Santos GLNG Gas Field Development Project

Water Quality Management

Prepared for:
Santos GLNG

May 2019

Commercial in Confidence

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Maisey Stage 2 Chemical Risk Assessment
EPBC 2012/6615

Prepared by:
EHS Support Pty Ltd



DOCUMENT CONTROL

PROJECT DETAILS

Project No.:	C02238/2437
Report Revision No.:	3
Date of Issue:	May 2019
Project Manager	Tom Biksey
Project Director	Nigel Goulding

REPORT DETAILS

Title:	Chemical Risk Assessment Report – Maisey Stage 2: Water Treatment Chemicals
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Independent Technical Review	Detailed technical review has been conducted by the following expert in accordance with best practices. Jackie Wright, PhD (Fellow ACTRA), Environmental Risk Sciences Pty Ltd
Client	Santos GLNG
Client Reference	232705

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The following table presents the topics of Water Quality Management Condition 29 of the Santos Gladstone Liquefied Natural Gas (GLNG) Field Development (GFD Project) *Environmental Protection and Biodiversity Conservation Act* (EPBC) approval (EPBC 2012/6615) and the relevant sections of this risk assessment where the topic is addressed. Condition 29 states that the approval holder must submit a Water Quality Management Plan for the written approval of the Minister.

	Condition Topic	**Section**
29B a	A complete list of chemicals that are proposed to be used in coal seam gas extraction: i. For the relevant purpose; and ii. In the area that is the subject of the WQMP The list must include each chemical name, CAS registry number, likely quantities, concentrations and the chemical's general use and function	Section 5, Table 5-2 Section 6, Table 6-7 Appendix B
b	A chemical risk assessment, in accordance with the terms of reference approved under condition 28, of all chemicals that listed under (a)	Not Applicable
c	Consideration of the chemical life-cycle, under specific sit conditions in the area that is the subject of the WQMP, at both the surface and subsurface.	Section 4.0 Section 5.0
d	Mitigation and management measures to reduce the risk to matters of national environmental significance to a low level for each chemical listed under (a)	Section 2.1, Table 2-1 Section 3.1 Section 8.0
e	A monitoring and reporting framework to assess the efficacy of the mitigation and management measures identified at (d)	Section 2.1 Section 8.0
f	If the relevant purpose is hydraulic fracturing – i. A description of the scale of hydraulic fracturing proposed, including the likely number of wells, number of fracturing events per well and types of wells to be stimulated. ii. A monitoring and reporting framework for the measurement and monitoring of fracture propagation.	Not Applicable
g	if a WQMP has previously been approved by the Minister for the same purpose in the project stage 1 area or project stage 2 area – how the WQMP will contribute to the management of cumulative impacts of the action on matters of national environmental significance.	Section 8.5
h	a schedule for the regular review of the WQMP, including to assess whether the WQMP needs to be revised to include new chemicals.	Section 1.0
i	a peer review by a suitably qualified chemical risk assessment expert. The peer review must include a statement from the suitably qualified chemical risk assessment expert stating that they carried out the peer review of the findings of the chemical risk assessment required at (b) and evaluated the adequacy of the monitoring, mitigation and management measures at (d) and (e).	Document control page attached Appendix A
29C	Despite condition 29B, a WQMP for a purpose for the project stage 2 area: a. is not required to comply with condition 29B(b); and b. must include a chemical risk assessment of all chemicals that are listed under condition 29B(a) that includes: i. a description of the project stage 2 area;	Section 3.1 Section 5.0 Section 6.0 Section 7.0 Section 8.0

	ii. problem formulation and issue identification; iii. hazard assessment; iv. exposure assessment; v. risk characterisation; and vi. risk management and mitigation.	

FLUID SYSTEM REGISTER

PROJECT DETAILS

Project No.:	C02238/2437
Report Revision No.:	2
Date of Issue:	May 2019
Project Manager	Tom Biksey
Project Director	Nigel Goulding
Client	Santos GLNG
Client Reference	1091551

NEW FLUID SYSTEM DETAILS

Report Title:	Chemical Risk Assessment Report – Maisey Stage 2: Water Treatment Chemicals
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Leases or Tenures Assessed	Roma
Fluid Systems Assessed	Water Management Facility
Fluid System Chemicals Assessed	The following table provides the chemical name, CAS registry number, likely quantities stored, and the chemical's general use and function at the WMF. Please refer to Appendix C of this Chemical Risk Assessment Report for detailed information regarding the usage and exposure point concentrations for the exposure scenarios for the WMF chemicals.

