Australian Government
Department of Health, Disability and Ageing
Australian Industrial Chemicals Introduction Scheme

Alcohol ethoxysulfates

Evaluation statement (EVA00196)

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Draft

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AICIS evaluation statement (EVA00196)

Subject of the evaluation

Alcohol ethoxysulfates

Chemicals in this evaluation

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Ethanol, 2-[2-[2-(dodecyloxy)ethoxy]ethoxy]-, 1-(hydrogen sulfate), sodium salt (1:1)	13150-00-0
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Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-(decyloxy)-, ammonium salt (1:1)	52286-19-8
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-(tridecyloxy)-, sodium salt (1:1)	54116-08-4
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Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-(dodecyloxy)-, magnesium salt (2:1)	62755-21-9
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-(decyloxy)-, sodium salt (1:1)	63428-87-5
3,6,9,12,15,18,21,24,27,30,33,36-Dodecaoxaoctatetracontan-1-ol, 1-(hydrogen sulfate), sodium salt (1:1)	66161-57-7
3,6,9,12,15,18,21-Heptaoxatritriacontan-1-ol, 1-(hydrogen sulfate), sodium salt (1:1)	66197-75-9
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C10-16-alkyl ethers, ammonium salts	67762-19-0

CAS name	CAS number
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C10-16-alkyl ethers, magnesium salts	67762-21-4
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C6-10-alkyl ethers, ammonium salts	68037-05-8
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-18-alkyl ethers, sodium salts	68081-91-4
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C14-18-alkyl ethers, sodium salts	68187-52-0
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-15-alkyl ethers	68511-39-7
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Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C6-10-alkyl ethers, sodium salts	73665-22-2
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Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C10-18-alkyl ethers, sodium salts	102783-14-2
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C16-18-alkyl ethers, potassium salts	103818-96-8
Ethanol, 2,2′-iminobis-, compd. with .alpha.-sulfo-.omega.-(hexadecyloxy)poly(oxy-1,2-ethanediyl) (1:1)	104339-49-3
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-13-alkyl ethers, sodium salts	110392-50-2
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Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C16-18-alkyl ethers, magnesium salts	125301-91-9
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-14-alkyl ethers, magnesium salts	160104-51-8
Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-18-alkyl ethers	160738-88-5

Reason for evaluation

Evaluation Selection Analysis (ESA) indicated a potential environmental risk.

Parameters of evaluation

These chemicals are a group of structurally similar, medium to long chain (C6–C18) alcohol ethoxysulfates (AES) that are listed on the Australian Inventory of Industrial Chemicals (the Inventory). This group of chemicals belongs to a widely used class of anionic surfactants. This evaluation is an environmental risk assessment of the identified industrial uses of the chemicals in Australia.

These chemicals have been assessed as a group because they have similar chemical structures and use patterns.

The risks posed to the environment associated with the industrial uses of these chemicals have been evaluated according to the following parameters:

- introduction to Australia at high volumes
- expected release to sewage treatment plants (STPs) due to consumer and commercial use.

In this evaluation, chemical names have been abbreviated according to alkyl chain length (Cm) and degree of ethoxylation or average ethoxylate chain length (EOn).

For example, the chemical 'Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C12-18-alkyl ethers, sodium salts', which is a mixture containing C12–18 AES with unspecified degree of ethoxylation, is abbreviated to $C_{12–18}EO_xS.Na$.

Summary of evaluation

Summary of introduction, use and end use

The chemicals in this group have functional use as surfactants in a wide variety of consumer and commercial products. Available Australian and international data indicate that these chemicals are used in high volumes worldwide (> 100,000 t/year). The major use is in laundry and dishwashing products, cleaning and furniture care products and personal care products.

The chemicals may have site-limited use in tunnelling applications.

Based on international and limited Australian use data, the chemicals in this evaluation are also used in a range of additional products at lower volumes, including:

- adhesive and sealant products
- fuel, oil and fuel oil additives, and related products
- lubricant and grease products
- painting and coating products

- plastic and polymer products
- construction products
- fabric, textile and leather products
- electronic products
- air care products
- automotive care products
- water treatment products.

Environment

Summary of environmental hazard characteristics

According to domestic environmental hazard thresholds (DCCEEW 2022), and available hazard information, chemicals in this evaluation are Not Persistent (Not P) and Not Bioaccumulative (Not B).

Based on the available information, the following chemicals are Toxic (T):

- $C_{16}EO_xS.NH_4$ (CAS RN 59764-60-2)
- $C_{16}EO_xS$.DEA (CAS RN 104339-49-3)
- $C_{12–15}EO_xS$ (CAS RN 68511-39-7).

There is insufficient information to categorise the chemical $C_{10–18}EO_xS$.Na (CAS RN 102783-14-2) as toxic or not toxic according to Australian PBT criteria.

All other chemicals in this evaluation are Not Toxic (Not T).

Environmental hazard classification

Most of the chemicals in this evaluation satisfy the criteria for environmental hazards classification according to the Globally Harmonized System of Classification and Labelling of Chemicals (GHS) (UNECE 2017). This evaluation does not consider classification of physical hazards.

Many chemicals in this evaluation are UVCBs (unknown or variable composition, complex reaction products or of biological origin) comprising homologues with different alkyl and/or different ethoxylate chain lengths. The hazards of these chemicals will depend on the composition, which may differ between different introducers.

Classifications are primarily based on available experimental ecotoxicity information and read-across principles (see **Supporting information**). UVCBs without sufficient ecotoxicity data were classified using the ‘summation method’ by considering the alkyl chain length distributions of the precursor alcohols (UNECE 2017).

Classifications are assigned to chemicals based on their CAS Registry Number (RN). Chemicals with the same generic CAS RN may include a range of ethoxylation degrees, which may affect the ecotoxicological properties. The proposed default classifications for these CAS RNs are based on the most conservative level of ethoxylation for the chemical.

Default classifications for the chemicals are recommended as below. As classifications for chemicals in this evaluation can change with composition, the classification and labelling entries for these chemicals should be appended with the following note:

'The chemical is a substance of unknown or variable composition, complex reaction product, or biological material (UVCB). The hazards of the chemical may depend on the composition. For more information refer to the assessment report published on the website of the Australian Industrial Chemicals Introduction Scheme.'

If empirical data are available for a specific chemical, for example to justify a lower classification, this data may be used to amend the default classification for that chemical.

The following chemicals are classified according to the table below:

- $C_{8–10}EO_xS.NH_4$ (CAS RN 68891-29-2).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short term)	Aquatic Acute 3	H402: Harmful to aquatic life

The following chemicals are classified according to the table below:

- $C_{10}EO_xS.NH_4$ (CAS RN 52286-19-8)
- $C_{10}EO_xS.Na$ (CAS RN 63428-87-5)
- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{18}EO_xS$ (CAS RN 45294-11-9)
- $C_{6–10}EO_xS.NH_4$ (CAS RN 68037-05-8)
- $C_{6–10}EO_xS.Na$ (CAS RN 73665-22-2)
- $C_{6–12}EO_xS.NH_4$ (CAS RN 75422-21-8).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short term)	Aquatic Acute 2	H401: Toxic to aquatic life

The following chemicals are classified according to the table below:

- $C_{12}EO_xS.Na$ (CAS RN 9004-82-4)
- $C_{12}EO_xS$ (CAS RN 26183-44-8)
- $C_{12}EO_xS.TEA$ (CAS RN 27028-82-6)
- $C_{12}EO_xS.NH_4$ (CAS RN 32612-48-9)
- $C_{12}EO_xS.Mg$ (CAS RN 62755-21-9)
- $C_{12}EO_1S.Na$ (CAS RN 15826-16-1)
- $C_{12}EO_2S.Na$ (CAS RN 3088-31-1)
- $C_{13}EO_xS.Na$ (CAS RN 54116-08-4)
- $C_{13}EO_3S.Na$ (CAS RN 25446-78-0)
- $C_{14}EO_xS.NH_4$ (CAS RN 27731-61-9)
- $C_{14}EO_xS.Na$ (CAS RN 27731-62-0)
- $C_{14}EO_3S.Na$ (CAS RN 25446-80-4)
- $C_{10–12}EO_xS.Na$ (CAS RN 68610-66-2)
- $C_{10–12}EO_xS.NH_4$ (CAS RN 68890-88-0)
- $C_{10–16}EO_xS.NH_4$ (CAS RN 67762-19-0)
- $C_{10–16}EO_xS.Mg$ (CAS RN 67762-21-4)

