

# Boric acid and precursors to boric acid: Environment tier II assessment

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**CAS Registry Numbers: 10043-35-3, 11113-50-1, 13460-51-0, 12008-41-2, 26038-87-9, 1303-96-4**



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## Preface

This assessment was carried out by staff of the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) using the Inventory Multi-tiered Assessment and Prioritisation (IMAP) framework.

The IMAP framework addresses the human health and environmental impacts of previously unassessed industrial chemicals listed on the Australian Inventory of Chemical Substances (the Inventory).

The framework was developed with significant input from stakeholders and provides a more rapid, flexible and transparent approach for the assessment of chemicals listed on the Inventory.

Stage One of the implementation of this framework, which lasted four years from 1 July 2012, examined 3000 chemicals meeting characteristics identified by stakeholders as needing priority assessment. This included chemicals for which NICNAS already held exposure information, chemicals identified as a concern or for which regulatory action had been taken overseas, and chemicals detected in international studies analysing chemicals present in babies' umbilical cord blood.

Stage Two of IMAP began in July 2016. We are continuing to assess chemicals on the Inventory, including chemicals identified as a concern for which action has been taken overseas and chemicals that can be rapidly identified and assessed by using Stage One information. We are also continuing to publish information for chemicals on the Inventory that pose a low risk to human health, the environment or both. This work provides efficiencies and enables us to identify higher risk chemicals requiring assessment.

The IMAP framework is a science and risk-based model designed to align the assessment effort with the human health and environmental impacts of chemicals. It has 3 tiers of assessment, with the assessment effort increasing with each tier. The Tier I assessment is a high throughput approach using tabulated electronic data. The Tier II assessment is an evaluation of risk on a substance-by-substance or chemical category-by-category basis. Tier III assessments are conducted to address specific concerns that could not be resolved during the Tier II assessment.

These assessments are carried out by staff employed by the Australian Government Department of Health and the Australian Government Department of the Environment and Energy. The human health and environment risk assessments are conducted and published separately, using information available at the time, and may be undertaken at different tiers.

This chemical or group of chemicals are being assessed at Tier II because the Tier I assessment indicated that it needed further investigation.

For more detail on this program please visit: [www.nicnas.gov.au](http://www.nicnas.gov.au).

## Disclaimer

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### Acronyms & Abbreviations

## Grouping Rationale

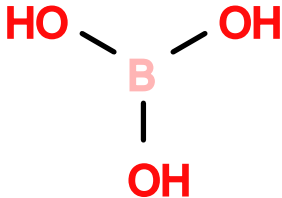
The Tier II risk assessment of the 5 boron compounds in this group has been carried out together because regardless of the parent compound the dominant boron species will be the same under normal environmental and physiological conditions (WHO, 1998). Furthermore, on a boron equivalent basis the substances in this group are likely to have similar toxicological and chemical properties when dissolved (WHO, 1998). In the environment, the chemicals in this group will dissociate and/or hydrolyse to release boron as boric acid [B(OH)<sub>3</sub> (also formulated as H<sub>3</sub>BO<sub>3</sub>)] and/or borate anions.

The boron compounds in this group have a variety of uses in household and commercial applications. Boric acid has applications in personal care products and high-volume consumer and commercial cleaning products which can lead to its release into sewers. As boron is not efficiently removed from wastewater during sewage treatment, the use of boron compounds in these products has significant potential to result in environmental exposure through a common pathway involving their release in the treated effluents and biosolids produced by sewage treatment plants (STPs).

This assessment provides reference information on the environmental fate and effects of boric acid which may be released into the environment from the industrial uses of other boron-containing substances listed on the Inventory. Over 100 boron-containing chemicals are listed on the Inventory that have the potential to dissociate and/or hydrolyse to release boron as boric acid. The environmental risks of these remaining boron substances will be assessed separately.

## Chemical Identity

The Chemical Abstracts Service has assigned CAS RN 10043-35-3 to the chemical identified as boric acid ( $H_3BO_3$ ). An alternate CAS RN (11113-50-1) has also been assigned to this chemical. Both CAS RNs are listed on the Inventory.

