

MEMO

To: Phill Wilkinson, Senex Energy

From: Dana McCue, EHS Support

CC: Jacob Cumpstay, Senex Energy
Joe Hayes, EHS Support

Date: 23 April 2026

Re: Chemical Risk Assessment for Atlas Stage 3 Gas Project – Hydro 327

This technical memorandum provides a chemical risk assessment of the chemicals in COHO product Hydro 327, a drilling additive product proposed to be used in coal seam gas (CSG) operations (production wells, drilling completions and workovers, exploration and core holes, production operations and abandonment) within the Senex Energy (“Senex”) Atlas Stage 3 Development and original Atlas tenure PL1037. This document was prepared in accordance with the Chemical Risk Assessment Framework (CRAF; Klohn Crippen Berger, 2024a) and the *Senex Atlas Stage 3 DCCEE/PD Response Drilling Chemical Risk Assessment* (“March 2024 CRAR”; Klohn Crippen Berger, 2024b) for chemical risk assessments for this area.

The CRAF incorporates best practice risk assessment methodologies for the assessment of the potential impacts of the chemicals proposed to be used in CSG operations on Matters of National Environmental Significance (MNES).

This assessment process is designed to align with national guidance and other regulatory frameworks and assesses the full lifecycle of chemicals that are stored, handled, used and/or disposed during or following drilling and hydraulic fracturing activities. Accidental release scenarios are not included; however, the outcomes of the assessment will be used to inform emergency response actions.

Goals

The aim of the chemical risk assessment is to evaluate the potential risks and effects of chemicals used during CSG operations (defined as production wells, drilling completions and workovers, exploration and core holes, production operations and abandonment) to MNES. No hydraulic fracturing is proposed for the Senex Atlas Stage 3 Development and Hydro 327 is not proposed for use in water treatment.

The goal of the chemical risk assessment is to demonstrate that potential risks to MNES, associated with the chemicals within Hydro 327, a product proposed for use in CSG operations, have been eliminated or reduced as much as is reasonably practicable. In addition, potential risks to non-MNES receptors (for example residents, agricultural workers and livestock) will be assessed where an activity results in exposure to water resources and there is potential for a complete exposure pathway to the non-MNES receptor (e.g., drilling and completion activities near a water bore used



for drinking water). Effects to terrestrial MNES and water resource MNES will be assessed via the identification of potentially complete exposure pathways to soils.

Approach

As noted above, formal assessments must be conducted on each chemical in accordance with the CRAF (Klohn Crippen Berger, 2024a). This technical memo serves as an addendum to the March 2024 CRAR and follows the assessment methodology outlined in the CRAF for the chemicals present within Hydro 327.

The framework for the chemical risk assessment involves a two-step process:

- Step 1 – classification of chemicals
- Step 2 – assessment of chemicals

The criteria to be used in the chemical category classification within this framework is provided in Appendix 1 of the CRAF (**Attachment 1**). Consistent with the CRAF, chemicals categorised as Tier 1 chemicals are designated as ‘low concern’ chemicals. Chemicals categorised as Tier 2 or Tier 3 chemicals are designated as ‘potential concern’ or ‘potentially high concern’ chemicals, respectively.

Based on the Tier classification of the chemical (and its potential toxicity, persistence and bioaccumulation potential in the environment), different levels of assessment are conducted with the most robust assessment conducted on the highest classification. Consistent with the screening matrix in Appendix 1 of the CRAF (**Table 1**):

- Chemicals previously assessed by national (e.g. NICNAS) or international regulators and considered to be of low hazard, and therefore low risk for human health and the environment to not require further assessment pursuant to the CRAF.
- Tier 1 chemicals, which are effectively low toxicity and therefore low hazard, would be subject to only the screening assessment.
- Tier 2 chemicals, in addition to the screening assessment, will be subjected to a qualitative risk assessment.
- Tier 3 chemicals will be subject to an additional quantitative risk assessment.

A Register of Assessed Chemicals has been developed and is published and maintained on Senex’s website and includes chemicals assessed in the March 2024 CRAR¹. The Register of Assessed Chemicals will, for each published chemical, provide a summary of the outcomes of the screening assessment, including the Tier (and Risk Level) categorisation, the activities the chemical has been assessed for (i.e. drilling and completions and/or production operations) and the assessed end use/fate of the chemical. Toxicological information for all chemicals will be re-evaluated approximately every 5 years.

Chemicals evaluated in this assessment were identified based on a review of the safety data sheet (SDS) for Hydro 327 (**Attachment 2**). A Register of Assessed Chemicals for chemicals evaluated in this risk assessment is included in **Attachment 3** and was developed for inclusion in the online Register of Assessed Chemicals (**Attachment 3**).

In the development of this screening assessment, toxicological profiles have been developed for all chemicals (Tier 1 through 3) and these are provided in **Attachment 4**. Consistent with the guidance

¹ <https://senexenergy.com.au/news/atlas3/>



documents contained within the CRAF, the risk assessment includes the following components for the different Tiers of Chemicals (**Table 2**).

TABLE 1 ASSESSMENT AND REPORTING REQUIREMENTS BY TIER

Tier	Risk Category	Screening Assessment and Categorisation	Toxicological Profile	Qualitative Risk Assessment	Quantitative Risk Assessment	Prohibited from Use on Project
1	Low Concern	X	X			
2	Potential Concern	X	X	X		
3	Potentially High Concern	X	X	X	X	
Prohibited From Use	Very High Concern					X

TABLE 2 QUALITATIVE AND QUANTITATIVE RISK ASSESSMENT COMPONENTS

Tier 2 (Qualitative Risk Assessment)	Tier 3 (Quantitative Risk Assessment)
Problem Formulation and Issue Identification Hazard Assessment Risk Communication and Management	Problem Formulation and Issue Identification Hazard Assessment Exposure Assessment Risk Characterisation Risk Communication and Management

Screening Assessment Findings

Chemical Classification and Risk Assessment

Senex is proposing to use Hydro 327 as a drilling additive. The additive in the fluid system will be installed with the surface casing vent (i.e., between the surface casing and production casing) to act as a corrosion inhibitor. In production wells and as part of well abandonment, the production casing will be cemented and surface casing will be filled with the additive to preserve the surface well casing. For abandoned wells, after a period of approximately six months, the top of the surface casing will be grouted, effectively encapsulating the liquid.

Exposure was assessed for the constituents of potential concern (COPCs) identified in Hydro 327 during the drilling and completions process. The chemicals identified in Hydro 327 are detailed in **Table 3**. The safety data sheet (SDS) for Hydro 327 is included as **Attachment 2**.



TABLE 3 HYDRO 327 CHEMICALS

Chemical Name	CAS No.
2-Butoxyethanol	111-76-2
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7
Propylene glycol	57-55-6
Acetic acid	64-19-7
Sodium thiosulphate pentahydrate	10102-17-7

The chemicals identified for evaluation as part of this chemical risk assessment were reviewed using the approved CRAF provided in **Attachment 1**. Based on the tier classification of the chemicals (and their potential toxicity, persistence and bioaccumulation potential in the environment), different levels of assessment are conducted with the most robust assessment conducted on the highest classification.

The findings of the screening assessment based on the CRAF is included in the Register of Assessed Chemicals provided as **Attachment 3**. This table documents the chemicals assessed, the key findings from the hazard assessment, the classification Tier determined, the activities the chemical has been assessed for (i.e. drilling and completions) and the assessed end use/fate of the chemical.

As presented in the Register of Assessed Chemical in **Attachment 3**, 2-butoxyethanol (also referred to as ethylene glycol monobutyl ether), propylene glycol, acetic acid and sodium thiosulphate pentahydrate were assessed as Tier 1 chemicals and require a hazard assessment only and development of a toxicological profile (risk assessment dossier).

These toxicological profiles are provided in **Attachment 4**. These are a critical data source for first responders (including emergency services) in the event of a release during transportation (determined to be the highest probability release event), Senex operators and the regulatory community.

One chemical, INCI, was assessed as a Tier 3 chemical. As a 'high risk' chemical, in addition to a screening assessment, Tier 3 chemicals are also subject to a qualitative and quantitative assessment of risk. This assessment is provided in **Attachment 5**.

Summary

The aim of this chemical risk assessment was to evaluate the potential risks and effects of chemicals in Hydro 327 used during CSG operations (defined as production wells, drilling completions and workovers, exploration and core holes, production operations and abandonment) to MNES. The goal of the chemical risk assessment was to demonstrate that potential risks to MNES associated with the chemicals used in CSG operations have been eliminated or reduced as much as is reasonably practicable.



The life cycle of the drilling and completion and production was assessed specifically for the proposed operations and included:

- storage, usage (e.g., blending, injection), and recovery of chemicals throughout operations; beneficial reuse of recovered drilling fluids and cuttings for well lease rehabilitation; and,
- storage of produced water.

In accordance with the CRAF an evaluation of all chemicals proposed for use was conducted, with four (4) chemicals classified as a Tier 1 chemical and one (1) chemical classified as a Tier 3 chemical (refer **Attachment 3**).

The chemical risk assessment completed for the chemicals indicated negligible risks and effects of chemicals used during CSG operations (production wells, drilling completions and workovers, exploration and core holes, production operations and abandonment) to MNES when appropriate management and mitigation controls were in place. Should assessments of additional chemicals indicate additional management control, the EMP and associated management plans will be updated accordingly.

In general, the management practices adopted and implemented by Senex are appropriate and have eliminated or reduced as much as is reasonably practicable the potential risks to MNES associated with the chemicals used in CSG extraction.

References

Klohn Crippen Berger. (2024a). Atlas Stage 3 DCCEEW PD Response Chemical Risk Assessment Framework. Final. Revision 1. March.

Klohn Crippen Berger. (2024b). Atlas Stage 3 DCCEEW PD Response Drilling Chemical Risk Assessment. Final. Revision 2. March.



Attachment 1 CRAF Screening Matrix

Attachment 1
Summary of Chemical Risk Assessment Framework

Criteria	Category 1	Category 2	Category 3	Category 4	Category 5
General PBT Assessment Step					
Combined PBT Assessment Category	Not a PBT	Not a PBT	Not a PBT	Identified as a PBT	N/A
Chemical Databases of Concern Assessment Step					
Listed as a chemical of concern on relevant databases	Not listed as a chemical of potential concern on the following databases: - European Union Substance of Very High Concern (EU SVHC). - US National Toxicology Program (US NTP) Report on Carcinogens or International Agency Research on Cancer (IARC) Monographs. - European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity. - Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical.	Not listed as a chemical of potential concern on the following databases: - European Union Substance of Very High Concern (EU SVHC). - US National Toxicology Program (US NTP) Report on Carcinogens or International Agency Research on Cancer (IARC) Monographs. - European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity. - Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical.	Listed as a chemical of concern on the following databases: - European Union Substance of Very High Concern (EU SVHC). - US National Toxicology Program (US NTP) Report on Carcinogens or International Agency Research on Cancer (IARC) Monographs. - European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity. - Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical.	Listed as a chemical of concern on the following databases: - European Union Substance of Very High Concern (EU SVHC). - US National Toxicology Program (US NTP) Report on Carcinogens or International Agency Research on Cancer (IARC) Monographs. - European Commission Endocrine Disruptors Strategy - list of Category 1 substances with endocrine disrupting capacity. - Chemical Substances Control Law of Japan (CSCL) Class I and II Specified Chemical.	Chemicals noted in the Rotterdam Accord including: - octabromodiphenyl ether - pentabromodiphenyl ether - perfluorooctane sulfonic acid - perfluorooctane sulfonates - perfluorooctane sulfonamides - perfluorooctane sulfonyls - polybromated biphenyls - short chain chlorinated paraffins - tetramethyl lead - tributyl tin compounds Chemicals banned in the State of Queensland including: - Benzene* - Toluene* - Ethylbenze* - Xylene*
Identified as Polymer of Low Concern	Yes (no further assessment required)	No	No	No	N/A
Persistence Assessment Step					
Persistence	Not persistent as defined by: Air - Half life < 2 days Water - Half life < 60 days Soil and Sediment - Half life < 6 months	Not persistent as defined by: Air - Half life < 2 days Water - Half life < 60 days Soil and Sediment - Half life < 6 months	Persistent as defined by: Air - Half life ≥ 2 days Water - Half life ≥ 60 days Soil and Sediment - Half life ≥ 6 months	Persistent as defined by: Air - Half life ≥ 2 days Water - Half life ≥ 60 days Soil and Sediment - Half life ≥ 6 months	N/A
Other Persistence Concerns - Chemical identified as potentially accumulating in soil and posing risks	No potential concerns with accumulation in soil and impacts on flora and fauna	No potential concerns with accumulation in soil and impacts on flora and fauna	Potential concerns with accumulation in soils based on ANZECC assessment b (for example metals such as Cd)	Potential concerns with accumulation in soils based on ANZECC assessment b (for example metals such as Cd)	N/A
Bioaccumulative Assessment Step					
Bioaccumulative	Does not Bioaccumulate as defined by: - Aquatic - BAF < 2000 or BCF < 2000 or log KoW < 4.2 (if BAF and BCF are not available) -Terrestrial - log Koa < 6 and log Kow < 2 - Food Chain Bioaccumulation Potential - BMF < 1	Does not Bioaccumulate as defined by: - Aquatic - BAF < 2000 or BCF < 2000 or log KoW < 4.2 (if BAF and BCF are not available) -Terrestrial - log Koa < 6 and log Kow < 2 - Food Chain Bioaccumulation Potential - BMF < 1	Does not Bioaccumulate as defined by: - Aquatic - BAF < 2000 or BCF < 2000 or log KoW < 4.2 (if BAF and BCF are not available) -Terrestrial - log Koa < 6 and log Kow < 2 - Food Chain Bioaccumulation Potential - BMF < 1	Does Bioaccumulate as defined by: - Aquatic - BAF ≥ 2000 or BCF ≥ 2000 or log KoW ≥ 4.2 (if BAF and BCF are not available) -Terrestrial - log Koa ≥ 6 and log Kow ≥ 2 - Food Chain Bioaccumulation Potential - BMF > 1	N/A
Toxicity Assessment Step					
Toxicity	Acute Toxicity: Fish -96h LC 50 > 10 mg/L Invertebrates - 48h EC50 > 10 mg/L Algae and other aquatic plants -72 or 96h ErC50 > 10 mg/L	Acute Toxicity: Fish -96h LC 50 >1 to < 10 mg/L Invertebrates - 48h EC50 >1 to < 10 mg/L Algae and other aquatic plants -72 or 96h ErC50 >1 to < 10 mg/L	Acute Toxicity: Fish -96h LC 50 ≤ 1 mg/L Invertebrates - 48h EC50 ≤ 1 mg/L Algae and other aquatic plants -72 or 96h ErC50 ≤ 1 mg/L	Acute Toxicity: Fish -96h LC 50 ≤ 1 mg/L Invertebrates - 48h EC50 ≤ 1 mg/L Algae and other aquatic plants -72 or 96h ErC50 ≤ 1 mg/L	N/A
	Chronic Toxicity: Fish NOEC or ECx >1 mg/L Invertebrates NOEC or ECx > 1 mg/L Algae and other aquatic plants -NOEC or ECx > 1 mg/L	Chronic Toxicity: Fish NOEC or ECx >0.1 to < 1 mg/L Invertebrates NOEC or ECx >0.1 to < 1 mg/L Algae and other aquatic plants -NOEC or ECx >0.1 to < 1 mg/L	Chronic Toxicity: Fish NOEC or ECx ≤ 0.1 mg/L Invertebrates NOEC or ECx ≤ 0.1 mg/L Algae and other aquatic plants -NOEC or ECx ≤ 0.1 mg/L	Chronic Toxicity: Fish NOEC or ECx ≤ 0.1 mg/L Invertebrates NOEC or ECx ≤ 0.1 mg/L Algae and other aquatic plants -NOEC or ECx ≤ 0.1 mg/L	N/A
RISK ASSESSMENT ACTIONS REQUIRED					
RISK ASSESSMENT ACTIONS REQUIRED	Hazard Assessment only. Do screening only and note it meets the above criteria. Develop toxicological profile	Hazard Assessment and Qualitative Assessment Only. Do screening only and note it meets the above criteria. Develop toxicological profile and PNECs for water and soil and provide qualitative discussion of risk	Quantitative Risk Assessment: Complete PBT, qualitative and quantitative assessment of risk. Quantitative assessment of risk will consider only Category 3 chemicals in end use determination.	Quantitative Risk Assessment and Full Life Cycle Assessment: Need to demonstrate that the chemical cannot be substituted. If retained will need to conduct a full life cycle quantitative risk assessment including food chain risk assessment	Banned from Use on Project. Would require specific assessment process and require extensive consultation prior to assessment.

* Above levels prescribed in the Queensland Environment Protection Act 1994

N/A - Not Applicable

ANZECC Australian and New Zealand Environment and Conservation Council

BAF = bioaccumulation factor

BCF = bioconcentration factor

BMF = biomagnification factor

Cd = cadmium

EC = effect concentration

Ec_x = effect concentration at x% effect (e.g., mortality, inhibition of growth, reproduction) is observed compared to the control group.

ErC50 = the concentration of test substance which results in a 50 percent reduction in growth rate (ErC50) relative to the control within 72 hours exposure

h = hour

K_{oa} = octonal-air partition coefficient

K_{ow} = octonal-water partition coefficient

LC = lethal concentration

mg/L = milligrams per litre

NOEC = no observed effect concentration

PBT = persistent, bioaccumulative, and toxic

PNEC = predicted no effects concentration



Attachment 2 Safety Data Sheet

SAFETY DATA SHEET

According to Safe Work Australia

Hydro 327

Section 1: Product and Company Identification

1.1 Product identifier

Product name Hydro 327

1.2 Uses and uses advised against

Use(s) Applied in drilling fluids for Corrosion Inhibition.

1.3 Details of the supplier of the product

Supplier name COHO Resources
Address 3/35 Astor Terrace Spring Hill 4000
Telephone 0447 725 362

1.4 Emergency telephone number(s)

Emergency 0447725362

2. HAZARD IDENTIFICATION

GHS classification of the substance/mixture

Not classified as Hazardous according to the Globally Harmonised System of Classification and Labelling of Chemicals (GHS7) including Work, Health and Safety regulations, Australia.

Not classified as Dangerous Goods according to the Australian Code for the Transport of Dangerous Goods by Road and Rail. (7th edition)

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Name	CAS	Proportion
Diethylene glycol monobutyl ether	112-34-5	10-30 %
Filming Amine	61791-39-7	10-30 %
---PROPRIETRY INGREDIENTS ONLY---		TO MAKE 100%
(Propriety ingredients are classed as non-hazardous)		

SDS Error CAS 112-34-5 is incorrect and should be 111-76-2 per manufacturer

SAFETY DATA SHEET

According to Safe Work Australia

Hydro 327

4. FIRST-AID MEASURES

Inhalation

If fumes or combustion products are inhaled remove from contaminated area. Other measures are usually unnecessary.

Ingestion

If swallowed DO NOT induce vomiting. If vomiting occurs, lean patient forward or place on left side (head-down position, if possible) to maintain open air ways and prevent aspiration. Observe the patient carefully.

Skin

Wash with plenty of soap and water.

Remove contaminated clothing and rinse the contaminated skin area. Wash clothes before reuse. If irritation occurs seek medical advice.

Eye contact

Immediately irrigate with copious quantity of water for at least 15 minutes. Eyelids to be held open.

Seek immediate medical assistance.

Advice to Doctor

Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Fire Fighting Measures

As in any fire, wear an approved self-contained breathing apparatus in pressure-demand, and full protective gear.

Prevent by any means available, spillage from entering drains or water courses.

Suitable Extinguishing Media

Use appropriate fire extinguisher for surrounding environment.

Hazards from Combustion Products

Not considered to be a significant fire risk.

Expansion or decomposition on heating may lead to violent rupture of containers.

Decomposes on heating and may produce toxic/irritating fumes.

Special Protective Equipment for fire fighters

Proper protective equipment including breathing apparatus must be worn when approaching a fire in a confined space.

6. ACCIDENTAL RELEASE MEASURES

Emergency Procedures

Clean up all spills immediately. Avoid breathing vapours and contact with skin or eyes. Control personal contact by using PPE (personal protective equipment).

Contain and absorb spills with sand, earth, inert material or vermiculite.

Personal Protection

Chemical goggles, Butyl, Neoprene or Viton gloves and type A filter of sufficient capacity respirator.

Environmental Precautions

Prevent contamination of soil and water.

Prevent from spreading or entering into drains, ditches or rivers by using sand, earth, or other appropriate barriers.

Prevent further leakage or spillage if safe to do so.

7. HANDLING AND STORAGE

Precautions for Safe Handling

Only use in well-ventilated areas.

Prevent concentration in hallows and sumps.

Conditions for safe storage, including any incompatibilities

SAFETY DATA SHEET

According to Safe Work Australia

Hydro 327

Keep only in original container.
Keep container tightly closed and in a cool, well-ventilated place
Storage Incompatibility: None Known.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Occupational exposure limit values

TLV not established
No data supplied.

Appropriate Engineering Controls

Use in a well ventilated area only.
Local exhaust ventilation system may be required.
The performance of the ventilation system should be checked regularly.
Always work with the wind behind you.

Respiratory Protection

Type A filter of sufficient capacity.

Eye Protection

Safety glasses with side shields or chemical goggles.

Hand Protection

Butyl, Neoprene or Viton gloves

9. PHYSICAL AND CHEMICAL PROPERTIES

Form

Liquid

Appearance

Clear golden amber liquid with a slight odour.

Melting Point

Not available

Boiling Point

100°C

Solubility in Water

Miscible

Specific Gravity

0.980 - 0.985 @ 20°C Approx

pH

5 - 7 (neat product)

Vapour Pressure

Not available

Vapour Density (Air=1)

Data not available

Viscosity

Not Available

Volatile Component

Not Available

Flash Point

Not applicable.

