baseline level of lead in drinking water supplied by NUO's in Australia contains less than 1 µg/L. Fluctuations may occur in areas in close proximity to mining sites or lead smelters. These levels compare well with many developed countries.³¹

Hence, research suggests³² where lead is present in drinking water in quantities above that permitted by AS/NZS 4020, the likely cause is plumbing products in contact with drinking water from within the property.

Cases of lead leaching into drinking water in Australia

There have been a number of highly publicised incidences of lead being found in Australian drinking water exceeding 10 µg/L in recent years. Fortunately, these incidences are rare and examples are provided below.

Perth Children's Hospital

In 2016, testing of the drinking water system at the new Perth Children's Hospital (PCH) found concentrations of lead greater than those permitted by AS/NZS 4020.

A report issued by the Chief Health Officer (CHO) in 2017 considered that:³³

- The source of lead was from brass fittings that had undergone a process of dezincification.
- Many of the brass fittings were located within the Thermostatic Mixing Valve (TMV) Assembly Boxes, which were located in close proximity to drinking water outlets.
- Phosphate treatment had been partially, but not sufficiently, effective in reducing lead levels.

The investigators also considered that there were additional mechanisms other than the initial leaching of lead from new surfaces which contributed to the problem.

³¹ World Health Organisation (2009) Lead in Drinking Water: Background document for development of WHO Guidelines for Drinking-water Quality. Page 2.

³² Taylor, M. Harvey, P. & Morrison, A. Lead in Plumbing Products and Materials. Macquarie University, NSW, Australia. ISBN: 978-1-74138-468-0

³³ WA Department of Health (2017) 'Report on Perth Children's Hospital Potable Water Chief Health Officer Review'.

Dezincification was the likely cause and this was supported by a small sample study of brass fittings from the TMV Assembly Boxes by Curtin University.³⁴ Some components of the TMV Assembly Boxes lacked identifying markings required for certification under the WMCS, leading to questions about the source, quality and compliance of the fittings.

The history of the hospital's plumbing system was also examined including chlorination flushing and phosphate treatment. The investigators suspected that chlorination may have contributed to the high rates of dezincification and associated lead leaching, however records were not available to confirm the contact time or concentration of chlorine used during commissioning of the plumbing system.

Spiral Spring Mixer Taps

In 2017, the Queensland Building and Construction Commission (QBCC) reported a popular type of mixer tap released up to 15 times the permissible level of lead. Independent tests by the retailer showed the product to be compliant with lead levels permitted by AS/NZS 4020 when tested by an accredited AS/NZS 4020 testing laboratory. Queensland Health sought advice from NATA on the inconsistency of the results. NATA could not identify anything that would account for the difference in the original results.

Public water fountains

In 2018, a random sample of public water fountains were found to have lead concentrations in excess of 10 µg/L in Geelong, Victoria.³⁵ The evidence indicated that lead levels had accumulated in the drinking water because the drinking fountains were infrequently used and the resulting stagnation caused lead to leach from the brass fittings. It is also understood that of all the drinking fountains investigated in Geelong, 57% exceeded 10 µg/L. Of the 130 sites investigated, 16% still exceeded 10 µg/L following a flush of the pipes – demonstrating the significant impact of lead leaching at some of those sites.

³⁴ Curtin University (2017) 'Analysis of Brass Fittings Collected 12/07/17 from Potable Water System of the New Perth Children's Hospital'.

³⁵ ABC (2018) 'Geelong water fountains shut off over unsafe lead levels'

><https://www.abc.net.au/news/2018-05-16/geelong-water-fountains-shut-off-over-unsafe-lead-levels/9768252> Accessed 15 June 2020.

Lead content from drinking fountains in the Borough of Queenscliffe and Warrnambool, Victoria, was also found to be at levels higher than 10 µg/L following testing of water fountains in the same year. Testing revealed levels of lead and nickel above the acceptable amount specified in the ADWG in water from six public drinking fountains in the Borough of Queenscliffe and two public drinking fountains in Warrnambool.^{36,37}

Water Meters

Following an investigation into two children (siblings) with high blood lead levels, a sampling program for lead at point of delivery was undertaken by a water supply operator in Queensland. While water was found to not be the source of lead for the children, lead was detected in water samples taken at the water meters of some control properties.

Investigations into this issue are ongoing with a report being prepared by the NUO after investigations are complete. Existing water meters are also being replaced with low lead alternatives where high levels of lead have been found. Queensland Health also understands at least one other local government area has replaced existing water meters with low lead meters.

Impacts of lead exposure on human health

Lead is a cumulative toxicant and there is no blood lead level which is considered safe.³⁸ Once lead enters the blood, it is distributed to organs such as the brain, kidneys, liver and bones. At high exposure, lead has been known to cause coma, convulsion and death.

Chronic exposure causes haematological effects, such as anaemia, or neurological disturbances, including headache, irritability, lethargy, convulsions, muscle weakness, ataxia, tremors and paralysis. Acute exposures may cause gastrointestinal disturbances (anorexia, nausea, vomiting and abdominal pain), hepatic and renal

³⁶ Council News (2018) 'Public drinking fountains re-open' ><https://www.councilnews.com.au/2018/10/2348970-public-drinking-fountains-to-re-open>< Accessed 15 June 2020.

³⁷ The Standard (2018) 'Drinking taps shut off after elevated lead levels detected' ><https://www.standard.net.au/story/5456354/drinking-taps-shut-off-after-slightly-elevated-lead-levels-detected/#:~:text=Residents%20may%20notice%20that%20Warrnambool%27s,Lake%20Pertobe%2C%20parks%20and%20A%20quazone.<> Accessed 4 September 2020.

³⁸ World Health Organisation (2018) Lead poisoning and health. > <https://www.who.int/news-room/fact-sheets/detail/lead-poisoning-and-health> Accessed 4 September 2020.

damage, hypertension and neurological effects (malaise, drowsiness, encephalopathy).³⁹

Children are particularly vulnerable to the neurotoxic effects of lead and even low levels of exposure can cause serious and, in some cases, irreversible neurological damage. The potential for adverse effects of lead exposure is greater for children than for adults because the intake of lead per unit of body weight is higher, lead absorption in the gastrointestinal tract is higher, the blood-brain barrier is not yet fully developed and neurological effects occur at lower levels than in adults.⁴⁰

At blood lead levels which were previously considered safe, lead is now associated with reduced intelligence quotient (IQ). Behavioural changes such as reduced attention span and increased antisocial behaviour, anaemia, hypertension, renal impairment, immunotoxicity and toxicity to reproductive organs have also been established from blood lead levels of 10 µg/dL and above. These effects are believed to be irreversible.

The most critical effect of lead in young children is on that of the developing nervous system. Subtle effects on IQ are expected from blood lead levels at least as low as 5 µg/dL and the effects gradually increase with increasing levels of lead in blood. Lead exposure has also been linked epidemiologically to attention deficit disorder and aggression.⁴¹

Evidence from the NHMRC on the effects of lead on human health

In 2015, the NHMRC released a report on the effects of lead on human health. After considering the evidence and taking into account the quality and design of the studies, the Lead Working Committee made the following conclusions about the health effects on the population with blood lead levels less than 10 µg/dL: ⁴²

“While the body of evidence indicates that there may be an association between blood lead levels and health effects in some population groups, there is not enough high-quality evidence (i.e. results of studies that were

³⁹ World Health Organisation (2010) “Exposure to Lead: A Major Public Health Concern.”><https://www.who.int/ipcs/features/lead..pdf> Accessed 18 May 2020.

⁴⁰ WHO (2007) Blood lead levels in children. Copenhagen, World Health Organization Regional Office for Europe, European Environment and Health Information System (Fact Sheet No. 4.5; http://www.enhis.org/object_document/o4738n27387.html). Accessed 19 May 2020.

⁴¹ IARC (2006). Summaries & evaluations: Inorganic and organic lead compounds. Lyon, International Agency for Research on Cancer (IARC Monographs for the Evaluation of Carcinogenic Risks to Humans, Vol. 87.

⁴² NHMRC (2015). NHMRC Information Paper: Evidence on the Effects of Lead on Human Health. Page 18.

well-designed, well-conducted and well-reported) to conclude that a blood lead level less than 10 micrograms per decilitre was the causing factor for any health effects that were observed.

The available evidence suggests that blood lead levels between 5 micrograms and 10 micrograms per decilitre are associated with reduced IQ and academic achievement in children. The relative contribution of lead in causing reduced IQ is unknown. Certain populations of children may be affected by other factors (e.g. socioeconomic status, education, parenting style, diet, or exposure to other substances) that put them at greater risk, making it difficult to know how much blood lead levels between 5 micrograms and 10 micrograms per decilitre may contribute to reduced IQ.”

Despite the uncertainty of these findings, the NHMRC and experts from the Lead Working Committee had sufficient concerns about the health impacts to issue the NHMRC Statement: Evidence on the effects of lead on human health (2015) (the Statement).⁴³ The Statement recommends that exposure to lead should be eliminated as much as possible to reduce the risk of harm to the individual and the community. It is also recommended that if an individual has a blood lead level greater than 5 µg/dL, the source of lead exposure should be identified and reduced, particularly if the person is a child or a pregnant woman. The Lead Working Committee had expertise in public and environmental health, health risk management, toxicology and paediatric medicine. The Statement was endorsed by the NHMRC Council, which includes the Chief Health and Medical Officers from the states and territories.

The findings of the NHMRC are important for two reasons. Firstly, they show there may be an association between low level lead exposure and health impacts and more high-quality evidence could reveal a causal relationship. Secondly, the findings demonstrate that quantifying the health impacts below a blood lead level of 10 µg/dL will be difficult and may not reflect the true impacts based on the uncertainty of health impacts below this threshold, however this does not mean the impacts do not exist.

In response to the Consultation RIS, the NHMRC further emphasised the need to lower lead exposure from all sources despite the ongoing uncertainty on the extent

⁴³ enHealth (2018) 'enHealth Guidance Statement Lead in drinking water from some plumbing products' [https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/\\$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf](https://www.health.gov.au/internet/main/publishing.nsf/content/A12B57E41EC9F326CA257BF0001F9E7D/$File/Lead-plumbing-products-Guidance-Statement-July2018.pdf) Accessed 3 December 2020.

low lead exposure from drinking water is contributing to the total health effects of lead exposure:

“In the section on health effects, it needs to be made clear that, as well as being a cumulative toxicant, the critical health effects observed from lead exposure (e.g. known or suspected reproductive/developmental, mutagenic and carcinogenic health effects (AICIS 2016)) can be realised in a relatively short timeframe, particularly those observed in children. The uncertainty about the blood lead levels at which these effects occur means that a safe threshold of lead exposure cannot be established and the risks will only increase with ongoing exposure to lead as it accumulates within the body.”

The NHMRC’s position is supported by the 2017 revision to the WHO Guidelines for Drinking-water Quality, which states:

“The guideline value is designated as provisional based on treatment performance and analytical achievability. As this is no longer a health-based guideline value, concentrations should be maintained as low as reasonably practical. New sources of lead, such as service connections and lead solder, should not be introduced into any system, and low lead alloy fittings should be used in repairs and new installations”.

Both of these statements encourage further intervention in reducing lead exposure from all sources despite the uncertainty associated with low lead exposure from plumbing products in contact with drinking water.

Regulatory interventions in Australia

National regulatory intervention

Due to the consequences of high-level lead exposure, there have been several significant regulatory interventions over the past two decades to reduce lead levels in Australia.

These interventions include:

- Lead no longer being added to petrol since 2002. Lead is permitted in unleaded petrol up to 0.5 mg/L (500 µg/L) when tested to ASTM D3237.⁴⁴

⁴⁴ Department of Agriculture, Water and Environment (2020) Petrol fuel quality standard ><https://www.environment.gov.au/protection/fuel-quality/standards/petrol>< Accessed 12 June 2020.

- The amount of lead in house paints was limited to 1% in 1965, 0.25% in 1992 and 0.1% in 1997.⁴⁵
- The amount of lead in water was limited to 10 µg/L of water in 1991 via the ADWG.
- Regulations now restrict or prevent the use of lead in consumer goods (e.g. toys, cosmetics, ceramics, and medicines) and the importation of products that contain lead.⁴⁶

The above regulatory interventions show that reducing the amount of lead has occurred across a range of products and consumables, including drinking water. A common theme of each intervention is not prescribing lead to be absolute zero. This recognises that due to very small trace amounts of lead, its presence cannot be eliminated.

These national interventions have resulted in a measurable decline in lead exposure in Australia, significantly lowering the background levels of lead and blood lead levels of the general population. Despite this reduction, public health experts, continue to support efforts to limit potential exposure from all sources.

This is reflected by Australia’s Chief Medical Officer:

“There is no evidence of adverse effects on human health from the consumption of lead in drinking water in Australia. However, lead is not considered to be beneficial or necessary for humans; therefore public health experts recommend Australians take every opportunity to limit potential exposure from all sources.”⁴⁷

State-based regulatory intervention

In 2019, the Victorian School Building Authority announced that all new schools and school upgrade works must exclude any plumbing product containing lead. Any piping, tapware or fittings that hold or distribute drinking water, or form part of a water source where a child could fill a cup or drink bottle for consumption, must be comprised of products that either: do not contain lead, or do not allow contact between brass containing lead and water, where appropriate products are available on the Australian

⁴⁵ Department of Agriculture, Water and Environment (2020) Lead in house paint > <https://www.environment.gov.au/protection/chemicals-management/lead/lead-in-house-paint>< Accessed 12 June 2020.

⁴⁶ NHMRC Information Paper: Evidence on the Effects of Lead on Human Health.

⁴⁷ Department of Health (2018) Statement from Australia’s Chief Medical Officer, Professor Brendan Murphy, on lead in drinking water from some plumbing products and the enHealth Guidelines ><https://www.health.gov.au/news/statement-from-australias-chief-medical-officer-professor-brendan-murphy-on-lead-in-drinking-water-from-some-plumbing-products-and-the-enhealth-guidelines-0>< Accessed 22 May 2020.

market.⁴⁸ This requirement is embedded in new procurement rules for new schools and school upgrades.

This recent change in Victoria highlights the desire for use of low lead products in the Australian market and the ability to further reduce lead exposure beyond that currently prescribed by plumbing regulations.

Regulatory framework for plumbing products in contact with drinking water

The manufacture of plumbing products in contact with drinking water is regulated in Australia through Volume Three of the NCC and the WMCS.

National Construction Code

The NCC is Australia's primary set of technical design and construction provisions for buildings. As a performance-based code, it sets the minimum required level for safety, health, amenity, accessibility, sustainability and liveability of certain buildings.

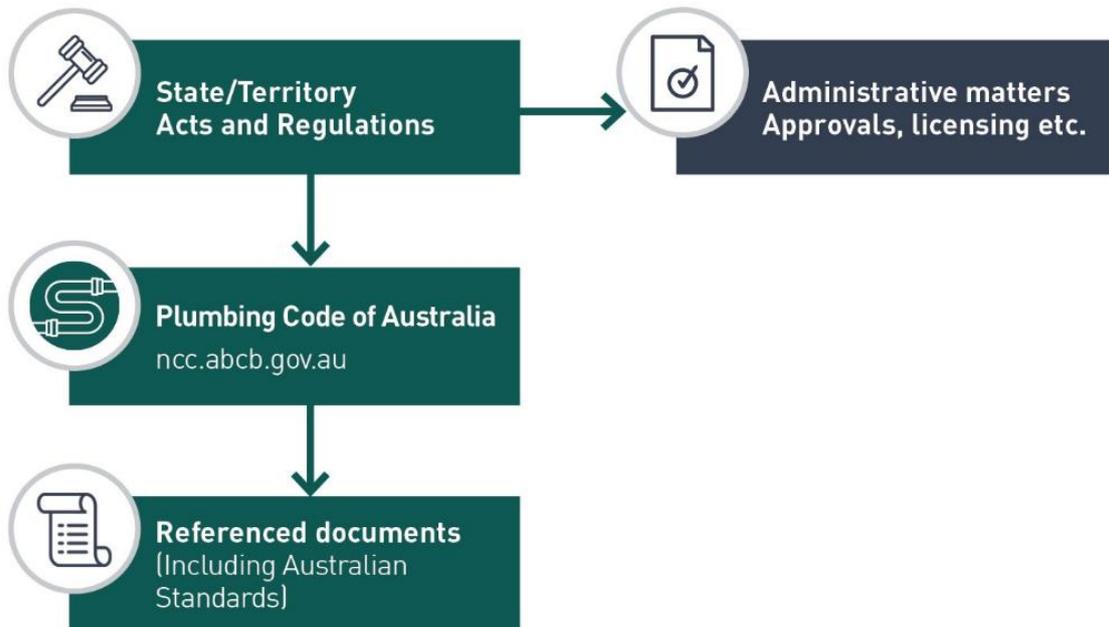
NCC Volume Three, the Plumbing Code of Australia (PCA), contains technical requirements for the design and construction for plumbing and drainage systems in new and existing buildings. The PCA applies to these systems in all building classifications whenever plumbing work is carried out. The PCA additionally applies to sites where water services are constructed independent of buildings.

The PCA is given legal effect by relevant legislation in each state and territory. This legislation prescribes that plumbing practitioners are to fulfil any technical requirements that are required to be satisfied under the PCA when undertaking plumbing and drainage installations.

Each state and territory's legislation consists of an Act of Parliament and subordinate legislation which empowers the regulation of certain aspects of building work or plumbing and drainage installations, and contains the administrative provisions necessary to give effect to the legislation. Refer to Figure 4 for the current regulatory framework.

Figure 4: Plumbing regulatory framework

⁴⁸ Victorian School Building Authority (2020) 'Building Quality Standards Handbook' ><https://www.education.vic.gov.au/Documents/school/principals/infrastructure/vsba-building-quality-handbook.pdf>< Page 121. Accessed 4 September 2020.