- $C_{10-16}EO_xS.Na$ (CAS RN 68585-34-2)
- $C_{10-16}EO_xS$ (CAS RN 68611-29-0)
- $C_{12-13}EO_xS.Na$ (CAS RN 110392-50-2)
- $C_{12-14}EO_xS.Na$ (CAS RN 68891-38-3)
- $C_{12-14}EO_xS.Mg$ (CAS RN 160104-51-8).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short term)	Aquatic Acute 2	H401: Toxic to aquatic life
Hazardous to the aquatic environment (chronic / long term)	Aquatic Chronic 3	H412: Harmful to aquatic life with long lasting effects

The following chemicals are classified according to the table below:

- $C_{16}EO_xS.NH_4$ (CAS RN 59764-60-2)
- $C_{16}EO_xS.DEA$ (CAS RN 104339-49-3)
- $C_{16-18}EO_xS.Na$ (CAS RN 68585-40-0)
- $C_{16-18}EO_xS.K$ (CAS RN 103818-96-8)
- $C_{16-18}EO_xS.NH_4$ (CAS RN 116726-95-5)
- $C_{16-18}EO_xS.Mg$ (CAS RN 125301-91-9).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short term)	Aquatic Acute 1	H400: Very toxic to aquatic life

The following chemicals are classified according to the table below:

- $C_{12-15}EO_xS$ (CAS RN 68511-39-7)
- $C_{12-18}EO_xS.Na$ (CAS RN 68081-91-4)
- $C_{12-18}EO_xS.NH_4$ (CAS RN 68610-22-0)
- $C_{12-18}EO_xS.Mg$ (CAS RN 125301-90-8)
- $C_{12-18}EO_xS$ (CAS RN 160738-88-5)
- $C_{14-18}EO_xS.Na$ (CAS RN 68187-52-0).

Environmental Hazard	Hazard Category	Hazard Statement
Hazardous to the aquatic environment (acute / short term)	Aquatic Acute 1	H400: Very toxic to aquatic life
Hazardous to the aquatic environment (chronic / long term)	Aquatic Chronic 3	H412: Harmful to aquatic life with long lasting effects

The following chemicals are not classified for aquatic hazards:

- $C_8EO_xS.NH_4$ (CAS RN 52286-18-7)
- $C_{12}EO_7S.Na$ (CAS RN 66197-75-9)

- $C_{12}EO_{12}S.Na$ (CAS RN 66161-57-7).

The following chemicals are not classifiable for aquatic hazards:

- $C_{10–18}EO_xS.Na$ (CAS RN 102783-14-2).

Summary of environmental risk

Based on Australian and international use information, chemicals in this evaluation are introduced into Australia in high volumes. These chemicals are used in a wide variety of domestic and commercial products. They are primarily released to wastewater as a normal part of their use pattern.

According to Australian thresholds (DCCEEW 2022), the chemicals in this evaluation are not persistent and not bioaccumulative, but some chemicals are toxic. These chemicals are readily biodegradable and have low bioaccumulation potential, with measured bioaccumulation factors less than 2,000 L/kg. $C_{16}EO_xS$ and $C_{12–15}EO_xS$ are toxic to aquatic life, with measured acute endpoints less than or equal to 1 mg/L and/or chronic endpoints less than or equal to 0.1 mg/L. All other chemicals are not toxic. Based on measured concentrations in STP effluent obtained from international monitoring studies, the chemicals in this evaluation are expected to be present in Australian surface waters at concentrations below the level of concern.

The calculated risk quotient (RQ) for chemicals in this evaluation in surface water is less than one. Therefore, the current industrial use of these chemicals in Australia is not expected to pose a significant risk to the environment.

Conclusions

The Executive Director proposes to be satisfied that the identified risks to the environment from the introduction and use of these industrial chemicals can be managed.

Note:

1. Obligations to report additional information about hazards under *Section 100* of the *Industrial Chemicals Act 2019* apply.
2. A person introducing these chemicals should be aware of their obligations under environmental, workplace health and safety and poisons legislation as adopted by the relevant state or territory.

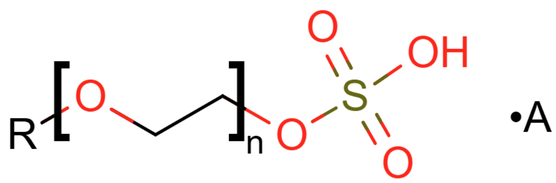
Supporting information

Grouping rationale

This evaluation considers the environmental risks associated with the industrial use of a group of 45 AES chemicals. Chemicals in this evaluation are used in high volumes worldwide and were selected for evaluation because the ESA indicated a potential risk to the environment. These chemicals have been assessed as a group as they have similar chemical structures, industrial uses and environmental release patterns, and are expected to have similar environmental effects.

Chemical identity

Representative structure



Additional chemical identity information

The chemicals in this evaluation are structurally similar AES surfactants. They consist of a saturated linear or branched alkyl chain attached to a polyethoxylated chain that is terminated with a sulfate group. The typical structure is R-$(OCH_2CH_2)_n$-OSO_3.A (pictured), where R is an alkyl chain of the form C_mH_{2m+1} (m = 6–18), OCH_2CH_2 is an ethoxylate (EO) unit and A is a counterion.

The shorthand notation C_mEO_nS.A is used for specific chemicals in this evaluation, where ‘m’ is the size of the alkyl chain and ‘n’ is the ‘degree of ethoxylation’, or average ethoxylate chain length.

For example, the chemical ‘Ethanol, 2-[2-(dodecyloxy)ethoxy]-, 1-(hydrogen sulfate), sodium salt (1:1)’ (CAS RN 3088-31-1), consisting of a C12 alkyl chain with 2 ethoxylate units and a sodium counterion, is referred to as $C_{12}EO_2S$.Na.

The nomenclature $C_{(m1–m2)}EO_nS$.A is used for chemicals with a range of alkyl chain lengths in the chemical name.

For example, the chemical ‘Poly(oxy-1,2-ethanediyl), .alpha.-sulfo-.omega.-hydroxy-, C10-18-alkyl ethers, sodium salts’ (CAS RN 102783-14-2), which has a range of alkyl chain lengths, is referred to as $C_{10–18}EO_xS$.Na, where ‘x’ indicates an unspecified degree of ethoxylation.

Chemicals in this evaluation are UVCBs (unknown or variable composition, complex reaction products or biological materials) comprising AES homologues with different alkyl chain lengths and different ethoxylate chain lengths:

- This evaluation includes chemicals with C6–C18 alkyl chains specified in the chemical name. AES mixtures may include small amounts of longer or shorter alkyl chain lengths. The distribution and linearity of alkyl chains in mixtures may vary between different manufacturers.
- This evaluation includes chemicals with specified degrees of ethoxylation between 2 and 12. However, most chemical names do not specify the degree of ethoxylation. As a result, the degree of ethoxylation may vary between different manufacturers. Typical ethoxylate chains lengths in household products are between 0–8 EO units (AISE and Cefic 2003).
- Chemicals in this evaluation may contain alkyl sulfates (AS) [n(EO) = 0] in addition to other impurities. For example, commercial sodium AES reportedly contains 15–45% AS, 2–4% unsulfated ethoxylated alcohols and 1–2% unreacted alcohols, with optionally trace amounts of pH buffering agents (AISE and Cefic 2003).