Auto-Ignition Temperature

Not applicable

SAFETY DATA SHEET

According to Safe Work Australia

Hydro 327

Explosion Limit - Upper

Not Applicable

Explosion Limit - Lower

Not Applicable

Relative Evaporation Rate

Not Available

10. STABILITY AND REACTIVITY

Chemical Stability

Stable under normal use conditons.

Hazardous Polymerization

Will not occur

11. TOXICOLOGICAL INFORMATION

Toxicology Information

Not available for product refer individual constituents.

Diethylene Glycol Monobutyl Ether:

Oral(rat)LD50 = 5660 mg/kg

Dermal(rabbit)LD50 = 4120 mg/kg

Eye(rabbit): 5mg-Severe

Eye(rabbit): 20mg/24hr-Moderate

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Ingestion

May be harmful if swallowed.

Inhalation

May be harmful by inhalation.

Skin

May be irritating to skin.

Eye

May produce discomfort of the eyes.

Chronic Effects

Not Applicable

12. ECOLOGICAL INFORMATION

Ecotoxicity

Diethylene glycol monobutyl ether:

Persistence Water/soil - LOW

Bioaccumulation - LOW

Mobility - HIGH

Environmental Protection

This substance may be hazardous to the environment; special attention should be given to preventing any form of spillage.

SAFETY DATA SHEET

According to Safe Work Australia

Hydro 327

13. DISPOSAL CONSIDERATIONS

Waste Disposal

Refer to State Land Waste Management Authority or a Licensed disposal contractor for disposal.
Empty containers must be decontaminated, rinse with water before landfill disposal.

14. TRANSPORT INFORMATION

U.N. Number

None Allocated

UN proper shipping name

None Allocated

Transport hazard class(es)

None Allocated

15. REGULATORY INFORMATION

Poisons Schedule

Not Scheduled Other: Not Scheduled

Packaging & Labelling

Labelling requirements of the Standard for Uniform Scheduling of Drugs and Poisons do not apply to a poison that is packed and sold solely for industrial, laboratory or manufacturing purposes; however is labelled in accordance with the National Occupational Health and Safety Commission's 'National Code of Practice for the Labelling of Workplace Substances'.

16. OTHER INFORMATION

Additional Information:

Disclaimer

This SDS is prepared in accord with the Safe Work Australia document "Code of Practice for the Preparation of Safety Data Sheets for Hazardous Chemicals - December 2011"

The information contained in this safety data sheet is provided in good faith and is believed to be accurate at the date of issuance. COHO Resources Pty. Ltd makes no representation of the accuracy or comprehensiveness of the information and to the full extent allowed by law excludes all liability for any loss or damage related to the supply or use of the information in this material safety data sheet. The user is cautioned to make their own determinations as to the suitability of the information provided to the circumstances in which the product is used.



Attachment 3 Chemical Register

Attachment 3
Chemical Register

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Tier ³	Risk Level	Assessed Drilling Activity(ies)					
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²			Completion and Workover	Exploration and Core Holes	Production Operations	Monitoring Wells	Drilling additive - CSG Production Well	Abandonment
2-Butoxyethanol	111-76-2	Not a PBT	No	No	No	No	No	No	1	1	1	Low	X	X	X		X	X
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	Not a PBT	No	No	No	No	Yes	Yes	3 (fish, inv, algae)	3 (algae)	3	High	X	X	X		X	X
Propylene glycol	57-55-6	Not a PBT	No	No	No	No	No	No	1	1	1	Low	X	X	X		X	X
Acetic acid	64-19-7	Not a PBT	No	No	No	No	No	No	1	1	1	Low	X	X	X		X	X
Sodium thiosulphate pentahydrate	10102-17-7	Not a PBT	No	No	NA	No	No	No	1	1	1	Low	X	X	X		X	X

Footnotes:
1 - PBT Assessment based on PBT Framework.
2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).
3 – Tier 1 – Hazard Assessment only
Tier 3 - Quantitative Risk Assessment: Complete PBT, qualitative and quantitative assessment of risk.

Notes:
PBT = Persistent, Bioaccumulative and Toxic
B = bioaccumulative
P = persistent
T = toxic



Attachment 4 Risk Assessment Dossiers for Tier 1 Chemicals

ACETIC ACID

This dossier on acetic acid presents the most critical studies pertinent to the risk assessment of acetic acid in its use in coal seam gas extraction activities. It does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – Acetic acid is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Acetic acid is a flammable liquid. It readily dissociates in aqueous media to the acetate ($\text{H}_3\text{C}_2\text{O}_2^-$) and hydrogen (H^+) ions. The acetate ion is readily biodegradable, is not expected to bioaccumulate, and has a low potential to adsorb to soil. Acetic acid is of moderate toxicity to aquatic organisms, in part because of the effect of pH changes from the dissociated hydrogen ion. The acetate ion is of low toxicity concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Acetic acid

CAS RN: 64-19-7

Molecular formula: $\text{C}_2\text{H}_4\text{O}_2$

Molecular weight: 60.1 g/mol

Synonyms: Acetic acid, ethanoic acid, ethylic acid, methane carboxylic acid, vinegar acid

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1 Overview of the Physico-chemical Properties of Acetic Acid

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless liquid with a pungent odour.	2	ECHA
Melting Point	16.64°C @ 101.3 kPa	2	ECHA
Boiling Point	117.9°C @ 101.3 kPa	2	ECHA
Density	1040 kg/m ³ @ 25°C	2	ECHA
Vapor Pressure	2079 Pa @ 25°C	2	ECHA
Partition Coefficient (log K _{ow})	-0.17 @ 20°C	2	ECHA
Water Solubility	602.9 g/L @ 25°C	2	ECHA

Property	Value	Klimisch Score	Reference
Viscosity	1.056 mPa s @ 25°C	2	ECHA
Dissociation constant (pKa)	4.756 @ 25°C	2	ECHA

Acetic acid readily dissociates in aqueous media to the acetate ($\text{H}_3\text{C}_2\text{O}_2^-$) and hydrogen (H^+) ions.

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for acetic acid.

NICNAS has assessed acetic acid in an Inventory Multi-tiered Assessment and Prioritisation (IMAP) Tier 1 assessment and concluded that it poses no unreasonable risk to the environment.¹

Based on an assessment of environmental hazards, NICNAS has also identified acetic acid as a chemical of low concern to the environment (DoEE, 2017a). Chemicals of low concern are unlikely to have adverse environmental effects if they are released to the environment from coal seam gas operations.

Table 2 Existing International Controls

Convention, Protocol or Other International Control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

The acetate ion of acetic acid is readily biodegradable, is not expected to bioaccumulate, and has a low potential to adsorb to soil.

B. Partitioning

The pKa of acetic acid is 4.76, indicating that this substance will exist partially in anion form in the environment and anions generally do not adsorb more strongly to soils containing organic carbon and clay than their neutral counterparts (PubChem).

¹ <https://services.industrialchemicals.gov.au/assessment-detail/?id=5053433e-f36b-1410-8de4-00e8f2afc108>

Volatilization of acetic acid from water and moist soil surfaces is not expected to be an important fate process given a Henry's Law constant of 0.21 Pa·m³/mol (ECHA). Acetic acid is expected to volatilize from dry soil surfaces based upon its vapour pressure.

Hydrolysis is not expected to be an important environmental fate process since this substance lacks functional groups that hydrolyse under environmental conditions (PubChem).

C. Biodegradation

Acetic acid was readily biodegradable in a non-acclimated freshwater study. Degradation was 96% after 20 days (Price et al., 1974; ECHA) [Kl. score = 2]. Acetic acid is also readily biodegradable under anaerobic conditions (Kameya et al., 1995) [Kl. score = 2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017b).

D. Environmental Distribution

No experimental data are available for acetic acid. Using KOCWIN in EPISuite™ (USEPA, 2019), the estimated K_{oc} values from log K_{ow} and the molecular connectivity index (MCI) are 1.153 and 1.0 L/kg, respectively. Based on these values, acetic acid has a low potential for adsorption to soil and sediment and is expected to have very high mobility in soil.

Acetic acid is highly soluble in water and dissociates completely in aqueous solution to acetate and its hydrogen ion. However, the chemistry of the receiving water compartment, such as its pH and the presence of metal ions, may affect the speciation and partitioning of this substance and its buffering capacity (DoEE, 2017c).

E. Bioaccumulation

There are no bioaccumulation studies on acetic acid. Bioaccumulation of acetic acid is not expected to occur because acetic acid dissociates completely in aqueous solution to acetate and its hydrogen ion. Both ions are ubiquitous in the environment. Acetate is naturally found in eukaryotic and prokaryotic cells and is involved in their biochemical pathways.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Acetic acid is of moderate acute toxicity concern to aquatic organisms, in part because of the effect of pH changes from the dissociated hydrogen ion. The acetate ion is of low acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 presents the results of acute aquatic toxicity studies on acetic acid and potassium acetate.

Table 3 Acute Aquatic Toxicity Studies on Acetic Acid and Potassium Acetate

Test Substance	Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Potassium acetate	<i>Oncorhynchus mykiss</i>	96-hour LC ₅₀	>300.82*	2	ECHA
Potassium acetate	<i>Danio rerio</i>	96-hour LC ₅₀	>300.82*	2	ECHA
Acetic acid	<i>Oncorhynchus mykiss</i>	96-hour LC ₅₀	64.8 (measured)	4	ECHA
Acetic acid	<i>Oncorhynchus mykiss</i>	96-hour LC ₅₀	31.3–67.6	4	ECHA
Potassium acetate	<i>Daphnia magna</i>	48-hour EC ₅₀	>300.82*	2	ECHA
Acetic acid	<i>Daphnia magna</i>	48-hour EC ₅₀	79.5 (measured)	4	ECHA
Acetic acid	<i>Daphnia magna</i>	48-hour EC ₅₀	18.9 (measured)	4	ECHA
Acetic acid	<i>Desmodesmus subspicatus</i>	72-hour EC ₅₀	486.5	4	ECHA

*As the acetate ion.

Chronic Studies

In a 21-day fish (*Oncorhynchus mykiss*) chronic study, the measured NOEC values for 60% and 100% acetic acid were 57.2 and 34.3 mg/L, respectively (ECHA). [Kl. score = 4]

In a 21-day *Daphnia* reproduction study, the measured NOEC for 60% and 100% acetic acid were 80 and 31.4 mg/L, respectively (ECHA). [Kl. score = 4]

In a 21-day *Daphnia* reproduction study, the measured NOEC for 100% acetic acid was 22.7 mg/L (ECHA). [Kl. score = 4]

C. Terrestrial Toxicity

No data are available.

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (IChEMS, 2022; ECHA, 2023).

Acetic acid is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Bioaccumulation of acetic acid is not expected to occur because acetic acid dissociates completely in aqueous media to acetate and its hydrogen ion. Both ions are ubiquitous in the environment. Acetate is naturally found in eukaryotic and prokaryotic cells and is involved in their biochemical

pathways. The $\log K_{ow}$ for acetic acid is -0.17. Thus, acetic acid does not meet the screening criteria for bioaccumulation.

NOECs from the chronic aquatic toxicity studies on acetic acid are > 0.1 mg/L. The $E(L)C_{50}$ values from acute aquatic toxicity studies are > 1 mg/L. Thus, acetic acid does not meet the screening criteria for toxicity.

The overall conclusion is that acetic acid is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for acetic acid.

8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
Acetic Acid	64-19-7	Not a PBT	No	No	No	No	No	No	1	1	1

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 – Tier 1 – Hazard Assessment only.

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
CAS RN	Chemical Abstract Services Registry Number
COC	constituent of concern
DoEE	Department of the Environment and Energy
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/cm ³	grams per cubic centimetre
g/L	grams per litre
g/mol	grams per mole
hPa	hectopascal
ICHEMS	Industrial Chemicals Environmental Management Standard
IUPAC	International Union of Pure and Applied Chemistry
KI	Klimisch scoring system
KOCWIN™	USEPA organic carbon partition coefficient estimation model
kPa	kilopascal
L/kg	litres per kilogram
LC	lethal concentration
MCI	molecular connectivity index
mg/L	milligrams per litre
mPa s	millipascal second
NCBI	National Center for Biotechnology Information
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme

NOEC	no observed effect concentration
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
USEPA	United States Environmental Protection Agency

ETHYLENE GLYCOL MONOBUTYL ETHER

This dossier on ethylene glycol monobutyl ether (EGBE) presents the most critical studies pertinent to the risk assessment of EGBE in its use in coal seam gas extraction activities. It does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the OECD-SIDS documents on EGBE, and from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – EGBE is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

EGBE is readily biodegradable. It is not expected to bioaccumulate. EGBE has a low tendency to bind to soil or sediment. EGBE is of low toxicity concern to aquatic organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): 2-Butoxyethanol

CAS RN: 111-76-2

Molecular formula: C₆H₁₄O₂

Molecular weight: 118.18 g/mol

Synonyms: Ethylene glycol monobutyl ether, EGBE, 2-butoxyethanol, butyl cellosolve, butyl glycol, glycol monobutyl ether

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1 Overview of the Physico-chemical Properties of EGBE

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	A colourless liquid. Odour is mild, ether-like, and slightly rancid.	2	ECHA
Melting Point	-74.8°C @ 101.3 kPa	2	ECHA
Boiling Point	171–171.5°C @ 101.3 kPa	2	ECHA
Density	900 kg/m ³ @ 20°C	2	ECHA
Vapor Pressure	115 Pa @ 25°C	2	ECHA
Partition Coefficient (log K _{ow})	0.81 @ 20°C	1	ECHA
Water Solubility	900 g/L @ 20°C (fully soluble)	2	ECHA
Dissociation Constant (pKa)	15 @ 20°C	2	ECHA

Property	Value	Klimisch Score	Reference
Viscosity	3.28 mPa.s @ 20°C	2	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for EGBE.

Based on an assessment of environmental hazards, NICNAS identified EGBE as a chemical of low concern to the environment (DoEE, 2017a). Chemicals of low concern are unlikely to have adverse environmental effects if they are released to the environment from coal seam gas operations.

Table 2 Existing International Controls

Convention, Protocol or Other International Control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

EGBE is readily biodegradable. It is not expected to bioaccumulate. EGBE has a low tendency to bind to soil or sediment.

B. Biodegradation

EGBE was considered readily biodegradable in an OECD 301B test. Degradation was 90.4% after 28 days; the 10-day window was met (ECHA) [Kl. score = 2]. Results from another OECD 301B test showed 63% and 74-75% degradation after 10 and 28 days, respectively (ECHA) [Kl. score = 2]. An OECD 301 D test showed 67-75% degradation after 15 days and 73-77% after 28 days (ECHA) [Kl. score = 2]. In a Zahn-Wellen (OECD 302B test), degradation of EGBE was 95% after 8 days, measured as DOC removal (ECHA) [Kl. score = 2].

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017b).

C. Environmental Distribution

No experimental data are available for EGBE. Using KOCWIN in EPISuite™ (USEPA, 2019), the estimated soil organic carbon partition coefficient (K_{oc}) value from $\log K_{ow}$ is 7.624 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 2.823 L/kg.

Based upon these K_{oc} values, if released to soil, EGBE is expected to have low potential for adsorption and a high potential for mobility. If released to water, based on its K_{oc} and high water solubility values, EGBE is likely to remain in water and not adsorb to sediment.

D. Bioaccumulation

No bioconcentration studies have been conducted on EGBE. EGBE is not expected to bioaccumulate based on the experimental $\log K_{ow}$ of 0.81 (ECHA).

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

EGBE is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on EGBE.

Table 3 Acute Aquatic Toxicity Studies on EGBE

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
<i>Oncorhynchus mykiss</i>	96-hour LC_{50}	1,474	2	ECHA
<i>Pimephales promelas</i>	96-hour LC_{50}	2,137	2	ECHA
<i>Pimephales promelas</i>	96-hour LC_{50}	1,700	2	ECHA
<i>Pimephales promelas</i>	96-hour LC_{50}	1,580	2	ECHA
<i>Lepomis macrochirus</i>	96-hour LC_{50}	1,490	2	ECHA
<i>Salmo gairdneri</i>	96-hour LC_0	>1,000	2	ECHA
<i>Daphnia magna</i>	48-hour EC_{50}	1,800	2	ECHA
<i>Daphnia magna</i>	48-hour EC_{50}	1,815	2	ECHA
<i>Daphnia magna</i>	48-hour EC_{50}	881 (cited) 1,100 (recalculated by ECHA)	2	ECHA
<i>Daphnia magna</i>	48-hour EC_{50}	2,650	2	ECHA
<i>Pseudokirchneriella subcapitata</i>	72-hour EC_{50} NOEC	911 (biomass) 88	1	ECHA
<i>Selenastrum capricornutum</i>	72-hour EC_{50} NOEC	720 (biomass) 280	2	ECHA

Chronic Studies

A 21-day fish (*Brachydanio rerio*) study was conducted to examine the potential for endocrine disrupting effects; the study design was based on the OECD TG 204. The NOEC was >100 mg/L (ECHA) [KI. score = 2].

The NOEC from a 21-day *Daphnia* reproduction study was 100 mg/L (ECHA) [KI. score = 1].

C. Terrestrial Toxicity

No studies are available.

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (IChEMS, 2022; ECHA, 2023).

EGBE is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of 0.81, EGBE does not meet the screening criteria for bioaccumulation.

The chronic aquatic toxicity data on EGBE show NOECs of >0.1 mg/L. Thus, EGBE does not meet the screening criteria for toxicity.

The overall conclusion is that EGBE is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for EGBE.

8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
EGBE	111-76-2	Not a PBT	No	No	No	No	No	No	1	1	1

Footnotes:
1 - PBT Assessment based on PBT Framework.
2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).
3 – Tier 1 – Hazard Assessment only.

Notes:
NA = not applicable
PBT = Persistent, Bioaccumulative and Toxic
B = bioaccumulative
P = persistent
T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

Department of the Environment and Energy [DoEE]. (2017a). *Environmental risks associated with surface handling of chemicals used in coal seam gas extraction in Australia*. Prepared by the Chemicals and Biotechnology Assessments Section (CBAS), in the Chemicals and Waste Branch of the Department of the Environment and Energy as part of the National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, Commonwealth of Australia, Canberra. <https://www.dcceew.gov.au/sites/default/files/documents/technical-report-number-14-environmental-risks.pdf>

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B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
CAS RN	Chemical Abstract Services Registry Number
COC	constituent of concern
DOC	dissolved organic carbon
DoEE	Department of the Environment and Energy
EC	effective concentration

ECHA	European Chemicals Agency
EGBE	ethylene glycol monobutyl ether
EU	European Union
g/L	grams per litre
hPa	hectopascal
ICHEMS	Industrial Chemicals Environmental Management Standard
IUPAC	International Union of Pure and Applied Chemistry
kg/m ³	kilograms per cubic metre
KI	Klimisch scoring system
KOCWIN™	USEPA organic carbon partition coefficient estimation model
kPa	kilopascal
L/kg	litres per kilogram
LC	lethal concentration
mg/L	milligrams per litre
mm ² /s	square millimetres per second
mPa.s	millipascal second
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
SIDS	screening information data set
TG	test guideline
USEPA	United States Environmental Protection Agency

PROPYLENE GLYCOL

This dossier on propylene glycol presents the most critical studies pertinent to the risk assessment of propylene glycol in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

Screening Assessment Conclusion – propylene glycol is classified as a **tier 1** chemical and requires a hazard assessment only.

1 BACKGROUND

Propylene glycol is readily biodegradable. It is not expected to bioaccumulate and has a low tendency to bind to soil or sediment. Propylene glycol is of low toxicity concern to aquatic and terrestrial organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): propane-1,2-diol

CAS RN: 57-55-6

Molecular formula: C₃H₈O₂

Molecular weight: 76.09 g/mol

Synonyms: Propylene glycol; 1,2-propanediol; alpha-propylene glycol

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-chemical Properties of Propylene Glycol

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear colourless liquid	1	ECHA
Melting Point	< -20 °C @ 101.3 kPa	1	ECHA
Boiling Point	184 °C @ 101.3 kPa	1	ECHA
Density	1,030 kg/m ³ @ 20 °C	1	ECHA
Vapor Pressure	20 Pa @ 25°C	1	ECHA
Partition Coefficient (log K _{ow})	-1.07 @ 20.5°C	1	ECHA

Property	Value	Klimisch score	Reference
Water Solubility	1,000 g/L @ 20°C	1	ECHA
Dissociation constant (pKa)	Not applicable	-	-
Viscosity	43.4 mPa s @ 25°C	2	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for propylene glycol.

NICNAS has assessed propylene glycol in an IMAP Tier 1 assessment and concluded that it poses no unreasonable risk to the environment¹.

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

Propylene glycol is readily biodegradable, is not expected to bioaccumulate and has a low potential to adsorb to soil or sediments.

B. Biodegradation

Propylene glycol is expected to degrade rapidly in water from biological processes but is not expected to be significantly influenced by hydrolysis, oxidation, volatilization, bioconcentration, or adsorption to sediment (ECHA).

Propylene glycol is considered readily biodegradable. Under aerobic conditions, 106.8 % (O₂ consumption), 81.7% (CO₂ evolution) and 98.3% (DOC removal) biodegradation was found for 100 mg/l propylene glycol tested according to OECD Guideline 301 F (Ready Biodegradability):

¹ <https://services.industrialchemicals.gov.au/assessment-detail/?id=c34e433e-f36b-1410-8de4-00e8f2afc108>

Manometric Respirometry Test) (West et al., 2007 as cited in ECHA [KI. Score = 1]) and in another OECD 301 F study 81 -97% biodegradation was found for 84 mg/l propylene glycol tested under aerobic conditions (The Dow Chemical Company, 1999 as cited in ECHA [KI. Score = 1]).