WaterMark Certification Scheme

The WMCS is a mandatory certification scheme for plumbing and drainage products to ensure they are fit-for-purpose and appropriately authorised for use in plumbing and drainage installations. Not all plumbing and drainage products require WaterMark certification and authorisation, with some products listed on the WaterMark Schedule of Excluded Products. Under the WMCS, products must comply with applicable referenced product specifications, which, for products in contact with drinking water, in most cases reference the requirements of AS/NZS 4020.⁴⁹

Regardless of the requirement for certification under the WMCS, or the content of the referenced product specification, compliance with AS/NZS 4020 is a requirement for all products in contact with drinking water through its reference in A5.3 of the PCA.

Australian and New Zealand Standard (AS/NZS) 4020 Testing of Products for Use in Contact with Drinking Water

AS/NZS 4020 specifies requirements for products in contact with drinking water. The standard aims to assess the impact of a product on the quality of drinking water and requires that products be tested by exposure to test water. This standard requires testing for a range of metals, including lead.

⁴⁹ Some plumbing products not in contact with drinking water require WaterMark Certification but do not require compliance with AS/NZS 4020.

Duplicate samples of the product being tested are exposed to test water for 24 hours and the metal concentration measured for the two test extracts. If any of the metals exceed the specified concentration limits for metals and organics in leachate specified in the ADWG, further extracts are prepared by exposing both samples to an extra six sequential periods, including four 24-hour periods, one 72-hour period, and concluding with another 24-hour period (9 days in total). Fresh test water is used for each period. The seventh extract is analysed. The number of specified metals in the first and/or final extracts, after applying a scaling factor if applicable, shall not exceed the specified values taken from the ADWG. If the limit for any metal is exceeded in the final extract from any of the duplicate samples, the product shall be deemed unsuitable for contact with drinking water, unless a further three samples are examined and the mean of the specified metals in their final extracts do not exceed the limits specified.

In submissions received at consultation, there were several calls to amend AS/NZS 4020 to varying degrees with an aim to improve the testing of lead and other heavy metals in drinking water. These comments are discussed under the heading Alternative Regulatory Option.

Material and Product Specifications

In addition to the AS/NZS 4020 water quality test, the WMCS also references a number of product specifications which products must comply with. These set limits on the amount of lead that can be within the raw materials and are included in Attachment C.

Regulatory intervention internationally

The following information has been prepared as a summary of the current state of international regulation for prescribing lead in plumbing products in contact with drinking water.

Austria

The permissible amount of lead in drinking water is legislated through the Austrian Drinking Water Ordinance which has set a limit of 10 µg/L since 2013.⁵⁰ Previously, the lead limit in drinking water was 50 µg/L prior to 2003 and 25 µg/L from 2004 to 2013.

Plumbing products in contact with drinking water are required to undergo assessment and comply with the national standard ÖNORM B 5014 Parts 1, 2 and 3: 'Sensory and chemical requirements and testing of materials in contact with drinking water'.⁵¹

Although there is no explicit limit in the amount of lead in plumbing material, if the amount of lead in the material exceeds 0.02% (by mass), only up to 50% of the allowed limit, i.e. 5 µg/L of lead, is permitted.

Canada

Health Canada lowered its drinking water limit to 5 µg/L from 10 µg/L in 2019. Newly published changes to NSF/ANSI/CAN 61 set a maximum acceptable concentration of 1 µg/L of lead in drinking water. Under the new requirements, certification of products to the more stringent criteria is optional for the next three years to allow manufacturers time to comply.⁵² In addition, Canada also regulates 'lead-free' requirements for plumbing components. The primary standard pertaining to brass fittings is CSA B125.3 (plumbing fittings), which adopts the 0.25% lead maximum for wetted surfaces. This requirement is within the National Plumbing Code of Canada and enforceable since December 2013.

⁵⁰ The Austrian Drinking Water Ordinance (Austria), 2001.

⁵¹ Ordinance on Building Materials List ÖA (Austria), 2019.

⁵² World Plumbing Council (2020) "New criteria for drinking water standard tightens lead leaching allowance for plumbing products. ><https://www.worldplumbing.org/https-www-globenewswire-com-news-release-2020-09-22-2097163-0-en-new-criteria-in-drinking-water-standard-tightens-lead-leaching-allowance-for-plumbing-products-html/>. Accessed 31 October 2020.

Germany

The requirements of drinking water are regulated through the Drinking Water Ordinance, which has set a 10 µg/L maximum amount of lead in drinking water since 2013.⁵³ Previously, the lead limit in drinking water was 40 µg/L in the late 1990s and 25 µg/L thereafter.

The maximum usable quantities of lead in products in contact with drinking water are limited in the 'Assessment Basis for Metallic Materials in Contact with Drinking Water' issued by the Federal Environmental Agency. This document is adopted through the Drinking Water Ordinance and was produced by the 4MS Initiative of which Germany is a member.⁵⁴

Japan

The Ministry of Health, Labor and Welfare has jurisdiction over the drinking water quality standards for lead and has set a maximum of 10 µg/L since 2003.⁵⁵ Previously, the lead limit in drinking water was 100 µg/L prior to 1992 and 50 µg/L from 1992 to 2003.⁵⁶ Plumbing products in contact with drinking water are required to be tested and there are two main categories with different permissible limits of lead leaching.⁵⁷ The first category pertains to endpoint devices such as faucets and has a maximum discharge of not more than 7 µg/L of lead. The second category pertains to products installed midway through the supply system such as valves and joints, and is not to discharge more than 10 µg/L of lead.

Netherlands

The Netherlands legislates the amount of lead permissible in drinking water in the Drinking Water Decree, which sets the limit to 10 µg/L. Netherlands previously reviewed the regulation of lead in plumbing in 2010.

Within the Drinking Water Decree, further requirements are given towards the composition of an alloy & impurities that may contain a metal. In Annex A, Section 2.8.2 of the Government Gazette 2011, 11911, it states for plumbing products such as

⁵³ (Germany) Ordinance on the Quality of Water Intended for Human Consumption. Accessed 26 May 2020.

⁵⁴ Federal Ministry of Health (2018) Contents of Drinking Water Ordinance,

><https://www.bundesgesundheitsministerium.de/en/topics/drinking-water-ordinance.html>< Accessed 26 May 2020.

⁵⁵ Ministry of Health, Labour and Welfare (2015) Drinking Water Quality Standards in Japan

>https://www.mhlw.go.jp/english/policy/health/water_supply/dl/4a.pdf Accessed 26 May 2020.

⁵⁶ Ministry of Health (2002) Labour and Welfare, Ministerial Ordinance No. 43.

⁵⁷ Estelle, A. (2016) Drinking water lead regulations: impact on the brass value chain, Materials Science and Technology, vol.32, no.17, p. 1763-1770

fittings which are of copper alloy composition with a certain percentage of lead, the contact surface is limited to a maximum of 10% of the total contact surface of drinking water installations.⁵⁸

New Zealand

Potable water is regulated by the Ministry of Health. It has prescribed a maximum of 10 µg/L of lead in drinking water since 2005.⁵⁹

The New Zealand Building Code regulates water intended for human consumption. The point of use lead concentrations is controlled through the Building Code clause G12 which refer to AS/NZS 4020:2005, AS/NZS 3500.1 and AS/NZS 3500.4 as a means of compliance.⁶⁰ For lead, the maximum allowable leached into the drinking water is 10 µg/L, as per AS/NZS 4020:2005.

Norway

In Norway, the lead content of water at the tap is regulated by the Food Safety Authority. The limit of lead in drinking water for Norway is 10 µg/L, and is based on the implementation of EU Drinking Water Directive in Norwegian regulation. For plumbing products, the Nordic product rules No. 4 (NKB 4), set in 1986, currently prescribes a maximum lead value of 20 µg/L.⁶¹

Singapore

Singapore's drinking water quality is regulated by the Environment Public Health (EPH) (Quality of Piped Drinking Water) Regulations 2008.⁶² The drinking water standards are set out under the EPH Regulations. All metallic material in contact with water shall comply with the test outlined in Appendix H - Extraction of Metals, and the maximum allowable concentration of metals as listed in AS/NZS 4020:2005.⁶³ For lead, the maximum allowable concentration in drinking water is 10 µg/L, as stated in Table 2 of AS/NZS 4020:2005.

⁵⁸ The State Secretary for Infrastructure and the Environment, Government Gazette (2011) 11911 (Regulation of materials and chemicals for drinking and hot tap water).

⁵⁹ Ministry of Health (2008) Drinking-Water Standards for New Zealand 2005.

⁶⁰ Ministry of Business (2014) Innovation & Employment, Acceptable Solutions and Verification Methods for New Zealand Building Code G12 Water Supplies.

⁶¹ C. J. Engelsen (2016) Short term leaching of Pb from products in contact with drinking water.

⁶² PUB, Drinking Water Quality (2018) <https://www.pub.gov.sg/watersupply/waterquality/drinkingwater>. Accessed 26 May 2020.

⁶³ PUB (2019) Stipulation of Standards & Requirements for Water Fittings for Use in Potable Water Service Installations.

Spain

The amount of lead permissible in drinking water is established by law in Royal Decree 140/2003. The lead concentration set by the legislation since 2014 is not to exceed 10 µg/L in drinking water. Previously, the lead limit was 50 µg/L prior to 2003 and 25 µg/L from 2004 to 2013.

Sweden

The Swedish Boverket's Building Regulations (BBR) contains the permissible amount of dissolved lead in drinking water. Chapter 6.62 relates to tap water installations and states the amount of dissolved lead in water from taps where drinking normally occurs, should not exceed 5 µg/L when tested in accordance with NKB 4.⁶⁴ For materials in contact with drinking water, the amount of lead should not exceed 5 µg/L when tested in accordance with SS-EN 15664. The BBR have not provided a recommended limit value for lead in materials that are in contact with drinking water.⁶⁵ Sweden last reviewed the regulations for lead in plumbing in 2014.

United Kingdom

In the UK, the legal drinking water standards are set in the European Drinking Water Directive (Directive 98/83/EC).⁶⁶ The Directive limits the amount of lead in drinking water to 10 µg/L. The limit of 10 µg/L (previously 50 µg/L set in EU Directive 80/778/EEC)⁶⁷ was established in 1998 when members of the EU were to reduce lead in drinking water to 25 µg/L by 2005 and 10 µg/L by 2013.⁶⁸

In England, water fittings are to conform to the Water Supply (Water Fittings) regulations 1999.⁶⁹ In Scotland, the legal requirements for plumbing materials in contact with drinking water are covered in the Scottish Water Byelaws.⁷⁰ Both England and Scotland require water fittings to bare an appropriate CE marking in accordance with the Directive, or conform to an appropriate harmonised British Standard. The relevant British Standard concerning the leaching of metals in plumbing products is

⁶⁴ (Sweden) Boverket's Building Regulations (2019) Chapter 6.62.

⁶⁵ The Swedish National Board of Housing, Building and Planning (2014) Impact Assessment BBR: Amendments to the Swedish National Board of Housing, Building and Planning's Building Regulations (BBR) – Sections 1, 5, 6, 7 and 8.

⁶⁶ Drinking Water Inspectorate (2017) What are the drinking water standards? <http://dwi.defra.gov.uk/consumers/advice-leaflets/standards.pdf>. Accessed 16 May 2020.

⁶⁷ The Council of the European Union (1980) Council Directive 80/778/EEC.

⁶⁸ The Council of the European Union (1998) Council Directive 98/83/EC.

⁶⁹ Drinking Water Inspectorate (2019) Guidance to Water Companies. <http://www.dwi.gov.uk/stakeholders/guidance-and-codes-of-practice/wswq/intro.pdf>. Accessed 16 May 2020.

⁷⁰ (Scotland) Water Supply (Water Fittings) Byelaw (2014) Accessed 16 May 2020.

BS EN 15664.⁷¹ In addition to the Regulations, the 4MS Initiative, of which the UK is a member, has agreed on collaboration in the harmonization of tests for the hygienic suitability of products in contact with drinking water.⁷² The 4MS Initiative has produced the Part B – 4MS Common Composition List. The document lists the composition of low leaching metals and limits the amount of lead in each accepted metallic material.⁷³

United States

The US Environmental Protection Agency (EPA) set the standard of drinking water through the Safe Drinking Water Act (SDWA). The EPA health-based guideline value for lead is 15 µg/L. The SDWA does not allow a person to ‘use any pipe, plumbing fitting or fixture or any solder after June 1986, in the installation or repair of i) any public water system; or ii) any plumbing in a residential or non-residential facility providing water for human consumption, that is not lead-free’.⁷⁴ The current definition of lead-free is a maximum weighted average of 0.25% lead calculated across the wetted surface area of a pipe, pipe fitting, plumbing fitting and fixture, and 0.2% lead for solder and flux. The standard was set at 0.25% weighted average in recognition that it is not possible to source 100% lead-free raw material. Small trace amounts of lead are permitted, consistent with the requirements for paint, fuel and other regulated goods. This amount is considered the lowest lead content achievable without having significant consequences on the copper alloy supply chain.

In addition, newly published changes to NSF/ANSI/CAN 61 set a maximum acceptable concentration of 1 µg/L of lead in drinking water. Under the new requirements, certification of products to the more stringent criteria is optional for the next three years to allow manufacturers time to comply.⁷⁵

Summary of international comparisons

The maximum lead content of drinking water in Australia is consistent with the majority of other jurisdictions compared (Germany, Netherlands, New Zealand, Singapore,

⁷¹ Drinking Water Inspectorate (2019) Annex 2.3 – British Standards BS EN & BS on the Influence of Materials on Water Intended for Human Consumption ><http://www.dwi.defra.gov.uk/drinking-water-products/approved-products/Annex2.pdf>< Accessed 16 May 2020.

⁷² German Environment Agency, Approval and Harmonization – 4MS Initiative (2017) ><https://www.umweltbundesamt.de/en/topics/water/drinking-water/distributing-drinking-water/approval-harmonization-4ms-initiative> Accessed 17 May 2020.

⁷³ 4MS Initiative (2019) Acceptance of Metallic Materials Used for Products in Contact with Drinking Water.

⁷⁴ (US) Safe Drinking Water Act (2018) s1417.

⁷⁵ World Plumbing Council (2020) “New criteria for drinking water standard tightens lead leaching allowance for plumbing products. ><https://www.worldplumbing.org/https-www-globenewswire-com-news-release-2020-09-22-2097163-0-en-new-criteria-in-drinking-water-standard-tightens-lead-leaching-allowance-for-plumbing-products-html/>. Accessed 31 October 2020.

Spain and the United Kingdom). Five jurisdictions (Austria, Canada, Japan, Sweden and the United States) have lower lead level thresholds prescribed by water quality standards and only one jurisdiction (Norway) has a higher allowance, though the health-based guideline value in the US remains at 15 µg/L. The mix of regulation type is also consistent with Australia and is implemented either through product standards or water quality testing standards, or in some cases, a combination of both.

The Consultation RIS asked stakeholders whether they agreed with the description of the nature of the problem and whether there were any other characteristics not described.

Comments on the nature of the problem

The majority of respondents (89%) agreed with the nature of the problem as described.

Of those that did not agree, an Australian plumbing products manufacturer (Enware) expressed several points of strong disagreement.

The following key points were raised in their submission:

- The description of the dezincification process should include data and discussion more relevant to the processes as expected to occur under Australian conditions (i.e. water parameters, WaterMark certified materials etc.).
- Examples given in the discussion of water parameters affecting lead leaching from brass materials do not align with water parameters commonly reported and delivered in Australia.
- Examples of cases of lead leaching into drinking water in Australia should be discussed with respect to these being isolated incidents that are often the result of several mitigating circumstances.
- Discussion of the health impacts of lead in drinking water is limited and misses several important studies that provide information key to the question of the contribution of lead in water to vulnerable populations (i.e. children), and thus associated health consequences. This discussion should be expanded to include the additional information provided.

In response to these concerns, the Decision RIS makes the following observations:

- The discussion on lead release in the Consultation RIS has been reviewed and revised to better reflect the differences that may occur as a result of Australian conditions.
- It is acknowledged that the known incidences of high-water lead levels found in Australian drinking water are isolated, however this should also be considered having regard to the relatively low onsite testing of lead currently, particularly from within the premises.
- The discussion and studies submitted are discussed in more detail in the next section.

In addition to the concerns raised by Enware, a plumbing industry group (PPI Group) felt the problem was better expressed as the presence of higher levels of lead permitted by Australia in the manufacture of certain plumbing products in contact with drinking water, and the need to substantially reduce these lead levels, thereby reducing the potential for lead to be unintentionally added to drinking water. They added that this would better address the relevant NCC Performance Requirements and the aim of the Australian Drinking Water Guidelines to assure safer, good quality drinking water for the community. The description of the problem is not in disagreement with this opinion.

The NHMRC and enHealth felt that the recent report commissioned by the ABCB (Taylor et al. 2018) did not appear to be adequately considered and addressed in the RIS.

“There are recommendations made by the authors that do not appear to have been acknowledged or considered as part of the RIS process. Notably, this report demonstrates internationally and nationally that lead is known to leach into drinking water from brass components. It further recognises that there are a variety of factors that influence the passivation and release of lead into drinking water, none of which are described in the RIS.”

The Consultation RIS acknowledges the previous research undertaken by Macquarie University as the basis for the development of the RIS. The variety of factors listed by Taylor, et al. (2018) is summarised by the RIS and those of relevance are discussed.

The scope of the Consultation RIS was deliberately limited to Recommendation 1 of Macquarie University's Report as it was the only recommendation applicable to changing the National Construction Code.

It is also understood that this comment was partly made in relation to the potential for galvanic corrosion to occur and contribute to the problem. It should be noted that the cited examples of galvanic corrosion in the Macquarie University report would either be non-compliant with the current regulations (i.e. use of lead solder/piping and its reaction to brass and other copper alloys) or not in alignment with current practice, where it is not otherwise addressed via other means (e.g. backflow prevention in the case of a fire sprinkler system connected to mains water).