These AES are produced by sulfonation of ethoxylated alcohols using sulfur trioxide or chlorosulfonic acid, followed by neutralisation with a base to produce a salt (AISE and Cefic 2003). Chemicals in this evaluation include salts of sodium (Na), potassium (K), magnesium (Mg), ammonium and alkanolamines [diethanolamine (DEA) and triethanolamine (TEA)], though not all chemical names specify the counterion. Commercial AES are available in solution, paste and solid forms (AISE and Cefic 2003).

Primary alcohols used to manufacture ethoxylated alcohols and subsequently AES are derived from oleochemical sources (vegetable oils and animal fats), manufactured from ethylene using the Ziegler process, or manufactured from olefins using oxo synthesis (addition of CO to an olefin) (AISE and Cefic 2003). The size and linearity of these alcohols vary depending on the production method used (AISE and Cefic 2003, AICIS 2025):

- Alcohols manufactured from oleochemical feedstocks or from the Ziegler process are practically 100% linear and have even chain lengths between C6 and C22.
- Alcohols manufactured from linear olefins using oxo synthesis are mostly linear or mono-branched with even and odd chain lengths between C7 and C17.
- Alcohols manufactured from highly branched olefins using oxo synthesis may contain more than one tertiary or quaternary carbon centre.

Commercial AES mixtures may contain trace amounts of 1,4-dioxane (CAS RN 123-91-1) as a by-product of the manufacturing process (Lu et al. 2024). Release of 1,4-dioxane from ethoxylated surfactants has been assessed low risk for the Australian environment and is not considered further in this evaluation (NICNAS 1998).

Relevant physical and chemical properties

Measured physical and chemical properties for selected AES chemicals were retrieved from the registration dossiers for chemicals submitted under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) legislation in the European Union (EU) (REACH n.d.-a; REACH n.d.-b; REACH n.d.-c; REACH n.d.-d):

Chemical	$C_{12}EO_2S.Na$	$C_{8–10}EO_xS.NH_4$	$C_{12–14}EO_xS.Na$	$C_{12–18}EO_xS.Na$
CAS RN	3088-31-1	68891-29-2	68891-38-3	68081-91-4
Physical form	Liquid	Solid	Solid	Solid

Melting point	7.5 °C	172 °C	150–159 °C	73 °C
Boiling point	103 °C at 92 kPa	221 °C (decomp.)	> 400 °C	206 °C (decomp.)
Water solubility	1,000 g/L at 39 °C	> 380 g/L at 20 °C and pH = 5.03	280 g/L at 20 °C and pH = 6.8	> 300 g/L at 20 °C
Ionisable in the environment?	Yes	Yes	Yes	Yes
pK_a	0	1.06–1.07 (calc.)	≤ 2	2.36
log K_{ow}	0.25 at 39 °C and pH ~ 7	1.07 at 25 °C and pH = 9	0.3 at 23 °C and pH = 6.1	≤ 1.08 at 20 °C (calc.)

As chemicals in this evaluation can form micelles, the critical micelle concentration (CMC) should be used instead of the water solubility as an upper bound on the concentration of free surfactant monomers in water. In the environment, this property of AES depends on the alkyl chain length and the ethoxylate chain length:

- As a general rule, the CMC of anionic surfactants is expected to decrease by a factor of 2 for each additional methylene group added to the hydrophobic alkyl chain (Holmberg 2019).
- According to available experimental data, the CMC of AES decreases slightly with increasing ethoxylate chain length. For example, the CMC of the C12 AS ($C_{12}EO_0S.Na$) is 8.2 mM or 2.36 g/L at 25 °C, compared to 2.5 mM or 1.05 g/L for the $C_{12}EO_3S.Na$ homologue and 1.3 mM or 0.95 g/L for the $C_{12}EO_{10}S.Na$ homologue (Del Regno et al. 2021; Hato and Shinoda 1973).

Based on these trends, the CMC of AES chemicals and mixtures is expected to decrease with increasing alkyl chain length and decrease slightly with increasing degree of ethoxylation.

The chemicals in this evaluation are strong acids, or salts of strong acids, and will dissociate completely in the pH range of environmental waters and biological fluids. These chemicals are expected to have very low vapour pressures and will not be volatile from surface water.

Different counterions may influence the physico-chemical properties of undissociated chemicals (Könnecker et al. 2011). However, chemicals in this evaluation exist in the dissociated state under environmental conditions and so the influence of the counterion is not considered.

Introduction and use

Australia

Australian introduction and use information are available for a subset of chemicals in this evaluation. This information was provided to the former National Industrial Chemicals Notification and Assessment Scheme (NICNAS) under previous calls for information.

The chemical $C_{12}EO_xS.Na$ (CAS RN 9004-82-4) is reportedly used in cleaning/washing agents and additives, cosmetics and surface-active agents at volumes of 1,000–9,999 t/year (NICNAS 2006).

The chemical, $C_{10–16}EO_xS.Na$ (CAS RN 68585-34-2) is reportedly used in cleaning/washing agents and additives at volumes of 1,000–9,999 t/year (NICNAS 2006).

The following chemicals have reported use volumes of 100–999 t/year:

- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{12}EO_xS.NH_4$ (CAS RN 32612-48-9)
- $C_{12–14}EO_xS.Na$ (CAS RN 68891-38-3).

The following chemicals have reported use in laundry and dishwashing products, cleaning and furniture care products, and personal care products (NICNAS 2013):

- $C_{12}EO_2S.Na$ (CAS RN 3088-31-1)
- $C_{12}EO_xS.Na$ (CAS RN 9004-82-4)
- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{12}EO_1S.Na$ (CAS RN 15826-16-1)
- $C_{12}EO_xS.NH4$ (CAS RN 32612-48-9)
- $C_{12}EO_{1}2S.Na$ (CAS RN 66161-57-7).

According to information provided to AICIS as part of this evaluation, chemicals in this group are also used in abrasive article products and hard floor maintenance products.

International

Available data from international regions indicate high use volumes of AES worldwide:

- In Europe, the total volume of AES used in 2000 was estimated at 276,000 t (AISE and Cefic 2003).
- In North America, the total volume of AES reportedly used in 2008 was 229,330 t (Cowan-Ellsberry et al. 2014).
- In Japan, use volumes of approximately 10,000–15,000 t/year between the years 2017 and 2023 have been reported for a subset of chemicals captured under the generic term, 'Onium salt or sodium salt of alpha-(alkyl(C=10-16))-omega-(sulfooxy)poly[(oxyethylene)(or oxyethylene/oxy(methylethylene))] (It is limited that the average of repeating number of the repeating unit is 1-4.)' (NITE n.d.).

These AES are primarily used in domestic laundry and dishwashing products, and domestic cleaning and furniture care products:

- In North America, 59% of the total use volume for the year 2008 was used in household laundry detergents (powders and liquids) (Cowan-Ellsberry et al. 2014). Another 15% was used in hand dishwashing detergents, while 2% was used in other household cleaning products, including hard-surface cleaners, and rug and upholstery cleaners.
- In Europe, 39% of the total use volume for the year 2000 was used in household detergents and cleaning products (AISE and Cefic 2003).

The chemicals in this group are also used in personal care products. In North America, around 17% of the total use volume for the year 2008 was used in these products, mainly shampoos, bubble baths and body soaps (Cowan-Ellsberry et al. 2014).

To a lesser extent AES are used in other commercial and non-industrial uses. In North America, 7% of the total use volume for 2008 was used in institutional and commercial cleaning products and other industrial and non-industrial applications, mainly emulsion polymerisations and agricultural herbicides (Cowan-Ellsberry et al. 2014).

According to available use information from REACH, chemicals in this evaluation have reported uses in a range of additional products (NICNAS 2013; REACH n.d.-a; REACH n.d.-b; REACH n.d.-c; REACH n.d.-d):

- adhesive and sealant products
- lubricant and grease products
- paint and coating products
- plastic and polymer products
- construction products
- fabric, textile and leather products
- air care products
- automotive care products
- water treatment products.

AES surfactants are reportedly constituents in commercial foaming agents used as soil conditioners for mechanised tunnelling applications (Barra Caracciolo et al. 2021).