If a chemical is found to be readily biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for propylene glycol. The estimated soil organic carbon partition coefficient (K_{oc}) value calculated using the equation from the Technical Guidance Document on Risk Assessment from the $\log K_{ow}$ (-1.07) is 2.9 L/kg (ECHA). [KI. Score = 2]

Based upon this K_{oc} value, if released to soil, propylene glycol is expected to have low potential for adsorption and a high potential for mobility. If released to water, based on its K_{oc} and high water solubility values, propylene glycol is likely to remain in water and not adsorb to sediment. From the water surface, the substance will not evaporate into the atmosphere (ECHA).

D. Bioaccumulation

Based on a $\log K_{ow}$ of ≤ 3 (value of -1.07) and relatively high water solubility, propylene glycol is not expected to bioaccumulate. This is supported by a calculated BCF value of 0.09 (ECHA). [KI. Score = 2]

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Propylene glycol is of low toxicity concern to aquatic and terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on propylene glycol.

Table 3: Acute Aquatic Toxicity Studies on Propylene Glycol

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Oncorhynchus mykiss</i> (Rainbow trout)	96-hr LC ₅₀	40,613	2	ECHA
<i>Ceriodaphnia dubia</i> (Water flea)	48-hr EC ₅₀	18,340	2	ECHA
<i>Raphidocelis subcapitata</i> (Green alga)	96-hr EC ₅₀	19,000	1	ECHA

Chronic Studies

No chronic experimental studies were available for fish and algae. The substance is readily biodegradable and would be expected to degrade rapidly in the environment, therefore limiting the potential for chronic toxicity to occur (ECHA).

Based on the EPISUITE™ ECOSAR version 2.2 predicted model, a 30-day NOEC value was estimated to be 1,768 mg/L for fish on the basis of mortality effects (ECHA). [Kl. Score = 2].

A 7-day NOEC of 13,020 mg/L was determined for *Ceriodaphnia dubia* (water flea) based on reproduction or growth (ECHA). [Kl. score = 2].

C. Terrestrial Toxicity

No studies available. The substance has a low potential for adsorption and is readily biodegradable. Therefore, significant exposure to the soil or sediment organisms is not expected (ECHA).

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (IChEMS, 2022; ECHA, 2023).

Propylene glycol is readily biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of -1.07 and an estimated BCF of 0.9 L/kg, propylene glycol does not meet the screening criteria for bioaccumulation.

The lowest chronic NOEC for propylene glycol is >0.1 mg/L. The acute $E(L)C_{50}$ values are >1 mg/L. Thus, propylene glycol does not meet the screening criteria for toxicity.

The overall conclusion is that propylene glycol is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for propylene glycol.

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8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
Propylene glycol	57-55-6	Not a PBT	No	No	No	No	No	No	1	1	1

Footnotes:

- 1 - PBT Assessment based on PBT Framework.
2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).
3 - Tier 1 – Hazard Assessment only.

Notes:

NA = not applicable
PBT = Persistent, Bioaccumulative and Toxic
B = bioaccumulative
P = persistent
T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
COC	constituent of concern
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
IChEMS	Industrial Chemicals Environmental Management Standard
IUPAC	International Union of Pure and Applied Chemistry
kg	kilograms
KI	Klimisch scoring system

KOCWIN™	USEPA organic carbon partition coefficient estimation model
kPa	kilopascal
L	litre
L/kg	litres per kilogram
LC	lethal concentration
LD	lethal dose
m ³	cubic metre
MCI	molecular connectivity index
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m ³	milligrams per cubic metre
mL	millilitre
mPa s	millipascal second
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
Pa	pascal
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SGG	Synthetic Greenhouse Gases
USEPA	United States Environmental Protection Agency

SODIUM THIOSULPHATE SODIUM THIOSULPHATE PENTAHYDRATE

This dossier on sodium thiosulphate and sodium thiosulphate pentahydrate presents the most critical studies pertinent to the risk assessment of these chemicals in their use in coal seam gas extraction activities. It does not represent an exhaustive or critical review of all available data. The information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – Sodium thiosulphate and sodium thiosulphate pentahydrate are classified as **tier 1** chemicals and require a hazard assessment only.

1 BACKGROUND

Sodium thiosulphate and sodium thiosulphate pentahydrate dissociate in aqueous media to sodium (Na^+) and thiosulphate ($\text{S}_2\text{O}_3^{2-}$) ions. These ionic species are ubiquitous in the environment and are present in most water, soil and sediment mediums. Neither sodium thiosulphate, sodium thiosulphate pentahydrate nor its dissociated ions are expected to bioaccumulate. These substances are of low toxicity concern to aquatic organisms.

Sodium thiosulphate pentahydrate is a hydrated form of sodium thiosulphate. For the purposes of this dossier, information will be focused on sodium thiosulphate as when dissolved in water both substances have the same environmental fate and toxicity profiles.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Disodium sulphanidesulphonate

CAS RN: 7772-98-7

Molecular formula: $\text{Na}_2\text{S}_2\text{O}_3$

Molecular weight: 158.1 g/mol

Synonyms: Sodium thiosulphate; disodium sulphanidesulphonate; sodium thiosulphate; thiosulphuric acid, disodium salt; disodium sulphurothioate

Chemical Name (IUPAC): Sodium sulfurothioate--water (2/1/5)

CAS RN: 10102-17-7

Molecular formula: $\text{H}_{10}\text{Na}_2\text{O}_8\text{S}_2$

Molecular weight: 248.19 g/mol

Synonyms: sodium thiosulfate pentahydrate; disodium thiosulfate pentahydrate; thiosulfuric acid ($\text{H}_2\text{S}_2\text{O}_3$), disodium salt, pentahydrate

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1 Overview of the Physico-chemical Properties of Sodium Thiosulphate

Property	Value	Klimisch Score	Reference
Physical state at 20°C and 101.3 kPa	Colourless crystalline solid	2	ECHA
Melting Point	≤500°C (decomposition occurs) @ 101.3 kPa	1	ECHA
Boiling Point	Decomposes	-	ECHA
Density	1690 kg/m ³ @ 20°C	2	ECHA
Vapor Pressure	Not applicable, substance is an inorganic salt	-	ECHA
Partition Coefficient (log K _{ow})	Not applicable, substance is an inorganic salt	-	ECHA
Dissociation Constant (pKa)	Not relevant	-	ECHA
Water Solubility	764 g/L @ 25°C	2	ECHA
Viscosity	Not applicable, substance is a solid	-	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for sodium thiosulphate.

NICNAS has assessed sodium thiosulphate in an Inventory Multi-tiered Assessment and Prioritisation (IMAP) Tier 1 assessment and concluded that it poses no unreasonable risk to human health or the environment. It is an inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC¹ water quality guidelines for physical and chemical stressors are not exceeded.²

Table 2 Existing International Controls

Convention, Protocol or Other International Control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No

¹ Water quality guidelines were revised in 2018 and are now referred to as Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG)

² <https://services.industrialchemicals.gov.au/search-assessments/?assessmentcasnumber=7772-98-7>

Convention, Protocol or Other International Control	Listed Yes or No?
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

Sodium thiosulphate dissociates in aqueous media to sodium (Na^+) and thiosulphate ($\text{S}_2\text{O}_3^{2-}$) ions. The thiosulphate anion is stable in neutral or alkaline media, but not in acidic media (USEPA, 2007). In aqueous media, thiosulphate irreversibly disproportionates to sulphide and sulphate (USEPA, 2007).

Biodegradation is not applicable to inorganic compounds. Sodium thiosulphate is not expected to bioaccumulate; it will dissociate to ions that are ubiquitous in the environment. Sodium thiosulphate is not expected to absorb to soil or sediment because of its dissociation properties and high water solubility.

6 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

Sodium thiosulphate is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No acute studies were identified for sodium thiosulphate. Table 3 lists the results of acute aquatic toxicity studies conducted on ammonium thiosulphate (CAS RN 7783-18-8).

Table 3 Acute Aquatic Toxicity Studies on Ammonium Thiosulphate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Lepomis macrochirus</i>	96-hr LC_{50}	510	1	ECHA
<i>Salmo gairdneri</i>	96-hr LC_{50}	770	1	ECHA
<i>Daphnia magna</i>	48-hr EC_{50}	230	1	ECHA
<i>Pseudokirchneriella subcapitata</i>	72-hr EC_{50}	>100	1	ECHA

Chronic Studies

No studies were identified for sodium thiosulphate or ammonium thiosulphate. However, reliable chronic toxicity data were available for sodium sulphite (CAS RN 7757-83-7) and sodium disulphite (CAS RN 7757-74-6). Table 4 lists the results of chronic aquatic toxicity studies conducted on sodium sulphite and sodium disulphite.

Table 4 Chronic Aquatic Toxicity Studies on Sodium Sulphite and Sodium Disulphite

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Zebrafish	34-d NOEC	≥316	2	ECHA
<i>Daphnia magna</i>	21-d NOEC	>10* (8.41)	1	ECHA
<i>Desmodesmus subspicatus</i>	EC ₁₀	33.3* (22)	2	ECHA

*Test substance: sodium disulphite; adjusted concentration for sodium sulphite in parentheses.

C. Terrestrial Toxicity

No studies were identified.

7 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (ICHEMS, 2022; ECHA, 2023).

Sodium thiosulphate is an inorganic salt that dissociates completely to sodium, sulphide, and sulphate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; these ionic species are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistence criteria is not considered applicable.

Sodium thiosulphate dissociates to ionic species. The sulphide ion can be oxidized by bacteria to sulphate. The sodium and sulphate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium thiosulphate is not expected to bioaccumulate.

The NOEC or EC₁₀ values from chronic aquatic toxicity studies on read-across sodium sulphite is >0.1 mg/L. The acute EC(L)₅₀ values from acute aquatic toxicity studies on read-across ammonium thiosulphate are >1 mg/L in fish, invertebrates and algae. Thus, sodium thiosulphate does not meet the screening criteria for toxicity.

The overall conclusion is that sodium thiosulphate is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for sodium thiosulphate.

8 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
Sodium Thiosulphate	7772-98-7	Not a PBT	No	No	NA	No	No	No	1	1	1
Sodium Thiosulphate Pentahydrate	10102-17-7	Not a PBT	No	No	NA	No	No	No	1	1	1

Footnotes:
1 - PBT Assessment based on PBT Framework.
2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).
3 – Tier 1 – Hazard Assessment only.

Notes:
NA = not applicable
PBT = Persistent, Bioaccumulative and Toxic
B = bioaccumulative
P = persistent
T = toxic

9 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
AICS	Australian Inventory of Chemical Substances
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
CAS RN	Chemical Abstract Services Registry Number
COC	constituent of concern
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
IChEMS	Industrial Chemicals Environmental Management Standard
IMAP	Inventory Multitiered Assessment and Prioritisation
IUPAC	International Union of Pure and Applied Chemistry
kg/m ³	kilogram per cubic metre
kPa	kilopascal
mg/L	milligrams per litre
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
Pa	Pascal
PBT	Persistent, Bioaccumulative and Toxic
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals



Attachment 5 Quantitative Assessment for Tier 3 Chemicals

Qualitative and Quantitative Tier 3 Assessment

1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs.

In accordance with Senex Energy ("Senex") Atlas Stage 3 Development Project Area Chemical Risk Assessment Framework (CRAF) (Klohn Crippen Berger, 2024), chemicals assigned a Tier 3 designation require a hazard assessment and a qualitative and quantitative assessment of risk.

Consistent with National Industrial Chemicals Notification and Assessment Scheme (NICNAS), the human health hazards for each chemical are characterised by analysing the toxicokinetics (the absorption, distribution, metabolism and excretion of the chemical in humans or laboratory animals), acute toxicity, irritation and corrosivity, repeat dose toxicity, genotoxicity, carcinogenicity, reproductive toxicity, and other health effects. The environmental hazards for each chemical are characterised by analysing the environmental fate properties (such as mobility, persistence, bioavailability and bioaccumulation), acute toxicity and chronic toxicity. In support of the hazard assessment, a risk assessment dossier is prepared for each of the chemicals included in the assessment.

Potentially complete exposure pathways (in that a source, a migration pathway, a mechanism for exposure, and a potential receptor are present) are assessed herein to determine the potential for risk. An incomplete pathway precludes an exposure occurring and an associated potential risk. In this context, site setting and management protocols associated with the action are evaluated. Key controls limiting the potential for exposure include:

- Engineering controls (including fencing and secondary containment);
- Storage (drums, totes and storage tanks) constructed in accordance with Australian standards and managed and monitored in accordance with regulatory requirements;
- Maintenance of access control restrictions during site activities that will preclude access by the public, livestock and large native fauna; and,
- Safe Work Australia and Senex Health, Safety and Environmental Management System (HSEMS) used to minimise human health exposure.

This qualitative and quantitative assessment provides information to be used as a complement to the risk assessment dossier to provide a summary of human and ecological hazards that may occur from exposure to the chemical. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and safety data sheets (SDSs) and are available to emergency responders, health and safety managers, and environmental hazard clean-up teams.

As a result, the assessment for this Tier 3 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No-Effects Concentrations (PNECs) for water and soil; and completing a qualitative and quantitative assessment of risk. Each of these components is detailed within this attachment.



Background

1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (also referred to as INCI) is a component in a product proposed for use in drilling and completion activities and well abandonment. During drilling, the product will be installed with the surface casing vent (i.e., between the surface casing and production casing) to act as a corrosion inhibitor. In production wells and as part of well abandonment, the production casing will be cemented and surface casing will be filled with chemicals to preserve the surface well casing. For abandoned wells, after a period of approximately six months, the top of the surface casing will be grouted, effectively encapsulating the liquid.

The purpose and maximum quantity for this chemical is summarised in **Table 1**.

Table 1 Drilling Fluid Chemicals

Chemical Name	CAS No.	Use	Quantity
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	Corrosion Inhibition	0.3%

CAS No = Chemical Abstracts Service Number

NA = Not available

The assessment of toxicity of this chemical was used to evaluate human health exposure scenarios and is presented in **Attachment 1**. It is not genotoxic or carcinogenic, and, as a result, only a non-carcinogenic oral reference dose (RfD) was derived. A detailed discussion of the derivation of the oral RfD and drinking water guideline value is presented in the attachment. **Table 2** provides a summary of the derivation.

Table 2 Oral Reference Doses and Derived Drinking Water Guidelines

Constituent (CAS No.)	Study	Critical Effect/ Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (mg/L)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI) (CAS No. 61791-39-7)	Short-Term Repeat Dose in Rats	Local gastric irritation	60	3000	0.02	0.07

CAS = Chemical Abstracts Service

mg/L = milligram per litre

mg/kg-day = milligram per kilogram-day

NOAEL = No observed adverse effect level

Refer to **Attachment 1** for information on the key studies selected for oral reference dose and drinking water level development.

For ecological receptors, the assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna to the chemical. The qualitative assessment focuses on the aquatic invertebrate and fish species within the surface water resources, and the soil flora and fauna associated with releases to the soil. The quantitative assessment includes evaluating the potential risks to these same aquatic and soil ecological receptors, in addition to higher trophic level organisms such as livestock and terrestrial wildlife.



The determination of toxicological reference values (TRVs) was conducted according to the PNEC guidance in the *Environmental Risk Assessment Guidance Manual for Industrial Chemicals* prepared by the Australian Environmental Agency (AEA, 2009). PNECs for freshwater and sediment are developed to assess aquatic receptors, and PNECs for soil are developed for terrestrial receptors.

Table 3 present the chemical, the endpoint, no observable effects concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). PNECs for sediment and soil are detailed in **Tables 4** and **5**, respectively. Refer to **Attachment 1** for the development of PNECs, or the rationale for PNECs that do not have a calculated PNEC.

Table 3 PNECs Water – Tier 3 Chemicals

Constituents	Endpoint	EC ₅₀ or NOEC (mg/L)	Assessment Factor	PNEC _{water} (mg/L)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI) (CAS No. 61791-39-7)	Chronic fish	0.022	100	0.00022

EC₅₀ = effects concentration – 50%

mg/L = milligram per litre

NOEC = no observed effects concentration

PNEC = predicted no effect concentration

Refer to **Attachment 1** for information on the development of PNECs listed above.

Table 4 PNECs Sediment – Tier 3 Chemicals

Constituents	Endpoint	EC ₅₀ or NOEC (mg/kg wet wt)	Assessment Factor	PNEC _{sed} (mg/kg wet wt)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI) (CAS No. 61791-39-7)	^a	-	-	0.13

^a Calculated using equilibrium partitioning method

EC₅₀ = effects concentration – 50%

mg/kg wet wt = milligram per kilogram wet weight

NOEC = no observable effects concentration

PNEC = predicted no effect concentration

Refer to **Attachment 1** for information on the development of PNECs listed above.



Table 5 PNECs Soil – Tier 2 Chemicals

Constituents	Endpoint	EC ₅₀ or NOEC (mg/kg dry wt)	Assessment Factor	PNEC _{soil} (mg/kg dry wt)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI) (CAS No. 61791-39-7)	^a	-	-	0.12

^a Calculated using equilibrium partitioning method

EC₅₀ = effects concentration – 50%

mg/kg dry wt = milligram per kilogram dry weight

NOEC = no observable effects concentration

PNEC = predicted no effect concentration

Refer to **Attachment 1** for information on the development of PNECs listed above.

A detailed assessment of the risks posed by this Tier 3 chemical is provided in the following sections.

General Overview

Long-chain alkyl (saturated and unsaturated) hydroxyethyl imidazolines, such as INCI, have reported commercial uses in polishes and wax blends, corrosion inhibitors, lubricants and greases, oil and gas extraction, cutting fluids, paint removers, fuel additives, anti-set off and anti-adhesive agents. Group members are substituted alkyl imidazolines, with each containing a hydroxyethyl group at the 1 position of the imidazoline ring, and a long chain alkyl (saturated or unsaturated) chain at the 2 positions of the imidazoline ring (AICIS, 2022). INCI is an Unknown or Variable composition, Complex reaction products, or Biological materials (UVCB) substance which lacks information regarding molecular structure. The molecular structure of group member 1H-imidazole-1-ethanol, 2-heneicosyl-4,5-dihydro (CAS No. 39957-00-1) is presented in **Figure 1**.

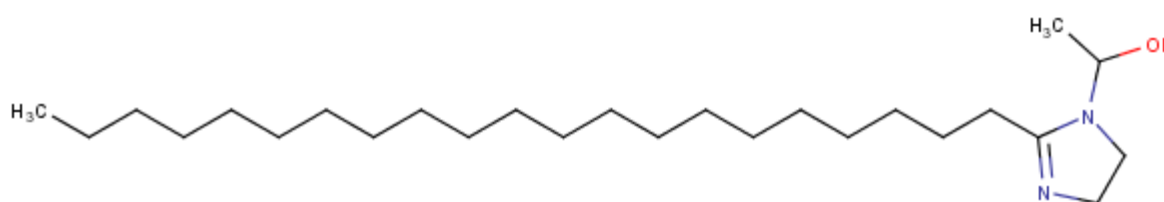


Figure 1 Molecular Structure of INCI Read-Across Group Member¹

INCI is inherently biodegradable. It is immobile in soil. If released to water, based on its insolubility, it is expected to strongly adsorb to suspended solids or sediment. There are no bioaccumulation studies on INCI. Based on its partition coefficient (log K_{ow} of 5.4) it has a potential to bioaccumulate in the environment.

The Persistent, Bioaccumulative and Toxic (PBT) assessment for INCI is included in the dossier provided in **Attachment 1**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that the chemical is not a PBT substance.

¹ Source <https://comptox.epa.gov/dashboard/chemical/details/DTXSID30960466>



Human Health Hazards

INCI has the potential to absorb into the skin following exposure, with dermal penetration increased due to its corrosive properties. INCI is moderately acutely toxic by the oral and dermal routes. The substance is corrosive to the skin and has the potential to cause serious damage to the eyes. It is not a skin sensitiser. Adverse effects following repeated oral exposure is caused by the corrosive properties of INCI. It is not genotoxic nor is it a reproductive or developmental toxicant.

Based on a review of repeated dose and reproductive/developmental toxicity studies, toxicological reference values were derived for INCI. The drinking water guideline value derived for the substance using the non-carcinogenic oral RfD is 0.07 mg/L (see **Table 2**). Description of the oral RfD and calculation of the drinking water guideline value is included in the dossier provided in **Attachment 1**.

The lifecycle of chemicals, including INCI, used in the drilling and completion of wells and in well abandonment, includes the following general categories: transportation of chemicals; drilling and completion operations; and, treatment, recycling, disposal and beneficial reuse. Without management controls in place, there is the potential for human receptors to be exposed to drilling fluid chemicals that contain INCI during drilling, completion and well abandonment operations and management of wastes. Wastes associated with drilling operations and abandonment of wells will be either removed from well sites for disposal at a licensed facility, or disposed of using mix-bury-cover or other method of disposing to land that is certified as not causing environmental harm (Senex, 2023; EHS Support, 2024). Based on an assessment of land use and an understanding of the project description (Senex, 2023; EHS Support, 2024), potential human receptors include:

1. Workers at the well lease involved with blending, storage, transfer, reuse, recovery and recycling of drilling fluids and cuttings; well abandonment activities; recycling, reuse or disposal of recovered materials including beneficial reuse activities such as land applications of drilling materials and dust suppression; and, mitigating releases at the well lease or along the transport or conveyance routes.
2. Agricultural workers or residents in irrigation areas.
3. Landholders that have access to the water supply from a bore hydraulically downgradient of well lease.

In terms of risks associated with transport of chemicals and wastes, this risk is considered to be managed to a level as low as reasonably practicable. This is because the potential for a release is controlled through implementation of traffic management principles including use of designated trucking routes, vehicle signage, vehicle management systems (to manage speed and driving behaviour/habits) and, in the unlikely event of a vehicular accident, implementation of incident and spill response procedures. Given the highly regulated nature of transportation of chemicals (at both a Commonwealth and State level), transport-related scenarios are not evaluated further in this assessment. However, the outcome of the assessment should be used to inform emergency response actions.