CAS RN	10043-35-3 11113-50-1
Chemical Name	Boric acid ( $H_3BO_3$ )
Synonyms	boric acid
Structural Formula	
Molecular Formula	$H_3BO_3$
Molecular Weight (g/mol)	61.83
SMILES	<chem>B(O)(O)(O)</chem>

CAS RN	13460-51-0
Chemical Name	Boric acid ( $H_3B_3O_6$ )
Synonyms	metaboric acid
Molecular Formula	$H_3B_3O_6$

Molecular Weight (g/mol)	131.45
CAS RN	12008-41-2
Chemical Name	Boric acid, (H <sub>2</sub> B <sub>8</sub> O <sub>13</sub> ), disodium salt
Synonyms	disodium octaborate sodium borate
Formula	B <sub>8</sub> Na <sub>2</sub> O <sub>13</sub>
Molecular Weight (g/mol)	340.46

The monoethanolamine compound with boric acid (CAS RN 26038-87-9) has indefinite chemical composition. According to industry information, alkanolamine borates such as this substance are complex mixtures of monomeric and polymeric borate esters and salts (Alkanolamine Borates Consortium, 2015).

CAS RN	26038-87-9
Chemical Name	Boric acid (H <sub>3</sub> BO <sub>3</sub> ), compound with 2-aminoethanol
Synonyms	monoethanolammonium borate monoethanolamine, boric acid salt MEA borate
Molecular Formula	C <sub>2</sub> H <sub>7</sub> NO·xBH <sub>3</sub> O <sub>3</sub>
Molecular Weight (g/mol)	Not applicable

CAS RN	1303-96-4
Chemical Name	Borax ( $\text{Na}_2(\text{B}_4\text{O}_7) \cdot 10\text{H}_2\text{O}$ )
Synonyms	disodium tetraborate decahydrate borax boric acid ( $\text{H}_2\text{B}_4\text{O}_7$ ), disodium salt decahydrate Tincal
Molecular Formula	$\text{Na}_2(\text{B}_4\text{O}_7) \cdot 10\text{H}_2\text{O}$ (or $\text{Na}_2(\text{B}_4\text{O}_5(\text{OH})_4) \cdot 8\text{H}_2\text{O}$ )
Molecular Weight (g/mol)	381.37

## Physical and Chemical Properties

Limited measured data are available for the compounds of boric acid in this group. In the environment, these chemicals are expected to dissociate and/or hydrolyse to release boric acid at neutral pH. Therefore, measured data available for boric acid have been presented as analogue data for these substances. This analogue chemical is also expected to be the dominant boron species formed from the dissociation and hydrolysis of borax at environmentally relevant concentrations (Cotton & Wilkinson, 1988). Measured data for boric acid were retrieved from Haynes (Haynes, 2015):

Physical Form	white or colourless crystalline granules
Melting Point	170.9°C (decomposition point)
Boiling Point	not applicable
Water Solubility (g/100g at 25°C)	5.8
pK <sub>a</sub>	9.14
Ionisable in the Environment?	yes

## Import, Manufacture and Use

### Australia

Borax and boric acid (CAS RN 10043-35-3), are listed on the 2006 High Volume Industrial Chemicals List (HVICL) within the total reported volume range of 1000–9999 tonnes (NICNAS, 2006). Based on previous mandatory and/or voluntary calls for information, these substances are mainly used industrially as construction materials, additives, flame retardants, fire-preventing agents, tanning agents, domestic/cleaning products and for the manufacture of other chemicals.

Chemicals in this group have reported site-limited uses as intermediates, and for the manufacture of products such as glass, fibreglass and porcelain. A number of non-industrial uses have also been identified including use in pharmaceutical preparations, as insecticides and herbicides, and for wood preservation (NICNAS, 2017).

As boron is an essential plant nutrient, soluble boron compounds (including borax) have an agricultural application as fertilisers in boron deficient soils, with these compounds being applied directly to soil or as a foliar spray (NSW Agriculture, 2003).

Boron compounds, including boric acid, are used in domestic coal seam gas (CSG) applications (Commonwealth of Australia, 2014). However, release from this use is beyond the scope of this assessment.

### International

Boron compounds (including boron oxides, boric acid, boron minerals) have a wide range of applications in industry (e.g. manufacture of glass, fibreglass and porcelain enamels, and precursors for chemical manufacture), agriculture (e.g. fertilisers, herbicides and insecticides), and in household settings (e.g. flame retardants and detergents) and personal care products. The greatest consumption of boric acid is for fibreglass manufacture (WHO, 1998).