AES has potential to be used for enhanced oil recovery to improve process flow in the oil and gas industry (Negin et al. 2017). However, none of the chemicals in this evaluation have been reportedly used in oil or gas production in the US Chemical Data Reporting (CDR) or in REACH registration dossiers.

Chemicals in this evaluation with C12 alkyl chains have reported non-industrial uses in pharmaceuticals, agricultural pesticides, preservatives and food/feedstuff flavouring and nutrients (NICNAS 2013).

Existing Australian regulatory controls

Environment

The industrial use of the chemicals in this group is not subject to any specific national environmental regulations.

International regulatory status

United Nations

Chemicals in this evaluation are not currently identified as a Persistent Organic Pollutants (POP) (UNEP 2001), ozone depleting substances (UNEP 1987), or hazardous substances for the purpose of international trade (UNEP & FAO 1998).

Environmental exposure

The chemicals in this evaluation are mostly used as surfactants in products that are typically released to sewers as part of their domestic or commercial use. Depending on the degradation and partitioning processes of these chemicals in STPs, a fraction of the quantity of chemicals in raw sewage entering STPs will be emitted to rivers and/or oceans in treated effluent, or to soil by application of biosolids to agricultural land.

A subset of uses may result in direct or diffuse release of these chemicals to the environment, such as use in automotive care products. In such uses, these chemicals may be emitted to the soil compartment, or to surface water without STP treatment through stormwater drainage systems. However, these uses are minor compared to the widespread, continuous use of laundry and dishwashing, cleaning, and personal care products, that make up most of the use volume.

Chemicals used in foaming agents for mechanised tunnelling applications are expected to be removed from the excavation site within tunnel spoil (excess material generated during excavation). Tunnel spoil may be reused in construction projects, leading to direct release to soil.

Environmental fate

Partitioning

The chemicals in this evaluation are surface active and are anionic across the environmental pH range (4–9). As a result, the partitioning behaviour of these chemicals is complex and may change with local environmental conditions, such as pH, water hardness and the mineral composition of sludges, soils and sediments (Sigmund et al. 2022). Available experimental data for C12, C14 and C16 AES indicates that these chemicals have low mobility in soil and will partition to sediments in the environment.

Based on an experimental soil study of a commercial AES mixture in agricultural topsoils (calcareous fluvisol), the chemicals in this evaluation have low mobility in soil, with mobility decreasing with increasing alkyl or ethoxylate chain length (Fernandez-Ramos et al. 2017). Batch sorption/desorption experiments covering $C_{12}EO_{0–3}S$ and $C_{14}EO_0S$ homologues were initially conducted. These experiments indicate concentration dependent adsorption properties depending on alkyl and ethoxylate chain length:

- Sorption/desorption data were fitted to a Freundlich adsorption isotherm. For $C_{12}EO_0S$, an approximately linear concentration/adsorption relationship was observed. Increasing the alkyl or ethoxylate chain length reduced the linearity of the relationship, indicating more complex adsorption behaviour.
- Reported Freundlich constants (K_f) for sorption (uptake) declined with increasing ethoxylation from 307.51 L/kg for $C_{12}EO_0S$ to 36.75 L/kg for $C_{12}EO_3S$, indicating reduced sorption strength up to n = 3. By contrast, the K_f value for $C_{14}EO_0S$ was 440.6 L/kg, indicating increased sorption strength for longer alkyl chain lengths.
- The organic carbon partition coefficient (K_{OC}) can be derived from K_f by assuming a standard aqueous concentration (1 mg/kg) and a standard organic carbon fraction in soil (f_{OC} = 0.02). Under these assumptions, the K_{OC} values for $C_{12}EO_0S$ and $C_{14}EO_0S$ are approximately 15,000 L/kg and 22,000 L/kg, respectively, and the K_{OC} value for $C_{12}EO_3S$ is approximately 1,800 L/kg, indicating low mobility in soil.

Continuous-flow column experiments covering $C_{12}EO_{0-10}S$ and $C_{14}EO_{0-7}S$ homologues were then conducted to further characterise AES/soil interactions (Fernandez-Ramos et al. 2017). These experiments indicate decreasing mobility for AES with longer ethoxylate chain lengths ($n > 4$):

- The movement of AES in soil columns under continuous flow conditions was fitted to an advection-dispersion-diffusion model with linear equilibrium conditions. From this model, a retardation factor (*R)* was inferred and can be used to compare the mobility of different chemicals under the experimental conditions (where a larger *R* value indicates lower mobility). In agreement with batch sorption/desorption experiments, *R* was much larger for C14 compared to C12 and approximately decreased with increasing ethoxylation up to approximately $n = 4$. However, *R* rapidly increased with increasing ethoxylation above $n = 4$, indicating reduced mobility of AES homologues with longer ethoxylate chain lengths.

Based on a monitoring study identified in the literature (Corada-Fernández et al. 2011), AES will partition to sediments upon release to surface water. C12, C14 and C16 AES were measured in 4 surface water and 10 sediment samples collected from the middle stretch of a river in southern Spain. C12 and C14 AES were measured in both water and sediment samples, while C16 AES was mostly measured in sediment (Corada-Fernández et al. 2011).

Degradation

Chemicals in this evaluation are not persistent, will rapidly and ultimately degrade in all environmental compartments. While it is possible that a small proportion of highly branched chemicals with low degradation potential are present in some commercial AES mixtures, measured biodegradation data for the precursor ethoxylated alcohols suggest that these chemicals will pass ready biodegradation tests (AICIS 2025).

Primary biodegradation of AES predominantly occurs via ether cleavage, leaving an alcohol or an ethoxylated alcohol, and an oligo(ethylene glycol) sulfate (AISE and Cefic 2003). These degradants are subsequently mineralised:

- Linear and mostly linear alcohols and ethoxylated alcohols are rapidly and ultimately degraded in the environment (AICIS 2025). Some highly branched homologues are persistent, but commercial mixtures with high degrees of branching pass ready biodegradability tests.
- Oligo(ethylene glycol) sulfates are ultimately degraded to inorganic sulfate and carbon dioxide in the environment (AISE and Cefic 2003).

Standard test results for ready biodegradability were identified in available REACH dossiers (REACH n.d.-a; REACH n.d.-b; REACH n.d.-c) and in the literature (Miljøstyrelsen 2001; Pérez-Carrera et al. 2010). These studies cover linear and mostly linear AES with C8–C18 alkyl chains and varying degrees of ethoxylation up to 8.5. These chemicals achieved passing results in 28 day and 30 day tests conducted according to OECD 301 test guidelines (TG), indicating rapid degradation in the environment for the chemicals in this evaluation.

The chemicals in this evaluation degrade under anaerobic conditions. An experimental screening study reported 75% degradation of $C_{12-14}EO_2S$ by gas production (CH_4 and CO_2) over a 41 day incubation period (Cowan-Ellsberry et al. 2014). A second experimental study using an anaerobic digester reported 88% degradation of $C_{14}EO_3S$ by gas production over a 17 day incubation period. Other studies reporting low anaerobic biodegradability of AES are available in the literature, but these results have been attributed to inhibitory test substance to biomass concentration ratios (Cowan-Ellsberry et al. 2014).

Abiotic degradation is not expected to be an important removal process for chemicals in this evaluation in the environment. The sulfate headgroup is resistant to hydrolysis at environmental pH (4–9), while photodegradation is unlikely due to the low volatility and the lack of a chromophore.