Exposure of workers to drilling fluid chemicals is possible via inadvertent spills and leaks, during the recycling and beneficial reuse of recovered materials (e.g., drilling fluids and cuttings), and during application of the recovered material to land. However, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion. In addition, Safe Work Australia and Senex HSEMS are used to minimise human



health exposure. As a result, petroleum workers, are also excluded from assessment. No potentially complete exposure pathways were identified.

The management of chemicals and wastes will be conducted at the well lease using drums, totes and engineered tanks designed to contain the fluids. In the unlikely event of a release to ground, the potential for exposures (other than workers) is limited. Releases on the well pad would be of limited volumes and well pad sites are fenced and access is controlled, which limits access to the public. If drilling fluid chemicals are spilled to ground then investigation, remediation and rehabilitation activities would be implemented to address soil impacts.

On-lease storage may utilise tanks, pits or turkey nests and there is the possibility that a containment failure could result in the release of the materials to the well lease and the surrounding environment. Releases on the well pad would be of limited volumes and as such these products would not be anticipated to migrate a significant distance off lease to the surrounding environment, including proximal water bodies.

The potential for a significant drilling fluid loss during drilling is rare, particularly given the volumes used and the management controls in place during drilling. Where lost circulation is identified during drilling, a lost circulation fluid (i.e., cellulose) is used to plug the interval and prevent further loss of fluids. Likelihood of losses during production operations and well abandonment is considered low because the fluid will be encapsulated within established casing. Despite the limited potential for large scale losses during drilling, EHS Support (2015) completed modelling of how a conservative tracer or highly soluble organic constituents could migrate in the subsurface to assess the potential effects of potential loss of drilling muds on groundwater systems. The BIOSCREEN model was utilized to facilitate assessment of organic constituent mobility with and without biodecay. The modelling indicated that the potential for impact on ground water quality is limited even under a worst-case scenario utilising conservative assumptions.

Exposure of potential receptors (other than workers) is also possible to residual chemicals in areas that have been used for the application of materials for beneficial reuse. However, Environmental Authority (EA) or Beneficial Use Approval conditions regulate project reuse. A plan for the beneficial reuse of materials is being developed by a Suitably Qualified Person (SQP) in accordance with the EA conditions and will require materials of a certain quality and controls the maximum volumes that can be applied to land. In addition, the application techniques and location of application are controlled with specific monitoring required. Additional details regarding mitigation and management controls are discussed in the CRAF.

As a result, potential exposures during drilling and completion activities and well abandonment are low due to the employment of mechanical equipment/processes, engineering controls (including secondary containment) and other mitigation and management strategies. Similarly, there is a low potential for human receptors exposed to surface water bodies that may receive runoff from beneficial reuse applications. Finally, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is very low.

Environmental Hazards

INCI is of high toxicity concern to aquatic organisms. There are no toxicity data for sediment-dwelling organisms. INCI has low toxicity to terrestrial organisms based on avian studies. Under expected



environmental conditions, the mixture is inherently biodegradable. There are no bioaccumulation studies on INCI. Based on a log K_{ow} of 5.4 it has a potential to bioaccumulate in the environment.

PNECs for INCI are provided in **Tables 3 – 5**. Experimental toxicity data on water organisms was available for three trophic levels to calculate PNECs in water. There is limited toxicity data for terrestrial or soil organisms and no toxicity data for sediment-dwelling organisms. Therefore, PNECs for soil and sediment were calculated using the equilibrium partitioning method. PNEC calculations and assumptions are detailed in the dossier provided in **Attachment 1**.

During the drilling process, there is the potential for environmental receptors to be exposed to drilling fluid chemicals that contain INCI. Pipelines (where treated water is conveyed) can transect sensitive ecological areas (including Matters of National Environmental Significance [MNES]). There is the concern of wildlife (terrestrial and aquatic receptors) and livestock in the vicinity of the well leases to have adverse effects from potential exposures. Potential environmental receptors include:

1. Wildlife and livestock accessing the well lease and areas adjacent to the well lease, including surface water features, that have received runoff from an accidental release during drilling and completion operations or loss of containment.
2. Wildlife and livestock accessing areas of the well lease where materials have been applied, as well as accessing stored materials in pits and turkey nests.
3. Aquatic flora and fauna within a proximal surface water body that has received runoff from an accidental release during drilling and completion operations or loss of containment, or from beneficial use applications.
4. Wildlife, including livestock, that have access to the water supply from a bore hydraulically downgradient of the well lease.

The potential for exposure of sensitive receptors (including MNES) is considered low. The drilling and completion activities and well abandonment occur over a short duration and are conducted in controlled/operational areas within a perimeter fence. Further, the activity level, noise, etc. will be a disincentive for wildlife and livestock to access the lease through gaps in the fencing or unsecured gates.

Based on the engineering and management controls described in the previous section (Human Health Hazards), there is a low potential for ecological receptors exposed to surface water bodies that may receive runoff from an accidental release. There is also concern that recovered material applied to the land surface could migrate to groundwater or surface water and therefore result in adverse effects to the environment (e.g., uptake by aquatic receptors). Due to EA conditions regulating land application techniques, the remote nature of the well leases, vertical separation of groundwater and distances to watercourses, the ephemeral nature of the watercourses and the physical and chemical properties of INCI post treatment or beneficial reuse, these potential exposures are low.

Risk Characterisation

The purpose of the risk characterisation portion of the assessment is to provide a conservative estimate of the potential risk resulting from exposure to INCI that may occur during activities associated with drilling and completion operations and management of drilling fluids and cuttings. These exposures may include operational activities where planned direct releases to the environment may occur (e.g., land application). The risk characterisation evaluates the toxicity of



this chemical and characterises the risk of the chemical assessed for specific exposure pathways identified in the previous sections.

A two-stage process is employed during risk characterization. First, risk ratios are developed for the chemical for potentially complete exposure pathways associated with applicable release scenarios. The risk ratio is calculated by dividing the exposure point concentration (EPC) by the applicable risk-based screening level (drinking water level or PNECs for aquatic and terrestrial receptors). If the ratio of exceedance of screening levels is less than 1.0, then there are no anticipated adverse effects associated with the exposure scenario evaluated. No risk / hazard reduction measures are required. There should be no need for further management controls on the chemical additional to those already in place (DoEE, 2017).

If the ratio is greater than 1.0, then further quantitative analysis is conducted. Consistent with the assessment framework, quantitative assessment of risk will consider only Tier 3 chemicals in end use determination.

Exposure Point Concentration Calculations

A quantitative mass balance calculation was undertaken to identify the amount of INCI proposed for use in the drilling fluid systems. For the mass balance calculation, 100% of the mass of chemicals in the liquids was conservatively assumed to be partitioned into the dry solids (accounting for the additional mass of native silts and clays introduced into the fluid during drilling – a conversion) by applying a factor of 0.6 to the estimated fluid mass to calculate a solids estimated concentration.

Table 6 presents the calculated chemical additive concentrations of the drilling fluids.

Table 6 Mass Balance Estimates for INCI

Chemical Name	CAS No.	Water Maximum Estimated Concentration (mg/L)	Solids Maximum Estimated Concentration (mg/kg)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000044	0.0000026

CAS No = Chemical Abstracts Service Number
mg/kg = milligram per kilogram
mg/L = milligram per litre

The mass balance of the chemicals was then used to estimate the potential EPCs within the aqueous phase of residual drilling materials. It is anticipated that the solid materials may be stockpiled and allowed to dry (potentially one week) prior to land application. Therefore, the EPC of INCI within the drilling fluids will decrease, where applicable, to account for the biodegradation and photolytic degradation of the chemical over time. The biodegradation information was obtained from the OECD ready tests (OECD, 1992) that were developed as a first-tier testing scheme to provide preliminary screening of organic chemicals. The ready tests are stringent screening tests that are conducted under aerobic conditions in which a high concentration of the test substance is used, and biodegradation is measured by non-specific parameters including dissolved organic carbon, biochemical oxygen demand and carbon dioxide production. **Attachment 2, Table 1** includes the environmental fate information that was used to assess biodegradation of the chemical, and that was applied at the time periods of 0, 3 and 7 days from initial recovery. The time periods of 0, 3 and 7 days were based on the length of drilling operations that would generate INCI in the drilling fluids



systems that may result in exposure. It is not expected that drilling operations would last longer than 7 days.

Release Scenario Assessment

There is no potentially complete exposure pathway to sources of drinking water; however, as a conservative measure, the theoretical concentrations for the three exposure scenarios (0, 3 and 7 days) were compared to human health toxicity-based screening levels to screen for potential effects as a result of a release from the well lease that may migrate to groundwater used as a drinking water source. The results of this comparison, including the ratio of exceedance of screening levels, is presented in **Attachment 2, Table 2**. As detailed in the table, INCI did not exceed the screening levels for any exposure scenario.

To screen for a potential release of drilling fluids to surface water, the theoretical concentrations of the three exposure scenarios were also compared to the PNEC for aquatic receptors. **Attachment 2, Table 3** presents the results of this comparison, including the ratio of exceedance of screening levels. INCI did not exceed the screening levels for any exposure scenario.

There is also the potential for exposure of receptors to INCI in residual drilling materials prior to or during application of the material to land. To evaluate the potential exposure of the receptors to residual drilling material, two scenarios were considered: a conservative scenario that addressed the full concentration of the COPC in the residual drilling materials and a post-application scenario that considered the resultant concentrations on the well lease after utilising mix bury cover (MBC) or land application beneficial reuse techniques. To estimate the resultant concentration of the chemical post management (treatment), an MBC scenario was used where the residual drilling materials were mixed and covered with *in situ* soils at a rate of 20 cubic metres (m³) within 1 hectare (10,000 square metres [m²]) x 10 centimetres (cm) (0.01 metre [m]), resulting in a management (treatment) factor of 0.02. **Attachment 2, Table 4** presents the theoretical estimates of the residual INCI concentrations.

The theoretical concentrations were compared to PNECs for solids for ecological receptors and are presented in **Attachment 2, Table 5**. The ratio of exceedance of screening levels to the untreated and treated concentrations are also presented in the table. The ratio of estimated concentrations in both untreated and treated soils to PNECs for soil did not exceed the threshold level of 1.

To further evaluate potential risks to non-MNES receptors (mammals and avian) receptors, additional quantitative analysis of the potential exposure pathway was also conducted. The Northern Quoll and Cattle Egret were selected as ecological endpoints for potential exposure to COPCs in soils on the well lease (residual drilling fluid COPCs with soils). Exposure assumptions, TRVs and total intake calculations are detailed in **Attachment 2, Tables 6 and 7**.

Attachment 2, Table 6 presents the calculated risk estimates for the Northern Quoll. As indicated in the table, the calculated hazard quotient (HQ) for INCI did not exceed the risk threshold level of 1 for either scenario (untreated or treated).

Attachment 2, Table 7 presents the calculated risk estimates for the Cattle Egret. As indicated in the table, the calculated HQ for INCI did not exceed the risk threshold level of 1 for either scenario (untreated or treated)..



The primary land use within the development area is agricultural (grazing on improved or unimproved pastures), and it is sparsely populated. However, as noted earlier, there may be potential for human receptors such as residents and agricultural workers to be exposed to chemicals in recovered materials during beneficial reuse applications. Relative potential exposure to agricultural workers or trespassers is considered low due to the remote location of the well leases and the sparse population. In addition, activities are undertaken in operational and controlled areas of the well lease. There are no risk-based screening levels (RBSLs) to evaluate potential exposures of agricultural workers or residents to COPCs in residual drilling materials. Therefore, to further evaluate potential direct contact risks to these receptors, additional quantitative analysis was conducted.

For potential human health exposure scenarios, exposure assumptions are detailed in **Attachment 2, Table 8**. As detailed in the table, the resident exposure pathway assumes that a child/adolescent may come in contact with redistributed soils (both untreated and treated) while trespassing on the well lease once partially or completely decommissioned and rehabilitated. The agricultural worker exposure pathway includes potential contact with untreated and treated soils through agricultural activity.

RfDs and total intake calculations are detailed in **Attachment 2, Tables 9 and 10**. **Attachment 2, Table 9** presents the calculated risk estimates for the resident. **Attachment 2, Table 10** presents the calculated risk estimates for the agricultural worker. As indicated in the tables, the calculated HQ for INCI did not exceed the risk threshold level of 1 for either receptor in any of the scenarios evaluated.

Cumulative Impacts

The potential for cumulative impacts associated with chemicals proposed for this project is limited based on the distance between well pad sites where the chemicals are being used. Modelling has demonstrated that the migration of drilling chemicals is limited in the subsurface with no potential to interact with those from other wells and hydraulic fracturing chemicals are contained within the target units. Residual chemicals may be entrained within produced water and subsequently transported for water treatment at a water management facility (WMF). However, these chemicals are removed by the treatment systems; and, therefore, no additional risk is provided during beneficial reuse, including irrigation. Likewise, the presence of water treatment chemicals at the point of produced water storage or during beneficial reuse also poses no significant increase in risk.

Only Tier 3 chemicals which trigger persistence and bioaccumulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted earlier and discussed in detail in the dossier (**Attachment 1**), INCI does not meet the criteria for persistence. Thus, there is negligible incremental risk posed by the use of this Tier 3 chemical and the existing (and proposed) management and monitoring controls are appropriate to ensure that the risk to MNES (and non MNES) receptors remains low.

Uncertainty Analysis

The procedures and assumptions used to assess potential human health risks in this Tier 3 assessment are subject to a wide variety of uncertainties. However, the presence of uncertainty is inherent in the risk assessment process, from the sampling and analysis of the chemical in environmental media to the assessment of exposure and toxicity, and risk characterisation. Accordingly, it is important to note that the risks presented within this Tier 3 assessment are based



on numerous conservative assumptions in order to be protective of human health and the environment, and to ensure that the risks presented herein are more likely to be overestimated rather than underestimated.

The discussion detailed in **Table 7** provides an evaluation of uncertainty for this Tier 3 assessment, including elements previously discussed within this assessment.

Table 7 Evaluation of Uncertainty – INCI

Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment – Chemical additive COPC concentrations	The concentrations of COPCs in residual drilling materials were estimated based on previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with Senex occurred to identify a conservative estimate of the COPC; however, there is the potential that the empirical concentrations would differ than those presented in the risk assessment.	Low	This assumption may overestimate or underestimate the calculated risks to receptors, dependent on-site-specific conditions.
Hazard Assessment – Chemical additive COPC concentrations	Concentrations of residual COPCs evaluated in the quantitative risk assessment were assumed to be 100 percent of the injected mass. This is a conservative assumption for chemicals that may degrade rapidly or volatilise.	Medium	This assumption may overestimate the calculated risks to receptors.
Exposure Assessment	The use of the food consumption relationship with body weight for mammalian and avian receptors.	Low to Medium	Low to medium potential to underestimate or overestimate risk
Exposure Assessment	Cattle Egret dietary intake assume consumption of earthworms as 50% of their food intake, which is not their typical dietary prey selection.	Medium	Medium to high potential to overestimate risks.
Exposure Assessment – EPC	The EPCs for drilling fluid chemicals used the maximum concentration of a COPC from all of the fluid systems assessed.	Low to Medium	Low to medium potential to overestimate risks.
Exposure Assessment – EPC	The assessment for all receptors considers the maximum concentration in days 0, 3, and 7 in any one year and does not evaluate further degradation of residual concentrations	Medium	Medium to high potential to overestimate risks.
Toxicity Assessment	The use of toxicity values in a risk assessment is based on extrapolations from animal data, adjust factors for inherent uncertainty in the toxicological estimate and use of surrogate toxicity criteria	Low	Low potential to underestimate risk
Toxicity Assessment	The use of LOAEL/NOAEL for calculation of the TRVs	Low to Medium	Low to medium potential to underestimate or overestimate risk



Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Toxicity Assessment	The use of the allometric scaling method to estimate the population-level effects on wildlife based on individual level of exposures.	Low to Medium	Low to medium potential to underestimate or overestimate risk

References

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Attachment 1 Risk Assessment Dossier

1H-IMIDAZOLE-1-ETHANOL, 4,5-DIHYDRO-, 2-NORTALL-OIL ALKYL DERIVS.

This dossier on 1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall oil alkyl derivative (also known as INCI) presents the most critical studies pertinent to the risk assessment of the substance in its use in coal seam gas extraction activities. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

Screening Assessment Conclusion – INCI was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. INCI was not identified in chemical databases used by NICNAS as an indicator that the chemical is of concern and is not a PBT substance. INCI was assessed as a tier 3 chemical for acute and chronic aquatic toxicity. Therefore, INCI is classified overall as a **tier 3** chemical and requires a quantitative risk assessment for end uses.

1 BACKGROUND

Long-chain alkyl (saturated and unsaturated) hydroxyethyl imidazolines, such as INCI, have reported commercial uses in polishes and wax blends, corrosion inhibitors, lubricants and greases, oil and gas extraction, cutting fluids, paint removers, fuel additives, anti-set off and anti-adhesive agents. Group members are substituted alkyl imidazolines, with each containing a hydroxyethyl group at the 1 position of the imidazoline ring, and a long chain alkyl (saturated or unsaturated) chain at the 2 positions of the imidazoline ring (AICIS, 2022).

INCI is inherently biodegradable. It is immobile in soil. If released to water, based on its insolubility it is expected to strongly adsorb to suspended solids or sediment. INCI has a potential to bioaccumulate in the environment.

INCI has the potential to absorb into the skin following exposure, with dermal penetration increased due to its corrosive properties. INCI is moderately acutely toxic by the oral and dermal routes. The substance is corrosive to the skin and has the potential to cause serious damage to the eyes. It is not a skin sensitiser. Adverse effects following repeated oral exposure is caused by the corrosive properties of INCI. It is not genotoxic nor is it a reproductive or developmental toxicant.

INCI is of high toxicity concern to aquatic organisms and of low toxicity concern to terrestrial organisms.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): 1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall oil alkyl derivatives

CAS RN: 61791-39-7

Molecular formula: Unspecified, substance is a UVCB

Molecular weight: Unspecified, substance is a UVCB

Synonyms: tall oil hydroxyethyl imidazoline (INCI); 2-imidazoline, 1-(2-hydroxyethyl)-2-(tall oil alkyl)-; tall oil, 1-(2-hydroxyethyl)-2-imidazolin-2-ylnor; 1H-imidazoline-1-ethanol, 4,5-dihydro-, 2-nortall oil

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for the substance are shown in Table 1.

Table 1: Overview of the Physico-chemical Properties of INCI

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	amber coloured, viscous liquid with a weak amine like odour	1	ECHA
Melting Point	-20°C @ 101.3 kPa	1	ECHA
Boiling Point	Decomposes before boiling	1	ECHA
Density	941 kg/m ³ @ 20 °C	1	ECHA
Vapor Pressure	0.001 Pa @ 25°C	1	ECHA
Partition Coefficient (log K _{ow})	5.4 @ 35°C	1	ECHA
Water Solubility	0.000001 g/L @ 20°C	2	ECHA
Dissociation constant (pKa)	Not available	-	ECHA
Viscosity	Not available	-	ECHA

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

A review of international and national environmental regulatory information was undertaken (Table 2). This chemical is listed on the Australian Inventory of Chemical Substances – AICS (Inventory). No conditions for its use were identified. No specific environmental regulatory controls or concerns were identified within Australia and internationally for INCI.

Table 2 Existing International Controls

Convention, Protocol or other international control	Listed Yes or No?
Montreal Protocol	No
Synthetic Greenhouse Gases (SGG)	No
Rotterdam Convention	No
Stockholm Convention	No
REACH (Substances of Very High Concern)	No
United States Endocrine Disrupter Screening Program	No
European Commission Endocrine Disruptors Strategy	No

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

INCI is inherently biodegradable. It is immobile in soil. If released to water, based on its insolubility it is expected to strongly adsorb to suspended solids or sediment. INCI has a potential to bioaccumulate in the environment.

B. Biodegradation

In a test according to OECD 301B (Ready Biodegradability: CO₂ Evolution Test), the substance attained 31% degradation after 28 days and 77% degradation after 60 days. Thus, INCI is classified as being inherently biodegradable (ECHA). [KI. Score = 1]

If a chemical is found to be readily or inherently biodegradable, it is categorised as Not Persistent since its half-life is substantially less than 60 days (DoEE, 2017).

C. Environmental Distribution

No experimental data are available for INCI. Using KOCWIN in EPISUITE™ (EPA, 2019), the estimated log soil organic carbon partition coefficient (K_{oc}) value from log K_{ow} is >4.6 and <9.7. The estimated log K_{oc} value from the molecular connectivity index (MCI) is >5.1 and <10 (ECHA). [KI. Score =2]

If released to soil, based on these log K_{oc} values, the substance is expected to be immobile. If released to water, based on these log K_{oc} values and its insolubility, INCI is expected to strongly adsorb to suspended solids and sediment.

D. Bioaccumulation

There are no bioaccumulation studies on INCI. Based on a log K_{ow} of 5.4 it has a potential to bioaccumulate in the environment (ECHA).

6 HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

INCI has the potential to absorb into the skin following exposure, with dermal penetration increased due to its corrosive properties. INCI is moderately acutely toxic by the oral and dermal routes. The substance is corrosive to the skin and has the potential to cause serious damage to the eyes. It is not a skin sensitiser. Adverse effects following repeated oral exposure is caused by the corrosive properties of INCI. It is not genotoxic nor is it a reproductive or developmental toxicant.

B. Toxicokinetics

INCI has the potential to absorb into the skin following exposure, with dermal penetration increased due to its corrosive properties. Absorption via the gastrointestinal tract occurs following ingestion and can lead to accumulation in adipose tissues. INCI can rapidly hydrolyse and form oxidation products counteracting the potential to bioaccumulate, with biliary excretion also identified (AICIS, 2022).