Comments on other characteristics of the problem

One third of responses felt there were other characteristics not described by the Consultation RIS.

The following suggested additions were received in addition to those discussed above:

- The problem includes other hazards, such as arsenic and nickel.
- There are differences in the way jurisdictions regulate and collect data on drinking water and this may disguise the true extent of the problem at the point of consumption.
- Scaling factors may misrepresent the real amount of contamination when products are installed in a situation where they only supply a single point of discharge.

The following points are made in relation to each point:

- The RIS is deliberately limited to lead in plumbing products in contact with drinking water to reflect the ABCB's work program.
- While state and territory drinking water is regulated separately, plumbing products in contact with drinking water must comply with the PCA and WMCS.
- It is acknowledged that differences in the extent of the problem may be attributable to the rates of testing, which are currently low and varied.
- Scaling factors are used in many Australian Standards and vary based on product type. Despite this, there is no evidence to indicate that these factors

are contributing to the problem and removal of such factors would place an unnecessary burden on product testing.

Extent of the Problem

The extent of the problem is influenced by three factors:

- The amount of new leaded plumbing products in contact with drinking water sold each year.
- The extent to which lead is leached into drinking water from point of discharge plumbing fittings and fixtures.
- The extent of health impacts associated with using leaded plumbing products in contact with drinking water.

Number of products installed in Australia

The Australian market for copper alloy plumbing products in contact with drinking water has been estimated with the assistance of the PPI Group and the AI Group. Table 1 reflects those products in contact with drinking water and the volume of products impacted by any change to the permissible lead content.

Table 1: Annual sales data of leaded copper alloy plumbing products in contact with drinking water

Product type	Units (annual sales)	Definition
Fittings	45 million	
Valves	13 million	Includes pressure and temperature valves, pressure limiting valves, isolating valves, ball valves and in-line valves.
Fittings of stainless-steel braided hoses	12 million	Includes hoses connected to mixers.
Taps	1 million	
Mixers	3 million	
Water heaters	700,000	Heated water systems.
Residential water filtration	150,000	

Product type	Units (annual sales)	Definition
Water dispensers	20,000	Includes water coolers, bubblers and refrigerators with chilled water dispensers.

Despite low lead copper alloy plumbing products being available in the Australian market, higher production costs result in these products being comparatively more expensive than their leaded equivalent. As such, low lead copper alloy products contribute to less than 10% of all units sold in Australia.⁷⁶

Extent lead is present in Australian drinking water

Lead contamination of drinking water occurs almost exclusively through contact with materials or fittings which contain lead. This has been validated by laboratory testing which shows that plumbing products in contact with drinking water can leach lead. The extent to which this is a problem at a population level is difficult to measure as no such studies have been conducted in Australia. An assessment by the WHO found that 20% of total lead intake is attributable to water consumption with the other 80% coming from food, dirt and dust.⁷⁷ The US EPA also estimates that drinking water can make up 20% of a person's total lead intake with higher contributions found in children.⁷⁸

It is known through data from the annual reports of NUOs that the lead levels of drinking water supplied to the premises is very low. A review of metropolitan NUO data in each jurisdiction revealed that lead content was less than 1 µg/L. There could be exceptions to these levels, however the vast majority of drinking water supplied to the point of connection to a property (generally the water meter) from NUO infrastructure, meets or is significantly less than the level required by the ADWG. Hence, where lead is found at end-use fixtures, it is likely to be the result of leaching from plumbing products in contact with the drinking water from within the premises.

Limited sampling from within the premises occurs nationwide and there is a lack of awareness by consumers in identifying the presence of lead due to it being odourless, colourless and tasteless when consumed. Therefore, the extent that lead is leaching

⁷⁶ ABCB (2019) Lead in Plumbing Products Forum Survey. 89% of industry stakeholders felt that lead-free products made up 10% of all annual sales in Australia.

⁷⁷ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality.

⁷⁸ Environmental Protection Association (2019) 'Basic Information about Lead in Drinking Water' ><https://www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water> Accessed 24 June 2020.

into Australian drinking water from copper alloy plumbing products is difficult to estimate and likely to be under-reported.

Available data on lead contamination

Data on lead contamination of drinking water in Australia includes the following:

- Analysis of 212 first draw drinking water samples in New South Wales homes found that 56% of samples contained detectable concentrations of lead. Of total samples, 8% exceeded 10 µg/L. If this percentage was representative of the problem nationally, approximately 800,000 homes would be impacted.⁷⁹
- In 2002, lead in drinking water was measured in 95 new houses less than 18 months old in the Sydney metropolitan area. Three samples (first-flush, post-first-flush, and fully flushed water) were collected from each house. Of the first-flush samples, lead was above the ADWG in 60% of houses. Of the post-first-flush samples, lead was above the ADWG in 24%. In fully flushed water, the levels of lead were well below ADWG.⁸⁰
- From 2000 to 2019, NUO Sydney Water received 755 complaints where the lead content of the water was subsequently tested. Approximately 10% of complaints contained a lead level which exceeded the 10 µg/L limit required by the ADWG.
- Between October 2017 and May 2020, samples from 272 individual drinking water sources in 21 of the 29 local government areas in Tasmania found approximately 30% had lead content in excess of 10 µg/L. First drawn samples in excess of the ADWG ranged from 10.1 to 1,300 µg/L with a median value of 19.3 µg/L.
- In 2018, a study on newly installed water meters in Australia found that they had the potential to leach lead above 10 µg/L. Stagnation time and source water characteristics impacted the concentration of lead in first draw water.⁸¹ Lead levels were reduced to compliant levels following flushing.
- In 2020, a study conducted by TasWater collected in-premise first-draw samples (no prior flushing) from 26 residences in Hobart. The results found

⁷⁹ Based on a stock of 10 million dwellings

><https://www.abs.gov.au/ausstats/abs@.nsf/Lookup/by%20Subject/2071.0~2016~Main%20Features~Snapshot%20of%20Australia,%202016~2>< Accessed 4 June 2020.

⁸⁰ Rajaratnam, G., et al. (2002). "Metals in Drinking Water from New Housing Estates in the Sydney Area." *Environmental Research* 89(2): 165-170.

⁸¹ McDonald, S. Elliot, B. & Bee Quek, S (2018) 'Investigation into lead leaching from a water meter.

that 15% of the residences exhibited lead levels greater than 10 µg/L. Exceeding samples ranged from 10.2 to 25 µg/L, with the highest being in a newly constructed property containing new plumbing materials.

Based on the limited data samples, the extent to which lead is leaching into drinking water in excess of that permitted by AS/NZS 4020 could be greater than or equal to 8% within the existing building stock, however there is a high degree of uncertainty regarding the accuracy of this lower bound given the small sample size and limitations identified by the authors of the study. This was reflected by an Australian manufacturer (Enware) in response to the Consultation RIS:

“The CRIS widely cites a 2016 study that reports that 8% of 212 homes studied in NSW presented lead levels from drinking water outlets that exceeded the 10 µg/L standard, using this study to extrapolate more widely within the CRIS document the potential number of homes within the broader population likely to present elevated lead levels above the ADWG threshold due to in-line fittings containing lead.

There are several limitations identified by the authors in this study and described therein.

These include:

- *Volunteer bias - based on the potential that volunteers may only respond to be included in the study when they suspect the quality of their drinking water to be poor (thus only the most contaminated samples are being analysed).*
- *Water source - the study did not examine the source of water supplying the individual properties (i.e. tank water, bore water, or infrastructure used to collect water (i.e. potential contributions from lead painted roofing)), making this a significant potential source of error in the findings.*

Other cited data include that from Sydney Water reporting that between 2000 and 2019 some 10% of complaints regarding household water quality were identified to result in a recorded lead concentration above 10 µg/L. These data are likely to significantly overestimate the magnitude of the problem at the broad household level due to samples being taken only in

instances where an issue with the quality of the potable water supply was suspected.”

The Consultation RIS acknowledged the limited availability of data and the benefits nationwide studies would have on standards setting bodies such as the ABCB. Given the limitations, the reported studies have not been used for the purposes of quantifying the benefits of each option considered in the impact analysis but rather presented as examples of recent studies examining the extent of the problem in Australia.

The Consultation RIS asked stakeholders whether they were aware of any studies on the occurrence of lead leaching into Australian drinking water from within the premises and whether they had any data on the extent lead levels exceeded 10 µg/L in drinking water.

Three responses provided references to additional studies, which have been reflected in the Decision RIS.

Both enHealth and the NHMRC also suggested approaching WSAA for further information, however WSAA advised through their submission to the Consultation RIS that they were not aware of any additional studies, noting that in many cases water utilities contributed to the studies cited in the Consultation RIS.

Health impacts of lead in drinking water

Globally

The health consequences as a result of lead exposure both in Australia and internationally is significant. In 2004, 143,000 deaths and a loss of almost 9 million disability adjusted life years (DALYs) were attributed to lead exposure worldwide, representing 0.6% of the total global burden of disease.⁸² Health related consequences were primarily from lead-associated adult cardiovascular disease and mild intellectual disability in children.⁸³ Epidemiological studies have also linked high blood lead levels with cancer, stroke and hypertension.

⁸² World Health Organisation (2011) Brief guide to analytical methods for measuring lead in blood. Accessed 21 April 2020. > https://www.who.int/ipcs/assessment/public_health/lead_blood.pdf

⁸³ World Health Organisation (2010) Exposure to lead: A major public health concern. Page 3.

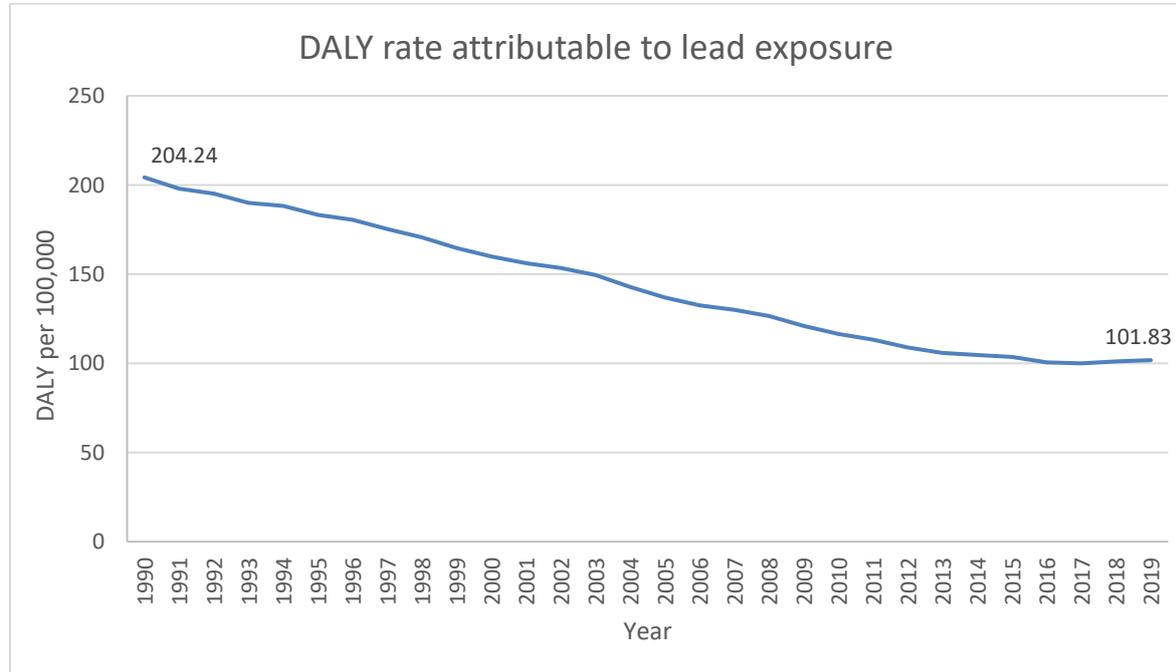
Fortunately, there is a global effort to reduce the amount of lead sources. This includes a sizeable reduction in lead exposure from lead-based paint, fuel and consumer goods such as toys, make-up and food.⁸⁴

Continued effort to reduce the consumption of lead was also reflected in toxicological advice published by the Joint FAO/WHO Expert Reference Panel on Food Additives in 2011. This Panel identified negative impacts associated with blood pressure and reductions in IQ from dietary lead exposure. Whilst this conclusion was based on lead from food, the Panel also recommended that other sources of exposure needed to be considered.

Australia

Australia has achieved a 50% reduction in lead exposure since 1990.⁸⁵ This is largely due to interventions aimed at reducing the use of lead in commonly used products and consumables. The reduction of lead related health effects is shown in Figure 5. Based on the current trend, further reductions could also be expected over time.

Figure 5: DALY rate (all ages) per 100,000 (1990 to 2019)



Source: Global Burden of Disease Database – Institute for Health Metrics and Evaluation

⁸⁴ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality.

⁸⁵ The Institute of Health Metrics and Evaluation (2019) Global burden of disease. Australia: All causes attributable to lead exposure, both sexes, all ages. Based on the all-ages rate.

Blood Lead Levels in the Australian Population

Most people in Australia will have some level of lead in their blood because of the small amounts of lead found throughout the environment. Exposure to these small amounts of lead is considered to make up the 'background' level of exposure.

There are limited studies on blood lead levels within the Australian population. No such studies have been undertaken on the extent lead in drinking water contributes to blood lead levels as studies are typically focused on populations with exposure through other means, such as residing in close proximity to lead smelters or working in industries involving the use of lead.

Two Victorian studies provide an indication of blood lead levels in children and in adults in the general population.

Adults

In 2013, the results of a population-based cross-sectional health measurement survey of 3,622 adults in Victoria between 2009 and 2010 revealed that the geometric mean and median blood lead levels from the adult (18 years – 75 years) sample were 1.45 µg/dL and 1.04 µg/dL respectively. Elevated blood lead levels (≥ 10 µg/dL) were identified in 0.7% of participants. Additionally, 1.8% of participants were identified with blood lead levels between 5 to < 10 µg/dL. These results are shown in Table 2. The geometric mean blood lead level was significantly higher for males, compared with females. Blood lead levels increased significantly with age for both sexes reflecting the cumulative effect of lead entering the body.⁸⁶

Table 2: Blood lead levels in Victorian adults (2009 to 2010)

Sample	Geometric mean (µg/dL)	Median BLL (µg/dL)	5 to < 10 µg/dL	≥ 10 µg/dL
3,622	1.45	1.04	1.8%	0.7%

Source: Kelsall, L.M, et al. (2013)

⁸⁶ Kelsall, L.M., de Gooyer, T.E., Carey, M., Vaughan, L. and Ansari, Z. (2013) Blood lead levels in the adult Victorian population: results from the Victorian Health Monitor. Australian and New Zealand Journal of Public Health, 37: 233-237. doi:10.1111/1753-6405.12064.

Children

A similar study of infants in Victoria from 2010 to 2013⁸⁷ found the median blood lead level of 523 children was 0.8 µg/dL and the geometric mean blood lead level after propensity weighting was 0.97 µg/dL. This result was lower than in previous Australian surveys and recent surveys indicated that no children had levels above 5 µg/dL. These results are shown in Table 3.

Table 3: Blood lead levels in Victorian children (2009 to 2010)

Sample	Geometric mean (µg/dL)	Median blood lead level (µg/dL)	> 5 µg/dL
523	0.97	0.8	0%

Source: Symeonides, C, et al. (2020)

Additional studies

One South Australian study⁸⁸ of blood lead levels of children in Port Pirie, the location of one of the world's largest lead and zinc smelters, found that in 2018, the geometric mean of blood lead levels was 4.2 µg/dL. This average had decreased by 0.3 µg/dL compared to the same reporting period in the previous year. The average blood lead level of children aged 24 months was 5.8 µg/dL, which increased by 0.4 µg/dL compared to the same reporting period in the previous year. The geometric mean blood lead level for two-year-old children is considered to be a robust indicator of trends in lead exposure for the whole population of Port Pirie.

A similar study was conducted in 2006 by Queensland Health in Mount Isa of children between one and four years old. Children were recruited by invitation. The 400 recruited for the study were found to be representative of the general population of one to four-year old's in Mount Isa in terms of age, sex and indigenous status. Results of the study indicated that the geometric mean blood lead level for the group of children sampled was 5.0 µg/dL, with a minimum value of 1.3 µg/dL and maximum value of 31.5 µg/dL. Forty-five children (11.3% of those in the study group) had blood lead

⁸⁷ Symeonides, C., Vuillermin, P., D Sly, P., Collier, F., Lynch, V., Falconer, S., Pezic, A., Wardrop, N., Dwyer, T., Ranganathan S. & Ponsonby, A. (2020) Pre-school child blood lead levels in a population-derived Australian birth cohort: the Barwon Infant Study. Medical Journal of Australia.

⁸⁸ SA Health (2018) Port Pirie Blood Lead levels: Analysis of blood lead levels for the first nine months of 2018 (1 January – 30 September 2018)

levels greater than or equal to 10 µg/dL. Of these, two children had blood lead levels greater than 20 µg/dL.⁸⁹

Conclusions on blood lead levels

There is continued research into the effects of low lead levels on population health outcomes in Australia. Although the average 'background' blood lead level among Australians is not known with certainty, the average level is estimated to be less than 5 µg/dL based on a comprehensive review of the evidence by the NRHMC in 2015. This level is lower than the level of exposure for previous generations as the presence of lead in the environment is slowly decreasing over time.⁹⁰ A blood lead level greater than 5 µg/dL suggests that a person has been, or continues to be, exposed to lead at a level that is above what is considered the average 'background' exposure.⁹¹ At levels below 5 µg/dL, the health impacts of lead are not easily quantifiable, however NHRMC in the submission contend:

"It is important to consider the cumulative and relatively short-term health effects of lead and the uncertainty around these at low levels as this demonstrates the need to minimise exposure to lead."