A major use of boron compounds is in detergents and cleaning products where perborates are the most commonly used boron compounds. The boron compounds in this group are also used in cleaning products, but in smaller volumes than perborates (HERA, 2005).

Borate salts are commonly used in coal seam gas applications internationally (Stringfellow, et al., 2014).

## Environmental Regulatory Status

### Australia

High reliability trigger values for boron for freshwater have been determined. The guideline value to protect 95% of species in a *slightly-moderately disturbed* ecosystem is 370 µg B/L (ANZECC, 2000a & b). Irrigation water trigger values are also given as irrigation water is a major source of high boron levels in agricultural soils (WHO, 1998). There were insufficient data to derive guideline values for marine waters. The ANZECC guidelines recommended using the background concentration in seawater (5100 µg/L) as a low reliability trigger value (ANZECC, 2000b).

There is insufficient data to determine a soil cumulative contaminant loading limit (CCL). However, the threshold for extractable boron in the top 100 mm of agricultural soils is 15 mg B/kg. It is generally accepted that exceeding this threshold will cause toxicity to plants (Cartwright, et al., 1986, Government of South Australia, 2009). Other research has suggested that horticultural crops may be more sensitive to boron toxicity.

Boron is one of the most common phytotoxic ions that may be present in treated wastewater effluent (FAO, 1992). A long-term trigger value for boron in irrigation water has been recommended in the ANZECC guidelines (0.5 mg B/L) (ANZECC, 2000c).

## United Nations

None of the chemicals in this group are currently identified as a Persistent Organic Pollutant (UNEP, 2001), ozone depleting substance (UNEP, 1987), or hazardous substance for the purpose of international trade (UNEP & FAO, 1998).

## OECD

Borax, boric acid, and disodium octaborate are listed as OECD High Production Volume (HPV) chemicals (OECD, 2009). The chemicals are produced at a level greater than 1000 tonnes per year in at least 1 member country of the OECD.

## Canada

Four chemicals in this group are listed on the Canadian Domestic Substances List (DSL) (Government of Canada, 2016). Boric acid, sodium borate, monoethanolammonium borate, and borax were categorised as Persistent (P), not Bioaccumulative (not B), and not Inherently Toxic to the Environment (not iT<sub>E</sub>) by Environment Canada during the DSL Categorization.

Boric acid and borax are prioritised under the second phase of the Chemicals Management Plan (CMP). A draft screening assessment of 'Boric acid, its salts and its precursors' was published in 2016 and proposed to conclude that the substances in that group are harmful to the environment according to section 64 (a) of the *Canadian Environmental Protection Act 1999* (CEPA) (Canada Gazette, 2016).

The chemicals in this group are not currently listed under Schedule 1 (the Toxic Substances List) of the *CEPA* (Government of Canada, 2016).

The remaining chemical in this group is not currently listed on the DSL.

## European Union

With the exception of metaboric acid, all substances in this group have been pre-registered for use in the European Union (EU) under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation (ECHA, 2016) and have also undergone the full registration process (REACH, 2017).

Boric acid and borax have both been identified as a Substance of Very High Concern and recommended for inclusion in Annex XIV (the Authorisation List) of the REACH legislation in the European Union on the basis of its toxicity for reproduction (Article 57c) (ECHA, 2017b). The chemical is not currently identified as being of environmental concern.

## United States of America

With the exception of metaboric acid, all substances in this group are listed on the inventory of chemicals manufactured or processed in the USA, as published under the *Toxic Substances Control Act 1976* (TSCA) (US EPA, 2017).

## Environmental Exposure

All of the chemicals in this group will transform into boric acid in the aquatic environment. This simple mononuclear boron compound is highly water soluble and is the predominant form of dissolved boron in surface waters. It is a mobile species in the environment and is found in all major environmental compartments.

## Environmental Fate

## Dissolution and Speciation

In the environment, borates and compounds of boric acid will dissociate and/or hydrolyse to form the same boron species (WHO, 1998). For example, when borax dissolves in dilute solutions, it dissociates into  $\text{Na}^+$  ions and the tetraborate anion ( $\text{B}_4\text{O}_5(\text{OH})_4^{2-}$ ). Boric acid ( $\text{B}(\text{OH})_3$ ) is formed following acid catalysed hydrolysis of the tetraborate anion. Under alkaline conditions, dilute solutions of the tetraborate anion depolymerise rapidly to the mononuclear borate anion ( $\text{B}(\text{OH})_4^-$ ) (Cotton & Wilkinson, 1988).