C. Acute Toxicity

Oral

In an acute oral toxicity study (OECD 423), Sprague Dawley (SD) rats (3/sex) were treated with INCI at 2000 mg/kg bw by gavage. Limited study details are available. Mortality was reported at 2000 mg/kg bw (numbers not reported) and one female was euthanised in extremis two days after treatment. Clinical signs such as hunched posture, lethargy, piloerection, decreased respiratory rate, diarrhoea, dehydration, ptosis, gasping, laboured and noisy respiration. Necropsy results for one female showed haemorrhage and sloughing of the gastric mucosa and gastric epithelium of the stomach, and haemorrhage of the intestines. Necropsy of males showed stomach adhered to the liver and/or presence of white foci in the non-glandular epithelium of the stomach. The LD₅₀ was determined to be >2500 mg/kg bw. (ECHA; AICIS, 2022). [KI. Score = 1]

In an acute oral toxicity study (OECD 401), rats (strain unspecified) (5/sex/dose) were treated with read-across substance 1H-imidazole-1-ethanol, 2-(2-heptadecenyl)-4,5-dihydro- (CAS No. 95-38-5) at 200 mg/kg bw (females only), 500 mg/kg bw (both sexes) and 2000 mg/kg bw (males only). The reported clinical signs of toxicity included piloerection, hunched posture, dyspnoea, reduced locomotor activity, and distended abdomen. Necropsy results showed a haemorrhagic thymus in one female at 500 mg/kg bw and dilated caecum in three animals at 2000 mg/kg bw. The LD₅₀ in males and females was 1000 mg/kg bw and 1085 mg/kg bw, respectively. The calculated LD₅₀ for both sexes was 1265 mg/kg bw (AICIS, 2022).

In an acute toxicity study (OECD 423), rats (strain unspecified) (3/sex/dose) were treated with read-across substance 1H-imidazole-1-ethanol, 4,5-dihydro-,2-norcoco alkyl derivatives (CAS No. 61791-38-6) at 300 mg/kg bw (females only), 1000 mg/kg bw (both sexes) and 2000 mg/kg bw (females only). Mortality was recorded in one male and one female at 1000 mg/kg bw and three females at 2000 mg/kg. Clinical signs of toxicity included poor general state, wetness and brown staining of the mouth area, piloerection, diarrhoea, chromorhinorrhea (pigmented discharge), dyspnoea (laboured breathing), hunched posture and ptosis (sagging eyelids). The oral LD₅₀ was reported to be between 1000 and 2000 mg/kg bw for this study (AICIS, 2022).

Dermal

In an acute dermal toxicity study, New Zealand White (NZW) rabbits (5/sex) were treated with 2000 mg/kg bw/day of INCI via an occlusive patch on the back for 24 hours. There was evidence of loss of skin elasticity; however, there were no other signs of acute dermal toxicity. The dermal LD₅₀ was determined to be >2000 mg/kg bw (ECHA; AICIS, 2022). [KI. Score = 1]

Inhalation

No data are available.

D. Irritation

Skin

In an *in vivo* skin irritation study (OECD TG 404) in New Zealand White (NZW) rabbits (n=3/dose), INCI was applied (0.5 mL, neat) under semi-occlusive conditions for 3 minutes, 1 hour and 4 hours to

intact skin. Severe erythema (score of 4/4 at 1 hour and 4 hours post treatment), severe oedema (score of 2/4 at 1 hour and 4/4 at 4-hour reading) and hardened dark brown/black scabs were observed at sites following the 1-hour and 4-hour exposure. Very slight erythema and very slight oedema was observed following the 3-minute exposure. Based on these findings, the substance was classified as corrosive (ECHA; AICIS, 2022). [KI. Score = 1]

In an acute dermal irritation/corrosion study (OECD 404), male NZW rabbits (n=3) were treated with read-across substance 1H-imidazole-1-ethanol, 2-(2-heptadecenyl)-4,5-dihydro- (CAS No. 95-38-5) (0.5 mL) for 4 hours under an occlusive dressing. Observations were recorded at 24 hours after patch removal. The following mean scores of 4/4 and 3/4 for erythema and oedema were reported, respectively. All treated animals were euthanised 24 hours after removal of the bandage due to severe to moderate weight loss and irreversible corrosive effects (AICIS, 2022).

In another study conducted according to OECD TG 404, NZW rabbits (3/sex) were treated with 0.5 mL of read-across substance 1H-imidazole-1-ethanol, 2-(2-heptadecenyl)-4,5-dihydro- (CAS No. 95-38-5) (5% in water) to shaved skin for 4 hours under occlusive dressing. After patch removal, skin reactions were assessed up to a period of 7 days. Mean scores of 3.7/4 and 3/4 for erythema and oedema were reported, respectively. Severe irritation with signs of necrosis were reported in all treated animals (AICIS, 2022).

Eyes

In an eye irritation study, 0.1 mL of INCI was instilled into the eye of a NZW rabbit. Mean scores reported at 24 hours were: corneal opacity 4/4, iritis 2/2, conjunctival redness 3/3, chemosis 4/4. The study was terminated after the 24-hour reading due to severe eye irritation (ECHA; AICIS, 2022). [KI. Score = 1]

In an eye irritation study (OECD 405), 0.1 mL of the undiluted read-across substance 1H-imidazole-1-ethanol, 2-(2-heptadecenyl)-4,5-dihydro- (CAS No. 95-38-5), was instilled into 1 eye each of Russian breed rabbits (3/sex). The eyes were washed out after 24 hours and observed at 1, 24, 48, 72 hours, and at 8 days. The following mean scores were reported at 24, 48 and 72 hours: corneal opacity 2.9/4, iritis 1/2, conjunctival redness 2/3, chemosis 4/4. The effects were not reversible in all animals within 8 days (AICIS, 2022).

E. Sensitisation

In a guinea pig maximisation test (OECD 406), male albino Dunkin-Hartley guinea pigs (n=10) were administered INCI in PEG 300 as a 0.05% intradermal induction dose, a 3% topical induction dose and a 1% challenge dose under occlusive dressing. No local skin reactions were observed at 24 or 48 hours post treatment (ECHA; AICIS, 2022). [KI. Score = 1]

In another skin sensitisation test (OECD TG 406 with deviations in exposure period), Pirbright-Hartley guinea pigs (10 animals/dose) were first injected intradermally with 0.1 mL of 0.1% of read-across substance 1H-imidazole-1-ethanol, 2-(2-heptadecenyl)-4,5-dihydro- (CAS No. 95-38-5). On day 7, the same area on the shoulder region was treated with a 30% topical application. Occlusive dressing was kept in place for 48 hours. In the challenge phase, the animals were treated with 0.1 % in saline epicutaneously. After 24 hours, the dressing was carefully removed, and the degree of erythema and oedema was quantified. No positive response was seen after 24 hours (AICIS, 2022).

F. Repeated Dose Toxicity

Oral

In a combined repeated oral dose and reproductive/developmental toxicity study (OECD TG 422), INCI, was administered to Wistar rats (10/sex/dose) at ingested doses of 15, 30 or 60 mg/kg bw/day for 42 days (males) or day 4 post-partum for females. Minimal to moderate squamous cell hyperplasia of the non-glandular stomach was seen in males at 30 and 60 mg/kg bw/day and all treated females. Moderate to marked submucosal inflammation was observed in males and females, respectively. Minimal focal erosion in one male and moderate focal erosion in one female at 60 mg/kg bw/day were reported. Focal slight epithelial degeneration in one female at 60 mg/kg bw/day and marked ulceration with marked submucosal inflammation and marked peritonitis in one female at 15 mg/kg bw/day were reported. The reported no observed adverse effect level (NOAEL) in relation to systemic toxicity in the absence of any toxicologically significant effects was 60 mg/kg bw/day (ECHA; AICIS, 2022). [Kl. Score = 1]

Inhalation

No data are available

G. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on INCI are presented in Table 3.

Table 3: *In vitro* Genotoxicity Studies on INCI

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial mutagenicity assay (OECD 471); <i>S. typhimurium</i> (TA98, TA100, TA 1537) up to 5000 µg/plate; <i>E. coli</i> WP2uvrA up to 5000 µg/plate	-	-	1	ECHA
Gene mutation test (OECD TG 476); CHO mammalian cells (HPRT locus) up to 48 µg/mL	-	-	1	ECHA
Chromosome aberration test (OECD TG 473); Chinese hamster lung fibroblasts (V79) up to 20 µg/mL (CAS No. 95-38-5)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

No *in vivo* study data was available.

H. Carcinogenicity

No data are available.

I. Reproductive and Developmental Toxicity

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422), INCI was administered to Wistar rats (10/sex/dose) at 15, 30 or 60 mg/kg bw/day for 42 days (males) or day 4 post-partum for females. No treatment related effects on reproductive performance were reported. No significant differences in litter size, or offspring body weights, at birth, or on days 1 and 4 post-partum were reported compared with control group animals. No clinical signs of toxicity were detected in offspring from all treatment groups. No treatment related adverse effect on surface righting reflex was detected. The NOAEL in relation to developmental and reproductive toxicity in the absence of any toxicologically significant effects was reported to be 60 mg/kg bw/day for this study (ECHA; AICIS, 2022). [KI. Score = 1]

J. Derivation of Toxicological Reference and Drinking Water Guidance Values

The toxicological reference values developed for INCI follow the methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2021).

Non-Cancer

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test, the oral administration of INC to rats by gavage, at dose levels of 15, 30 and 60 mg/kg bw/day, resulted in local irritant gastric irritation in all treatment groups. Therefore, a no observed effect level (NOEL) for local irritant effects was determined as 15 mg/kg bw/day for males. However, in relation to systemic and reproductive/developmental toxicity in the absence of any toxicologically significant effects, the NOAEL was considered to be 60 mg/kg bw/day. The NOAEL of 60 mg/kg bw/day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

$$\text{Oral RfD} = \text{NOAEL} / (\text{UF}_A \times \text{UF}_H \times \text{UF}_L \times \text{UF}_{\text{Sub}} \times \text{UF}_D)$$

Where:

UF_A (interspecies variability) = 10

UF_H (intraspecies variability) = 10

UF_L (LOAEL to NOAEL) = 1

UF_{Sub} (subchronic to chronic) = 10

UF_D (database uncertainty) = 3

$$\text{Oral RfD} = 60 / (10 \times 10 \times 1 \times 10 \times 3) = 60 / 3000 = \underline{0.02 \text{ mg/kg bw/day}}$$

Drinking water guidance value

$$\text{Drinking water guidance value} = (\text{animal dose}) \times (\text{human weight}) \times (\text{proportion of intake from water}) / (\text{volume of water consumed}) \times (\text{safety factor})$$

Using the oral RfD,

Drinking water guidance value = (oral RfD) x (human weight) x (proportion of water consumed) / (volume of water consumed)

where:

Human weight = 70 kg (ADWG, 2011)

Proportion of water consumed = 10% (ADWG, 2011)

Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = $(0.02 \times 70 \times 0.1) / 2 = 0.07 \text{ mg/L}$

Cancer

There was no data available or evidence of carcinogenicity. Thus, a cancer reference value was not derived.

K. Human Health Hazard Assessment of Physico-Chemical Properties

INCI does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

INCI is of high toxicity concern to aquatic organisms and of low toxicity concern to terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

Table 4 lists the results of acute aquatic toxicity studies conducted on INCI.

Table 4: Acute Aquatic Toxicity Studies on INCI

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
<i>Oncorhynchus mykiss</i> (Rainbow trout)	96-hr LC ₅₀	0.4	1	ECHA
<i>Oncorhynchus mykiss</i> (Rainbow trout)	96-hr LC ₅₀	1.07	-	ECOTOX
<i>Lepomis macrochirus</i> (Bluegill sunfish)	96-hr LC ₅₀	1.17	-	ECOTOX
<i>Daphnia magna</i>	48-hr EC ₅₀	0.098	1	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
(Water flea)				
<i>Daphnia magna</i> (Water flea)	48-hr EC ₅₀	1.7	-	ECOTOX
<i>Raphidocelis subcapitata</i> (Green alga)	72-hr EC ₅₀	0.084	1	ECHA

Chronic Studies

No chronic experimental studies were available for fish and algae.

A 72-hour NOEC of 0.022 mg/L was determined for *Raphidocelis subcapitata* (green alga) based on growth (ECHA). [Kl. score = 1].

C. Terrestrial Toxicity

Studies have been performed with avians. In an 8-day study with mallard ducks (*Anas platyrhynchos*), the LC₅₀ value was >5,000 mg/kg and the NOEL was 2,500 mg/kg (ECOTOX). In an 8-day study with northern bobwhite quail (*Colinus virginianus*), the LC₅₀ value was >5,000 mg/kg and the NOEL was 2,500 mg/kg (ECOTOX).

D. Calculation of PNEC

The PNEC calculations for INCI follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for three trophic levels. Acute E(L)C₅₀ values are available for fish (0.4 mg/L), invertebrates (0.098 mg/L) and algae (0.084 mg/L). Results from chronic studies are available for algae (0.022 mg/L). On the basis that the data consists of short-term studies for three trophic levels and long-term results studies for one trophic level, an assessment factor of 100 has been applied to the lowest reported NOEC of 0.022 mg/L for fish. The PNEC_{water} is 0.00022 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Nonetheless, a PNEC_{sed} was calculated using the equilibrium partitioning method. The PNEC_{sed} is 0.13 mg/kg sediment wet weight.

The calculations are as follows:

$$\begin{aligned}
 \text{PNEC}_{\text{sed}} &= (K_{\text{sed-water}} / \text{BD}_{\text{sed}}) \times 1000 \times \text{PNEC}_{\text{water}} \\
 &= 765.2 / 1280 \times 1000 \times 0.00022 \\
 &= 0.13 \text{ mg/kg}
 \end{aligned}$$

Where:

$K_{\text{sed-water}}$ = suspended matter-water partition coefficient (m^3/m^3)

BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 kg/m^3 [default]

$\text{PNEC}_{\text{water}}$ = 0.00022 mg/L

$K_{\text{sed-water}} = 0.8 + [(0.2 \times K_{\text{p}_{\text{sed}}})/1000 \times \text{BD}_{\text{solid}}]$

$= 0.8 + [(0.2 \times 1592)/1000 \times 2400]$

$= 765.2 \text{ m}^3/\text{m}^3$

And:

$K_{\text{p}_{\text{sed}}}$ = solid-water partition coefficient (L/kg)

BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 kg/m^3 [default]

$K_{\text{p}_{\text{sed}}} = K_{\text{oc}} \times f_{\text{oc}}$

$= 39811 \times 0.04$

$= 1592 \text{ L}/\text{kg}$

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). No experimental data are available.

The K_{oc} for INCI based on the log K_{ow} method is 39,811 L/kg (log K_{oc} of 4.6) (EPA, 2019).

f_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There is limited INCI toxicity data for terrestrial or soil organisms. Therefore, the $\text{PNEC}_{\text{soil}}$ was calculated using the equilibrium partitioning method. The $\text{PNEC}_{\text{soil}}$ is 0.12 mg/kg soil dry weight.

The calculations are as follows:

$\text{PNEC}_{\text{soil}} = (K_{\text{p}_{\text{soil}}}/\text{BD}_{\text{soil}}) \times 1000 \times \text{PNEC}_{\text{water}}$

$= (796/1500) \times 1000 \times 0.00022$

$= 0.12 \text{ mg}/\text{kg}$

Where:

$K_{\text{p}_{\text{soil}}}$ = soil-water partition coefficient (m^3/m^3)

BD_{soil} = bulk density of soil (kg/m^3) = 1,500 kg/m^3 [default]

$K_{\text{p}_{\text{soil}}} = K_{\text{oc}} \times f_{\text{oc}}$

$= 39811 \times 0.02$

$= 796 \text{ m}^3/\text{m}^3$

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). No experimental data are available.

The K_{oc} for INCI based on the log K_{ow} method is 39,811 L/kg (log K_{oc} of 4.6) (EPA, 2019)..

f_{oc} = fraction of organic carbon in soil = 0.02 [default].

8 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REAC Criteria methodology (IChEMS, 2022; ECHA, 2023).

INCI is inherently biodegradable; thus, it does not meet the screening criteria for persistence.

Based on a measured log K_{ow} of 5.4, INCI does not meet the screening criteria for bioaccumulation.

The lowest chronic NOEC for INCI is <0.1 mg/L. The lowest acute $E(L)C_{50}$ values are also <1 mg/L. Thus, INCI meets the screening criteria for toxicity.

The overall conclusion is that INCI is not a PBT substance.

B. Other Characteristics of Concern

No other characteristics of concern were identified for INCI. .

9 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment ¹	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required ³
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity ²	Chronic Toxicity ²	
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall oil alkyl derivative (INCI)	61791-39-7	Not a PBT	No	No	No	No	Yes	Yes	3 (fish, inv, algae)	3 (algae)	3

Footnotes:

1 - PBT Assessment based on PBT Framework.

2 - Acute and chronic aquatic toxicity evaluated consistent with assessment criteria (see Framework).

3 - Tier 3 - Quantitative Risk Assessment: Complete PBT, qualitative and quantitative assessment of risk.

Notes:

NA = not applicable

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

- ADWG (2011). National Water Quality Management Strategy. Australian Drinking Water Guidelines, Section 6, Australian Government, National Health and Medical Research Council, Natural Resource Management Ministerial Council. Updated June 2025. Available: <https://www.nhmrc.gov.au/about-us/publications/australian-drinking-water-guidelines>
- Australian Industrial Chemicals Introduction Scheme [AICIS] (2022). Long-chain Alkyl Hydroxyethyl Imidazolines Evaluation Statement. Available: <https://cdnservices.industrialchemicals.gov.au/statements/EVA00054%20-%20Evaluation%20Statement%20-%2030%20June%202022.pdf>
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- Department of the Environment and Energy [DoEE]. (2017). Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, Guidance manual prepared by Hydrobiology and ToxConsult Pty Ltd for the Department of the Environment and Energy, Commonwealth of Australia, Canberra. Available: www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual
- ECHA. ECHA REACH database: <http://echa.europa.eu/information-on-chemicals/registered-substances>.
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- European Chemicals Agency [ECHA]. (2023). Chapter R.11: vPvB assessment. In *Guidance on information requirements and chemical safety assessment*. Version 4.0. <https://echa.europa.eu/guidance-documents/guidance-on-information-requirements-and-chemical-safety-assessment>
- Industrial Chemicals Environmental Management Standard [IChEMS]. (2022). Australian Environmental Criteria for Persistent, Bioaccumulative and/or Toxic Chemicals. Available: <https://www.dcceew.gov.au/sites/default/files/documents/australian-pbt-criteria.pdf>
- Klimisch, H.J., Andreae, M., and Tillmann, U. (1997). A systematic approach for evaluating the quality of experimental and toxicological and ecotoxicological data. *Regul. Toxicol. Pharmacol.* 25:1-5.

U.S. Environmental Protection Agency [EPA] (2019). EPISuite™ v. 4.11, United States Environmental Protection Agency, Office of Pollution Prevention and Toxics and Syracuse Research Corporation. Available at: <https://www.epa.gov/tsca-screening-tools/epi-suite-estimation-program-interface>.

B. Abbreviations and Acronyms

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
AICIS	Australian Industrial Chemicals Introduction Scheme
AICS	Australian Inventory of Chemical Substances
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
HHRA	enHealth Human Risk Assessment
IChEMS	Industrial Chemicals Environmental Management Standard
IUPAC	International Union of Pure and Applied Chemistry
kg	kilograms
KI	Klimisch scoring system
KOCWIN™	USEPA organic carbon partition coefficient estimation model
kPa	kilopascal
L	litre
L/kg	litres per kilogram
LC	lethal concentration
LD	lethal dose
LOAEL	lowest observed adverse effect level
m ³	cubic metre
MCI	molecular connectivity index
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m ³	milligrams per cubic metre
mL	millilitre
mPa s	millipascal second
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme

NOAEL	no observed adverse effect level
NOEL	no observed effect level
Pa	pascal
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SGG	Synthetic Greenhouse Gases
USEPA	United States Environmental Protection Agency



Attachment 2 Risk Characterisation Tables

Attachment 2, Table 1
Summary of Theoretical Biodegradation of Vendor Chemicals in Aqueous Drilling Fluids

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L) ¹	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Drilling Fluids Including Biodegradation Half-Life (mg/L)		
		Drilling Fluids	Half-Life (days)	Temporal Scenario (days)		
				0	3	7
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000044	150	0.0000044	0.0000043	0.0000042

Notes:

CAS = Chemical Abstracts Service

mg/L = milligrams per litre

NA = not applicable

1 - maximum of oxygen scavenger treatments

Attachment 2, Table 2
Comparison of Theoretical Concentrations of COPCs to Drinking Water Guidelines

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Drilling Fluids Including Biodegradation Half-Life (mg/L)			Drinking Water Screening Level	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)		
				Temporal Scenario (days)				Temporal Scenario (days)		
		Drilling Fluids	Half-Life (days)	0	3	7		0	3	7
				0	3	7		0	3	7
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000044	150	0.0000044	0.0000043	0.0000042	0.07	6.2E-05	6.1E-05	6.0E-05

Notes:

CAS = Chemical Abstracts Service

COPC = constituent of potential concern

mg/L = milligrams per litre

NA = not applicable

Attachment 2, Table 3
Comparison of Theoretical Concentrations of COPCs to PNECs (Water)

Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Drilling Fluids Including Biodegradation Half-Life (mg/L)			PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)		
				Temporal Scenario (days)				Temporal Scenario (days)		
		Drilling Fluids	Half-Life (days)	0	3	7		0	3	7
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000044	150	0.0000044	0.0000043	0.0000042	0.00022	2.0E-02	2.0E-02	1.9E-02

Notes:

CAS = Chemical Abstracts Service

COPC = constituent of potential concern

mg/L = milligrams per litre

NA = not applicable

PNEC = predicted no effects concentration

Attachment 2, Table 4
Summary of Theoretical Concentrations of Vendor Chemicals in Drilling Fluid Solids

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Drilling Fluids (Solids Unmixed) (mg/kg)	Estimated Vendor Chemical Concentration in Drilling Fluids (Solids Mixed [Unmixed Muds Concentration x MBC factor]) (mg/kg)
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000026	0.000000052

Notes:

Mix Bury Cover (MBC) treatment includes mixing 20m³ of solid drilling injected material in 1 ha/ 100 mm deep. Therefore, the MBC factor is 20 m³/1000 m³ or 0.02.