Data on blood lead levels exceeding 5 µg/dL is not collected nationally and is instead collected separately by each state and territory. The ABCB approached the enHealth to obtain data of elevated blood lead levels from state and territory health departments. Queensland, Tasmania, Victoria and Western Australia were the only jurisdictions able to respond. Data from these jurisdictions is shown in Tables 4 to 10. It should be noted that due to changes in reporting requirements, data on elevated blood lead levels exceeding 5 µg/dL is only available from 2016.

⁸⁹ Queensland Health (2006) >https://www.health.qld.gov.au/__data/assets/pdf_file/0036/428868/mtisa-lead-report-2006-07.pdf Accessed 1 August 2020.

⁹⁰ NHMRC (2015) Effects of Lead on Human Health.

⁹¹ NSW Department of Health (2018) Lead in Blood Control Guideline.

><https://www.health.nsw.gov.au/Infectious/controlguideline/Pages/lead.aspx> Accessed 22 May 2020.

Table 4: Blood lead levels exceeding 5 µg/dL in Victoria (new cases)

Exposure Type	2016*	2017	2018
Non-occupational	35	59	70
Occupational	103	135	123
Unknown	35	40	39
Total	173	234	232

Source: Department of Health and Human Services (Victoria)

Note: * Part year from 4 April 2016.

Table 5: Blood lead levels exceeding 5 µg/dL in Victoria 2016* to 2018 (non-occupational only)

Blood Lead Level (µg/dL)	Number of non-occupational cases
5-9 µg/dL	90
10-14 µg/dL	35
15-19 µg/dL	15
20-24 µg/dL	9
25-29 µg/dL	3
30-34 µg/dL	2
35-39 µg/dL	1
40-44 µg/dL	1
45-50 µg/dL	0
> 50 µg/dL	8
Total	164

Source: Department of Health and Human Services (Victoria)

Note: * Part year from 4 April 2016.

Table 6: Blood lead levels exceeding 5 µg/dL in Queensland

Exposure Type	2016	2017	2018	2019*
Non-occupational	228	237	223	187
Occupational	1,103	3,144	3,601	4,036
Unknown	13	21	28	75
Total	1,344	3,402	3,852	4,298

Source: Queensland Health

Note: * Part year to August 2019.

Table 7: Blood lead levels exceeding 5 µg/dL in Queensland 2016 to 2019 (non-occupational only)

Blood Lead Level (µg/dL)	Number of non-occupational cases
5-9 µg/dL	560
10-19 µg/dL	231
≥ 20 µg/dL	84
Total	875

Source: Queensland Health

Table 8: Blood lead levels exceeding 5 µg/dL in Tasmania

Exposure Type	2016	2017	2018	2019
Non-occupational	16	12	13	8
Occupational	47	65	65	39
Unknown	3	4	5	14
Total	66	81	83	61

Source: Department of Health (Tasmania)

Table 9: Blood lead levels exceeding 5 µg/dL in Tasmania 2016 to 2019 (non-occupational only)

Blood Lead Level (µg/dL)	Number of non-occupational cases
5-9 µg/dL	38
10-19 µg/dL	9
≥ 20 µg/dL	2
Total	49

Source: Department of Health (Tasmania)

Table 10: Blood lead levels exceeding 5 µg/dL in Western Australia

Exposure Type: Non-occupational	2016	2017	2018	2019
5-9 µg/dL	Not available	19	21	17
10-29 µg/dL	Not available	8	24	29
≥ 30 µg/dL	Not available	0	< 5	< 5
Exposure Type: occupational	2016	2017	2018	2019
5.1-10.0 µg/dL	121	103	131	131
10.1-20.0 µg/dL	98	118	167	160
20.1-30.0 µg/dL	61	112	90	51
≥ 30.1 µg/dL	63	66	25	5
Total	> 343	426	≥ 459 ≤ 462	≥ 394 ≤ 397

Sources: Occupational data: Department of Mines, Industry Regulation and Safety (WA).

Non-occupational data: Department of Health (Western Australia).

The above data suggests, instances of non-occupational lead exposure where 5 µg/dL is exceeded are rare, and represents 0.0046% of residents in Queensland, 0.0010% of residents in Victoria, 0.0015% in Western Australia and 0.0023% of residents in Tasmania in 2018.⁹² These findings only reflect instances where testing has been undertaken. As such, this data may substantially understate the frequency of elevated blood lead levels within the general population. The ABCB approached a large pathology company to obtain data on blood lead levels within the general population, however the company was unable to fulfil the request.

The Consultation RIS asked stakeholders whether they were aware of any other studies on blood lead levels in Australia.

enHealth's submission offered assistance in contacting key personnel from jurisdictions other than those already cited in the Consultation RIS. Since 2019, the

⁹² Australian Bureau of Statistics (2020) 'Australian Demographic Statistics, Dec 2019' Category 3101.0 ><https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3101.0Dec%202019?OpenDocument>< Accessed 26 August 2020.

ABCB has attempted to source information including via enHealth and has been unsuccessful. Other stakeholders were not aware of any additional Australian specific studies or publicly available data.

Disability Adjusted Life Year Estimates

In the absence of national data, the Global Burden of Disease (GBD) database is the most comprehensive effort to collect data to measure epidemiological levels and trends worldwide and provides a tool to quantify health loss from hundreds of diseases, injuries and risk factors.⁹³ According to the GBD, the total health consequence of lead exposure in Australia, was estimated to be 25,017 DALYs in 2019. That is, 0.11% of total DALYs attributable to lead exposure globally⁹⁴ or 0.53% of total DALYs (all causes) in Australia.⁹⁵ These results are consistent with the problem being isolated to a minority within the population.

DALYs attributable to lead in drinking water is a subset of total DALYs attributable to lead. It is not known what proportion lead in drinking water contributes to the problem overall, however an assessment by the WHO found that up to 20% of total lead intake is attributable to water consumption.⁹⁶ This contribution has also been supported by the US EPA.

If the relationship between lead consumption from all sources and total DALYs is linear⁹⁷, this would represent 5,003 DALYs in 2019 and 0.11% of total DALYs (all causes) in Australia.

Limitations of the GBD

The lead exposure indicator is the best available metric on quantifying the health effects of lead in drinking water.

While the GBD is the leading epidemiological study on environmental risks, several limitations in this indicator are worth noting. First, measuring lead exposure is a burdensome process, and the GBD must draw upon sparse datasets of blood and

⁹³ Institute for Health Metrics and Evaluation (2019) About GHDx. > <http://ghdx.healthdata.org/about-ghdx> Accessed 25 September 2020.

⁹⁴Based on 305.88 DALYs per 100,000 and a global population of 7,547,858,900 in 2017.

⁹⁵ Based on a report from the Australian Institute of Health and Welfare which reported total DALYs in 2015 to be 4.75 million.

⁹⁶ World Health Organisation (2011) Background document for development of WHO Guidelines for Drinking-water Quality. Page 3.

⁹⁷ Lead absorption rates from consumption of water, food, dust is not known.

bone samples. Interpolation of exposure levels introduces uncertainty into the final DALY rate estimates. Second, the collection of tissue samples faces a number of challenges, including unknown contaminants, lack of quality assurance, and the short half-life of lead in blood. The GBD also makes assumptions when linking lead exposure to actual health outcomes and the distribution of diseases and death across populations.

Summary of the nature and extent of the problem

The nature of the problem can be summarised as the use of lead in the manufacture of plumbing products in contact with drinking water and lead leaching from these plumbing products into drinking water both over the short and long term. The problem of lead leaching is directly attributable to two issues; a leaded film which exists immediately after the manufacturing of some new plumbing products and the process of dezincification over the life of the product causing lead leaching from the bulk alloy.

The presence of lead in drinking water is directly attributable to the presence of lead within copper alloy plumbing products in contact with the drinking water. Hence, any regulatory intervention that aims to reduce lead in drinking water should involve removal from the source (the bulk alloy).

Current regulatory interventions have proven effective at reducing lead exposure with a measurable decline in health-related consequences over the last 30 years. This trend is likely to continue in the absence of any additional regulatory interventions. However, lead exposure from drinking water will not reduce until such time lead is not used in the manufacture of plumbing products in contact with drinking water.

The extent of the current problem is difficult to quantify. This is both in terms of quantifying the extent to which lead is leaching into drinking water and the extent to which lead is absorbed by the body. Recent studies, albeit small in sample size, indicate the extent of the problem could be 8% or higher in terms of water quality. There is however, a high degree of uncertainty regarding the extent of the problem nationwide, based on these studies being limited to small samples and particular locations.

For blood lead levels, contemporary instances where 5 µg/dL have been exceeded would be considered rare, based on available data, at a rate of less than 0.01% of

residents in Queensland, Tasmania, Victoria and Western Australia. However, this rate is likely to be an understatement of the problem as it only includes where testing for lead has occurred. At a population level, limited studies on blood lead levels are somewhat inconclusive. One study in Victoria revealed a 1.8% frequency of elevated blood lead levels exceeding 5 µg/dL within adults, while another Victorian study indicated no cases of elevated blood lead levels exceeding 5 µg/dL in children. However, there are several studies that identify the problem of elevated blood lead levels in areas in close proximity to lead smelters. These areas present higher risks to individuals and, as such, regulatory intervention aims to reduce the cumulative health effects of lead exposure from all sources, including drinking water.

In the absence of national population data on blood lead levels, the GBD database indicates that lead continues to be a problem in Australia with an estimated DALY rate of 25,017 in 2019. It is not known with certainty the extent to which lead in drinking water contributes to this rate. However, studies from the US indicate lead in drinking water could contribute up to 20% of all health consequences. This would amount to 5,003 DALYs in 2019 and represent 0.11% of the total burden of disease in Australia. This level is consistent with the extent of the problem being isolated to a minority within the population and small relative to all other causes of disease.

The Consultation RIS asked stakeholders whether they agreed with the description of the extent of the problem and whether they had any information that would assist the ABCB.

The majority of respondents (71%) agreed with the description of the extent of the problem.

Two submissions (from Enware and a product material association) challenged the validity of using the US study as the basis for describing drinking water's contribution to overall lead exposure and its associated health consequences in Australia.

A product material association felt that it was inappropriate to cite the US drinking water's contribution to health consequences as being representative in Australia due to the widely publicised legacy issues major US cities have from existing lead water mains. Enware also disagreed with the 20% assumption, citing international literature

and data from Victoria between 2011 to 2014 as justification that the contribution could be much lower.

For the purposes of the Decision RIS, the Victorian data provided by Enware has been simplified and updated to include data from 2016 to 2018. This is shown in Table 11.

Table 11: Non-occupational risk factors for cases of recorded elevated blood lead levels

Lead exposure source	2011	2012	2013	2014	2015	2016* - 2018
Plumbing	6%	0%	0%	3%	N/A	1.4%
All other sources	88%	98%	100%	82%	N/A	80.6%
Unknown	6%	2%	0%	15%	N/A	18%

Note: * Part year from 4 April 2016

As can be shown above, the extent plumbing has been identified as a contributing risk factor in Victoria in recorded elevated blood lead levels has been very low, between 0 and 6% in recent years. This rate is inclusive of drinking water from all sources and not just those connected to mains supply. If this rate was representative of each jurisdiction, the contribution plumbing makes to the problem would be much smaller than that presented by the Consultation RIS and negligible relative to all other sources. This would further support the view expressed in the Consultation RIS that Australia's drinking water is currently very safe.

However, as was accepted and expressed by several submissions to the Consultation RIS (enHealth, NHMRC, a product material association, HIA, PPI Group), there is a high degree of uncertainty on the contribution lead in plumbing products in contact with drinking water makes to the total problem in Australia and the findings in Victoria alone do not overcome the high degree of uncertainty.

Given the uncertainty, there were two conflicting views expressed by stakeholders on how decision makers should select which option to implement.

The first view, as reflected by Enware's submission, was to undertake additional research and data collection on a national level to determine the true extent plumbing products in contact with drinking water contributed to the problem of lead exposure in

Australia. In doing so, it is recognised that this would take time and coordination across jurisdictions to ensure that the data collected was done so consistently and with a high degree of accuracy and relevance.

The second view, as reflected by enHealth and the NHMRC, was to acknowledge the limitations of the existing data but to give recognition to the problem occurring in Australia, albeit at differing rates, which may not be capable of being further quantitatively defined.

This opinion was based not on the monetary benefit that could be derived by such intervention but rather the common goal of health authorities, both domestically and internationally, in reducing lead exposure from all sources, thereby reducing the cumulative effect of lead exposure.

Whilst it is difficult to reconcile the conflicting views, the goal of reducing lead from all sources and the international movement towards lower lead plumbing products and materials in contact with drinking water, reflects no level of consumed lead is safe. Further regulatory intervention also reflects the common goal of governments safeguarding the community from all sources and is consistent with international best practice.

Objective

A core goal of the NCC is to address safety and health in the design, construction and performance and liveability of buildings. In relation to drinking water, the NCC requires a drinking water system to have a safe drinking water supply that minimises adverse impacts on building occupants⁹⁸ and the water service system is fit-for-purpose and does not create significant risks or any likely outcome of personal illness, loss, injury or death.⁹⁹ The NCC achieves this goal by adopting standards that minimise occupants' exposure to hazardous chemicals and metals.

Hence, the objective of this RIS is to evaluate whether the permissible lead content in plumbing product and material specifications should be reduced given the risk of lead leaching from plumbing products in contact with drinking water.

This objective aligns with the goal of reducing lead use to non-essential levels in all goods and consumables, including drinking water.

Options

The Council of Australian Governments (COAG) 'Principles of Best Practice Regulations Guidelines' requires that regulations are effective and proportional to the problem and there is no regulatory or non-regulatory option that would generate higher net benefits. This is also reflected in the ABCB's Intergovernmental Agreement (IGA).¹⁰⁰

Having regard for these principles, there are three options presented for consideration:

Option 1: Retain the status quo

The status quo is the default choice for decision-makers in considering alternatives to achieve the objectives. Where the incremental impacts of other options would result in more costs than benefits, or would be ineffective in addressing the problem or achieving the objectives, the RIS will conclude in favour of the status quo.

⁹⁸ Functional Statements Part BF.1 and BF2 NCC Volume Three(2019).

⁹⁹ Manual for the WaterMark Certification Scheme, (2016) ABCB, page 23.

¹⁰⁰ ABCB Intergovernmental Agreement (2020). ><https://abcb.gov.au/Resources/Publications/Corporate/2020-intergovernmental-agreement>< Accessed 7 December 2020.

Option 2: Require all products in contact with drinking water have a weighted average lead content of no more than 0.25%

This option would set a reduced maximum allowable lead content within plumbing products in contact with drinking water of 0.25% or less when calculated using a weighted average against the wetted surface area and evaluated against NSF/ANSI 372.

This option would result in a change to the 'Evidence of Suitability' criteria within the Plumbing Code of Australia. A complete description of the changes and an explanation can be found at Attachment A.

Option 3: Recommend changes to government procurement standards to require compliance with NSF/ANSI 372

This option has been amended since the Consultation RIS. Industry stakeholders (PIPA, Galvin Engineering, Ideal Tapware) reflected the challenges associated with creating an additional labelling scheme over and above the existing requirements that apply both domestically and internationally to low lead plumbing products in contact with drinking water. This was also reflected by enHealth who suggested the option would be less effective and by other stakeholders, who interpreted a voluntary industry labelling scheme as burdensome and easily undermined.

Under this revised option, state and territory and Australian Government procurement standards would be changed to require the use of low lead plumbing products in government owned buildings. Conceptually, this would use the influence of government procurement on the market to encourage a transition by manufacturers to low lead plumbing products by increasing the demand for such products.

The Consultation RIS asked stakeholders whether there were any other feasible options that would address the problem.

The following suggestions were received in addition to those discussed throughout the Decision RIS:

- Require all plumbing products in contact with drinking water to have 0.25% lead content regardless of the surface area in contact with water (i.e. a blanket 0.25% rule for all products).

- Require all plumbing products in contact with drinking water to have zero lead content.
- Create an advertising campaign to encourage flushing of taps, especially after long periods of stagnation.
- Apply greater controls to imported products.
- Ban the sale of products in Australia that do not meet the regulatory minimum.
- Manage lead through in-premise flushing and habituating or formalising such practices, where appropriate.
- Agree to implement Option 2 with a five year transition and recommend changes to government procurement standards to occur within this transitional period (i.e. a combination of Options 2 and 3).

The following points are made in response to each proposed option:

- Changes to the regulatory option would create an inconsistency with the US model regulation. Such inconsistency could create higher prices and restrict consumer choice.
- The ABCB will consider the need to provide education and awareness material in supporting any regulatory changes.
- The control of imported products is not within the remit of the ABCB. As such, any increase in oversight would need to be considered by the relevant authority.
- It is outside the scope of the PCA to include ongoing requirements to owners and occupiers for flushing their plumbing system prior to use. This is on the basis that the requirement is unenforceable and unlikely to have a high degree of uptake.
- Products in contact with drinking water that do not meet the regulatory minimum of the WMCS are not permitted to be installed in Australia under the status quo.
- Decision makers may choose to implement Options 2 and 3 concurrently until such time the transition period associated with Option 2 has ended.

Alternative Regulatory Option

In addition to the above options, an alternative regulatory option was considered during the development of the Consultation RIS. This option would have resulted in changes being made to the current testing requirements for lead in AS/NZS 4020. This

consideration was in response to an outcome of the 2019 Lead in Plumbing Products Forum where some participants recommended that the problem be addressed via AS/NZS 4020 and not changes to the product and material standards.

Following the forum, a report was commissioned by the ABCB to investigate what changes to AS/NZS 4020 could be made to better reflect the range of variables affecting drinking water in Australia.¹⁰¹ This report has been made available and can be accessed through the [ABCB's website](#).