Boric acid ( $\text{B}(\text{OH})_3$ ) has been used as an analogue chemical in this assessment as this will be the dominant boron species in surface waters under typical environmental conditions. Boric acid is a Lewis acid that acts as a weak monoprotic acid by accepting  $\text{OH}^-$  and not as a proton donor ( $\text{p}K_a 9.14$ ). Therefore, at the near neutral pH of most environmental systems and at low concentrations ( $<0.025$  mol B/L), the neutral mononuclear species ( $\text{B}(\text{OH})_3$ ) will dominate and only a small proportion of boron will exist as the borate monoanion,  $\text{B}(\text{OH})_4^-$  (WHO, 1998). Therefore, in the environment boric acid is in equilibrium with borate anions. Both species are very stable as they do not undergo biotransformation or redox reactions under normal environmental conditions.

Polyborate anions (e.g.  $\text{B}_3\text{O}_3(\text{OH})_4^-$  and  $\text{B}_5\text{O}_6(\text{OH})_4^-$ ) are present in concentrated solutions; however, their concentrations will be negligible in the environment (Ingri, et al., 1957) in (Xiao, et al., 2011).

## Partitioning

Boron compounds occur in the atmosphere as particulate matter or as a vapour, with the latter being the dominant form in air. The largest contributor to boron in the atmosphere is volatilisation of boron from seawater. However, boron is not present in the atmosphere at significant levels due to the low volatility and high solubility of borates (Sprague, 1972). The average concentration of boron in the atmosphere is low [ $20 \text{ ng/m}^3$ , (WHO, 1998)].

Boric acid is highly water soluble and it tends to remain in surface waters. Although some partitioning from water to soil and sediment does occur, the adsorption is pH dependent with the greatest adsorption occurring under alkaline conditions [pH 7.5 to 9.0, (WHO, 1998)].

Borates can adsorb to soil particles. However, under certain conditions, boron is relatively mobile and susceptible to leaching – particularly in acidic, sandy soils that receive high rainfall (Keren & Bingham, 1985). Conversely, boron can accumulate in heavy-textured sodic soils that have a high concentration of clay and Al/Fe oxides and receive low rainfall (550 mm/yr). The adsorption of boron to clay particles increases at high ionic strength (Peak, et al., 2003). The main factors that control the adsorption of boron to soil particles are soil type, concentration of organic matter, concentration of Al/Fe oxides, clay mineralogy, and soil pH.

Soil pH is one of the most important factors affecting boron adsorption. Over the pH range of 3 to 9, boron adsorption increases with increasing pH. Maximum adsorption usually occurs near the  $\text{p}K_a$  of boric acid (9.14) (the affinity of clay minerals for the uncharged boric acid species ( $\text{B}(\text{OH})_3$ ) is relatively low). Above this pH, the borate anion ( $\text{B}(\text{OH})_4^-$ ) becomes the dominant species and boron adsorption decreases due to competition with  $\text{OH}^-$  ions for adsorption sites.

The mechanisms that control the adsorption of boron on clays are not fully understood; however, it is likely that boron adsorbs to the edges of clay minerals (Goldberg, 1997). As boric acid is relatively soluble and mobile in soil, boron usually only accumulates in heavy clay soils in low-rainfall areas.

## Bioaccumulation

Boric acid does not accumulate in mammals, fish or insects. However, it does accumulate in aquatic and terrestrial plants, but does not biomagnify through the food chain (CMME, 2009).

The uptake of boron by plants is a passive process (Dannel, et al., 2002). Boron is transported from the roots to the shoots in the xylem where it accumulates following evapotranspiration. Once in the leaves it is typically considered immobile as it does not translocate to other plant parts (e.g. fruit). However, recent evidence suggests that in some species, specifically those that



transport polyols, boron is mobile in the phloem and can be transported to other plant tissues [e.g. flowers or grain (Hendrix, 2005)].