CAS = Chemical Abstracts Service

ha = hectare

m³ = cubic metres

mg/kg = milligrams per kilogram

mm = millimetres

Attachment 2, Table 5
Comparison of Theoretical Concentrations of COPCs to PNECs (Solid)

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Drilling Fluids (Solids – Unmixed) (mg/kg)	Estimated Vendor Chemical Concentration in Drilling Fluid (Solids – Mixed) (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
					Spent Muds	Mixed Spent Muds
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	0.0000026	0.000000052	0.12	2.2E-05	4.4E-07

Notes:

CAS = Chemical Abstracts Service

COPC = constituent of potential concern

mg/kg = milligrams per kilogram

NA = not applicable

PNEC = predicted no effects concentration

Attachment 2, Table 6
Risk Estimates for Small Mammal from Vendor Chemicals in Drilling Fluids

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Northern Quoll	
			Animal	Body Weight (kg)	Body Weight	Derived TRV
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	6.00E+01	Rat	3.50E-01	8.00E-01	4.88E+01

Notes:

CAS = Chemical Abstracts Service
kg = kilogram
NA = not applicable
NOAEL = No observed adverse effect level
NOAELt = No observed adverse effect level test animal
NOEC = no observed effect concentration
TRV = toxicity reference value

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weight_{test}}{Body\ Weight_{receptor}} \right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR-S	Ingestion rate soil	kg/day	0.000274	Calculated with average ingestion rate (2.74 g/day) and assumption of 10% soil intake through ingestion. ¹
	IR-F	Ingestion rate food	kg/day	0.00137	Calculated with average ingestion rate (2.74 g/day) and assumption of diet composition of 50% earthworms (USEPA, 1993). ¹
	HR	Home Range ratio	unitless	0.25	The home range for Northern quoll varies from 10 ha to 1000 ha, depending upon habitat. Given that the well leases range from 1 ha to 2.5 ha, a conservative home range ratio of 0.25 is assumed. ²
	BW	Body weight	kg	0.80	Average body weight from Menkhorst & Knight 2001. Weight ranges from 0.7 kg to 0.1 kg. ³

Notes:

a/ Units:

kg = kilogram
kg/day = kilograms per day

b/ Source:

- 1 - USEPA. (1993) Wildlife Exposure Factors Handbook United States Environmental Protection Agency Office of Research and Development. EPA/600/R-93/187. December 1993.
- 2 - Australian Government Department of the Environment. "Pseudomys pilligaensis". Available online at: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=99 . Retrieved 2 June 2015.
- 3 - Menkhorst, Peter; Knight, Frank (2001). A field guide to the mammals of Australia. South Melbourne, Australia: Oxford University Press. pp. 194–195. ISBN 019550870X.

g/day = grams per day

ha = hectare

Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Unmixed)	EPC ¹ Surface Cuttings (Mixed)	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CS (mg/kg)	CS (mg/kg)	TRVs	Unmixed	Incidental Ingestion	Mixed	Incidental Ingestion
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	2.61E-06	5.22E-08	4.9E+01	1.3E-09	2.7E-11	2.7E-11	5.5E-13

Notes:

1/ EPC is estimated concentration in drilling fluid solids presented in Attachment 2, Table 4.

CAS = Chemical Abstracts Service

CS = concentration in soil

EPC = exposure point concentration

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilograms per day

NA = not applicable

TRV = toxicity reference value

- not present in spent muds

$$Total\ Intake = \frac{[(EPC \times IR - S) + (EPC \times IR - F)] \times HR}{BW}$$

$$Hazard\ Quotient = \frac{Total\ Intake \left(\frac{mg}{kg - day} \right)}{TRV \left(\frac{mg}{kg - day} \right)}$$

Attachment 2, Table 7
Risk Estimates for Avian Receptor from Vendor Chemicals in Drilling Fluids

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAEL ¹	Avian NOAEL		Avian Receptor	
			Test Animal			Test Animal		Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight (kg)	Derived TRV
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	6.00E+01	Rat	3.50E-01	ND	NA	NA	3.90E-01	5.84E+01

Notes:

1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.

CAS = Chemical Abstracts Service

kg = kilogram

NA = not applicable

NOAEL = No observed adverse effect level

NOAELt = No observed adverse effect level test animal

NOEC = no observed effect concentration

TRV = toxicity reference value

$$Derived\ TRV = NOAEL_{test} * \left(\frac{Body\ Weight_{test}}{Body\ Weight_{receptor}} \right)^{(1/4)}$$

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR-S	Ingestion rate soil	kg/day	0.031	BPJ
	IR-F	Ingestion rate food	kg/day	0.157	The Cattle Egret feeds mostly on grasshoppers, other insects, and small mammals (Marchant& Higgins, 1990). For this evaluation, diet is assumed to consist entirely of earthworms (BPJ) to link the potential COPCs in soil and feed habits of egret. The ingestion rate is calculated using USEPA T-REX model equations.
	HR	Home Range ratio	unitless	0.5	BPJ
	BW	Body weight	kg	0.39	Siegfried, 1969
	PR	Prey Ratio	unitless	0.50	The cattle egret mainly consumes insects; a prey ratio of 0.5 is conservatively assumed and likely overestimates potential

Notes:

a/ Units:

kg/day = kilograms per day

kg = kilogram

b/ Source:

BPJ - Best Professional Judgement

W.R. Siegfried (1969) Energy Metabolism of the Cattle Egret, Zoologica Africana, 4:2, 265-273, DOI: 10.1080/00445096.1969.11447375

Marchant & Higgins (1990). Handbook of Australian, New Zealand and Antarctic Birds : Volume 1: Ratites to Ducks : Part B: Australian Pelican to Ducks

COPC = constituent of potential concern

USEPA = United States Environmental Protection Agency

Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Unmixed)	EPC ¹ Surface Cuttings (Mixed)	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CS (mg/kg)	CS (mg/kg)	TRVs	Unmixed	Incidental Ingestion	Mixed	Incidental Ingestion
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	2.61E-06	5.22E-08	5.8E+01	3.68E-07	6.3E-09	7.35E-09	1.3E-10

Notes:

1/ EPC is estimated concentration in drilling fluid solids presented in Attachment 2, Table 4.

CAS = Chemical Abstracts Service

CS = concentration in soil

EPC = exposure point concentration

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilograms per day

NA = not applicable

TRV = toxicity reference value

- not present in spent muds

$$Total\ Intake = \frac{(EPC \times IR - S) + (EPC \times IR - F \times PR) \times HR}{BW}$$

$$Hazard\ Quotient = \frac{Total\ Intake \left(\frac{mg}{kg - day} \right)}{TRV \left(\frac{mg}{kg - day} \right)}$$

Attachment 2, Table 8
Human Receptor Exposure Assumptions

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value - Resident (Trespasser)	Source (b)	Parameter Value - Agricultural Worker	Source (b)
Soil	Ingestion	IR	Ingestion rate	mg/day	100	enHealth, 2012, USEPA, 2016	100	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ	4	BPJ
		ED	Exposure duration	yr	10	BPJ	35	BPJ
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012	chemical-specific	(f) enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012	85	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012	25,550	enHealth, 2012
	Dermal	CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012	1.0E-06	enHealth, 2012
		SA	Surface area for contact (exposed)	cm ² /day	4,700	(d) enHealth, 2012, USEPA, 2016	5,664	(d) enHealth, 2012, USEPA, 2016
		ABS	Absorption Factor	unitless	chemical-specific	enHealth, 2012	chemical-specific	BPJ
		EF	Exposure frequency	day/yr	20	BPJ	4	BPJ
		ED	Exposure duration	yr	10	BPJ	35	(f) enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012	85	(f) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212	25,550	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm ² skin	0.07	(e) enHealth, 2012, USEPA, 2016	0.08	(e) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 212	1.0E-06	enHealth, 2012

Notes:

a/ Units:

l/hr = litres per hour

hr/day = hours per day

day/yr = days per year

yr = year

kg = kilogram

cm² = square centimetre

cm/h = centimetre per hour

l/cm³ = litre per cubic centimetre

cm²/day = square centimetre per day

mg soil/cm² skin = milligrams soil per square centimetre skin

kg/mg = kilogram per milligram

b/ References:

enHealth, 2012:

enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommittee of the Australian Health Protection Principal Committee, Canberra, Australia.

BPJ:

Best Professional Judgement

USEPA, 2016

USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at <http://www.epa.gov/expobox>

c/ The body weight is the time weighted average calculated from enHealth exposure factors for a male or female child aged 8 to 18 years old.

d/ Exposed body surface area is the time weighted average of head, forearms, hands, lower legs, and feet.

Forearms are considered 45% of arm surface area; lower leg is considered 40% of leg surface area (USEPA, 2016).

e/ Adherence factor calculated for exposed body part surface area is the time weighted average of head, forearms, hands, lower legs, and feet.

f/ Male exposure factor used based on enHealth recommendation.

Attachment 2, Table 9
Risk Estimates for Resident from Vendor Chemicals in Drilling Fluids

Exposure to Soils Before Treatment							
Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Unmixed)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	2.61E-06	2.0E-02	2.8E-13	9.2E-13	1.4E-11	4.6E-11

Exposure to Soils After Treatment							
Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Mixed)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	5.22E-08	2.0E-02	5.6E-15	1.8E-14	2.8E-13	9.2E-13

Notes:

1/ EPC is estimated concentration in drilling fluid solids presented in Attachment 2, Table 4.

CAS = Chemical Abstracts Service

CS = concentration in soil

CADD = chronic average daily dose

EPC = exposure point concentration

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilograms per day

NA = not applicable

RfDo = oral reference dose

Consistent with enHealth guidance a default value of 1 used for both the RBA and ABS values (see Table 8).

$$Oral\ Intake = \frac{EPC \times IR \times EF \times ED \times RBA \times CF_{soil}}{BW \times AT}$$

$$Dermal\ Intake = \frac{EPC \times EF \times ED \times SA_{exp} \times AF \times ABS \times CF_{soil}}{BW \times AT}$$

Attachment 2, Table 10
Risk Estimates for Agricultural Worker from Vendor Chemicals in Drilling Fluids

Exposure to Soils Before Treatment							
Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Unmixed)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	2.61E-06	2.0E-02	3.4E-14	1.5E-13	1.7E-12	7.6E-12

Exposure to Soils After Treatment							
Constituent Name	CAS No.	EPC ¹ Surface Cuttings (Mixed)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7	5.22E-08	2.0E-02	6.7E-16	3.0E-15	3.4E-14	1.5E-13

Notes:

1/ EPC is estimated concentration in drilling fluid solids presented in Attachment 2, Table 4.

CAS = Chemical Abstracts Service

CS = concentration in soil

CADD = chronic average daily dose

EPC = exposure point concentration

mg/kg = milligrams per kilogram

mg/kg/day = milligrams per kilograms per day

NA = not applicable

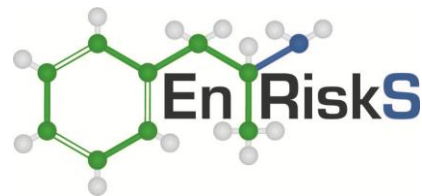
RfDo = oral reference dose

- not present in spent muds

Consistent with enHealth guidance a default value of 1 used for both the RBA and ABS values (see Table 8).

$$Oral\ Intake = \frac{EPC \times IR \times EF \times ED \times RBA \times CF_{soil}}{BW \times AT}$$

$$Dermal\ Intake = \frac{EPC \times EF \times ED \times SA_{exp} \times AF \times ABS \times CF_{soil}}{BW \times AT}$$



23 April 2026

EHS Support

Attn: Joe Hayes

Environmental Risk Sciences Pty Ltd
P.O. Box 2537
Carlingford Court, NSW 2118

Phone: +61 2 9614 0297
www.enrisks.com.au

Independent Peer Review of Chemical Risk Assessments – Chemical Product Hydro 327

Dr Jackie Wright, Director of Environmental Risk Sciences Pty Ltd (enRiskS) has been commissioned by EHS Support (EHS) to undertake an independent peer review of the Chemical Risk Assessments (CRA) that has been completed by EHS Support for the product Hydro 327, a drilling additive product within the Senex Energy Atlas Stage 3 Development.

Dr Jackie Wright has over 35 years' experience in human health and environmental risk assessment in Australia. Jackie holds a PhD in public health and is a Fellow of the Australasian College of Toxicology and Risk Assessment. A CV for Dr Jackie Wright is included in **Attachment A**.

A Chemical Risk Assessment Framework (CRAF) for the Atlas Stage 3 has been prepared for Senex Energy (Senex). The CRAF provides the framework for the chemical risk assessment process, specifically the classification of chemicals as Tier 1, Tier 2, Tier 3 and Tier 4, and the requirements that need to be addressed in the chemical risk assessments completed for each classification level. The CRAF includes checklists for use in the peer review of the chemical risk assessments.

This review relates to the product Hydro 327 proposed for the Atlas Stage 3 works.

Four of the chemicals within the product have been assessed as Tier 1 chemicals, with a risk assessment dossier provided for review for each chemical.

One chemical within the product has been assessed as Tier 3 chemical that also requires completion of a qualitative and quantitative assessment of risk.

All risk assessments provided for these chemicals were reviewed by Dr Jackie Wright. Comments were provided (where relevant) as a result of the peer-review process, and the assessments updated.

The review process undertaken includes consideration of whether the correct level of assessment has been completed for the chemicals.

The chemical assessed in this review is listed in **Table 1**.

Table 1: List of chemicals reviewed

Chemical name	CAS No.
Tier 1 chemicals	
2-Butoxyethanol	111-76-2
Propylene glycol	57-55-6
Acetic acid	64-19-7
Sodium thiosulphate pentahydrate	10102-17-7
Tier 3 chemical	
1H-Imidazole-1-ethanol, 4,5-dihydro-, 2-nortall-oil alkyl derivs. (INCI)	61791-39-7

The peer review process has been undertaken as follows:

- Review of the Tier 1 chemical dossiers was undertaken in line with the classification criteria and checklists provided in the CRAF. Review comments, along with any relevant notes, have been documented in the peer-review checklist. The review process has included checking that the classification of the chemical is appropriate, and if there is the basis for the classification to be revised. No chemicals required reclassification from Tier 1 to Tier 2. The Tier 1 chemical risk assessments did not require any revisions.
- Review of the Tier 3 chemical risk assessment was undertaken in line with the classification criteria and checklists provided in the CRAF. Review comments, along with any relevant notes, have been documented in the peer-review checklist. The review process has included checking that the classification of the chemical is appropriate, and if there is the basis for the classification to be revised. The Tier 3 chemical reviewed was appropriately classified. Comments were provided on the CRA, with the CRA amended to address the comments. The changes were reviewed to ensure all comments were appropriately addressed.

Peer review checklists have been provided to EHS that detail the review process undertaken for the chemicals evaluated.

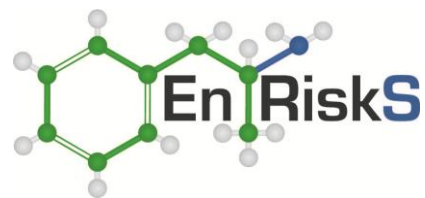
Based on the peer review completed for the chemical risk assessments reviewed (as listed in **Table 1**), the following is concluded:

- all Tier 1 chemicals reviewed were appropriately classified
- the Tier 3 chemical reviewed was appropriately classified
- the chemical risk assessments have been prepared appropriately, in accordance with the requirements of the CRAF, and provide an evaluation of each chemical consistent with current scientific knowledge
- risks relevant to the use of Tier 1 and Tier 3 chemicals as reviewed have been appropriately assessed.

Yours sincerely,



Dr Jackie Wright (Fellow ACTRA)
Principal/Director
Environmental Risk Sciences Pty Ltd



Attachment A: CV for Dr Jackie Wright

Director/Principal
Environmental Risk Sciences Pty Ltd
(+61 2) 9614 0297

Professional Profile

Jackie Wright has more than 35 years' experience in human health and ecological risk assessment in Australia. Experience includes leading and developing a national risk practice group for a major consultancy, training staff, providing technical (and toxicological) direction, developing technical standards and guidance, developing appropriate risk models, providing peer-review and expert evidence.

Areas of expertise include human and eco-toxicological review and evaluation of chemicals in line with Australian regulatory requirements, human health and ecological risk assessment, health impact assessment, impact of exposure to air and noise pollution, exposure modelling, indoor air quality assessment, fate and transport assessment, air dispersion modelling, environmental chemistry, environmental monitoring, and the assessment of air emissions and air toxics. Human health assessments have included a large number and wide range of sites that involve the evaluation of emissions to air, waste sites, residential and recreation areas, operating industrial plants as well as other industrial plants that have been closed and are in the process of property sales or redevelopment and remediation. Ecological assessments have included screening level and detailed assessments of contamination, potential for contamination and remediation of contamination in soil and the aquatic environment. Risk assessments, ecological and human health, have been conducted for review by regulatory agencies (including Contaminated Land Auditors), with Jackie also providing expert support on both human health and ecological risk assessments (including detailed aquatic eco-toxicological assessments) for a number of Auditors in NSW, Victoria, South Australia, Western Australia and Queensland.

Jackie has been heavily involved in the development of national guidance and investigation levels as presented in the National Environment Protection Measure (NEPM) for Site Contamination (1999 amended 2013), CRC CARE Technical Guidance on Petroleum Vapour Intrusion and Silica-Gel Cleanup, Australian Crime Commission Assessment and Remediation of Clandestine Drug Laboratories (2011) and Australian Voluntary Code of Practice, Assessment, remediation and validation: Former clandestine drug laboratories and other methamphetamine contaminated properties.

In addition, she has extensive experience in the assessment of vapour migration and intrusion, detailed evaluation of exposure by occupational, residential and recreational groups including the application of probability distributions to human health risk assessments. Jackie has also been involved in a number of key projects that require regular risk communication with interest groups, including resident action groups.

- Toxicological (human and ecological) Review and Assessment
- Human Health Risk Assessment
- Environmental Risk Assessment
- Exposure Assessment and Modelling
- Occupational Exposure Assessment
- Clandestine Drug Laboratories and Public Health Issued from Drug Exposures
- Vapour Intrusion
- Indoor Air
- Health Impact Assessment
- Wellbeing Assessment
- Health impacts of air and noise pollution
- Environmental Chemistry, Fate and Transport
- Risk Communication
- Air Dispersion Modelling

Professional Accomplishments

Toxicology and Risk Assessment

- 2005 to 2025 (ongoing process of development and revision) - Prepared over 50 toxicity summaries for a range of chemicals relevant to the inclusion and assessment of these chemicals within human health and ecological risk assessments in accordance with Australian guidance. Toxicity summaries prepared provide detail on the chemical use, sources, exposures, chemical properties, ecotoxicity (terrestrial and aquatic), environmental fate and transport, health effects, review and identification of appropriate data relevant to acute and chronic exposures by the inhalation, oral and dermal routes, including assessment of carcinogenicity and genotoxicity. Range of compounds assessed includes particulate matter, petroleum compounds, chlorinated compounds, asbestos, metals and more obscure industry-specific compounds. More specific, detailed review of arsenic dose-response has been undertaken based on current studies.
- 2014/2015 – conducting detailed toxicological review of TCE, particularly in relation to the quantification of inhalation dose-response.
- 2009 to 2013 – provided detailed toxicological review, determination of appropriate dose-response values, and derivation of proposed 2013 NEPM Soil Health Investigation Levels (HILs), including the interim soil gas HILs, and input into the petroleum Health Screening Levels (HSLs). The review included significant update and revision to Schedules B4 and B7 and involved incorporation of all comments from regulators, industry and the public.
- 2009 and ongoing – Detailed review of the toxicity of a range of illicit drugs relevant to the assessment of environmental exposures or public health impacts of exposure to second or third-hand exposures
- 2010 – provided detailed review of toxicological interactions, biomonitoring data and human exposure to metals (and metal mixtures) for a site in Tasmania.
- 2006 to 2025 (and ongoing) - Presentation and collaboration with regulatory bodies in Australia (New South Wales Environmental Protection Authority [EPA], New South Wales Department of Health and Victorian EPA) with regards to the approach adopted and information presented with toxicity summaries (addressing human health and aquatic toxicity where required) for key, high profile assessments.

Exposure and Risk Assessment (Human Health and General Environmental)

- 1992 to 2025 (ongoing) - Project management and evaluation of human health and environmental risks associated with over 350 contaminated sites in all states of Australia utilising national guidance that include NEPM, enHealth, ANZECC and NH&MRC guidance. Sites include operational sites as well as other industrial areas proposed for redevelopment for industrial, recreational or residential use. Most of the sites assessed are associated with petroleum contamination, chlorinated hydrocarbons, polycyclic aromatic hydrocarbons (PAHs) and metals. Other sites include those impacted with dioxins, phthalates, PCBs and PFOS/PFOA.
- 2011 to 2025 (ongoing) – Conduct of asbestos risk assessments, relevant to contaminated land and materials/recovered materials for reuse. These include assessments of risks to human health using a screening level assessment and detailed site-specific assessments (where required). Assessments have also included consideration of risk management measures relevant to preventing or minimising exposure to asbestos fibres.
- 1995 to 2025 (ongoing) - Detailed assessment and ongoing evaluation of risks to human health associated with contamination issues derived from the Orica Botany

site in Sydney. A number of assessments have been undertaken over a period of 17 years and has involved detailed review of risks to residents (including groundwater extraction and use), workers and recreational users of a large area affected by the discharge of contamination in shallow and deep groundwater to surface water within a drain and an estuary, historically deposited sediments and volatile chlorinated compounds in air. The assessment of risk has been tied closely with ongoing monitoring with detailed exposure reviews, including the collection of additional data and ongoing review of methods, being undertaken for many key aspects of the project. The process required evaluation within context of the NEPM (1999) and enHealth (2002) guidance with regular liaison with the NSW OEH, NSW Department of Health and independent reviewers.