The report recommended:

- expanding the test for lead from a single water type to three types to cover the range of water quality in Australia; and,
- expanding the duration of the test from 9 days to 8 weeks to better observe lead leaching from the bulk alloy.

The recommendations aimed to better align Australian testing requirements with the European testing standards. However, further consultation with industry groups and AS/NZS 4020 accredited testing laboratories revealed several challenges with implementing this option.

Specific concerns raised were:

- The testing of lead is currently one of many metals within AS/NZS 4020. While testing of lead could be separated in a future Standard, this would result in the test being duplicated (for lead and all other metals) and then tripled (to reflect three water types instead of a single water type). Industry groups and accredited testing laboratories indicated this would add significant cost and time to the process, without any clear benefit.
- There are distinct differences between the current Australian testing requirements and the European requirements. The European Standard EN 15664 is a material-based standard, whereas the Australian Standard is product specific. This results in significantly more testing being required under the current Australian Standard which, if amended, would place significant

¹⁰¹ Tallowood Rise Water Consulting (2020) Potential changes to AS/NZS 4020: Testing for lead leaching.

stress on accredited testing laboratories and manufacturers in meeting the new requirements.

- Lead leaching from the bulk alloy is likely to take much longer than 8 weeks to observe. A study in Europe found that lead leaching from the bulk alloy was most pronounced after 25 weeks in use. This is reflected in the European Standard EN 15664, which requires a minimum of 26 weeks in testing and extended to up to 52 weeks if the product fails after the initial period.
- The capacity of the accredited testing laboratories to retest all products within a specified period would be challenging, with laboratories indicating that a minimum 5-year transition would be required.
- Testing of larger plumbing products with three water types is difficult in practice. Often products are tested with mains water and so finding suitable alternative water sources may be difficult, particularly for larger products such as water heaters. Advice from one accredited testing laboratory also indicated that new products are normally supplied as a single unit. So, requiring three units (to allow testing with three water types) would place greater burden on the manufacturer at the time of product certification.

For the above reasons, this option was not subject to further analysis.

The Consultation RIS asked stakeholders whether they agreed with the alternative regulatory option being discontinued from further analysis.

Two thirds of respondents agreed. Of those who didn't support the option being discontinued, most felt that the test methods within AS/NZS 4020 did not sufficiently account for the range of variables influencing lead levels in drinking water, such as pH levels and water stagnation times.

The NHMRC and enHealth viewed discontinuing the option based on cost and logistics alone unreasonable and advocated for a full and comprehensive review of AS/NZS 4020 be undertaken concurrently with implementing Option 2.¹⁰²

An Australian manufacturer (Enware) also agreed with the outcome of the Lead in Plumbing Products Forum in 2019, where some recommended the issue be

¹⁰² Should decision makers support this recommendation, Option 2 would not meet the amendment cycle timeframes for NCC 2022 and would be deferred until a later edition of the NCC.

addressed in AS/NZS 4020 and not through changes to the product standards. They felt that compliance should follow European legislation and allow for material classifications to be tested against AS/NZS 4020. This would allow for a register of compliant materials and suppliers to be created. They also supported additional amendments to AS/NZS 4020 be made, which is understood to relate to expanding the use and duration of the standard's Test Methods E, F, G and H.

Other improvements suggested for AS/NZS 4020 included:

- Well defined sampling procedures which are repeatable.
- Quality control and random sample batch testing.
- Mandatory product rinsing requirements.
- Reverse uncertainty factors.
- Lowering the permissible lead content to account for background levels of lead.
- Aligning product testing and compliance requirements with in-field, water sampling testing and guidelines to remove interpretation and comparison error.

There appears to be strong support for a future review of AS/NZS 4020. This could include the testing requirements and threshold values for lead and other hazards currently specified by the Standard. Other changes may complement or support the other options under consideration, subject to further regulatory analysis and consultation.

Impact Analysis

This section provides an assessment of the incremental costs and benefits associated with Option 2 and Option 3 when compared with the status quo baseline.

Option 1: Retain the status quo

The impacts of the status quo are those reflected in the problem section of this RIS:

- Plumbing products in contact with drinking water will continue to be allowed to contain small amounts of lead (up to 6% lead for some products).
- Instances of lead levels above those permitted by AS/NZS 4020 will also likely continue to occur.

The status quo will be regarded as the baseline. Where the incremental impacts of each option result in a net cost, the status quo will be recommended.

Enware's submission suggested the regulatory burden and current issues associated with enforcing compliance with Watermark product specifications is overlooked as part of the status quo. Lowering lead content in plumbing products will require enforcement during certification and possibly at point of sale, also regular auditing will be required to ensure products produced meet the same high standards as the samples provided for certification. In their opinion, it is difficult to envisage how the regulatory burden can be balanced with ensuring all installed product becomes compliant, the cost of enforcement will be significant.

Cost-benefit analysis typically assumes full compliance with existing mandatory schemes unless there are strong reasons not too. Imported plumbing products and materials for use in contact with drinking water must obtain WaterMark Certification. However, it is acknowledged that the effectiveness of the policy change will be influenced by the extent it is enforced by State and Territory authorities and enforcement of the existing WMCS. In this regard, the cost of enforcement is expected to be the same as that required under the status quo. See section Enforcement for more details.

Option 2: Require all products in contact with drinking water to contain a maximum lead content of 0.25%.

Costs

The costs of Option 2 are difficult to quantify. There are a number of product categories impacted by this option and within each product category exists a subset of many product types which range in size and value.

The product categories and annual sales are shown in Table 12.

Table 12: Product categories and annual sales

Product type	Units (annual sales)
Fittings	45 million
Valves	13 million
Fittings of stainless-steel braided hoses	12 million
Taps	1 million
Mixers	3 million
Appliances	500,000
Water heaters	700,000
Water meters	760,000
Residential water filtration	150,000
Water dispensers	20,000

Notes:

1. All data is annual sales data.
2. All products contain lead and are subject to the WMCS.
4. Pipes are excluded on the basis they would meet proposed low lead requirements.

As shown in Table 12, Option 2 will impact over 75 million plumbing product units intended for installation in contact with drinking water annually, with 77% of the impacted units being valves and fittings.

A representative subset of product types was determined, which broadly reflect each product category, with assistance from PPI Group and the AI Group. These product

types are shown in Attachment B. The proportion of each product type sold within each product category was then estimated using industry sales data. Finally, the cost increase for each product type was estimated based on the price of a low lead alternative, or the change experienced in the US in percentage terms applied to current costs provided by a national Australian plumbing retailer. Also see discussion on the substitutes for copper alloy products.

Since the Consultation RIS, water meters have also been included in the costs to recognise in some instances pipework ownership is that of the body corporate, these would be classed as on-site plumbing and fall within the scope of the NCC inclusion in the scope of the proposed changes.

There is limited information on the price difference between plumbing products and low lead alternatives. Estimates reflect broad agreement between sources on changes experienced in the US following the transition to low lead products, ABCB’s desktop review, and advice of participants at the ABCB’s Lead in Plumbing Products Forum. The cost implications of Option 2 are shown in Table 13.

Table 13: Incremental aggregate costs of Option 2

Product Category	Annual Cost
Fittings	\$35,595,900
Valves	\$93,383,388
Fittings of stainless-steel braided hoses	\$18,780,000
Taps and combinations	\$4,990,000
Mixers	\$79,312,500
Water heater systems	\$8,212,575
Residential water filtration systems	\$29,745,000
Water dispensers	\$9,899,447

Product Category	Annual Cost
Water meters	\$28,880,000
Annual cost	\$308,798,810
Present Value cost	\$2,320,694,777

As shown by the above table, the cost of Option 2 is \$310 million annually or \$2.3 billion in Present Value terms, using a discount rate of 7% over 10 years.

This cost will need to be considered against the expected benefits of transitioning to low lead plumbing products as well as the goal of reducing the use of lead to non-essential levels.¹⁰³

There is some pre-existing industry capability to deliver lead free products, both domestically and with overseas suppliers. The price increases for each product type are derived from comparison, which would include costs borne by manufacturers in sourcing new raw material containing low lead, upgrading of equipment and re-tooling to machine low lead plumbing products and the associated testing that will be required to demonstrate compliance with the new requirements. The retail cost therefore also implicitly reflects existing costs for products to comply with the WMCS.¹⁰⁴

The difference in material cost may decrease over time (as a result of an increase in supply and demand of low lead brass). However, it is not known at what rate or time period this reduction would occur. As such, taking a conservative approach to calculating costs, reductions over time have not been assumed as part of calculating the central estimate, but rather tested under the heading of 'Sensitivity Analysis'.

Benefits

The benefits of Option 2 are also difficult to quantify. Research has not revealed any recent cost-benefit analyses which quantify the benefits of reducing low lead exposure from drinking water. Further, the available studies and data used to derive the benefits of reducing low lead exposure more broadly were not collected for the specific purpose of this analysis and are small in sample size. On this basis, the consideration of future

¹⁰³ World Health Organisation (2019) 'Lead'. >https://www.who.int/ipcs/assessment/public_health/lead/en/ Accessed 6 June 2020.

¹⁰⁴ This also assumes the timing of random testing has no impact on certification costs.

regulatory interventions would benefit from national sampling of blood lead levels (particularly in children) and water lead levels. Greater quantification of the health impacts of low lead exposure from drinking water in Australia would also benefit policy setting and standards writing bodies such as the ABCB.

Health benefits

Health benefits have been quantified using information from the GBD database, which reports the DALYs attributable to lead exposure in Australia. The composition of the DALY rate in Australia is shown in Table 14.

Table 14: Composition of the DALY rate in Australia attributable to lead exposure

Disease	Rate per 100,000	Proportion of total DALYs
Rheumatic heart disease	0.36	0.35%
Ischemic heart disease	46.45	45.62%
Hypertensive heart disease	3.91	3.84%
Stroke	20.69	20.32%
Atrial fibrillation and flutter	6.13	6.02%
Aortic aneurysm	1.45	1.42%
Peripheral artery disease	0.87	0.85%
Endocarditis	0.43	0.42%
Non-rheumatic valvular heart disease	1.35	1.33%
Other cardiovascular and circulatory diseases	1.37	1.35%
Cardiomyopathy and myocarditis	1.14	1.12%
Chronic kidney disease	9.53	9.36%

Disease	Rate per 100,000	Proportion of total DALYs
Idiopathic developmental intellectual disability	8.14	7.99%
Total	101.83	100%

The majority of the burden of disease from lead exposure in Australia is linked to ischemic heart disease, stroke and chronic kidney disease. These conditions represent nearly 75% of the total burden associated with lead exposure. While health literature typically associates these conditions with high lead exposure, the cumulative effect (i.e. lead exposure from multiple sources) is important when considering further regulatory intervention. Individuals who are already exposed to high levels of lead (e.g. through their environment or occupation) are at greater risk from lead exposure from drinking water than individuals who are not. Therefore, reducing the compounding effect of lead exposure in Australia is the basis of current regulatory intervention and is reflected in the goal of reducing lead use to non-essential levels in all goods and consumables, including drinking water.

The GBD database presents a DALY range for the total lead exposure in Australia. Based on the range of health consequences, the total health related benefits are estimated in Table 15. These benefits have been calculated using the Value of Statistical Life Year (VSLY) and reflects the population's willingness to pay to avoid such diseases.¹⁰⁵

Table 15: Total annual cost of lead exposure in Australia (2019)

	Lower bound estimate	Central estimate	Upper bound estimate
Total lead exposure annually	\$2,366,201,976	\$4,941,467,259	\$7,846,352,924

¹⁰⁵ Department of Prime Minister and Cabinet (2014) 'Best Practice Regulation Guidance Note Value of Statistical Life Year'. > https://www.pmc.gov.au/sites/default/files/publications/Value_of_Statistical_Life_guidance_note.pdf< Accessed 28 August 2020.

	Lower bound estimate	Central estimate	Upper bound estimate
Exposure from drinking water annually (20% of total exposure)	\$473,240,395	\$988,293,452	\$1,569,270,585

Notes:

1. Total lead exposure is calculated by using the corresponding DALY rates for each bound. A total DALY rate of 11,979.09, 25,016.58 and 39,722.80 has been used for the lower, central and upper bounds respectively.

2. Value of Statistical Life Year has been calculated at \$197,528 in 2019 dollars.

It should be noted that an Australian manufacturer (Enware) felt that the total cost of lead exposure from plumbing products was overstated by the Consultation RIS for three primary reasons:

1. The total DALY rate reported from the Global Burden of Disease.

Enware identified a different set of values for lead exposure reported by the GBD database. A review of these values revealed two different datasets for lead exposure for all ages. Since consultation, the ABCB sought advice from the Institute of Health Metrics and Evaluation (IHME), the owners of the GBD database, to confirm which values were correct. IHME advised the differences were a result of an error in their tool and the Decision RIS relies on the updated estimates confirmed by the IHME.¹⁰⁶

2. The contribution drinking water makes to the total DALY rate (assumed to be 20%).

The Consultation RIS assumed 20% as the contribution drinking water makes to the problem of lead exposure from all sources. This was based on two reports from WHO and the US EPA on the contribution drinking water makes to total exposure in the US.

However, using alternative sources, Enware disputed the assumption and referenced the findings from three US studies, which reported the following values for the contribution drinking water made to blood lead levels:

¹⁰⁶ Personal correspondence IHME 5 May 2021.

- 39% for the 90th percentile of 0 – 6-month-olds¹⁰⁷ (BLL > 2.15 µg/dL)
- 11.9% for population mean of children ≤ 7 years old¹⁰⁸
- 7% for 90th percentile of 1 – 2-year-olds¹⁰⁹ (BLL > 2.39 µg/dL)
- 7.6% for 90th – 100th percentile of 2 – 6-year-olds¹¹⁰ (BLL > ~ 3.4 µg/dL)
- 7% for adults¹¹¹

To give recognition to the lack of Australian specific data and uncertainty, the Decision RIS has been expanded to include a break-even analysis on the required contribution drinking water must make in order for the costs to at least equal the benefits. See Break-Even Analysis section for further information.

3. The relationship between lead consumption from all sources and the total DALYs being linear

As discussed under the stakeholder responses to the extent of the problem, Enware did not agree with the assumption that the relationship between lead consumption from all sources and the total DALYs was linear. Their opinion appears to be based in part on data from the Victorian Department of Health over the years 2011 to 2014, which showed plumbing was suspected to be a low contributing risk factor (between 0 and 6%) in reported elevated blood lead levels.

If this data was to be representative of the relationship between plumbing and elevated blood lead levels for all jurisdictions, the contribution plumbing makes to the total problem would be much smaller than that presented by the Consultation RIS and negligible relative to all other sources.

However, sole reliance on this data should be treated with caution by decision makers as it is from only one jurisdiction. The nature of current testing is that these levels are only identified where lead exposure is suspected as a potential contributing factor by health practitioners. It was the view of health agencies (NHRMC and enHealth), there could be many instances where lead exposure does not get investigated or reported.

¹⁰⁷ Zartarian, V.; Xue, J.; Tomero-Velez, R.; Brown, J., (2017) Children's Lead Exposure: A Multimedia Modelling Analysis to Guide Public Health Decision-Making. *Environmental health perspectives*, 125 (9), 097009.

¹⁰⁸ Agency, U. S. E. P., (2007) Lead: Human Exposure and Health Risk Assessment for Selected Case Studies.

¹⁰⁹ Zartarian, V et al. (2017).

¹¹⁰ Zartarian, V et al. (2017).

¹¹¹ Bois, F. Y.; Tozer, T. N.; Zeise, L.; Benet, L. Z., (1989) Application of clearance concepts to the assessment of exposure to lead in drinking water. *Am. J. Public Health*, 79 (7), 827-831.

Drinking water is also essential unlike other sources, and therefore has the potential to contribute throughout life.

Hence, a decision based on this data alone would not reflect the goal of reducing the cumulative effect of lead from all sources, not only those reported as historically high contributing risk factors.

Effectiveness of the option addressing the problem over time

Under Option 2, the problem will reduce gradually over time at the rate new plumbing products are installed and existing plumbing products are replaced. The timeframe for the natural replacement of plumbing products is unlikely to be accurately estimated as there are several influences on replacement rates. These influences include:

- The extent retrofitting, refurbishment or change of use occurs within the existing building stock.
- The rate new buildings replace existing older buildings (i.e. the building stock renewal rate).
- The rate plumbing products reach their end of design life or are replaced voluntarily (e.g. for aesthetic reasons).

As a result of the difficulty in accounting for these influences, a simplifying assumption that 5% of plumbing products are replaced each year (i.e. twice within a building’s assumed life) equates broadly to all plumbing products being replaced within 20 years. The benefits of this option is shown in Table 16.

Table 16: Present Value benefits of Option 2

	Lower bound estimate	Central estimate	Upper bound estimate
Total annual benefit of Option 2	\$23,662,020	\$49,414,673	\$78,463,529
Present Value benefit of Option 2	\$2,015,758,730	\$4,209,617,720	\$6,684,279,097

Notes:

1. Present Values have been calculated over 20 years using a 7% discount rate.

2. The effectiveness of the option is based on a replacement and installation rate of 5% per year.

Under this option, benefits range between \$2 billion and \$6.7 billion in Present Value terms. Given the large variation in the results, key parameters, including the rate of replacement, have been tested under the heading of Sensitivity Analysis. Since consultation, a break-even analysis has also been included to give greater recognition to the limited availability of Australian specific studies on lead in plumbing products contribution to overall lead exposure.

The Net Present Values of each scenario is shown in Table 17.