## Transport

Boric acid and the borate ion occur naturally in the environment and enter soils and aquatic systems primarily through the weathering of rocks and other geological processes. Although they are highly soluble in water and tend to accumulate in surface waters, they do have the potential to partition to other compartments as discussed above. Under certain conditions, boric acid is relatively mobile in soils and is susceptible to leaching as it is soluble in soil solution.

## Predicted Environmental Concentration (PEC)

A PEC was not calculated for the chemicals or their ionic components addressed under this assessment.

The background concentrations of boron in the environment vary widely and depend on geological factors (WHO, 1998). Oceans contain the greatest amount of boron where it has an average concentration of 4.5 mg B/L and is an important pH buffer (CMME, 2009). No reliable or current data were identified for background concentrations of boron in Australian freshwaters. However, global concentrations are typically below 0.1 mg B/L, with a 90<sup>th</sup> percentile boron concentration of approximately 0.4 mg B/L (WHO, 1998).

Freshwater concentrations of boron are greatly influenced by the geochemical nature of the drainage area and anthropogenic inputs (CMME, 2009). The main anthropogenic input of boron to surface waters is from the use and manufacture of sodium perborates in detergent formulations (ANZECC, 2000b). Similarly, the most likely source of emissions of boron chemicals in this group—although in lower volumes than perborates—is from their use in detergents and cleaning products (ANZECC, 2000b, HERA, 2005).

The range of measured mean concentrations of boron in the treated effluents of 3 South Australian STPs (0.3 to 0.5 mg B/L) are comparable with findings from North America, Europe and the United Kingdom (1.0, 1.0 and 6.5 mg B/L, respectively) (ATSDR, 2010, SA EPA, 2005). No specific data regarding boron emissions to wastewater from domestic or industrial sources in Australia were identified for this assessment. Boron is largely unaffected by wastewater treatment (ATSDR, 2010) and therefore influent concentrations are not expected to be significantly higher than measured effluent concentrations.

## Environmental Effects

In ecotoxicological tests for boron, the exposure concentrations are expressed as boron equivalents i.e. mg B/L. This is because boric acid and borate salts will have the same boron speciation when dissolved in environmental matrices. Therefore, in the following sections toxicological values are given as mg B/L regardless of the form of boron that was tested.

## Effects on Aquatic Life

Based on the toxicity of boric acid, the chemicals in this group will have low acute and chronic toxicity to aquatic organisms.

Boron is an essential trace element for plants and is involved in a range of cellular processes (e.g. carbohydrate metabolism, cell wall synthesis (Tanaka & Fujiwara, 2008)). However, the essentiality of boron in other organisms, such as algae, is not fully understood. Despite the similarities between higher plants and algae in terms of photosynthetic pathways, it is not known if algae can actively regulate boron. This can complicate the interpretation of algae toxicity data. In addition, boron, as boric acid, is used as a trace element in the standard test media used for toxicity testing (for example, OECD Test Guideline 201).

## Acute toxicity

The following measured median effective concentration (EC50) and median lethal concentration (LC50) values for model organisms were retrieved from the scientific literature (Hanstveit & Oldersma, 2000), and the former European Centre for

Ecotoxicology and Toxicology of Chemicals (ECETOC, 1997) assessment of boric acid:

Taxon	Endpoint	Method
Fish	96 h LC50 = 14.2 mg B/L	Experimental <i>Brachydanio rerio</i> (Zebrafish)
Invertebrates	24 h EC50 = 242 mg B/L	Experimental <i>Daphnia magna</i> (Water flea)
Algae	72 h EC50 = 34–52 mg B/L	Experimental <i>Scenedesmus subspicatus</i> (Green algae) Growth inhibition

There is an extensive set of acute aquatic toxicity data available for boron compounds, including test results for aquatic plants, microalgae, aquatic invertebrates, and fish (WHO, 1998). The weight of evidence from these studies is that soluble boron compounds generally have low to very low toxicity to aquatic organisms for short term exposure.