- 2009 to 2015 - Derivation of national guidelines for the investigation and remediation of clandestine drug laboratories in Australia. The work involved the derivation of investigation levels, protective human health and the environment (terrestrial and aquatic), associated with former clandestine drug laboratories in Australia. Project required identification of key indicator compounds from over 200 base, intermediate and waste products that may be associated with over 20 different drug manufacturing methods. This required consideration of human health and environmental toxicity, behaviour/fate and transport in the environment and manufacturing methods. Guidelines were derived for indoor surface residues, indoor air, outdoor soil and the environment (local waterways and soil) for residential, commercial and recreational areas. The guidelines developed have been published by the Australian Government in April 2011. Further development of state guidelines, such as those from NSW Health have been undertaken to 2015.
- 2019 – Development of Australian Voluntary Code of Practice, Assessment, remediation and validation: Former clandestine drug laboratories and other methamphetamine contaminated properties, as published by Environmental Health Australia. The publication of these guidelines has included a range of workshops to share information and better understand issues and data gaps in the management of drug affected properties.
- 2017 to 2025 – Review of a range of issues relating to exposures to illicit drugs by the public and provision of expert advice to understand exposure, toxicity and potential for adverse effects.
- 2010 to 2024 – Detailed evaluation of community exposures and risks to PM₁₀ and PM_{2.5} derived from urban (combustion) sources as well as crustal (mining) sources. A number of urban projects have been completed, including major road infrastructure projects such as NorthConnex, WestConnex M4 East, WestConnex New M5, WestConnex M4-M5 Link, F6 Stage 1, Western Harbour Tunnel, Beaches Link and Great Western Highway in NSW and West Gate Tunnel and North East Link in Victoria and rail infrastructure projects including the Moorebank Intermodal Terminal and Botany Rail Duplication in NSW and the Suburban Rail Loop East in Victoria. These infrastructure projects have involved the development and researching of appropriate methodologies for the assessment of particulate exposures, with particular focus on community exposures and risks. The work has also considered detailed assessments related to other criteria pollutants that include ozone, nitrogen oxides, sulphur dioxide, particulate matter and other combustion products (such as polycyclic aromatic hydrocarbons and volatile organic compounds). Projects have involved detailed review of current literature in relation to the health effects and the identification and use of appropriate dose-response relationships relevant to the quantification of relevant health endpoints, with consultation conducted with stakeholders, including state health departments and the community. Works undertaken for the West Gate Tunnel, North East Link and Suburban Rail Loop East included the panel inquiry (presentation and

- attendance at the inquiry).
- 2018-2019 – Detailed assessment of particulate risks associated with power station emissions, including detailed critical peer review of public commentary papers as well as published papers and the available research underlying current understanding of health impacts from changes to particulate matter in urban and rural air environments.
 - 2010 to 2024 – Detailed assessment of health impacts associated noise, as generated from major road or rail infrastructure or from aircraft noise. These assessments require an understanding of various noise guidelines, as well as current literature on the health effects of noise on the community. Assessments have included qualitative, semi-quantitative as well as quantitative assessments of risk and population incidence utilising published exposure-response relationships.
 - 2016 to 2018 – Detailed assessment of roadway and tunnel design features to ensure public health is protected. This has included assessment of exposures to nitrogen dioxide and the build-up of carbon dioxide (in-cabin) in long tunnels, design of long tunnels to ensure public safety from fatigue and monotony and design of roadways to ensure flicker effects do not adversely affect road users.
 - 2015 to 2025 – conduct of detailed human health and ecological risk assessments for a range of sites (in particular airport and defence sites) where PFAS issues are of potential concern both on the site and in relation to offsite migration, discharge and exposure. Work has involved detailed evaluations and the development of site-specific guidelines and management measures within the context of a moving regulatory environment.
 - 2020 to 2024 – Detailed assessment of risks to human health and the environment in relation to the proposed reuse of materials in road infrastructure (considered a wide range of materials proposed for reuse, in a variety of use scenarios).
 - 2008 to 2014 - Detailed evaluation of human health and environmental issues associated with a former chlor-alkali plant. The assessment involved detailed evaluation of mercury fate and transport with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered environmental issues associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment, as well as issues associated with mercury (elemental and inorganic) in soil and groundwater with respect to fate and transport, human health and environmental issues.
 - 2010 to 2015 (with ongoing advice to 2023) – Conduct of a detailed Health Impact Assessment in relation to major rail infrastructure development proposal at Moorebank. The HIA involved consultation with stakeholders, in particular local councils, NSW Health and the community, with all aspects of the proposal being address in relation to health impacts, both positive and negative. The HIA was peer reviewed by the University of NSW and an international expert. Ongoing advice relates to construction and operational management of PFAS.
 - 2016 to 2018 – Literature review and assessment of community health impacts associated with landfill gas emissions, and emissions from water to energy facilities.
 - 2018 to 2025 – Conduct of a number of detailed human health risk assessment or health impact assessments in relation to the proposed development of waste-to-energy facilities in NSW, Victoria and Queensland. A number of the projects have been approved.
 - 2011 – Quantitative assessment of risks to human health associated with the placement of remediated soil that contains residual levels of radiological contamination, beneath a proposed commercial/industrial development in South Australia.
 - 2011 to 2016 – Detailed evaluation and development of chemical risk assessments

for a range of products/compounds utilised during coal seam gas operations in NSW and Queensland.

- 2017 to 2018 – Panel member on the WA Government Technical Enquiry on hydraulic fracturing.
- 2010 – Detailed assessment of risks (including detailed assessment of toxicity of individual compounds and mixtures) to human health associated with the presence of nitrate, nitrite and perchlorate contamination in drinking water (international project).
- 2009 to 2025 (and ongoing) – Expert support for contaminated land Auditors located in New South Wales, Victoria, Queensland, South Australia and Western Australia. Expert support has included review of human health and ecological risk assessments for a range of projects and issues.
- 2000 to 2024 - Detailed evaluation of risks to human health and the environment associated with redevelopment of large a number of gasworks sites in New South Wales and Victoria. Projects have involved the evaluation of the vapour migration pathway, including the collection of relevant soil gas and vapour emissions data to quantify exposure consistent with the proposed developments. The process required liaison with relevant site auditors, Vic EPA, SA EPA, NSW EPA and NSW Department of Health as required.
- 1995 to 2024 - Detailed evaluation, modelling and risk assessment of a number of landfill and waste depots in Australia (in New South Wales, Australian Capital Territory, Queensland and Victoria). This includes proposed waste destruction technologies, proposed waste depots and landfills, operational landfills, composting operations and closed landfills with assessments considering workers, residents and recreational users of the site and surrounding areas. Assessments undertaken have considered issues associated with the presence of a wide range of chemicals, landfill gas emissions, leachate generation and leaks, stormwater management, bioaerosols and other pathogens and bacteria.
- 1995 to 2025 (ongoing process as vapour issues are relevant for many projects) - Evaluation of vapour migration (and vapour intrusion) from numerous sources including contaminated soils and groundwater (dissolved phase and free phase) for many different chemicals, and subsequent assessment of human health risks associated with the estimated vapour concentrations. In addition, Jackie has developed and managed various techniques for the direct measurement of vapour migration in residential, recreational and industrial settings as part of the risk assessment process.
- 2009 to 2024 - Detailed evaluation of public health issues associated with recreational exposures to arsenic, lead and/or PAHs in surface soil in primary/secondary schools, sporting areas and children's playgrounds. Provision of technical advice along with appropriate general advice relevant for presentation to the public and responses to questions from the general public.
- 1995 to 2021 - Evaluation of human health risks associated with potential exposure to emissions from coal mining activities, including the assessment of potential risks and health effects associated with exposure to fine particulates.
- 1998 to 2009 - Evaluation of human health risks associated with the existence of, and potential remediation of encapsulated scheduled waste materials located near residential and recreational areas. The assessment has involved ongoing monitoring, review of toxicity and exposures on an ongoing basis, review of remediation options and risks derived from the application of preferred remediation options. The encapsulation has now been remediated.
- 2007 to 2013 – Assessment of risks to human health and the environment associated with the re-use of water (including irrigation uses) from a groundwater treatment plant located in Sydney.
- 2000 to 2005 - Evaluation of human health risks associated with a number of

contaminated sites located in Abu Dhabi, Spain and Azerbaijan. These risk assessments involved assessment of human health risks using USEPA guidance as well as WHO guidance.

- 2005 to 2024 - Project management of large human health risk assessment associated with the redevelopment of explosives and munitions factories and firing ranges within various areas of NSW and Victoria.
- 1995 to 1998 - Evaluation of human health risks associated with off-site accumulation of lead from historical deposition associated with a former operating lead paint site located within a residential area in Sydney. Project involved the review of lead exposure and toxicity, identification and agreement to lead action levels relevant for residential properties located close to and further away from the former source.
- 1995 - Evaluation and coordination of a multi-pathway health risk analysis for a large contaminated site in Sydney involving the use of probabilistic risk assessment methodology.
- 2000 to 2005 - Conducting a feasibility assessment for a waste destruction facility in Sydney, using a probabilistic risk assessment methodology. Conduct of a detailed health risk assessment associated with the operation of the selected technology, including presentation to the Commission of Enquiry. Subsequent review of the process and exposures in relation to placing the facility within a rural area (as opposed to an urban area) and consideration of other multi-pathway exposures.
- 1993 - Assessment of risks to human health and the environment associated with sewage sludge incinerators at North Head and Malabar Sewage Treatment Plants.
- 1992 to 2025 (and ongoing) - Determination of preliminary remediation goals for numerous contaminated sites based on risk criteria.
- 1995 to 2025 (and ongoing) - Development of air sampling procedures and techniques to collect air data relevant to the further assessment of vapour migration pathways in a range of areas. This includes the collection of ambient air, soil gas data (active and passive and sub slab) and flux emissions.

Ecological Risk Assessment

- 1998 to 2025 (ongoing) - Derivation of risk-based criteria for a range of projects that are based on the protection of the aquatic environment. Evaluations have considered the potential for physical parameters (turbidity, pH, dissolved oxygen) and contaminants (principally metals, polycyclic aromatic hydrocarbons [PAHs], PFAS, petroleum compounds and chlorinated compounds). The evaluations include the potential for contaminants to leach from soil, migrate to groundwater and potentially discharge to a receiving environment (considered both marine and freshwater [including ephemeral] systems). Some of the assessments have required review and consideration of fate and transport modelling.
- 2009 to 2025 (ongoing) – Identification and derivation of investigation levels protective the terrestrial and aquatic environments associated with former clandestine drug laboratories in Australia. Ecological Tier 1 levels (based on available ecotoxicological data primarily from overseas studies) were identified and proposed for use in remediation guidelines with additional guidance provided in relation to sites where more detailed assessments of environmental risk issues needs to be conducted.
- 2010, 2011 and 2012 – Conduct (co-presenter) of lectures at the University of Sydney for the Risk Assessment (Human Health and Ecological) module for undergraduates, School of Geosciences. Ecological risk assessment lectures addressed basic principles and frameworks, stressors, fate and transport, bioaccumulation, uptake, derivation of ANZECC Guidelines, reviewing available ecotoxicological studies and conduct of statistical analysis using the CSIRO

- Burrlioz software for establishing water guidelines.
- 2010 to 2011 – Expert witness in relation to ecotoxicological impacts of initial works proposed for the Barangaroo site in NSW.
 - 2010 - Assessment and derivation of water criteria for petroleum hydrocarbons relevant to the protection of the terrestrial and aquatic environments from the reuse of urban run-off for irrigation or a public park and associated runoff into a lake. Assessment required a detailed assessment of not only phytotoxicity, but levels at which grass growth would be affected to the extent by which grass cover on an important AFL playing field would be affected.
 - 2009 to 2011 – Detailed review of screening level risk ecological assessment (supporting studies and outcomes) for the discharge of contaminated groundwater into a sensitive marine environment in South Australia. Review required detailed consideration of the local environment, consideration that appropriate ecological indicator species have been selected, consideration of the range of urbanisation stressors within the environmental and potential for groundwater discharges to result in adverse effects to the aquatic environment, over and above those from urbanisation.
 - 2008 to 2010 - Detailed evaluation of environmental fate and transport issues associated with a former chlor-alkali plant. The assessment involved detailed evaluation of mercury fate and transport with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered ecotoxicological risks associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment.
 - 1992 to 2025 (and ongoing) - Determination of preliminary remediation goals for numerous contaminated sites based on risk criteria. In relation to environmental risk issues, this has included the identification of appropriate and screening level criteria that are protective of fresh and marine environments and phytotoxic effects. Where necessary more detailed evaluations of ecotoxicological effects have been considered. This has included the design of suitable surveys and sampling programs (including microtox, microalgae, fish, crustacean, amphipod (sediments), plant and earthworm), interpretation of information and data from these studies, discussion of results with relevant regulatory parties, uncertainty analysis and reporting. These studies have been conducted for the assessment of petroleum hydrocarbon, cyanide, inorganics, ammonia, chloride, phosphorous and nitrate concentrations in soil and discharges from groundwater.
 - 2000 to 2008 - Detailed evaluation of risks to human health and the environment (particularly aquatic species and sediments) associated with redevelopment of large a number of gasworks sites in New South Wales and Victoria. The project in NSW involved collaboration with sediment experts to determine the nature and extent of sediment contamination, potential for adverse ecotoxicological effects and requirements for remediation. The process required liaison with relevant site auditors and the DECCW (formerly NSW EPA) as required.
 - 2007 - Assessment of risks to terrestrial and aquatic (marine water) environments associated with the re-use of water from a groundwater treatment plant located in Sydney. Water is proposed to be reused for a range of proposes that include industrial water (where it may be directly discarded to the marine environment) and irrigation where the water may affect terrestrial species and runoff may enter local water ways. The assessment considered available ecotoxicological data and guidelines available from Australian and International studies (where relevant to Australian species).

Contaminant Transport

- All of the projects listed above have involved the assessment of contaminant transport in at least one media. More specific examples are listed below:
- Vapour partitioning and transport assessed for petroleum compounds, including the development of a national database of petroleum vapour data, related to over 300 petroleum impacted sites, and detailed review of the database in conjunction with technical specialists from the USEPA. The database developed has been peer-reviewed by the USEPA and has been incorporated into the USEPA technical review of data from both the US and Australia for the purpose of determining screening distances.
- Vapour partitioning and transport assessed for chlorinated compounds at numerous contaminated sites, including the assessment of vapour risk issues at the Orica Botany site from 1994 to 2024.
- Review and use of groundwater fate and transport modelling conducted in support of numerous detailed risk assessment outcomes. Reviews have been conducted for the purpose of ensuring these models adequately address the potential movement of contaminants from a source to a point of discharge, utilising appropriate inputs and site data.
- 2008 to 2014 - Detailed evaluation of mercury fate and transport in groundwater and air (mercury vapour) with use of specialised data collected and analysed by CSIRO and liaison with experts on mercury issues from the CSIRO. Assessment considered environmental issues associated with the presence of mercury in groundwater and discharge to an urban (highly modified) environment, as well as issues associated with mercury (elemental and inorganic) in soil and groundwater with respect to fate and transport, human health and environmental issues.

Air Emissions and Vapour Assessment

- Jackie Wright is experienced in all aspects of determining air quality, including monitoring, assessing and modelling soil gas, vapour emissions and emissions from stacks and other fugitive sources. Projects include analysing dust emissions from a number of quarries and coal mines, motor vehicle emissions; modelling vapour emissions from motor vehicles and sources such as creeks, ponds and waste areas; and assessing odour emissions from sewage treatment plants, landfills and other agricultural/industrial facilities.
- 2020 to 2025 – Assessment of inhalation exposures to drug residues derived from contaminated materials and within properties, prior to and post remediation.
- 2012 to 2013 – Development of petroleum vapour intrusion guidance for Australia in conjunction with CRC CARE. The project has involved the development of clear, prescriptive guidance that incorporates current science on the assessment of petroleum vapour intrusion. The guidelines being developed have been presented at a series of PVI training workshops (supported by ALGA and CRC CARE) run in Sydney, Melbourne and Perth.
- 2009 to 2022 - Development of a petroleum vapour database to assist in the interpretation and understanding of the behaviour of petroleum vapours in the subsurface environment. The database is unfunded and independent and has been interpreted by Jackie as well as industry experts in Australia and the US. The database has been peer-reviewed by the USEPA, and incorporated into the USEPA publication on the use of field data (from the US, Canada and Australia) to support and develop vertical exclusion/separation distances (refer to the following website for the USEPA review and access to the database developed: <http://www.epa.gov/oust/cat/pvi/>). This data has been used to support the development of screening distances that are being incorporated into guidance being developed in Australia and the US.

- 2005 to 2025 (ongoing) - Preparation of conceptual site models and completing screening level modelling (using published models such as Johnson & Ettinger) for the assessment of vapour migration and intrusion issues on a wide range of sites (over 200) affected by petroleum and chlorinated hydrocarbons.
- 2010 to 2025 – Detailed evaluation of community exposures and risks to PM₁₀ and PM_{2.5} derived from urban (combustion – associated with road and rail infrastructure) sources as well as crustal (mining) sources. A number of urban projects have also considered community exposures and risks to other criteria pollutants that include ozone, nitrogen oxides and sulphur dioxide. Projects have involved detailed review of current literature in relation to the health effects and appropriate dose-response relationships relevant to the quantification of relevant health endpoints, with consultation conducted with stakeholders, including state health departments.
- 1995 to 2025 (ongoing) - Development of methods and approaches for the sampling and assessment of vapour (e.g. soil gas, flux emissions, indoor and ambient air). Works conducted has involved the conduct of field activities for the purpose of collecting this data.
- 1995 to 2025 (ongoing) - Interpretation and assessment of vapour data for the purpose of characterising inhalation exposures in a range of scenarios. These include existing buildings and proposed developments.

Risk Communication

- 2000 to 2025 (ongoing) - Jackie Wright has experience in the preparation and presentation (communication) of risk outcomes from a number of key projects across Australia to a range of community groups. These groups include workers and unions, residents and community action groups. Successful communication with stakeholders and the community on controversial projects including infrastructure, coal seam gas and other mining projects has been required.

Air Quality Assessment

- 1990 to 1995 – Air dispersion modelling and air quality impact assessment conducted for various mining (coal mining and quarry activities) and transport (major roadways) in NSW and Victoria. Projects included the development of emissions inventories, setting up and running air dispersion models and reporting.
- 2011 to 2015 - Air dispersion modelling conducted for the assessment of exposures (and risks to human health) to crop, grain and timber fumigants. The assessment have been undertaken based on trial data, with scaling to address commercial application.
- 2010 to 2018 - Air dispersion modelling conducted for the assessment of exposures (and risks to human health) to grain fumigants, timber fumigants, hydrogen sulphide, chlorinated compounds, silica and dust (particulate) emissions from a range of facilities. Modelling has been conducted using Screening level and mode detailed Ausplume and Calpuff dispersion modelling packages.
- 2010 to 2025 - Review of air dispersion modelling undertaken for a range of projects. The reviews have been undertaken to determine if the assessments are adequate for the purpose of understanding and characterising community health impacts. In some cases, the review has been undertaken as part of a larger assessment of public health impacts. Projects have included communication of the air quality assessment and health impact assessment to community groups.

Noise Impact assessment

- 2019 to 2022 - Systematic review of health impacts of transport noise for Waka Kotahi NZ Transport Agency in New Zealand. The work has involved a detailed systematic review of the evidence in published and grey literature in relation to the

health effects of transport noise (road, rail and air) and whether the evidence is sufficient to support quantification of health impacts using exposure-response functions. The review has considered recent literature and the GRADE system of review to establish the robustness of the available publications and strength of evidence. This review considered the most recent reviews completed by the WHO and enHealth in 2018.

- 2014 to 2021 - Detailed Evaluation of Community Exposure and Risk to impacts associated with transport infrastructure projects for Transport for NSW and Transurban/Western Distributor Authority/ North East Link Authority in Victoria, Australia. Health impact assessments have included a detailed assessment of impacts from noise during construction and operation. This included a detailed review of current science in relation to health impacts of construction noise, as well as road transport noise sources. In some assessments quantitative risk assessment was required to be undertaken to address impacts on community health. Projects have included: NorthConnex (road - NSW); WestConnex projects - M4 East, New M5, M4-M5 Link (road - NSW); F6 Stage 1 (road - NSW); Gateway project (road and rail – NSW); Western Harbour Tunnel and Beaches Link (road - NSW); West Gate Tunnel (road -Victoria); North East Link (road – Victoria).
- 2016 to 2017 - Brisbane Airport Corporation, Queensland, Australia. Conduct of a review of the health impacts of aircraft noise as these relate to the identification and use of exposure response relationships for assessing health impacts, particularly related to flight paths near major airports.

Expert Witness

- Expert witness at Inquiry and Advisory Committee (IAC) hearings for mining and infrastructure projects in Victoria, specifically:
 - Avonbank Mineral Sands Project (2023), expert in relation to wellbeing
 - Goschen Rare Earths and Mineral Sands Project (2024), expert in relation to human health and wellbeing
 - Fosterville Sustained Operations Project (2024), expert in relation to human health and wellbeing.
 - Western Renewables Link (2025), expert in relation to wellbeing impacts.
 - Warracknabeal Energy Park (2025), expert in human health and wellbeing.
- Commonwealth of Australia at The Trust Company Limited and Qube RE Services Pty Ltd, Supreme Court Proceedings No. 2021/00351160 (2025).
- Hallam Road Waste Transfer Station, VCAT P145/2025, hearing at Victorian Civil and Administrative Tribunal (2025).
- Long Term Containment Facility at Nowingi, case presented in VCAT. The proponent was Major Projects Victoria, approvals application WA58772.
- Lend Lease (Millers Point) Pty Ltd and Orsats Australians for Sustainable Development Inc., Land and Environment Court Proceedings, 40965 of 2010 (NSW).
- Seppanen&Seppanen v Ipswich City Council, Minister for Economic Development Queensland and Queensland Urban Utilities (2016).
- Westgate Tunnel Project, Expert Witness, Inquiry and Advisory Committee (IAC) hearings (Victoria, August-September 2017).
- Child care centre project, Provision of advice as expert witness for ACT Government Solicitor (2017).
- Caltex Petroleum Pty Ltd v Campbelltown City Council Environment, Resources and Development Court Proceedings No 258 of 2015 (2017 to 2019) (SA).
- North East Link Expert Witness, Inquiry and Advisory Committee (IAC) hearings, Expert Witness (Victoria, 2019).