Chemicals in this evaluation degrade in soils. Standard soil degradation studies were not identified. However, literature studies covering commercial AES mixtures and foaming agents were identified. These studies demonstrate significant degradation of AES in a variety of soil types:

- In one study (Salvatori et al. 2021), more than 90% degradation of commercial ‘sodium lauryl ether sulfate’ (CAS RN 68585-34-2) was observed during 11 day tests using pots (1.5 L) containing a 50:50 mixture of sand and garden soil sown with maize (*Zea mays*).
- In a second study (Patrolecco et al. 2020), soil half-lives of 9–25 days were reported for ‘sodium lauryl ether sulphate’ in soil microcosms (2 L) containing clay and/or silt rich soils from a tunnelling project in Southern Italy.
- In a third study (Barra Caracciolo et al. 2021), 30–56% degradation of C12–14 AES (CAS RN 9004-82-4; 68891-38-3) was reported in 28 day soil mesocosms (1,000 L) containing a fine, sandy-silty-clay soil type from a tunnelling project in Central Italy. By contrast, no significant AES degradation was observed in mesocosms composed of a second, gravel-rich soil type, but this soil had very low water holding capacity (11%) and is not expected to be representative of typical soils in the environment.

Bioaccumulation

Chemicals in this evaluation do not significantly bioaccumulate in aquatic life. Available experimental bioconcentration factor (BCF) values for AES are below the domestic categorisation threshold (BCF < 2,000 L/kg) (DCCEEW 2022). Data for related surfactant groups with comparatively low lipophilicity as also support that the chemicals will have low bioaccumulation hazards.

Experimental bioaccumulation studies for AES were identified in the literature. These studies indicate low bioaccumulation potential, with measured BCF values less than 2,000 L/kg. In one study (Kikuchi et al. 1980), whole body BCF values of 18 L/kg and 4.7 L/kg in common carp were reported for ^{35}S-labelled $C_{12}EO_3S$ and $C_{12}EO_5S$. In a second study (Dyer et al. 2009), BCF values of 13.1 L/kg in trout and carp subcellular liver fractions, and 10.3 L/kg in carp hepatocyte cells were reported for ^{14}C labelled $C_{14}EO_2S$.

Due to their higher overall polarity, AES will have lower bioaccumulation potential compared to AS and ethoxylated alcohols with similar alkyl and/or ethoxylate chain length. These surfactant groups have been previously assessed as low bioaccumulation hazard based on experimental BCF values less than 2,000 L/kg (AICIS 2024; AICIS 2025).

Environmental transport

Chemicals in this evaluation are not expected to undergo long range transport based on their short half-lives in the environment and their tendency to partition to surfaces such as sediments.

Predicted environmental concentration (PEC)

Emissions of chemicals to environmental surface waters and sediments have been estimated as part of this evaluation. A PEC value of 18 µg/L has been selected for AES in surface water. This value is based on the highest reported levels of AES + AS in secondary sludge treated STP effluents from international monitoring studies. A PEC value of 0.6 mg/kg has been selected for river sediment. This value is based on limited international monitoring data for sediments from rivers impacted by STP outfall.

Emissions to soil have not been estimated as part of this evaluation as these chemicals have low toxicity to terrestrial life according to the available data (see **Effects on terrestrial life**).

No Australian monitoring data were identified in the literature. Monitoring studies covering STP influent, STP effluent and river water are available for Europe and the United States of America (USA).

AES monitoring data (>0 EO units) were pooled with AS monitoring data (0 EO units) to determine an overall AES concentration. This is because commercial AES mixtures typically contain a large fraction of non-ethoxylated homologues, and it is not feasible to distinguish these contributions from AS contributions in the available data. Additionally, AS surfactants have similar use patterns to AES surfactants and are observed in similar areas (AICIS 2024). Therefore, the following total AES concentrations reported in this evaluation are expected to be conservative.

The available monitoring data focusses on C12–C16 alkyl chain lengths. These chain lengths are expected to account for more than 95% of the total use volume of AES (AISE and Cefic 2003) and have the highest toxicity of the homologues in the evaluation (see **Environmental effects**). As the monitoring data covers the main homologues of concern, the data is considered sufficient for the purpose of this evaluation.

Three STP monitoring studies from the USA were identified in the literature (McAvoy et al. 1998; McDonough et al. 2016; Sanderson et al. 2006a). These studies encompass 57 STPs treating effluent to at least secondary levels, including 48 activated sludge treatment plants. The available data covers C12–C16 homologues with 0–8 EO units. Reported concentrations in influents were 155–2,180 µg/L while concentrations in effluents were 0.24–164 µg/L. Excluding trickling filter treatment plants, which typically achieve lower removal rates compared to activated sludge treatment plants, effluent concentrations were 4–18 µg/L.

Two STP monitoring studies from Europe were identified in the literature. In the first study (Matthijs et al. 1999), C12–C15 homologues with 0–8 EO units were monitored at 7 STPs from the Netherlands, including 3 aeration tank plants, 3 carrousel plants, and one oxidation ditch plant. The average concentration across all influents was 3,250 µg/L (1,200–6,000 µg/L) while the average concentration across effluents was 7 µg/L (3–12 µg/L). In the second study (Freeling et al. 2019), C12 and C14 homologues with 0–9 EO units were monitored across 33 activated sludge treatment plants from Germany. The average concentration in influents was 673 µg/L (400–1,000 µg/L) while the average concentration in effluents was 0.57 µg/L (<LOQ–1.9 µg/L).

An environmental monitoring study from the USA was identified in the literature (Sanderson et al. 2006b). C12–C15 homologues with 0–8 EO units were monitored at 3 locations in Mississippi and Ohio. These locations included a 'low exposure' containment pond with no known exposure to wastewater, a 'medium exposure' river location 5 km downstream of a municipal STP, and a 'high exposure' creek location adjacent to a trickling filter plant releasing effluent at a dilution ratio of 1:2 effluent to receiving water. These locations had different sediment characteristics but similar organic carbon content (1.3–1.7%). Total concentrations in the low and medium exposure locations were 0.025–0.034 mg/kg sediment on a dry weight basis (dw). Total concentrations in the high impact setting were 0.117 mg/kg sediment dw (Sanderson et al. 2006b).

An environmental monitoring study from Europe was identified in the literature (Corada-Fernández et al. 2011). C12–C16 AES homologues were monitored in 5 water samples and 10 sediment samples collected across a 31 km stretch of the Guadalete River in Southwest Spain. AES concentrations of 4.0–5.0 µg/L were measured in surface water while concentrations in sediments were less than 0.6 mg/kg. One outlier was reported at a site located where a small creek flows into the river. Here, the concentration in surface water was 72 µg/L and the concentration in sediment was 4.0 mg/kg. This creek reportedly received sewage from a small urban area, which may have been untreated (Corada-Fernández et al. 2011).

In Australia, approximately 80% of wastewater is subject to at least secondary treatment (BOM n.d.). An internal survey of Australian STPs indicated that only a minor proportion of wastewater is treated using trickling-filter processes and that most Australian secondary treatment plants currently utilise activated sludge processes. Considering river flows can consist entirely of STP effluent in some drier parts of Australia, a reasonable worst case environmental concentration for these chemicals in Australian rivers is 18 µg/L, based on the highest concentration of AES (including AS) reported in final effluents following secondary treatment by activated sludge. As the bulk of chemicals will enter the environment via STPs, this concentration is considered sufficient to account for potential contributions from stormwater and contaminated groundwater.

Environmental effects

Effects on aquatic Life

Chemicals in this evaluation have the potential to cause toxic effects in aquatic organisms across multiple trophic levels. The aquatic toxicity of AES is well studied, and acute and chronic endpoints are available for many standard test species across multiple trophic levels.

In Australia, default guideline values for AES in surface water are outlined in the Australia New Zealand Guidelines for Fresh and Marine Water Quality (ANZ Water Quality Guidelines) (ANZG n.d.). Water quality guidelines represent a starting point for assessing water quality and are recommended for generic applications in the absence of more relevant guideline values. In freshwater, a low reliability default guideline value of 650 µg/L is available for AES (ANZG 2000). This value is expected to protect 95% of aquatic species and was derived from a species sensitivity distribution (SSD) comprising 5 chronic endpoints normalised to the homologue $C_{12.5}EO_{3.4}S$.