Table 17: Present Value benefits of Option 2

Scenario	Present Value Costs	Present Value Benefits	Net Present Value
Low	\$2,320,694,777	\$2,015,758,730	(\$304,936,047)
Central	\$2,320,694,777	\$4,209,617,720	\$1,888,922,943
High	\$2,320,694,777	\$6,684,279,097	\$4,363,584,320

As is shown above, Option 2 demonstrates a net benefit under the central and high scenario but a net cost under the low scenario. Using the central estimates, Option 2 demonstrates a net benefit of approximately \$1.9 billion in Net Present Value terms.

Option 3: Recommend changes to government procurement standards to require compliance with NSF/ANSI 372

Costs

This option would recommend changes be made to state and territory government and Australian Government procurement standards to require the use of low lead plumbing products in contact with drinking water for all government-owned buildings when installed or replaced.

In 2019, the value of building work done by the public sector was 11.25% of the total value of building work undertaken.¹¹² As such, this analysis assumes the cost of this option to be 11.25% of the total cost of Option 2. This results in a cost of \$34.7 million annually or \$261 million in Present Value terms.

Benefits

This option would increase the demand for low lead products and assist the Australian market transition to a greater uptake of low lead plumbing products slowly as government demand increases total demand. This increase in demand would in turn increase the supply of low lead products in the market and therefore reducing the costs of such products over time.

This option could also benefit public housing tenants as product installations and replacements are the responsibility of the state and territory governments.

Like Option 2, the benefits of reducing low lead exposure are not known with certainty but assumed to be 11.25% of total exposure based on the contribution public sector expenditure contributes to overall expenditure.

Hence, the benefits of Option 3 are estimated to be \$5.6 million annually or \$474 million in Present Value terms using a 7% discount rate over 20 years. This results in a net benefit of \$213 million in Net Present Value terms if Option 3 was to be implemented.

One individual commented on the analysis of Option 3 being much less comprehensive relative to the analysis of Option 2. This is largely a reflection of Option 3 being a subset of Option 2, based on the percentage government owned buildings contribute to total construction activity.

¹¹² ABS (2020) Catalogue 8752.0 'Building Activity, Australia, March 2020. Table 12.

Sensitivity Analysis

A sensitivity analysis has been conducted on the Present Values by varying the key parameters around the central analysis of Option 2.

The sensitivity analysis has been undertaken in the following areas noting:

- A real discount rate of 7% has been used in the quantitative analysis, and sensitivity will be tested from a lower bound of 3% to an upper bound of 11%.
- The rate of change of new plumbing products replacing existing plumbing products is not known with certainty. As such, a low (2%) and high (7%) rate of change will be tested.
- With the introduction of new requirements impacting the entire plumbing copper alloy industry, there is the possibility of positive economies of scale being achieved over time. The sensitivity analysis will test a 10% and 20% reduction in input costs over 10 years.
- The contribution lead in drinking water makes to total health consequences is assumed to be up to 20% based on limited studies from the US. The sensitivity analysis will test a 50% reduction of health benefits from the central analysis (i.e. a 10% contribution to total health effects from lead in drinking water).

Table 18 shows the conclusions of the sensitivity analysis in Net Present Value terms.

Table 18: Sensitivity analysis of Option 2

Parameter	Present Value Cost	Present Value Benefit	Net Present Value
Discount rate – low (3%)	\$2,713,139,982	\$6,653,021,929	\$3,939,881,947
Discount rate – high (11%)	\$2,018,632,501	\$2,855,322,413	\$836,689,912
Rate of replacement – low (2%)	\$2,320,694,777	\$1,683,847,088	(\$636,847,689)
Rate of replacement – high (7%)	\$2,320,694,777	\$5,893,464,809	\$3,572,770,032

Parameter	Present Value Cost	Present Value Benefit	Net Present Value
Reduction in the cost of inputs – 10% over 10 years	\$2,229,118,513	\$4,209,617,720	\$1,980,499,207
Reduction in the cost of inputs – 20% over 10 years	\$2,137,542,248	\$4,209,617,720	\$2,072,075,472

The sensitivity analysis of key parameters indicates that Option 2 demonstrates a net benefit in most scenarios. The exception is where the rate of change is low (that is, total annual sales represent less than 2% of new installations and replacement). This scenario is unlikely given the average life expectancy of most plumbing products in contact with drinking water is less than or equal to 20 years in most cases.

Break-Even Analysis

There is continued uncertainty regarding the contribution lead in plumbing products makes to the total health burden associated with lead exposure in Australia.

In these circumstances a break-even analysis can be helpful to indicate the reasonableness or otherwise of the possible benefits. A break-even analysis calculates the benefits needed to equal the costs using a key assumption. In this case the key assumption is the contribution plumbing products makes to the total health burden of lead exposure.

For the benefits of the option to break-even with the cost (\$2,320,694,777) the contribution lead in plumbing products in contact with drinking water needs to make to the total health burden from lead exposure is approximately 11%.

Although higher than that reported in Victoria (which ranged between 0 and 6% over the years 2011 to 2014 and 2016 to 2018) this rate is small and plausible even when considering the reduction of sources of lead over the past two decades.

Unintended Consequences

Any unintended consequences of regulatory options need to be considered by the Decision RIS. This includes both the manufacturing and health implications associated with the possible substitutes for lead.

Known substitutes for lead

Experience from the US shows the likely substitutes for lead will be silicon or bismuth which display similar, but not identical, machinability characteristics.

The manufacturing implications of using silicon or bismuth will be an overall decrease in the machinability of copper alloy materials. A study in 2012, found that by increasing the silicon content from 1% to 4%, resulted in an increased tool wear by 40%, machined surface roughness by 25%, and the cutting force reducing by 50%.¹¹³ This cost to manufacturers is implicit in the estimated costs of Option 2.

From a health perspective, silicon and bismuth present less risk when compared to lead, though it is acknowledged that bismuth in particular is not well studied. Silicon is the principal component of glass, cement ceramics and is also an important constituent of some steels and a major ingredient in bricks. Elemental raw silicon and its intermetallic compounds are currently used as alloy integrals to provide more resistance to copper and other metals. Silicon concentrates in no particular organ of the body, but is found mainly in connective tissues and skin. Silicon is non-toxic in all its natural forms.¹¹⁴ It is also a common additive to manufacturing low lead brass plumbing products internationally.

Use of bismuth in the manufacture of copper alloy products is less examined from a machinability perspective. However, from a health perspective it is considered one of the less heavy metals. There are no known health consequences associated with the use of bismuth in products in contact with drinking water and it is a common additive in the manufacture of plumbing products in meeting the requirements for low lead in the US.

¹¹³ Mohamed A.Taha, Nahed A.El-Mahallawy, Rawia M.Hammouda, Tarek M.Moussa, Mohamed H.Gheith (2012) 'Machinability characteristics of lead free-silicon brass alloys as correlated with microstructure and mechanical properties' Ain Shams Engineering Journal Volume 3, Issue 4, December 2012, Pages 383-392.

¹¹⁴ Lenntech (2020) Chemical properties of silicon - Health effects of silicon - Environmental effects of silicon. ><https://www.lenntech.com/periodic/elements/si.htm>< Accessed 15 June 2020.

Product substitutes for copper alloy

Impact on supply

An unintended consequence of Option 2 could be the substitution of copper alloy products with other products made from different materials. A fall in demand could occur if as a consequence of using a low lead material prices rise beyond a point the market is willing to accept. In this event, a shift could occur towards use of other materials which are currently permitted by the PCA, such as cross-linked polyethylene, stainless steel or composite materials.

As there are no formal studies available, the Copper Development Association Inc., McLean, Virginia (CDA US) were contacted for information on the impact low lead provisions had on the copper alloy market in the US. CDA US advised that the regulatory change created significant disruption in the market and the brass supply chain, which resulted in a near immediate substitution away from brass/bronze products. Further information received from the CDA US, via the International Copper Association Australia, shows that the demand for brass plumbing rods declined by approximately 50% since the requirements for low lead products were first introduced. This fall in demand was a direct consequence of the changes.

Given the experience in the US, substitution away from copper alloy plumbing products in contact with drinking water needs to be considered by Australian decision makers.

For commercial buildings, where copper water service lines are common, copper alloy fittings are predominantly used. In these instances, the demand for copper alloy fittings is expected to remain as there are no close substitutes for copper alloy products in this segment of the market.

For residential buildings, use of cross-linked polyethylene piping is common in Australia. A high majority of these installations use copper alloy fittings. In these instances, the demand for copper alloy fittings is also expected to remain static, as there are no close substitutes for copper alloy fittings used in cross-linked polyethylene plumbing systems.

The possibility of substitution, similar to the US experience, is most likely to occur where copper water service lines are used in residential buildings, where copper

fittings can replace copper alloy fittings such as brass. In these instances, the demand for copper alloy is more likely to fall as the price of copper alloy products increase. This scenario represents a smaller proportion of all installations relative to the US experience, as use of copper water service lines represent approximately 30% of all residential plumbing installations in Australia, lower than that installed in the US.

From a cost-benefit analysis perspective, this substitution effect would decrease the cost of Option 2 and 3 (as consumers and plumbing practitioners will meet the requirements through more cost-effective means by selecting cheaper substitute products). However, decision makers should have regard to the impacts to the copper alloy industry.

In response to this view, an Australian manufacturer (Enware) submitted the following:

“Substituting for cheaper products often results in the reduction of product performance which can result in an increase in product failures, water damage and potential injury like scalding. A reduction in product performance can also increase our waste footprint as product lifecycles reduce and we become more of a throw-away society. Further to this, pressure on consumers to find cheaper alternatives will also impact our local manufacturing demand, resulting in a loss of local employment within our manufacturing sector already struggling to scale back after Covid 19 and the increase importation of cheaper alternatives. Enware believe the assumption made in the CRIS is based off evaluating the cost of copper pipe compared to cross linked polyethylene pipe. There is no doubt polymers are a cheaper alternative to metallic alloys, however, not all plumbing products identified within the scope can be made purely of polymer materials. Metallic materials will be required whether it is low lead copper alloys or other alloys like stainless steel. Early market evidence clearly indicates that these alternative low lead materials will result in significant price increases to manufactures and consumers. Investigations in like for like products made from low lead copper alloys equate to 15-20% price increases while we have estimates between 20-30% for stainless steel alternatives. Enware believe a more thorough cost benefit analysis be conducted to include the true cost of alternative product materials as well as a broader investigation into the potential loss of employment that may arise due to price pressures on consumers.”

The price increases for low lead copper alloy products used in the Decision RIS are not dissimilar to the estimates provided in the submission. Where existing alternatives to low lead products are higher in price, it is expected that consumers who select products based on price alone, will select low lead copper alloy products over more expensive products. This decision making is consistent with the expected impact of the proposal and is reflected in the cost of Option 2.

The Consultation RIS asked stakeholders what contributed the most to product selection for 'behind-the-wall installations'. Responses to the question were mixed with price and client preferences being the most dominant factors. The responses highlight that there will always be relative advantages and disadvantages between material types. Hence, differences should not automatically infer that a material is unsafe but rather reflect that there are trade-off considerations when selecting products of differing materials, including consumer preferences, price and a plumbing practitioner's familiarity with the product.

Further, this opinion does not recognise the flexibility and suitability of alternative materials which exist today. Under the status quo, the PCA allows for a range of products and materials to be used within a plumbing and drainage system, not only those of copper alloy material. There are few relevant studies on the health consequences of other materials currently deemed fit-for-use through the PCA. As such, there is no available evidence to suggest there are adverse health effects from other substitute materials that would warrant these materials being not accepted as fit-for-use under the PCA. Such evidence would warrant a much larger ABCB project on all plumbing products and materials.

The known effect on health

The Consultation RIS asked stakeholders whether they were aware of any health consequences associated with using substitutes for lead in the manufacture of plumbing products in contact with drinking water.

Health based values

On the question of whether stakeholders had any information on the health consequences associated with lead substitutes, the majority of respondents (76%) advised they were not aware of any studies.

The PPI Group and the NHMRC advised that there were lead substitutes other than bismuth and silicon used in the US, including such alloys as naval copper alloys (which is understood to be also commonly used); indium brass; gallium brass; graphite alloys and manganese/zinc alloys.

Naval copper alloys have had the lead removed and replaced with a combination of copper, zinc and tin, which would not result in any additional adverse health effects. However, naval copper alloys present a higher risk of dezincification and are difficult to machine. Other brass types cited are understood to be used infrequently as a replacement in plumbing products in contact with drinking water and are unlikely to be the dominant forms of low lead copper alloy in the market.

Of those familiar with the use of bismuth and silicon, many noted that there is no existing health-based guideline value for their use within AS/NZS 4020 or equivalent international standards. However, health agencies also noted that the absence of existing health-based guideline values did imply these substitutes are safe and may precipitate a need for change.

The NHMRC advised of anecdotal reports of health concerns with the use of bismuth in plumbing in Europe. However, at the time of drafting their submission to the Consultation RIS, these reports had not been published or substantiated.

Experts on its Water Quality Advisory Committee also raised concerns with the NHMRC about the social and environmental impacts of using bismuth as an alternative to lead in brass alloys. Global supply and demand may result in unsustainable pricing

of bismuth as a commodity and its depletion as a resource. The NHMRC suggested that the ABCB make an effort to explore the sustainability of alternatives to lead, should it drive industry to adopt substitutes.

Given there are no known health effects associated with silicon or bismuth, this Decision RIS does not support prohibiting the use of the known substitutes for lead. The choice of substitute will remain a decision of each manufacturer having regard to the availability of inputs.

Both the NHMRC and enHealth strongly recommended that any material that industry is encouraged to use in plumbing products as a result of a change in the requirements for lead needs to be established to be safe for consumer use under all Australian conditions. In this regard, they suggest any lead substitute have a health-based guideline value for inclusion in the Australian Drinking Water Guidelines. In addition, each material would also need to be appropriately tested under AS/NZS 4020 conditions to ensure that it does not leach into water at unsafe levels.

The Decision RIS acknowledges the need to set health-based guideline or threshold values for lead substitutes and supports in principle health authorities determining the most appropriate values as part of the scope of work for revision to AS/NZS 4020 and the Australian Drinking Water Guidelines¹¹⁵.

Opportunistic pathogens

One plumbing industry group (PPI Group) and one Australian manufacturer (Enware) did not agree that there was no available evidence on the health risks associated with bacterial contamination of end-of-line plumbing fixtures involving plumbing products.

They claimed the proposed changes would likely to cause undue infection risk and existing literature shows end-of-the line plumbing fixtures to be a significant source of microbial pathogens.

It is understood that product substitution concerns stem from the potential substitution of brass (known to inhibit the growth and colonisation of various waterborne opportunistic pathogens) with other end of line fixtures made from other materials,

¹¹⁵ For the purposes of assessing the impacts of Option 2, it has been assumed that the same threshold values for silicon, bismuth and selenium in NSF/ANSI/CAN 600 are replicated in AS/NZS 4020.

such as stainless steel and various polymers. While the effectiveness of copper alloy materials against inhibiting microbial growth is not disputed, there is no evidence which conclusively shows other materials are not suitable for use. This is also reflected by the current requirements of the PCA, which allows not only copper alloy products, but a range of products in contact with drinking water to be used.

The Decision RIS recognises the concerns being raised that an increase in bacterial contamination, particularly where copper, which is inherently resistant to microbial growth, is substituted for other materials. However, as the Consultation RIS explained, there are very few instances this is expected as a consequence of the proposed change as most of the substitution has already occurred due to other factors (predominantly cost). The importation of cheaper alternatives, is not a direct consequence of the proposal being considered.

The calls for continued evidence-based approaches to risk in plumbing is supported and the ABCB will continue to monitor and respond to any new research into the factors influencing waterborne opportunistic pathogens, including the influence of different material types.

Impacts on the recycling of brass

Option 2 may impact the ability to recycle copper alloy in the manufacture of new plumbing products intended for contact with drinking water. This is due to higher amounts of lead being present which would prevent the material's reuse in the manufacture of plumbing products intended for contact with drinking water. This wouldn't, however, impact the ability for the material to be used for plumbing products not in contact with drinking water or for other uses.

In developing the Consultation RIS, advice was sought from the Australian Metal Recycling Industry Association (ARIMA) on the impacts of low lead requirements on the ability to recycle copper alloy materials. ARIMA advised that it was common practice to use scrap brass as a substitute for new metal to reduce the cost of manufacturing new materials. Consequently, as available scrap brass in the future will contain higher concentrations of lead than that permitted, the demand for scrap brass by Australian smelters will fall.

ARIMA advised that this fall in demand would be softened by two factors:

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1. Brass is used in the manufacture of products which are not used in plumbing products in contact with drinking water (e.g. electrical, architectural, fluid transfer industries and plumbing products not in contact with drinking water). Therefore, the production of these types of products need not be affected.
2. There are now very few brass smelters in operation in Australia and the majority of scrap brass is exported to countries which may not require low lead brass. Therefore, the demand for scrap brass as an exportable good need not be affected.

Based on the above factors, ARIMA believe that if new regulations were to come into effect, there would be an initial local oversupply of recycled brass which would drive down the local price of scrap brass. However, based on price fluctuations within the industry being common, this wouldn't result in a large demand shock as scrap brass would continue to be a useful recycled material, particularly as an exportable good.

While supportive of Option 2, Advanced Alloys Holdings, representing a consortium of international companies across the plumbing products supply chain advised that if silicon brasses become the preferred substitute, as is the case in the USA, the demand for such brass as a recycled material would be less for both domestic and export markets across most brass products. It is understood that this is due to silicon being an impurity in many copper alloys, causing issues such as grain boundary embrittlement. This limits the ability of silicon brasses to be recycled, as many foundries have strict quality control measures in place producing alloys sensitive to such contaminants.

The recyclability of silicon brasses is noted and it is anticipated that with an increase in the quantity of recyclable material, existing controls may need to be softened or other substitutes may be preferred by the industry. Based on the available evidence there is no reason to apply further controls on lead substitutes on this basis.