- Clermont Quarries Pty Ltd v Isaac Regional Council, ECL Dalby Pty Ltd, Chief Executive, Department of State Development, Manufacturing, Infrastructure and Planning and Environment Court (Qld), Expert witness (2019 - 2020).

Parliamentary inquiries

- Provided submissions to the following inquiries:
 - Parliament of NSW, Select Committee on PFAS Contamination in Waterways and Drinking Water Supplies Throughout New South Wales – also appeared before committee (2025)
 - Parliament of Australia, Select Committee on PFAS (2025)
 - Parliament of NSW, Select Committee on Proposed Energy from Waste Facilities – also appeared before committee (2025).

Teaching

- 2009, 2010, 2012, 2013 to 2025 – Conduct of lectures at the University of Technology Sydney as part of the Contaminated Site Assessment and Management (CSARM) Professional Development Short Course, Risk Based Site Assessment.
- 2023 and 2025 – Human Health Risk Assessment module for ENV3016, Pollution in Practice. Fenner Lecture – Australian National University
- 2025 – University of Western Sydney, Clandestine Drug Laboratories Masterclass and Workshop
- 2025 – CRC CARE Risk to Remediation Course, Human Health Risk Assessment
- 2020 and 2022 – Toxicological Risk Assessment lecture to UNSW School of Business.
- 2022 – Environmental Health Australia, Workshop: Methamphetamine testing and remediation
- 2017 – ALGA Risk Assessment Training Course: New Zealand
- 2010 to 2012 – Conduct of lectures at the University of Sydney for the Risk Assessment (Human Health and Ecological) module for undergraduates, School of Geosciences.
- 2014 – ACLCA (Qld) Training Course on Vapour Intrusion and Landfill Gas Assessment (organising and teaching) – May 2014.
- 2014 and 2015 – ACLCA (SA and VIC) Training Course on Vapour Intrusion (teaching) – June 2014.
- 2013 and 2015 – ALGA Training Course on Vapour Intrusion (teaching).
- 2013 and 2015 – Vapour Intrusion Short Course. Training Course conducted at CleanUp 2013 and 2015, CRC CARE (teaching).
- 2016 – Clandestine laboratories – risk assessment (teaching) ALGA and ACTRA (separate workshops).
- 2014-2018 – Short courses/branch forums for ALGA – various issues regarding PFAS assessment, vapour intrusion, bioaccessibility methods, clandestine laboratories.
- 2016 and 2018 – Short course for WasteMINZ – bioaccessibility methods.
- 2010-2011 – Basic and Advanced Risk Assessment Course for Queensland Branch of the Australian Contaminated Land Consultants Association.

Work History

Principal/Director/ Owner	Environmental Risk Sciences Pty Ltd	2008 (current)
Adjunct Lecturer	Flinders University	2016 (current)
Principal Environmental Scientist	URS Australia, North Sydney, NSW (formerly Woodward-Clyde)	1992 to 2008
Project Engineer	Sydney Water, Sydney, NSW	1991-1992
Environmental Scientist	Nigel Holmes & Associates, Sydney NSW	1990-1992
Assistant	Dames & Moore, Crows Nest, NSW	1988-1990

Education

BE (Hons)	University of Sydney, Bachelor of Engineering (Hons)	1989
PhD	Public Health, Health and Environment, Flinders University	2016

Professional Accreditation

Fellow of the Australasian College of Toxicology and Risk Assessment (ACTRA)

Professional Development

American College of Toxicology - Virtual Advanced Comprehensive Toxicology Online training course (25 modules) (2021)

Invited member of task force - WA EPA scientific inquiry into fracking in WA (2018)

Clandestine laboratory safety and investigator training and synthesis run by the Clandestine Laboratory Investigators Association (8-hour course, 2011)

Ecological Risk Assessment Course run through AEHS and credited by University of Massachusetts Boston (2010)

Mid-America Toxicology Course (35 hours, 2010)

Dose-Response Boot Camp run by Toxicology Excellence for Risk Assessment (TERA) (5 day course, 35 hours, 2008)

Vapor Intrusion Assessment and Mitigation Short Course run by Air & Waste Management Association (4 hours, 2006)

USEPA Human Health Risk Assessment Short Course (24 hours, 1995)

Committees and Affiliations

ICHEMS Advisory Committee, 2024 - current

Member and Fellow (former committee member, remains co-opted committee member), Australasian College of Toxicology and Risk Assessment (since 2007).

Member, Australian Land and Groundwater Association (ALGA) (since 2010, now Life

Member).

Clean Air Society of Australia and New Zealand (re-joined 2015)

Member, Environmental Health Australia (since 2011).

Member, SETAC (Asia Pacific) (since 2011).

Member, Air & Waste Management Association (since 2006).

Member, Association for Environmental Health and Sciences Foundation (since 1997).

Awards

2024: Honorary Life Member ALGA

2020: Winner of Best Case Study (principal author), Australia New Zealand Policing Advisory Agency and National Institute of Forensic Science

2017: Winner of Best Case Study (principal author), Australia New Zealand Policing Advisory Agency and National Institute of Forensic Science

2017: Winner of ALGA Outstanding Leadership by a Woman in the Contaminated Land & Groundwater Industry

2017: Finalist of ALGA Outstanding Individual in the Contaminated Land & Groundwater Industry

Publications

Peer-reviewed journal articles:

Dawson M. L. et al 2025, Estimating safe doses of perfluorooctane sulfonate (PFOS): an international collaboration. Archives of Toxicology, published online 3 October 2025.

Kerry, G.L., Ross, K.E., Walker, G.S. and Wright, J., 2025. Determining extent and distribution of methamphetamine in cars: Air vs. surface vs. fabrics. Forensic Chemistry 42 (2025) 100628.

Burgoon, L. D. et al 2023, Range of the perfluorooctanoate (PFOA) safe dose for human health: An international collaboration, Regulatory Toxicology and Pharmacology, online 29 October 2023.

Kuhn, E.J., Ross, K.E., Walker, G.S., Whiley, H. and Wright, J., 2023. Thirdhand Exposure to Methamphetamine Syndrome: Symptoms Resulting from Environmental Exposure to Methamphetamine Contamination Arising from Manufacture or Use. Journal of Environmental Health, Volume 86, No. 3, October 2023.

Kuhn, E.J., Walker, G.S., Whiley, H. Wright, J. and Ross, K.E., 2023. Evaluation of commercially available methamphetamine presumptive tests for site contamination. Toxicology Communications, Volume 7, No. 1.

Kerry, G.L., Ross, K.E., Wright, J.L. and Walker, G.S., 2022. A Review of Methods Used to Detect Methamphetamine from Indoor Air and Textiles in Confined Spaces. Toxics, 10, 710.

Kuhn, E.J., Walker, G.S., Whiley, H. Wright, J. and Ross, K.E., 2021. Overview of Current Practices in the Methamphetamine Testing and Decontamination Industry: An Australian Case Study. International Journal of Environmental Research and Public Health 18, 8917.

- Wright, J., B. Symons, J. Angell, K. E. Ross and S. Walker, 2021. Current practices underestimate environmental exposures to methamphetamine: inhalation exposures are important. *Journal of Exposure Science & Environmental Epidemiology* 31: 45-54.
- Kuhn, E.J., Walker, G.S., Wright, J., Whiley, H. and Ross, K.E., 2021. Public health challenges facing Environmental Health Officers during COVID-19: methamphetamine contamination of properties. *Australian and New Zealand Journal of Public Health*, 45: 9-12.
- Wright, J., M. Kenneally, K. Ross and S. Walker, 2020. Environmental Methamphetamine Exposures and Health Effects in 25 Case Studies. *Toxics* 8 (3): 61.
- Wright, J., G. S. Walker and K. E. Ross, 2019. Contamination of Homes with Methamphetamine: Is Wipe Sampling Adequate to Determine Risk? *International Journal of Environmental Research and Public Health* 16 (19): 3568.
- Kuhn, E. J., G. S. Walker, H. Whiley, J. Wright and K. E. Ross, 2019. Household Contamination with Methamphetamine: Knowledge and Uncertainties. *International Journal of Environmental Research and Public Health* 16(23): 4676.
- Capon, A. and J. Wright, 2019. An Australian incremental guideline for particulate matter (PM_{2.5}) to assist in development and planning decisions. *Public Health Research & Practice* 29 (4).
- Wright, J., Kenneally, M. E., Edwards, J.W. and Walker, S., 2017. Adverse Health Effects Associated with Living in a Former Methamphetamine Drug Laboratory — Victoria, Australia, 2015. *Morbidity and Mortality Weekly Report (MMWR)* January 6, Vol.65, No. 52, p1470-1473
- Wright, J., Edwards, J. and Walker, S., 2016. Exposures associated with clandestine methamphetamine drug laboratories in Australia. *Reviews on Environmental Health*, 31(3): 329-352.
- Lahvis, M.A., Hers I., Davis, R.V., Wright, J. and DeVaul G.E., 2013. Vapor Intrusion Screening at Petroleum UST Sites. *Groundwater Monitoring & Remediation*.
- Wright J. and Howell M., 2003. "Volatile Air Emissions from Soil or Groundwater – Are They as Significant as Model Say They Are?". In *Contaminated Soils*, Volume 8, Edited by Edward J. Calabrese, Paul T. Kostecki and James Dragun, p375-393.
- Gorman J., Mival K., Wright J. and Howell M., 2003, Developing Risk-Based Screening Guidelines for Dioxin Management at a Melbourne Sewage Treatment Plant. *Water, Science and Technology*, Vol 47 No 10, pp 1-7.
- Wright J., and Howell M., 1995, "Health Risk Assessment - Practical Applications Related to Air Quality Issues". *Clean Air*, Volume 29, No. 2, May 1995.

Government and industry publications:

IICRC, 2025. ANSI/IICRC S900-2025, Standard for Professional Remediation of Precursors, Drug Residues, and Associated Chemical Waste. First Edition. Consensus Body Member.

Environmental Health Australia, 2019. Australian Voluntary Code of Practice, Assessment, remediation and validation: Former clandestine drug laboratories and other methamphetamine contaminated properties. Principal author.

CRC CARE, 2018. Weathered Petroleum Hydrocarbons (Silica Gel Clean-up), CRC CARE Technical Report no. 40, CRC for Contamination Assessment and Remediation of the Environment, Newcastle, Australia. Principal author.

NSW Health, 2015. NSW Remediation Guidelines for Clandestine Drug Laboratories and Hydroponic Drug Plantation. Principal author.

CRC CARE, 2013. Petroleum Vapour Intrusion (PVI) Guidance. CRC Care Technical Report No 23, CRC for Contamination Assessment and remediation of the Environment, Adelaide, Australia. Principal author.

NEPM 2013 Revision (released in 2013), Schedule B4 (Guideline on Site-Specific Health Risk Assessment Methodology) and Schedule B7 (Guideline on Derivation of Health-Based Investigation Levels). Primary author of toxicological evaluations and derivation of health investigation levels and contributing author to the Schedules (conducting full revision/rework of both Schedules, including responding to public comments and comments from state health agencies).

Australian Government, 2011. Guidelines for Environmental Investigations, Remediation and Validation of former Clandestine Drug Laboratory Sites [Guidelines], April 2011. Primary author of toxicological evaluations and derivation of remediation guidelines using risk based approach and listed contributor to main document.

Davis G.B., Wright J. and Patterson B.M., 2009. Field Assessment of Vapours, CRC CARE Technical Report no. 13, CRC for Contamination Assessment and remediation of the Environment, Adelaide, Australia.

Invited lectures

Wright, J. 2025. Keynote: Risk assessment – why do we care? New Zealand WasteMINZ Conference, Christchurch 2025.

Wright, J. 2020 to 2022. Toxicological risk assessment. Guest lecture to University of New South Wales School of Business.

Wright, J., 2013. Petroleum Vapour Intrusion Guidance in Australia. AEHS 23rd Annual International Conference on Soil, Water, Energy, and Air and AEHS Foundation Annual Meeting, March 18-21, 2013, Mission Valley Marriott, San Diego, California. Invited lecture

Wright, J., 2012. Evaluation of the Australia Hydrocarbon VI Data Base: Exclusion Criteria. AEHS 22nd Annual International Conference on Soil, Water, Energy, and Air and AEHS Foundation Annual Meeting, March 19-22, 2012, Mission Valley Marriott, San Diego, California. Invited lecture.

Articles

Jarman R., Wright, J., Manning, T., Goldsworthy, B. and Langdon, K. 2025. PFOS – a case study. Inside Waste Feb/Mar 2025, p18-21.

Conference Proceedings (Oral Presentations - selected):

Wright, J. (2025) Is EfW safe for the community. WMMR Energy from Waste Conference, Gold Coast June 2025

Wright, J. (2021) Weathered Petroleum – Assessing the toxicity of polar metabolites vs petroleum hydrocarbons. ACTRA Annual Scientific Meeting, Sydney 26-27 August 2021

Wright, J. (2021) Risk Assessment and CSMS? Presentation to ACLCA – Western Australian branch meeting

Wright, J. (2020) Clan labs and meth contaminated properties - Risks and issues. Environmental Health Australia, Professional Development Workshop

Wright, J. and Manning, T. (2020) Basements, Really, you thought THAT was a good idea !!!!. ALGA Ecoforum 2020

Wright, J. (2020) Attenuation Factors and VI. ACLCA Webinar, 29 April 2020

Wright, J. and Manning, T. (2020) Chlorinated Hydrocarbons - Myths and Realities. ACTRA webinar (industry training) 27 February 2020

Wright J. and Stratford, M. (2020) Methamphetamine Risk Management Industry Voluntary Code of Practice. ACTRA webinar (industry training) 20 February 2020

Wright, J. and Manning, T. (2018) Perplexing guidelines: What it means for measurement, RACI PFAS Symposium, November 2018

Wright, J. (2018) Contrasting current contamination issues: Inside the home – methamphetamine, ALGA Regional Conference, Townsville October 2018

Wright, J. (2018) Contrasting current contamination issues: Outside the home – PFAS, ALGA Regional Conference, Townsville October 2018

Capon, A. and Wright, J. (2018) An Australian incremental guideline for particulate matter less than or equal to 2.5 micrometres (PM2.5). ACTRA Conference, October 2018

Manning, T. and Wright, J. (2018) Contaminated Land Risk Assessment and the Building Code of Australia, Ecoforum October 2018

Jarman, R., Wright, J., Manning, T. and Pendergast, D. (2016). Using oral bioaccessibility testing to refine exposure assessment for carcinogenic PAHs in soil. EcoForum, October 2016.

Manning, T., Wright, J., Jarman, R. and Bowles, K. (2016) Per and poly fluorinated alkyl substances – where are we, ecologically speaking? SETAC AU October 2016.

Jarman, R., Manning, T., and Wright J. (2016). Setting toxicity reference values for PFAS – what can we learn from TOXCAST and TOX21. ACTRA Annual Scientific Meeting, September 2016.

Manning, T., Wright, J., Jarman, R. and Bowles, K. (2016) Per and poly fluorinated alkyl substances – the Australian Story. EmCon 2016 September 2016.

Manning, T. and Wright, J. (2016). Particulate Risk Assessments – Issues and Challenges. EcoForum, October 2016.

Manning, T. and Wright, J. (2015). Review of Ecological Investigation Levels for Total Petroleum Hydrocarbons. 6th International Contaminated Site Remediation Conference (Cleanup 2015), September 2015.

Manning, T. and Wright, J. (2015). Particulate Risk Assessments – Issues and Challenges. 22nd Clean Air and Environment Conference, September 2015.

Wright, J. and Manning, T. (2015). Bioavailability/Bioaccessibility – Practical Considerations. ALGA Workshop, Use of Bioavailability and Bioaccessibility Techniques to Refine Assessment of Human Health Risk, November 2015.

Wright, J. and Manning, T. (2015). PAHs and Bioaccessibility. ALGA Workshop, Use of Bioavailability and Bioaccessibility Techniques to Refine Assessment of Human Health Risk, November 2015.

Manning, T. and Wright, J. (2014). Contaminated Land – How do environmental guidelines get used? SETAC-AU Conference Adelaide September 2014.

Manning, T. and Wright, J. (2014). Use of Health Impact Assessment in Environmental Impact Statements. Ecoforum Conference Gold Coast October 2014.

Wright J., 2014. Particulate Risk Assessments – Issues and Challenges. ACTRA Annual Scientific Meeting, Sydney October 9-10 2014.

Wright J. and Manning T., 2014. Health Impact Assessment – Role in EIS. Keynote presentation. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J. and Manning T., 2014. Addressing Risk Perceptions through Risk Assessment. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J. and Manning T., 2014. Vapour Assessment for TCE. Ecoforum, 29-31 October 2014, Gold Coast.

Wright J., Howell J. and Newell P., 2014. Assessment and Remediation of Illegal Drug Laboratories. Ecoforum, 29-31 October 2014, Gold Coast.

Wright, J., 2014. Clandestine Drug Laboratories – Understanding Exposures and Public Health. The Second International Conference on Law Enforcement and Public Health, Amsterdam 5-8 October 2014.

Wright, J. 2014. ASC NEPM – Implementation. AEBN (Australian Environment Business Network) Conference on Managing Contaminated Land, September 2014.

Wright, J. 2014. Managing Vapours – The Issues to Consider for Developers and Councils. AEBN (Australian Environment Business Network) Conference on Managing Contaminated Land, September 2014.

Wright, J., 2012. Exposure and Risk Issues associated with Clandestine Drug Laboratories – development of guidelines. British Occupational Hygiene Society (BOHS), Occupational Hygiene 2012 Conference, 24-26 April 2012, Mercure Holland House Hotel, Cardiff.

Wright, J., 2012. Risks of Not remediating Clandestine Drug Laboratories. 66th Annual Western Australian Environmental Health Australia (WA) State Conference Environmental Health: Imagine Life Without Us, 28-30 March 2012.

Wright, J., 2011. Establishing exclusion criteria from empirical data for assessing petroleum hydrocarbon vapour intrusion. CleanUp 2011: Proceedings of the 4th International Contaminated Site Remediation Conference, 11-15 September, Adelaide, Australia.

Wright, J., 2010. Review of Petroleum Vapour Data from Australia. Abstract presented at Ecoforum 2010, 3rd ALGA Annual Conference 23-24 February 2010.

Wright, J., 2010. Interpretation and Use of Soil Gas and other Vapour Data. Abstract presented at Ecoforum 2010, 3rd ALGA Annual Conference 23-24 February 2010.

Weaver T., Hassell T., Wright J., Stening J. and Apte S., 2009. Speciation and Geochemical Modelling as a Tool to Refine a Risk Assessment for Mercury in Groundwater. Presented at EcoForum, Sydney 28-30 April 2009.

Wright J. and Robinson C., 2009. The Reality of Sampling and Assessing Vapour Intrusion on Petroleum Sites. Presented at Air & Waste Management Association's Vapor Intrusion 2009, January 27-29 2009, San Diego CA.

Wright J., Lee A. and Howell M., 2008. Role of Risk-Based Concentrations in Assessment and remediation of Contaminated Sites. Presented at EcoForum, Gold Coast, 27-29 February 2008.

Wright J., Howell M. and Barnes J., 2006. Risk Assessment – Important Tool for Managing Issues on Contaminated Sites or Just a Task. Presented at Enviro06, Melbourne 2006.

Hall, A, Wright J. and Calabrese N, 2006. Ray Street Landfill – Audit Acceptance Levels for CO₂ in Redeemed Soils. Presented at Enviro06, Melbourne 2006.

Wright J. and Howell M., 2004. "Evaluation of Vapour Migration Modelling in Quantifying Exposure". Presented at Enviro04, Sydney March 2004.

Lee A., Howell M., and Wright J. 2004. "TPH – Analysis, Guidelines and Risk Assessment" Presented at Enviro04, Sydney March 2004.

Pershke D., van Merwyk T., Graham-Taylor S., Wright J., Mitchell T., and Elliot P., 2004. "Health Risk Assessment: Broadening the Horizons of the Traditional Health and Safety Approach", Presented at Enviro04, Sydney March 2004.

Wright J., Buchanan V., and Howell M., "Health Risk Assessment using Probability Density Functions". Presented at the AWWA Waste and Wastewater Conference, Brisbane 1998.

Wright J. and Buchanan V., 1996, "Uptake of Organics and Inorganics into Edible Fruit and Vegetable Crops". Presented at Intersect-96 International Symposium on Environmental Chemistry and Toxicology, Royal Australian Chemical Institute and the Australian Society for Ecotoxicology, 14-16 July 1996.

Wright J. and Howell M., 1995, "Risk Based Approach to Assessment and Management of Air Quality Issues Associated with Contaminated Sites and Hazardous Waste". Presented at Waste

Management Institute (New Zealand) Inc., 7th Annual Conference and Exhibition, 31 October - 3 November, 1995.

Harrington J F, Clark L T and Wright J, 1994, "The Incineration of Sludge and its Effect on Ambient Air Quality in the Evaluation of Risk Factors for Primary School Children". Presented at Australia and New Zealand Clean Air Conference, Perth 1994.

Royston D, Clark L T and Wright J, 1993, "Chlorinated Dioxins and Furans from Combustion Sources: A review". Poster presented at the Sixth Conference of Asia Pacific Confederation of Chemical Engineering, Melbourne, 1993.