Standard ecotoxicity tests conducted according to internationally recognised test guidelines are available for a range of AES mixtures between C8–10 and C14–16, and individual alkyl chain length homologues between C11 and C18, except C17. Ecotoxicity data were identified in the following sources:

- International risk assessments (AISE and Cefic 2003)
- Literature studies and reviews (Cowan-Ellsberry et al. 2014; Dyer et al. 2000; Lizotte Jr et al. 1999; Miljøstyrelsen 2001; Pavlić et al. 2005; Sasi et al. 2021)
- REACH registration dossiers (REACH n.d.-a; REACH n.d.-b; REACH n.d.-c; REACH n.d.-d; REACH n.d.-e)

- Online databases (US EPA n.d.)
- Previous risk assessments (AICIS 2024).

The toxicity mechanism of AES is expected to be non-polar narcosis (Cowan-Ellsberry et al. 2014). Consistent with expected trends in bioavailability, toxicity is observed to increase with longer alkyl chain lengths up to C16 and decrease with increased ethoxylation. For example, invertebrate toxicity information for C14 and C15 AES indicates increased toxicity for C15 compared to C14, and reduced toxicity as the level of ethoxylation increases from n = 0 to n = 4 (Dyer et al. 2000). The toxicity of mixtures containing a range of AES homologues will depend on the distribution of alkyl and ethoxylate chains.

According to the available information for ethoxylated homologues (>0 EO units), acute ecotoxicity endpoints [median effective concentration (EC50) or median lethal concentration (LC50)] vary between 0.78 mg/L and 400 mg/L, and chronic endpoints [effect concentration (EC10) or no observed effect concentration (NOEC)] vary between 0.06 mg/L and 70 mg/L:

- C8–C14 AES homologues have low toxicity, with available acute endpoints greater than 1 mg/L and chronic endpoints greater than 0.1 mg/L.
- C15–C16 AES homologues are comparatively toxic, with available acute endpoints less than or equal to 1 mg/L and/or chronic endpoints less than or equal to 0.1 mg/L.
- AES homologues with longer alkyl chains (C>16) have low toxicity, with acute endpoints greater than 1 mg/L and chronic endpoints greater than 0.1 mg/L.
- No aquatic toxicity data were identified for AES homologues with alkyl chains shorter than C8. Chemicals with these alkyl chain lengths are less lipophilic than chemicals with longer alkyl chain lengths. Therefore, these chemicals will have low toxicity compared to chemicals with longer alkyl chain lengths.

Effects on terrestrial Life

Chemicals in this evaluation are not toxic to terrestrial organisms under typical exposure conditions.

A standard 28 day earthworm reproduction test conducted according to OECD TG 222 was identified for the chemical $C_{12–14}EO_{<2.5}S.Na$ (CAS RN 68891-38-3) (REACH n.d.-b). No adverse effects (reproduction, mortality and body weight) were observed in earthworms (*Eisenia fetida*) exposed to a nominal concentration of 750 mg/kg soil dw.

A study examining the toxicity of ‘sodium lauryl ether sulfate’ (CAS RN 68585-34-2) to plants was identified in the literature (Salvatori et al. 2021). Acute toxicity testing was performed on garden cress (*Lepdium sativum*) and maize (*Z. mays*) seeds in accordance with OECD TG 208 (seedling emergence and seedling growth test). Nominal AES concentrations were 120, 360 and 1,200 mg/kg soil. No adverse effects were reported except at the highest test concentration (1,200 mg/kg), where a large reduction (53%) in root elongation was observed in garden cress seeds compared to controls. Chronic toxicity testing was performed on juvenile maize by examining effects to photosynthesis endpoints under ‘realistic’ (360 mg/kg) and ‘high’ (1,200 mg/kg) exposures to AES. Significant adverse effects were initially observed in all tests compared to controls. However, these effects dissipated quickly, presumably due to rapid degradation of the surfactant.

Additional toxicity studies were identified for commercial AES foaming agents and polymers used in mechanised tunnelling (Barra Caracciolo et al. 2021; Patrolecco et al. 2020). Standard terrestrial toxicity tests using soils and elutriates were performed with garden cress (*L. sativum*), ostracods (*Hetereocypris incongruens*), and earthworms (*E. fetida*) in accordance with US EPA and OECD test guidelines. AES concentrations in soils were 52.2–648 mg/kg while concentrations in elutriates, prepared in a 1:10 ratio of soil to water, were 0.74–23 mg/L. No adverse effects were reported across all tests.

Effects on sediment dwelling life

No sediment ecotoxicity data were identified for AES.

Endocrine effects/activity

No evidence of endocrine effects or activity were identified for AES.

Predicted no-effect concentration (PNEC)

The surface water PNEC for AES is 65 µg/L. This value was derived from the current ANZ water quality guideline value of 650 µg/L adjusted using an assessment factor of 10. The normalised AES homologue $C_{12.5}EO_{3.4}S$ used to derive the water quality guideline is protective of chemicals in this evaluation as it represents the average distribution in STP effluents. However, an assessment factor of 10 was applied to account for the low reliability of the guideline value (EPHC n.d.).

A PNEC for soil has not been calculated as available information indicates that the chemicals in this evaluation are unlikely to cause harmful effects in terrestrial organisms at environmentally relevant concentrations.

A PNEC for sediment has not been calculated as there is insufficient information to determine effects on sediment dwelling organisms.

Categorisation of environmental hazard

The categorisation of the environmental hazards of the assessed chemical according to domestic environmental hazard thresholds is presented below. As counterions do not impact environmental hazards, these have been removed from shorthand names for compactness and clarity:

Persistence

Not Persistent (Not P). Based on measured degradation studies of AES, chemicals in this evaluation are categorised as Not Persistent.

Bioaccumulation

Not Bioaccumulative (Not B). Based on low measured bioconcentration factors (BCF) in fish, chemicals in this evaluation are categorised as Not Bioaccumulative.

Toxicity

Chemicals in this evaluation have been categorised using available aquatic ecotoxicity data and read across principles.

Most of the chemicals in the evaluation are UVCBs comprising AES homologues with different alkyl and/or ethoxylate chain lengths. These variations are observed to affect the toxicity of the chemicals (see **Environmental effects section**). The identity of these chemicals typically provides information on alkyl chain length but not the degree of ethoxylation. As this subset of chemicals can be formulated with variable degree of ethoxylation, they are categorised for the ethoxylate chain length with the most conservative toxicity outcome.

Toxic (T). Based on measured ecotoxicity endpoints less than or equal to 1 mg/L, the following chemicals are categorised as Toxic:

- $C_{16}EO_xS.NH_4$ (CAS RN 59764-60-2)
- $C_{16}EO_xS.DEA$ (CAS RN 104339-49-3)
- $C_{12–15}EO_xS$ (CAS RN 68511-39-7).

Not Toxic (Not T). Based on measured endpoints greater than 1 mg/L and measured chronic endpoints greater than 0.1 mg/L, the following chemicals are categorised as Not Toxic:

- $C_{12}EO_xS.Na$ (CAS RN 9004-82-4)
- $C_{12}EO_xS$ (CAS RN 26183-44-8)
- $C_{12}EO_xS.TEA$ (CAS RN 27028-82-6)
- $C_{12}EO_xS.NH_4$ (CAS RN 32612-48-9)
- $C_{12}EO_xS.Mg$ (CAS RN 62755-21-9)
- $C_{12}EO_1S.Na$ (CAS RN 15826-16-1)
- $C_{12}EO_2S.Na$ (CAS RN 3088-31-1)
- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{13}EO_xS.Na$ (CAS RN 54116-08-4)
- $C_{14}EO_xS.NH_4$ (CAS RN 27731-61-9)
- $C_{14}EO_xS.Na$ (CAS RN 27731-62-0)
- $C_{18}EO_xS$ (CAS RN 45294-11-9)
- $C_{8–10}EO_xS.NH_4$ (CAS RN 68891-29-2)
- $C_{10–16}EO_xS.NH_4$ (CAS RN 67762-19-0)
- $C_{10–16}EO_xS.Mg$ (CAS RN 67762-21-4)
- $C_{10–16}EO_xS.Na$ (CAS RN 68585-34-2)
- $C_{10–16}EO_xS$ (CAS RN 68611-29-0)
- $C_{12–13}EO_xS.Na$ (CAS RN 110392-50-2)
- $C_{12–14}EO_xS.Na$ (CAS RN 68891-38-3)
- $C_{12–14}EO_xS.Mg$ (CAS RN 160104-51-8).