## Chronic toxicity

The chronic toxicity of boron to freshwater species was critically evaluated for the compilation of water quality trigger values for environmental contaminants in the ANZECC guidelines (ANZECC, 2000a). Freshwater trigger values were calculated using chronic end-points from four taxonomic groups and converted to no-observed effect concentration (NOEC) equivalent values (ANZECC, 2000b):

Taxon	Endpoint	Method
Fish	32 d LC 50 = 27.6 mg B/L	Experimental <i>Oncorhynchus mykiss</i> (Rainbow trout) Mortality
Invertebrates	21 d NOEC = 4.67 mg B/L	Experimental <i>Daphnia magna</i> Growth

Taxon	Endpoint	Method
Algae	14 d NOEC = 0.40 mg B/L	Experimental <i>Chlorella pyrenoidosa</i> (Green algae) Population growth

There is an extensive set of chronic aquatic toxicity data available for boron compounds, including tests with a wide range of species in the sensitive early stages of development (WHO, 1998). The results of these studies show that boron has generally low toxicity to aquatic organisms for long term exposure.

## Effects on Sediment-Dwelling Life

Limited sediment toxicity data are available for boric acid and boron containing compounds in general.

Chronic toxicity values for the effects of boric acid on sediment-dwelling invertebrates have been obtained for a freshwater midge (*Chironomus riparius*, harlequin fly), a freshwater bivalve (*Lampsilis siliquoidea*, fatmucket clam), and the aquatic worm (*Lumbriculus variegatus*, California blackworm). The respective toxicity values for these species are as follows: 28 d NOEC = 37.8 mg B/kg; 21 d LC25 (survival) = 363.1 mg B/kg; and 28 d NOEC = 100.8 mg B/kg (Gerke, 2011, Hall, et al., 2014).

Due to the high water solubility of boron and its low partitioning to sediment, sediment toxicity testing for boron is particularly challenging as it is difficult to ensure that exposure is through the solid phase (i.e. sediment) and not from the aqueous boric acid in the overlying water (Environment and Climate Change Canada, 2016).

## Effects on Terrestrial Life

Boric acid and borax have insecticidal, fungicidal and non-selective herbicidal properties. For this reason, boron compounds are commonly used in domestic settings to control pests such as ants, termites and fruit flies. However, these properties typically only present at very high boron concentrations.

Although boron is required by plants at low concentrations, at high concentrations it is toxic. There is only a narrow concentration range where boron is beneficial to the plant; it is in fact the narrowest range of all nutrient elements (Goldberg, 1997, Peak, et al., 2003).

Ecotoxicological tests with plants and soil invertebrates have recorded modest chronic toxicity values (NOECs/EC<sub>10</sub>s) in the range of 15.3 to 84.0 and 5.2 to 315 mg total B/kg, respectively (ECHA, 2008). However, to predict the potential toxicity of boron to plants and soil organisms, measuring the total boron concentration may be unsuitable. Instead, potential toxicity is better predicted using boron concentrations in the soil solution (extractable boron) (Mertens, et al., 2011). In Australia, it is generally accepted that boron toxicity will pose a risk to terrestrial plants when soil concentrations exceed 15 mg/kg of extractable boron (Brennan & Adcock, 2004, Government of South Australia, 2009).

The phytotoxicity of boron is dependent on the plant species and soil type. Field trials have shown that phytotoxicity may occur if boron concentrations in irrigation water exceed 0.3 to 4 mg B/L (Keren & Bingham, 1985, Marschner, 1995). For example, in an agricultural setting, very sensitive crops cannot tolerate soil water concentrations that are >0.5 mg B/L, whereas very tolerant crops (e.g. asparagus) can tolerate boron concentrations up to 15 mg B/L (ANZECC, 2000a & c).

Boron toxicity to plants is more likely when the boron is present closer to the soil surface, where roots encounter high levels of boron in the early stages of development or as seedlings. The physiological effects of boron toxicity to plants include reduced cell division, decrease in leaf chlorophyll concentrations, and disruption to antioxidation pathways. These effects cause plant stunting and reduced growth (Nable, et al., 1997).

## Predicted No-Effect Concentration (PNEC)

The primary environmental effects of the chemicals in this group are expected to be caused by the release of boric acid. Given that the focus of this assessment is the release of boric acid to wastewater streams and aquatic environments, existing guideline values for boron in aquatic systems were considered.

In place of a PNEC for the aquatic compartments, the trigger values published for boron in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality have been used. The guideline value to protect 95% of species in a *slightly-moderately disturbed* ecosystem is 370 µg B/L (ANZECC, 2000a). However, this guideline value is currently being revised under updates to the National Water Quality Framework. There were insufficient data to derive guideline values for marine waters. The ANZECC guidelines recommended using the background concentration in seawater (5100 µg/L) as a low reliability trigger value (ANZECC, 2000b).