Lead leaching from low lead products

Small studies conducted by the Australian Water Quality Centre (AWQC) have observed higher levels of lead leaching from low lead plumbing products when compared to higher leaded products. When conducting further studies, lead levels fluctuated based on whether the product had been acid rinsed. Acid rinsed products

complied with the AS/NZS 4020 requirements whereas water rinsed products failed. These findings are consistent with reports in the US, which found some lead-free products still leached high concentrations of lead.

Although this unintended consequence is counter intuitive with the objectives of the changes, it highlights the importance of the correct finishing of products after manufacture. The findings of the AWQC support the need for the continued testing, by accredited testing laboratories, and certification of plumbing products in contact with drinking water to ensure adequate rinsing processes are achieved through the certification process.

Both the HIA and WSAA in response to the Consultation RIS highlighted the importance of ensuring the short-term release of lead is controlled. WSAA felt that the existing requirements within AS/NZS 4020 was insufficient to ensure that the existing threshold of 10 µg/L was satisfied in all cases. It was recommended that the ABCB further investigate the issue to ensure that appropriate controls are in place to meet the end goal of ensuring that the long-term release of lead is reduced. In light of this issue, they also suggested that the best instrument to make any changes was via AS/NZS 4020.

HIA also prompted consideration of mandatory rinsing requirements to ensure that short term release of lead was reduced. However, their preferred instrument was individual product specifications rather than through changes AS/NZS 4020.

The Decision RIS gives recognition to concerns about the short-term release of lead and underlying mechanisms. It is understood that when products are tested to AS/NZS 4020, they are done so using products supplied by the manufacturer. These products are likely to represent a cleaned product to ensure the best results are achieved by the testing laboratory. This may in turn result in the cleaned product not always being representative of a typical batch.

The Consultation RIS asked stakeholders whether there were incentives other than regulation that would address the problem.

A majority of respondents (58%) felt that regulation was the only means to achieve the stated objective.

Of those that felt there were other incentives available to address the problem, several types of government subsidies were proposed in the form of:

- Subsidising the incremental production costs of manufacturers producing low-lead plumbing products in contact with drinking water.
- Subsidising consumers when selecting low-lead plumbing products in contact with drinking water. This would be in the form of covering the price difference between low lead products and leaded products.
- A government 'swap-out' scheme whereby the government offers replacement of leaded plumbing products with low leaded products free of charge.

These incentives are expected to be either less effective or more expensive than those examined under the central options.

In addition to these suggestions, some stakeholders who responded to the question saw benefit in producing enhanced educational material to raise awareness of the problem of lead exposure in Australia. This would include promoting the use of low lead products in addition to flushing the plumbing system after periods of stagnation. It is envisaged that enhanced education material will complement any regulatory change.

Enforcement

PPIG and Enware raised existing compliance rates with the existing WMCS citing a report the ABCB commissioned in 2018 by Aither. In this regard, both respondents expressed a need for a renewed effort to improve the national administration and State and Territory monitoring, surveillance and enforcement of WaterMark, especially as it relates to lead in plumbing products.

“A manufacturer or supplier having made an initial application for WaterMark certification may provide a ‘sample’ product from a production run for testing which if successful is issued with a WaterMark license, and then may only be subject to a desk top (paper) audit until the term of the WaterMark license expires. An audit regime is needed that balances costs

and benefits, preferably involving one factory visit per annum. It would help counter the increased use of recycled materials, particularly lead, sometimes sourced from old car batteries, leading to lead content in brass being extremely variable.

To illustrate, NSF/ANSI/CAN 372 Low lead Product Certification in North America is typically based on two factory inspection per year. However, if Australia adopts a Low Lead policy as part of the NCC PCA, then a minimum of one factory inspection would most likely suffice. Most manufacturers of copper alloy based plumbing products have several suppliers of low lead brass, therefore the only way to effectively monitor low lead compliance, is by undertaking compliance inspections at the manufacturing site where chemical analysis reports can be reviewed for all received low lead copper alloy. Under the current ABCB WaterMark Product Certification Scheme, factory inspections are only required at 5 yearly intervals. i.e., within 12 months of the initial issuance of the WaterMark certification and then prior to the WaterMark licence renewal after the 5-year certification. WaterMark Product Inspections are required annually, however these are permitted to be undertaken at warehousing and retail locations. It would be impossible to verify low lead ongoing compliance at the Annual Product inspections unless conducted at the manufacturing location. We note that currently, this is only an optional requirement under the ABCB WaterMark Scheme.” – PPI Group.

A plumbing manufacturer who wished to remain anonymous also commented on the influence of imported products and felt that the problem would continue to occur without strengthening the importation controls. The compliance levels of plumbing products with existing Australian Standards were also challenged by an individual from a law firm, suggesting that these Standards were guidelines as opposed to mandatory requirements.

Local and imported plumbing products and materials for use in contact with drinking water must obtain WaterMark certification. In obtaining certification, compliance with the relevant WaterMark referenced product specifications is required, thus any product specification referenced by the WMCS is mandatory under the Scheme.

The ABCB is not aware of evidence isolating imported products as the source of the problem, however, it is recognised that imported products represent a large segment of the market, accounting for approximately 80% of all products sold annually. This should not deter policy makers in considering lowering lead levels, as imported products currently must meet the same rules as those manufactured domestically via the WMCS.

The effectiveness of the policy change will be influenced by the extent the WMCS is enforced by State and Territory plumbing authorities. Current enforcement levels are assumed not to play a role in the nature of the problem.

The ABCB Board recently committed to strengthening existing arrangements before considering point of sale regulations for the WMCS. Key findings of a review and report by Alther were that compliance with the WMCS was likely to increase when:

- the improved single level scheme was fully implemented
- concerted education and awareness activity was undertaken across the whole supply chain.

At a minimum, the WMCS presently requires an initial factory assessment and re-assessment every five years for re-certification (at each manufacturing site), coupled with annual product conformity surveillance. At a minimum, this surveillance comprises:

- review of type testing as per the product specification and when there has been any change to the product specification, design, material, manufacturing process or location
- product inspection of samples from, or intended for, the Australian market
- a desk top review, including an annual manufacturer's declaration of conformity
- investigation and resolution of any concerns arising from this annual review, which may require factory assessment and product testing.

However, testing, surveillance and inspection regimes are included in Appendix A of each product specification. Products or components with a high sensitivity to the manufacturing process, i.e. a propensity for non-conformance with the product specification during manufacture (rather than due to the design), should have a

commensurate regime of factory and product surveillance stipulated in the product specification.

Should requirements for low lead products be mandated, the ABCB as the WMCS's Administering Body, could issue a Notice of Direction requiring WMCABs to undertake more frequent factory surveillance for some, or all, low lead products, until their respective specifications have been amended.

Similarly, until all impacted WaterMark referenced product specifications are updated to include the important requirements for acid rinsing of products and/or suitable batch release testing regimes, the ABCB as the WMCS Administering Body could issue a Notice of Direction to WMCABs that they are to ensure that the licence holder's manufacturing process include low lead appropriate acid rinsing and batch release testing regimes.

These supporting mechanisms within the WMCS are available for the consideration of decision makers when contemplating the introduction of requirements for low lead products. They may be particularly effective at ensuring consistent compliance with the relatively new requirements for low lead products until such time as there can be confidence the domestic market has normalised a low lead environment.

Business compliance costs

Business compliance costs are assessed under the following checklist:

- Notification – businesses will not be required to report certain events.
- Education – businesses will be required to keep abreast of regulatory requirements.
- Permission – businesses will not need to seek permission to conduct an activity.
- Purchase cost – businesses may be required to purchase items such as new manufacturing equipment. This impact is embedded into the impacts of Option 2.
- Record keeping – businesses will not be required to update their records.
- Enforcement – businesses will not incur additional costs when cooperating with audits or inspections.

- Publication and documentation – businesses will not incur costs of producing documents for third parties.
- Procedural – businesses will not incur cost of a non-administrative nature.
- Other – businesses will not incur any other costs other than those identified by the analysis.

Regulatory burden

The Australian Government has introduced the 'Guide to Regulation', which discusses the importance of cutting red tape.

A key principle for Australian Government policy makers in the Guide to Regulation is that:

The cost burden of new regulation must be fully offset by reductions in existing regulatory burden.

All regulatory costs, whether arising from new regulations or changes to existing regulation, must be quantified using the Regulatory Burden Measurement framework. The framework must also be used for quantifying offsetting regulatory savings, where applicable.

As measured in accordance with the framework, the regulatory offset required to implement Option 2 would be a total of \$230 million annually. The Commonwealth's share of this is \$25.8 million annually.¹¹⁶

Governments of the states and territories are not required under COAG policy to identify regulatory offsets. Some jurisdictions may have their own mechanisms regarding regulatory offsets, which would be a matter for those jurisdictions to consider.

¹¹⁶ Regulatory burden has been calculated in accordance with the RBM framework. Annual burden calculated by dividing the Present Value costs by 10 and then dividing the total annual burden by 9 to reflect the Commonwealth's contribution to the decision making.

Consultation

Consultation is the cornerstone of the ABCB's commitment to create a contemporary and relevant NCC that delivers good societal outcomes for health, safety, amenity and sustainability in the built environment. This must be achieved in the context of good regulatory practice that evaluates the costs and benefits to society, as per the objective of the ABCB's Intergovernmental Agreement. The ABCB recognises the value of engaging constructively with the community and industry in order to achieve this.

Lead in Plumbing Products Forum

On 23 May 2019, the ABCB convened a Lead in Plumbing Products forum which was hosted by Standards Australia. The attendees of the forum were representatives of:

- Consumer Electronics Suppliers Australia
- Bunnings Group
- Reece Group
- Master Plumbers Association – Australia
- Master Plumbers Association – New Zealand
- Hydraulic Consultants Association of Australasia
- PPI Group
- AI Group
- enHealth
- Australian Association of Certifying Authorities
- Accredited testing laboratories
- Brassware Association Queensland
- Representatives of Standards Australia's technical committees:
- PL-021 – PVC, ABS and Polyamide Pipe Systems
- PL-006 – Polyolefin Pipe Systems
- WS-028 – Design and Installation of Buried Flexible Pipes
- WS-027 – Drinking Water Treatment Systems
- WS-026 – Valves Primarily for use in Warm and Hot Water Systems
- WS-022 – Valves for Waterworks Purposes
- WS-001 – Water and Gas Fittings
- EL-020 – Electric Water Heating Appliances
- WS-016 – Cast Iron Pressure and Pipe Fittings
- CH-034 – Materials in Contact with Drinking Water
- WS-003 – Sanitary Plumbing Fixtures

The forum provided useful information on the current market, range of products, impacts (costs) of reducing lead and the feasibility of options. The survey and discussion revealed a high level of support for reducing lead in plumbing products. The forum discussed products in general terms noting individual products more likely to be manufactured within Australia include valve manufacturing and storage water heaters, where instantaneous water heaters and flexible connectors are predominantly imported.

For affected products, a reduction of lead in brass material inputs increases machining time and wear, resulting in higher material costs and lower batch sizes. In general, prices would be expected to increase as a result of compliance with lower lead levels. As a highly competitive plumbing market these would be reflected in retail costs.

For the regulatory option, transition periods were acknowledged as an important factor in enabling:

Affected manufacturers to:

- test
- purchase equipment
- source raw materials.

Suppliers to:

- consider their response to the range of products
- undertake testing and certification
- place forward orders (up to 6 months in advance)
- allow throughput of old stock (in warehousing, branches and customers).

The consensus was a minimum of three years from enactment (to prepare and allow for throughput of remaining stock).

Stakeholders preferred option

The Consultation RIS asked stakeholders which was their preferred option and why.

The majority of respondents (70%) supported implementation of Option 2 with little support shown to retaining the status quo (5%) and Option 3 (2%). At an industry level, implementation of Option 2 was also supported, as reflected by major industry groups (PPI Group, Ai Group, a state industry association), in recognition that the proposed

requirements were already adopted in the USA and Canada and low lead products were currently available on the Australian market.

A further 23% supported an alternative option, which comprised of either:

- A hybrid of the Option 2 and the alternative regulatory option.
- Requiring all products in contact with drinking water contain 0.25% regardless of the weighted average of the wetted surface area.
- Require testing to AS/NZS 4020 at the point of use and require labelling.
- Further research being undertaken prior to a policy decision.

Conditional support

Responses were often caveated. Many within industry viewed Option 2 as a logical progression towards lower lead plumbing products having the benefit of being consistent with the much larger markets of the USA and Canada, removing any doubt regarding its implementation in practice. In doing so, industry groups and manufacturers wanted decision makers to acknowledge the significant impacts of Option 2 by way of implementing a suitable transition period, with most of the industry sector advocating for a 5-year transition period.

An industry group (Ai Group) wanted decision makers to acknowledge the high aggregate costs in meeting the community expectation the problem was addressed by lowering the permissible levels of lead in plumbing products in contact with drinking water.

Both the aggregate cost and need for a suitable transition period is reflected in the Decision RIS.

NHMRC and enHealth both noted the need for a review of AS/NZS 4020 to be more reflective of Australian conditions, the level of lead allowed under an AS/NZS 4020 test and any material included as a substitute for lead be established as safe and health-based guidelines for bismuth and silicone be subject to more research.

A manufacturer who wanted to remain anonymous, while supportive of Option 2 strongly encouraged the alternative option to be "Require all materials in contact with

drinking water to contain 0.25%, or less, lead content therefore no longer requiring any complex calculations for evaluating the weighted surface area.”

The writing body responsible for the development of NSF/ANSI 372 provided some helpful explanation on the origins of the standard and how compliance is achieved and the impact it has had on the availability of compliant products:

“Over 1800 manufacturers now have products currently certified to the standard by seven ANSI accredited certification organizations in the USA and Canada. One benefit of adopting NSF 372 is that it is a low cost and a fast test to conduct, where the testing can be finished in a few hours. Adoption of NSF 372 has led to the development of a number of low lead brass alloys that are used in NSF 372 compliant products”.

The US experience was positive given a number of certified manufacturers and ease at which the testing can be undertaken. As the low lead copper alloy product market increases, this will have a positive impact on competition and pricing of these products.

While not opposed to implementing Option 2, an industry association (HIA) suggested that a potential unintended consequence was to ensure compatibility with the requirements of other building standards that may be contradictory to the low lead requirements.

The ABCB and Standards Australia have discussed the impacts proposed changes to the PCA would have on product standards. This was also a topic at the 2019 industry forum, where Chairpersons from each impacted Standard were represented. Current discussions have revealed no incompatibility issues with Option 2, though it was acknowledged that each Standard would need to be updated to reflect any change to the PCA. Standards Australia have offered to coordinate this update with the assistance from the ABCB once agreed by decision makers.

Importantly, of the Australian manufacturers who responded to the Consultation RIS, Enware were the only manufacturer who did not support implementation of Option 2. Further, Enware’s proposed fourth option relies on data which could take several years to obtain should be treated as an extension of the status quo.

Summary of opinions accompanying preferred options

A summary of the responses received in support of stakeholder's preferred option is provided below:

Option 1

- Products can already meet the requirements of AS/NZS 4020 with ease under the current maximum lead limits.
- The extra costs involved do not justify the potential risk of lead poisoning over a lifetime from other sources. Many people also drink bottled water.

Option 2

- Ensures the end-goal of protecting the general public is achieved.
- Every attempt should be made to remove lead as much as possible.
- Likely the most acceptable option to the community.
- Current permitted lead levels are too high.
- Guaranteed way to ensure less lead is used and effective in addressing the problem provided short term release of lead is also addressed.
- Removes uncertainty and establishes a clear unambiguous benchmark.
- Avoids reliance on water treatment and instead addresses the problem via a proven solution from the USA.
- Thousands of products produced worldwide currently comply with NSF/ANSI 372.
- Preferred option relative to the other options considered.
- Prevents split incentives of the plumbing practitioners influencing product selection.
- A good starting point for future changes being possible (e.g. lowering the maximum threshold for lead in AS/NZS 4020 and making changes to water testing requirements).

Option 3

- Prevents a knee-jerk reaction to 'elevated' levels of lead in samples taken from new plumbing installations in a handful of high-profile projects where other

factors may have been at play in the desire to highlight the seriousness of the problem.

Other options

- (Require all materials to contain less than 0.25% lead) – Option 2, as it is proposed, will continue to allow higher lead content alloy to remain in the market by those manufacturers who are willing (and technically allowed to) work the system.
- (Undertake further research) – The information presented in the CRIS was completely deficient and the evidence presented did not provide sufficient cause to support any of the proposed options.
- (Require testing to AS/NZS 4020 at the point of use and require labelling) – There is a view that Watermarked products will assure compliance to the appropriate guideline (ADWG); this is not the case, when new (or replaced) plumbing fixtures are used and heavy metal leaching can be prevalent, particularly in corrosive potable water.

The Consultation RIS asked stakeholders whether there were any other comments they would to provide.

Other comments received centred around stakeholders' position on the need for a transition period. See the section titled Implementation and Review for further information.

An individual from an engineering firm (Galvin Engineering) raised three other considerations relating to:

- The need for compliant product identification through markings and labelling.
- Whether spare parts associated with products would be captured by the requirements.
- The impacts of the proposed changes on existing building and plumbing approvals.

The following points are made in relation to each point:

- In the short-run, labelling is identified as an important feature that will enable practitioners to readily identify compliant products. The importance of this will increase if the timeframes for enforcement occur at a point prior to all products having been certified to the new requirements and labelled in accordance with the WMCS. Given the existing labelling requirement in the US, it is recommended that the ABCB mutually recognise existing labelling requirements in the interim until such time all products are certified under the WMCS.
- All components of copper alloy plumbing products in contact with drinking water will be required to comply with NSF/ANSI 372 under Option 2. This includes spare parts for products.
- The impacts of the proposed changes will be softened by a suitable transition period. Professionals should have regard for the requirements when making recommendations regarding product selection. However, the installation of low lead products will not become mandatory until the transition period has ended.