Not Toxic (Not T). Based on read across from other not toxic chemicals, including AS surfactants of equivalent alkyl chain length, the following chemicals are categorised as Not Toxic:

- $C_8EO_xS.NH_4$ (CAS RN 52286-18-7)
- $C_{10}EO_xS.NH_4$ (CAS RN 52286-19-8)
- $C_{10}EO_xS.Na$ (CAS RN 63428-87-5)
- $C_{12}EO_7S.Na$ (CAS RN 66197-75-9)

- $C_{12}EO_{12}S.Na$ (CAS RN 66161-57-7)
- $C_{13}EO_3S.Na$ (CAS RN 25446-78-0)
- $C_{14}EO_3S.Na$ (CAS RN 25446-80-4)
- $C_{6–10}EO_xS.NH_4$ (CAS RN 68037-05-8)
- $C_{6–10}EO_xS.Na$ (CAS RN 73665-22-2)
- $C_{6–12}EO_xS.NH_4$ (CAS RN 75422-21-8)
- $C_{10–12}EO_xS.Na$ (CAS RN 68610-66-2)
- $C_{10–12}EO_xS.NH_4$ (CAS RN 68890-88-0)
- $C_{12–18}EO_xS.Na$ (CAS RN 68081-91-4)
- $C_{12–18}EO_xS.NH_4$ (CAS RN 68610-22-0)
- $C_{12–18}EO_xS.Mg$ (CAS RN 125301-90-8)
- $C_{12–18}EO_xS$ (CAS RN 160738-88-5)
- $C_{14–18}EO_xS.Na$ (CAS RN 68187-52-0)
- $C_{16–18}EO_xS.Na$ (CAS RN 68585-40-0)
- $C_{16–18}EO_xS.K$ (CAS RN 103818-96-8)
- $C_{16–18}EO_xS.NH_4$ (CAS RN 116726-95-5)
- $C_{16–18}EO_xS.Mg$ (CAS RN 125301-91-9).

The chemical, $C_{10–18}EO_xS.Na$ (CAS RN 102783-14-2) lacks specific ecotoxicity data or a suitable analogue for read across. As this UVCB chemical contains toxic and not toxic components, the overall ecotoxicity is difficult to predict. Therefore, there is insufficient information to categorise this chemical as toxic according to Australian PBT criteria. The categorisation of this chemical may change if further information becomes available.

Environmental hazard classification

Chemicals in the evaluation have been classified according to the GHS criteria for aquatic hazards (UNECE 2017).

Many chemicals in this evaluation are UVCBs comprising homologues with different alkyl and/or different ethoxylate chain lengths. The hazards of these chemicals will depend on the composition, which may differ between different introducers.

Classifications are primarily based on available experimental ecotoxicity information and read across principles (see **Supporting information**). UVCBs without sufficient ecotoxicity data were classified using the ‘summation method’ by considering the alkyl chain length distributions of the precursor alcohols (UNECE 2017).

Classifications are assigned to chemicals based on their CAS Registry Number (RN). Chemicals with the same generic CAS RN may include a range of ethoxylation degrees, which may affect the ecotoxicological properties. The proposed default classifications for these CAS RNs are based on the most conservative level of ethoxylation for the chemical.

Default classifications for the chemicals are recommended as below. As classifications for chemicals in this evaluation can change with composition, the classification and labelling entries for these chemicals should be appended with the following note:

‘The chemical is a substance of unknown or variable composition, complex reaction product, or biological material (UVCB). The hazards of the chemical may depend on the composition. For more information refer to the assessment report published on the website of the Australian Industrial Chemicals Introduction Scheme.’

If empirical data are available for a specific chemical, for example to justify a lower classification, this data may be used to amend the default classification for that chemical.

Based on the available information, the following chemicals are not classified for aquatic hazards:

- $C_8EO_xS.NH_4$ (CAS RN 52286-18-7)
- $C_{12}EO_7S.Na$ (CAS RN 66197-75-9)
- $C_{12}EO_{12}S.Na$ (CAS RN 66161-57-7).

Due to a lack of experimental ecotoxicity data or information on alkyl chain length distribution, it is not possible to classify $C_{10–18}EO_xS.Na$ (CAS RN 102783-14-2) for aquatic hazards.

Hazardous to the aquatic environment (acute / short term)

Based on measured EC50 and LC50 values less than or equal to 1 mg/L, the following chemicals satisfy the criteria for hazard category 'Aquatic Acute 1' with the hazard statement 'H400: Very toxic to aquatic life':

- $C_{16}EO_xS.NH_4$ (CAS RN 59764-60-2)
- $C_{16}EO_xS.DEA$ (CAS RN 104339-49-3)
- $C_{12–15}EO_xS$ (CAS RN 68511-39-7).

The following UVCB chemicals are expected to contain more than 25% C16 alkyl chain lengths. Therefore, these chemicals satisfy the criteria for hazard category 'Aquatic Acute 1' with the hazard statement 'H400: Very toxic to aquatic life':

- $C_{12–18}EO_xS.Na$ (CAS RN 68081-91-4)
- $C_{12–18}EO_xS.NH_4$ (CAS RN 68610-22-0)
- $C_{12–18}EO_xS.Mg$ (CAS RN 125301-90-8)
- $C_{12–18}EO_xS$ (CAS RN 160738-88-5)
- $C_{14–18}EO_xS.Na$ (CAS RN 68187-52-0)
- $C_{16–18}EO_xS.Na$ (CAS RN 68585-40-0)
- $C_{16–18}EO_xS.K$ (CAS RN 103818-96-8)
- $C_{16–18}EO_xS.NH_4$ (CAS RN 116726-95-5)
- $C_{16–18}EO_xS.Mg$ (CAS RN 125301-91-9).

Based on measured EC50 and LC50 values in the range 1–10 mg/L, the following chemicals satisfy the criteria for hazard category 'Aquatic Acute 2' with the hazard statement 'H401: Toxic to aquatic life':

- $C_{12}EO_xS.Na$ (CAS RN 9004-82-4)
- $C_{12}EO_xS$ (CAS RN 26183-44-8)
- $C_{12}EO_xS.TEA$ (CAS RN 27028-82-6)
- $C_{12}EO_xS.NH_4$ (CAS RN 32612-48-9)
- $C_{12}EO_xS.Mg$ (CAS RN 62755-21-9)
- $C_{12}EO_1S.Na$ (CAS RN 15826-16-1)
- $C_{12}EO_2S.Na$ (CAS RN 3088-31-1)
- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{13}EO_xS.Na$ (CAS RN 54116-08-4)
- $C_{14}EO_xS.NH_4$ (CAS RN 27731-61-9)

- $C_{14}EO_xS.Na$ (CAS RN 27731-62-0)
- $C_{18}EO_xS$ (CAS RN 45294-11-9)
- $C_{10-16}EO_xS.NH_4$ (CAS RN 67762-19-0)
- $C_{10-16}EO_xS.Mg$ (CAS RN 67762-21-4)
- $C_{10-16}EO_xS.Na$ (CAS RN 68585-34-2)
- $C_{10-16}EO_xS$ (CAS RN 68611-29-0)
- $C_{12-14}EO_xS.Na$ (CAS RN 68891-38-3)
- $C_{12-14}EO_xS.Mg$ (CAS RN 160104-51-8).

Based on read across to chemicals of similar toxicity, the following chemicals satisfy the criteria for hazard category ‘Aquatic Acute 2’ with the hazard statement ‘H401: Toxic to aquatic life’:

- $C_{10}EO_xS.NH_4$ (CAS RN 52286-19-8)
- $C_{10}EO_xS.Na$ (CAS RN 63428-87-5)
- $C_{13}EO_3S.Na$ (CAS RN 25446-78-0)
- $C_{14}EO_3S.Na$ (CAS RN 25446-80-4).