## Categorisation of Environmental Hazard

It is not currently possible to categorise the environmental hazards of metals and other inorganic chemicals according to standard persistence, bioaccumulation and toxicity (PBT) hazard criteria. These criteria were developed for organic chemicals and do not take into account the unique properties of inorganic substances and their behaviour in the environment (UNECE, 2007, US EPA, 2007).

Therefore, environmental hazard categorisation according to domestic PBT criteria has only been performed for the organic component (2-aminoethanol) of 1 chemical in this group (Boric acid (H<sub>3</sub>BO<sub>3</sub>), compound with 2-aminoethanol), as presented below. The discrete organic chemical, 2-aminoethanol (ethanol, 2-amino-; CAS RN 141-43-5), has been assessed at Tier I level under the IMAP framework and was found to be of low concern to the environment.

## Persistence

Not Persistent (Not P). Based on results obtained from ready biodegradation studies, the chemical is categorised as Not Persistent.

## Bioaccumulation

Not Bioaccumulative (Not B). Based on the high water solubility of 2-aminoethanol and the expected low octanol-water partitioning of the ionised form of the chemical present under typical environmental conditions, the chemical is categorised as Not Bioaccumulative.

## Toxicity

Not Toxic (Not T). Based on available acute ecotoxicity values greater than 1 mg/L, and chronic ecotoxicity values greater than 0.1 mg/L, 2-aminoethanol is categorised as Not Toxic.

## Summary

The organic component of boric acid (H<sub>3</sub>BO<sub>3</sub>), compound with 2-aminoethanol is categorised as:

- Not P
- Not B
- Not T

## Risk Characterisation

Risk quotients (RQs) have not been calculated for the chemicals in this group.

The majority of emissions of boron (as boric acid) to the environment will be from natural weathering processes not from anthropogenic sources. Therefore, the release of boric acid from cleaning products and detergents will contribute a small proportion of the total emissions of boron to the environment. Emissions of boric acid from these products do contribute to the total anthropogenic boron load added to surface waters in treated effluents produced by STPs.

The measured concentrations of boron in Australian treated effluent are comparable with the 90<sup>th</sup> percentile boron concentration in fresh surface waters. Therefore, based on currently available monitoring data, the quantities of boron that are released from cleaning products into sewage treatment systems in Australia are considered to pose a low risk to aquatic and soil ecosystems.

## Key Findings

Although the chemicals in this group have generally low aquatic toxicity, they are used in substantial quantities in detergents and cleaning products. Therefore, use of boron compounds in these products has significant potential to result in environmental exposure through a common pathway involving their release in the treated effluents of STPs. It is also known that the release of soluble boron compounds by this emission pathway will likely be dominated by other boron compounds, particularly perborates.

The boron-containing chemicals in this group are expected to have the same speciation when released into the environment, where uncharged boric acid ( $B(OH)_3$ ) and the borate mono-anion ( $B(OH)_4^-$ ) will dominate. Borates are wide-spread, naturally occurring substances in the environment and have low toxicity to aquatic organisms. However, moderate soil concentrations can cause toxic effects in terrestrial plants (phytotoxicity).

Release of boron to surface waters from chemicals in this group is expected to have limited long-term environmental effects due to the low chronic aquatic toxicity of boric acid. Release of boron to surface soil may result in localised toxic effects in terrestrial plants, depending on background boron concentrations, affected plant species, and soil characteristics. However, there are well developed regulatory guidelines and practices in place to manage the risks from over application of boron to soils in Australia.

## Recommendations

No further assessment under the IMAP Framework is required.

## Environmental Hazard Classification

The classification of the environmental hazards of boric acid ( $H_3BO_3$ ) (CAS RNs 10043-35-3 and 11113-50-1), according to the third edition of the United Nations' Globally Harmonised System of Classification and Labelling of Chemicals (GHS) has not been attempted. As outlined in Annex 9 of the interpretive guidance on hazards to the aquatic environment (e.g. p 469), it can be difficult to interpret the testing of essential elements that may be beneficial at certain levels (UNECE, 2009)). In addition, there is no clear guidance on how to classify inorganic compounds containing elements that are not essential for all aquatic trophic levels (UNECE, 2009).

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