Conclusion

Following a number of highly publicised incidences of lead being found in drinking water exceeding 10 µg/L, the ABCB has been tasked with investigating the use of lead in the manufacture of plumbing products in contact with drinking water.

The use of lead is currently permitted in the manufacture of plumbing products in contact with drinking water. It is most commonly found in small amounts when mixed with other metals to create copper alloys such as brass and bronze. Current product and material standards allow up to 6% lead content, and laboratory testing of plumbing products in contact with drinking water has shown that lead leaches from these products.

Current regulatory intervention aimed at reducing lead exposure has been effective in Australia with a 50% reduction in health consequences since 1990. This is largely due to interventions aimed at reducing the use of lead in commonly used products and consumables such as paint, fuel, drinking water and toys. Despite these improvements, health authorities, including the WHO and the NHMRC continue to encourage governments to eliminate all non-essential uses of lead.

There is limited available data on the impacts of reducing low lead exposure in Australia. Policy setting and standards writing bodies, such as the ABCB, would benefit from health authorities examining the water lead levels from within premises or properties in Australia and the blood lead levels within the general population. Available studies indicate that the problem of lead exceeding the 10 µg/L in drinking water could effect a proportion equal to or greater than 8% of properties. However, these studies are small in sample size¹¹⁷.

In the absence of national data on the health consequences of lead in drinking water, the GBD database shows that lead exposure continues to be a problem in Australia. It attributes the health burden of lead exposure to be between 11,979 and 39,723 DALYs in 2019, with a central estimate of 25,017 DALYs. This large range, coupled with the uncertainty of drinking water's contribution, reflects the limitations of the GBD as an indicator. This analysis acknowledges that specific studies, which examine the

¹¹⁷ Based on a study of 212 houses in NSW by Harvey, et al 2016.

health consequences of lead in Australian drinking water, may derive narrower quantitative conclusions.

Three options are presented for decision:

- Option 1: Retain the status quo. This option is regarded as the baseline.
- Option 2: Require all products in contact with drinking water to contain a maximum lead content of 0.25%.
- Option 3: Amended since consultation, this option recommends changes to government procurement standards to require compliance with NSF/ANSI 372.

The impacts of Option 2 are very large, both in costs and benefits. This reflects the number of products impacted by the proposed changes and the price difference between leaded copper alloy products and low lead copper alloy products (which result from higher production costs). The cost of this option is estimated to be \$2.3 billion in Present Value terms.

Further regulatory intervention aimed at reducing lead exposure from drinking water will not be immediate and exposure from drinking water is expected to gradually fall, as existing plumbing products in contact with drinking water are replaced by new products over time.

Having regard for the replacement rate, and using the corrected central estimates of the GBD database, the benefits of Option 2 are estimated to be in the range of \$2 billion and \$6.7 billion, with a central estimate of \$4.2 billion in Present Value terms. Option 2 demonstrates an overall net benefit of \$1.9 billion in Net Present Value terms under the central assumptions and is robust when sensitivity analysis of key parameters is undertaken, with strong net benefits in all but one scenario.

In the absence of certainty regarding the total benefits derived from Option 2, a break-even analysis has also been included in the Decision RIS. The contribution that lead in plumbing products in contact with drinking water needs to make to the total health burden of lead exposure is approximately 11% in order for the benefits to break-even with the cost. This rate is small and plausible even when considering the reduction of sources of lead over the past two decades, although higher than that reported in one jurisdiction (Victoria, which ranged between 0 and 6% over the years 2011 to 2014 and 2016 to 2018).

Option 3 has less overall impact and is a subset of Option 2. The costs of Option 3 are estimated to be \$261 million and the benefits to be \$474 million in Present Value terms, with a net benefit of \$213 million in Net Present Value terms.

As Option 2 has large impacts, particularly to the supply chain of copper alloy plumbing products in contact with drinking water, a suitable transition period is required (see implementation and review). In contrast, transitional arrangements may not be required for Option 3, which could be implemented sooner and, while it would be outside of the ABCB remit, its benefits would be tied to demand and the timing of changes to government procurement rules.

The preferred Option of the Decision RIS is Option 2, as this option is likely to produce the highest net benefits and be more effective relative to the alternative options analysed. If supported by decision makers, this would result in a requirement that products in contact with drinking water contain not more than 0.25% weighted average lead content in the PCA.

Recommendations that accompany Option 2

The Decision RIS has acknowledged the following additional administrative steps as being essential to achieving the objective and managing the impacts of the change:

- a. A minimum 3-year transition period for recertification of copper alloy plumbing products in contact with drinking water through the WMCS.
- b. Development of an implementation plan by ABCB in consultation with impacted stakeholders, outlining key milestones and review points for installation and enforcement of the change at the point of installation.
- c. Prioritise consequential amendments to product specifications and the WMCS which are necessary to ensure compatibility with changes to the NCC.
- d. Assist work to determine appropriate amendments to AS/NZS 4020 to ensure it is reflective of factors that influence quality of drinking water subject to analysis and further consultation with impacted stakeholders.
- e. Work be undertaken with health authorities to verify the suitability of lead substitutes and the need for threshold values or possible health-based guideline values.

Implementation and Review

If decision makers support changes to the PCA, the provisions will be included in NCC 2022. As a matter of policy, proposed changes to the PCA are released in advance of implementation to allow time for familiarisation and education and for industry to modify its practices to accommodate the changes. This would be expected to occur in mid-2021. It is also anticipated that the ABCB, in association with state and territory plumbing administrations and industry organisations, would conduct information and awareness raising practices.

If the preferred option is implemented, this will have significant impact on the copper alloy plumbing product supply chain in terms of sourcing suitable raw material, upgrading equipment and the need for retesting with both the new provisions and retesting to AS/NZS 4020. As such, a suitable transition period is required.

There are two possible regulatory mechanisms for transitioning to low lead plumbing products in contact with drinking water:

- via the PCA, which is amended every 3 years; or
- via the renewal of a product's WaterMark certificate where products are currently required to renew their certification every five years.

The Consultation RIS asked stakeholders whether they believed a transitional period was required and, if so, what time period was suitable.

Industry groups, in particular, saw the need for a transition period to be the key issue to be addressed.

A majority of respondents (85%) felt that a transition period was required when implementing Option 2. This was due to the change in manufacturing processes and consequent retesting required by the accredited laboratories being significant.

Opinions on the duration of the transition period required were mixed, with 47% recommending a 3-year transition and 38% recommending five years. Of those who advocated for the longer duration, most were manufacturers or industry groups with an in-depth understanding of the practical implications new requirements would have on domestic manufacturing and the time required to sell-down existing stock.

Impacted industry bodies (Ai Group, AWHF, HIA, a product material association, a state industry association, PPI Group, WSAA) all supported a 5-year transition period with many of these groups arguing that the need for an adequate transition warranted significantly more discussion with industry given the scale of change that would be required across the whole supply chain including:

- obtaining raw material for producing low lead products,
- the need for re-tooling,
- product redesign,
- reskilling plant operators who would be dealing with a new raw material,
- reassessing quality control functions,
- selling-down of current products,
- retesting and re-certification of all existing products.

Adding further support to their preferred 5-year transition, manufacturers and suppliers indicated that five years would still present challenges as they meet current demands, before obtaining raw materials, re-tooling, testing, certification, etc. could occur. Current uncertainty regarding the impacts of COVID-19 and ongoing border closures also added to calls for a longer time period with one manufacturer (Enware) requesting the 5-year transition commence after border restrictions had eased.

Accredited testing laboratories and industry groups have expressed preference with aligning the commencement of the new requirements with the WMCS. This would result in a 5-year transition period. It would also allow for the expiration of existing WaterMark certificates, allowing normal process of re/certification to WaterMark to manage compliance and labelling.

Given the concerns of industry, it is recommended that an implementation plan be developed in consultation with plumbing industry groups and testing laboratories to ensure key milestones and review points can be established for the transition period.

Figure 6: Key stages in the implementation of Option 2



Figure 6 shows the key stages required under the implementation of Option 2.

A specific review of the preferred option is not planned following implementation. The NCC is amended on a three-year cycle and the ABCB maintains regular and extensive consultative relationships with a wide range of stakeholders. It relies on this process to identify emerging concerns, and through these relationships can evaluate the effectiveness of the requirements over time.

Attachment A

Proposed changes to Plumbing Code of Australia

Option 2 would result in the following changes to the Evidence of Suitability criteria¹¹⁸:

A5.3 Evidence of Suitability

(1) Any product that is intended for use in contact with drinking water must—

- (a) Comply with the relevant requirements of AS/NZS 4020, verified in the form of either—
- i. a test report provided by an ~~certification body or~~ *Accredited Testing Laboratory*, in accordance with AS/NZS 4020; or
 - ii. a *WaterMark licence* issued in accordance with (2), if it includes compliance with AS/NZS 4020; and

(2) Any copper alloy product that is intended for use in contact with drinking water, must have a weighted average lead content of no more than 0.25% verified in the form of either—

- i. a test report provided by an Accredited Testing Laboratory, in accordance with NSF/ANSI 372; or
- ii. a WaterMark licence issued in accordance with (2), if it includes compliance with NSF/ANSI 372.

Application:

Products captured by A5.3(2) include:

- Fittings;
- Valves;
- Fittings for stainless steel braided hoses;
- Taps;
- Mixers;
- Water heaters;
- Residential water filters; and

Water dispensers (such as boiling and cooling units).

¹¹⁸ Draft proposal subject further consultation via the public comment draft of NCC 2022.

Exemption:

Products excluded by A5.3(2) includes:

- Showers for bathing;
- Emergency showers, eye wash and/or face wash equipment;
- Pipes;
- Fire-fighting equipment (including residential fire sprinklers);
- Irrigation;
- Appliances, including washing machines and dishwashers;
- Commercial boilers (associated with heating, ventilation and air-conditioning systems);
- Toilets; and

Non-drinking water systems (such as recycled water systems).

The following definitions are proposed for Schedule 3:

Weighted average – calculated across the *wetted surface area* of a pipe, pipe fitting and plumbing fixture.

Wetted surface area – calculated by the total sum of diameter (D) in contact with drinking water.

For the purposes of clarity in relation to low lead, the following definition is proposed for Schedule 3:

Low lead – a plumbing product or material in contact with *drinking water* calculated using a *weighted average* lead content of no more than 0.25%.

Explanation of changes

NSF/ANSI 372 is an American National Standard that establishes a standardised methodology for the determination and verification of product compliance to minimise lead contaminants.

The NSF/ANSI 372 standard includes:

- A maximum weighted lead content of 0.25% (0.2% for solders and fluxes).
- A formula for calculating the weighted average lead content of each product prior to testing.
- Specific procedures for testing products for lead content.
- Verification test requirements.

NSF/ANSI 372 addresses the lead content of a product and, to ensure compliance is achieved, it is proposed to require certification by an Accredited Testing Laboratory or certification body.

Conformance to an extraction or leaching test standard, AS/NZS 4020, would remain.

In accordance with the Governing Requirements (A1.4) the NCC over-rides any differences between it and its primary or secondary referenced document. The required limits of product and material specifications could be amended to align with this requirement post adoption of NCC 2022.

How to calculate the wetted surface area

A worked example of how to calculate the weighted average lead content of a plumbing product is shown in Table A1.

Table A1: NSF/ANSI 372 – 2016 Annex A (Informational) Example of weighted average lead content calculation

Component no.	Wetted surface area 1 (total = $\sum D$)	Ratio wetted surface area	% lead content	% lead contribution
1	1,142.27	0.0453	0	0.0000
2	4,472.17	0.1774	0.25	0.0444
3	157.58	0.0063	0.55	0.0034
4	1,013.50	0.0402	0.25	0.0101
5	382.60	0.0152	0	0.0000
6	695.74	0.0276	0	0.0000
7	425.85	0.0169	0	0.0000

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Component no.	Wetted surface area 1 (total = $\sum D$)	Ratio wetted surface area	% lead content	% lead contribution
8	16,915.63	0.6711	0.02	0.0134
	25,205.34			<u>0.0713%</u>

Notes:

1. This example assumes that there are eight components in the one product with varying degrees of wetted surface area.
2. The wetted surface area is measured by the total sum of diameter (D) in contact with drinking water. That is, the length of the pipe or fitting in contact with drinking water multiplied by its diameter.
3. The ratio wetted surface area is the wetted surface area of the component divided by the total wetted surface area of all components.
4. The percentage of lead contribution is calculated by multiplying the ratio of wetted surface area by the percentage of lead content (e.g. $0.1774 \times 0.25 = 0.0444$).

From NSF/ANSI 372:

4.2 Formula for determining weighted average lead content

The following formula shall be used when calculating the weighted average lead content of products:

$$WLC = \sum_{c=1}^n \left(LC_c \times \left[\frac{WSA_c}{WSA_t} \right] \right)$$

where;

WLC = weighted average lead content of product
 LC_c = maximum lead content of the cth component
 WSA_c = wetted surface area of the cth component
 WSA_t = total wetted surface area of all components
 n = number of wetted components in product

NOTE — An example calculation of the weighted average lead content of a product is provided in Annex A.

Attachment B

Table B1: Representative Product Types and Categories

Product Type
Fittings
Extension M & F 15mm x 50mm brass
Socket hex brass 20mm
Socket M & F red brass hex 20mm x 15mm
Elbow F & F brass 15mm
Cap brass 20mm
All thread nipple brass 15mm x 150mm
Elbow F & F brass 20mm
Plug hex square brass 15mm
All thread nipple brass 20mm x 300mm
Union barrel M & F brass 20mm
Elbow M & F brass 25mm
Elbow F & F brass 20mm
Plug hex square brass 20mm
Brass screwed tube 15mm x 600mm
Bush reducing brass 15mm x 25mm
Valves
Water meter including kit 20mm
M & F right angle ball valve 20mm
Y strainer 50mm
Brass Inline M & F cistern cock 15mm
Expansion control valve 15mm
Spring check valve 25mm
TMV 20mm
Brass ball valve 50mm F & F
Brass ball valve 20mm plain
Brass tempering valve 15mm
Compact PRV limiter 20mm
Brass duo non-return valve 15mm
Dual check valve 20mm
Brass RPZ valve 25mm
Stainless Steel Hoses
15mm S/S 300mm long
15mm S/S 450mm long
15mm S/S 600mm long
15mm S/S 1000mm long

Product Type
Taps and Combinations
Hose tap plain 15mm
Mini isolation cock plain 15mm
Taps other
Mixers
Kitchen mixers
Basin mixers
Shower mixer chrome
Shower bath mixer chrome
Sink with vegetable spray chrome
Water Heater Systems
Continuous Flow Gas
17ltr/min Gas wall instant
20ltr/min Gas wall instant
26ltr/min Gas wall instant
Gas Storage
130ltr/min Gas storage
170ltr/min Gas storage
Heat Pump
170ltr Heat pump electric
280ltr Heat pump electric
Solar
315ltr Solar H/W split system
Electric Storage
20ltr HWS electric
50ltr HWS electric
80ltr HWS electric
125ltr HWS electric
160ltr HWS electric
250ltr HWS electric
315ltr HWS electric
400ltr HWS electric
Mechanical Continuous Flow
Residential Water Filtration
Above sink or counter top filtration system
POU cartridge under sink filtration
POU twin housing under sink system
POU RO system
POE filtration system
POE water softener
Water Dispensers
Under sink cold water (unchilled/chilled)
Under sink hot and cold (entry level/mid-level)

Attachment C

List of material and product standards impacted by the proposed changes can be found in Table C1.

Table C1: Current Material Specifications

Australian Standard	Maximum allowable lead content
AS 1565: Copper and copper alloys — Ingots and castings	Castings comprise less than 4.5%
AS/NZS 1568: Copper and copper alloys— Forging stock and forgings	Hot pressing (forgings) less than 3.5%
AS/NZS 1567: Copper and copper alloys— Wrought rods, bars and sections	Rod for machined parts less than 3.5%
AS/NZS 1572: Copper and copper alloys— Seamless tubes for engineering purposes	Tubular component (typically outlets) 5%

The selection of the copper grade used to manufacture plumbing products is set out by each corresponding product standard. This is shown below in Table C2.

Table C2: Plumbing product standards containing maximum lead content levels

Product	Standard	Component	Copper Alloy Grade	Allowable lead
Gate Valves – Metal Seated	AS/NZS 2638.1	Spindle Seal Retainer, Gate, Gate Nut, Seat Rings	C83600	4% - 6%
Gate Valves – Resilient Seated	AS/NZS 2638.2	Spindle Seal Retainer, Gate Nut	C83600	4% - 6%
Spring Valves	AS 3952	Dome	C83600	4% - 6%
Non-return Valves	AS 4794	Disc, Seat Rings	C83600	4% - 6%
Butterfly Valves	AS 4795.1	Disc, Bearings	C95810	0.05%

Product	Standard	Component	Copper Alloy Grade	Allowable lead
	AS 4795.2 AS 5612		C92710 C93500 C93700	4% - 6% - -
Air Valves	AS 4956	Seat	C83600	4% - 6%
Tapping Bands	AS 4793	Body, Outlet	C83600 C48600	4% - 6% 2.5% - 6%
Meters	AS 3565	Body	Not specified	N/A
Ball Valves	AS 4796	Body	C37710 C83600	1% - 3% 4% - 6%
Automatic Control Valves	AS 5081	Piston, Guide Bushings, Pilot Valve Body, Plug	C90250 C83600 C93500	0.3% 4% - 6% -
Ferrules	AS/NZS 3718 AS 3496	Body	Not specified	N/A
Bronze Gate Valves	AS 1628	Body	Not specified	N/A
Copper Pipe – Main to Meter	AS 1432	Pipe	C12200	Nil
Miscellaneous Fittings and Connectors	AS 3688	Body	Not specified	N/A

Source: WSAA (2020)