The following UVCB chemicals are expected to contain more than 25% C10 and C12 alkyl chain lengths. Therefore, these chemicals satisfy the criteria for hazard category ‘Aquatic Acute 2’ with the hazard statement ‘H401: Toxic to aquatic life’:

- $C_{6-10}EO_xS.NH_4$ (CAS RN 68037-05-8)
- $C_{6-10}EO_xS.Na$ (CAS RN 73665-22-2)
- $C_{6-12}EO_xS.NH_4$ (CAS RN 75422-21-8)
- $C_{10-12}EO_xS.Na$ (CAS RN 68610-66-2)
- $C_{10-12}EO_xS.NH_4$ (CAS RN 68890-88-0)
- $C_{12-13}EO_xS.Na$ (CAS RN 110392-50-2).

Based on measured EC50 and LC50 values in the range 10–100 mg/L, the following chemicals satisfy the criteria for hazard category ‘Aquatic Acute 3’ with the hazard statement ‘H402: Harmful to aquatic life’:

- $C_{8-10}EO_xS.NH_4$ (CAS RN 68891-29-2).

Hazardous to the aquatic environment (chronic / long term)

Based on measured NOEC and EC10 endpoints in the range 0.1–1 mg/L, the following chemicals satisfy the criteria for hazard category ‘Aquatic Chronic 3’ with the hazard statement ‘H412: Harmful to aquatic life with long lasting effects’:

- $C_{12}EO_xS.Na$ (CAS RN 9004-82-4)
- $C_{12}EO_xS$ (CAS RN 26183-44-8)
- $C_{12}EO_xS.TEA$ (CAS RN 27028-82-6)
- $C_{12}EO_xS.NH_4$ (CAS RN 32612-48-9)
- $C_{12}EO_xS.Mg$ (CAS RN 62755-21-9)
- $C_{12}EO_1S.Na$ (CAS RN 15826-16-1)
- $C_{12}EO_2S.Na$ (CAS RN 3088-31-1)
- $C_{13}EO_xS.Na$ (CAS RN 54116-08-4)
- $C_{14}EO_xS.NH_4$ (CAS RN 27731-61-9)
- $C_{14}EO_xS.Na$ (CAS RN 27731-62-0)
- $C_{10-16}EO_xS.NH_4$ (CAS RN 67762-19-0)

- $C_{10–16}EO_xS.Mg$ (CAS RN 67762-21-4)
- $C_{10–16}EO_xS.Na$ (CAS RN 68585-34-2)
- $C_{10–16}EO_xS$ (CAS RN 68611-29-0)
- $C_{12–13}EO_xS.Na$ (CAS RN 110392-50-2)
- $C_{12–14}EO_xS.Na$ (CAS RN 68891-38-3)
- $C_{12–14}EO_xS.Mg$ (CAS RN 160104-51-8)
- $C_{12–15}EO_xS$ (CAS RN 68511-39-7).

Based on read across to chemicals of similar toxicity, the following chemicals satisfy the criteria for hazard category 'Aquatic Chronic 3' with the hazard statement 'H412: Harmful to aquatic life with long lasting effects':

- $C_{13}EO_3S.Na$ (CAS RN 25446-78-0)
- $C_{14}EO_3S.Na$ (CAS RN 25446-80-4).

The following UVCB chemical are expected to contain more than 25% C12, C13 and C14 alkyl chain lengths. Therefore, these chemicals satisfy the criteria for hazard category 'Aquatic Chronic 3' with the hazard statement 'H412: Harmful to aquatic life with long lasting effects':

- $C_{10–12}EO_xS.Na$ (CAS RN 68610-66-2)
- $C_{10–12}EO_xS.NH_4$ (CAS RN 68890-88-0)
- $C_{12–18}EO_xS.Na$ (CAS RN 68081-91-4)
- $C_{12–18}EO_xS.NH_4$ (CAS RN 68610-22-0)
- $C_{12–18}EO_xS.Mg$ (CAS RN 125301-90-8)
- $C_{12–18}EO_xS$ (CAS RN 160738-88-5)
- $C_{14–18}EO_xS.Na$ (CAS RN 68187-52-0).

Based on measured NOEC and EC10 endpoints greater than 1 mg/L, or other evidence of low chronic toxicity, the following chemicals satisfy the criteria for 'Not classified for long-term (chronic) toxicity':

- $C_{10}EO_xS.NH_4$ (CAS RN 52286-19-8)
- $C_{10}EO_xS.Na$ (CAS RN 63428-87-5)
- $C_{12}EO_3S.Na$ (CAS RN 13150-00-0)
- $C_{16}EO_xS.NH_4$ (CAS RN 59764-60-2)
- $C_{16}EO_xS.DEA$ (CAS RN 104339-49-3)
- $C_{18}EO_xS$ (CAS RN 45294-11-9)
- $C_{6–10}EO_xS.NH_4$ (CAS RN 68037-05-8)
- $C_{6–10}EO_xS.Na$ (CAS RN 73665-22-2)
- $C_{6–12}EO_xS.NH_4$ (CAS RN 75422-21-8)
- $C_{8–10}EO_xS.NH_4$ (CAS RN 68891-29-2)
- $C_{16–18}EO_xS.Na$ (CAS RN 68585-40-0)
- $C_{16–18}EO_xS.K$ (CAS RN 103818-96-8)
- $C_{16–18}EO_xS.NH_4$ (CAS RN 116726-95-5)
- $C_{16–18}EO_xS.Mg$ (CAS RN 125301-91-9).

Environmental risk characterisation

Based on the PEC and PNEC values determined above, the following Risk Quotient (RQ = PEC ÷ PNEC) have been calculated for release of the chemicals in this evaluation into surface water:

Compartment	PEC	PNEC	RQ
Surface water	18 µg/L	65 µg/L	0.28

For surface water, an RQ less than 1 indicates that chemicals in this evaluation are not expected to pose a significant risk to the environment based on estimated emissions, as environmental concentrations are below levels likely to cause harmful effects.

An RQ in soil was not determined as available ecotoxicity information suggests that the chemicals in this evaluation are not harmful to terrestrial life at environmentally relevant concentrations.

An RQ in sediment was not determined due to a lack of toxicity information for sediment life. The toxicity information for aquatic organisms and soil organisms indicates that risk to sediment organisms may be low.

Uncertainties

This evaluation was conducted based on a set of information that may be incomplete or limited in scope. Some relatively common data limitations can be addressed through use of conservative assumptions (OECD 2019) or quantitative adjustments such as assessment factors (OECD 1995). Others must be addressed qualitatively, or on a case-by-case basis (OECD 2019).

The most consequential areas of uncertainty for this evaluation are:

- Limited Australian monitoring information is available for the chemicals in this evaluation. This includes environmental concentration data, as well as a lack of Australia specific homologue distribution information for products, STP effluent, and surface waters.
- Pooled concentrations from monitoring data have been used to calculate risk, rather than individually measured homologue concentrations. The pooled concentrations include non-ethoxylated homologous, which may come from a variety of sources. Therefore, the magnitude of these pooled concentrations may overestimate exposure.
- Pooled concentrations from environmental monitoring data do not consider the relative ecotoxicity of these chemicals. Ecotoxicity normalised equivalent concentrations were not calculated for any pooled measurements. The available information suggests that the average AES homologue found in the environment is likely similar to the $C_{12.5}EO_{3.4}S$ homologue used in the Australian water quality guideline derivation. As such, the impact on the risk calculation is minimal.
- Insufficient data are available for chemicals in this evaluation to characterise the risk to the sediment compartment.
- Limited composition data are available to assess the ecotoxicity of AES in terms of ethoxylate chain length. Commercial AES with the same CAS RN can have different degrees of ethoxylation, which may impact aquatic hazards.

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