Water Management Facility Chemicals

Proprietary Name	Chemical Name	Cas No.	Use	Approximate quantity stored on site (Plant available storage)
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite Sodium Hydroxide	7681-52-9 1310-73-2	Oxidizing agent/disinfectant	15000 L
Hydrex 4129 (antiscalent)	Phosphonic Acid 1-Hydroxyethylene (1,1 diphosphonic acid) Diethylene triamine penta (methylene phosphonic acid) pentasodiun salt	13598-36-2 2809-21-4 22042-96-2	Antiscalant / scale inhibitor	2 x 1000 L (IBC)
Sodium Bisulphite	Sodium Bisulphite Water	7631-90-5 7732-18-5	Dechlorination	4 x 1000 L (IBC)

Ammonium Hydroxide 10-35%	Ammonia Water	7664-41-7 7732-18-5	Disinfectant	2 x 1000 L (IBC)
MAK MFC1 (multi floc coagulant)	Cationic Polymer Aluminium Hydroxychloride Water	n/a 1324-41-9 7732-18-5	Polymer / coagulant	2 x 1000 L (IBC)
MAK-SU Sulphuric Acid	Sulphuric Acid Water	7664-93-9 7732-18-5	pH adjustment	2 x 1000 L (IBC)
Sodium Hydroxide 50% (Caustic Soda)	Sodium Hydroxide Water	1310-73-2 7732-18-5	pH adjustment	2 x 1000 L (IBC)
Hydrex 4703 (Citrex)	Sodium Citrate Dihydrate Water	6132-04-3 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Hydrex 4705 (alkaline CIP)	EDTA Tetrasodium Salt Potassium Hydroxide Sodium Carbonate Water	64-02-8 1310-58-3 497-19-8 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Hydrex 4714 (CIP)	Hydrogen peroxide Acetic Acid Peroyxacetic Acid Water	7722-84-1 64-19-7 79-21-0 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Aluminium Chlorohydrate 50%	Dialuminium Chloride Pentahydroxide Water	12042-91-0 7732-18-5	Coagulant	20000 L
Hydrex 3502 (Actiflo Polymer)	Polyacrylamide (anionic)	9003-05-8	Actiflo polymer	1000 kg
Hydrex 69226 (Sludge Polymer	Adipic Acid Cationic acrylamide copolymer	124-04-9 69418-26-4	Sludge polymer	1000 kg

Cas No = Chemical Abstracts Service Number
n/a = not available
kg = kilogram
L = litre

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PREVIOUS WATER QUALITY MANAGEMENT PLAN APPORVAL REGISTER

<table>
<tr><td>Report Title:</td><td>Santos GLNG Gas Field Development Project Chemical Risk Assessment</td></tr>
<tr><td>Main Author(s)</td><td>Tom Biksey, EHS Support LLC, Risk Assessor
Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor
Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist
Nigel Goulding, EHS Support LLC, Technical Review</td></tr>
<tr><td>Project Stage</td><td>Scotia Project Area Stage 1 – Revision 1</td></tr>
<tr><td>Date approved</td><td>5 October 2017</td></tr>
<tr><td>Fluid Systems Assessed</td><td>KCl Drilling Fluid Systems including:
5% KCl/Polymer/PHPA Mud
KCl/Polymer Mud
Inhibited KCl/Polymer Mud with BORE-HIB
Inhibited KCl/Polymer Mud with Glycol
LCM Pill 1 Mud
LCM Pill 2 Mud
Please refer to Table 6-2 Mass Balance Estimates for COPCs of this Chemical Risk Assessment Report for information regarding exposure point concentrations.</td></tr>
<tr><td>Fluid System Chemicals Assessed</td><td>KCL Drilling Fluid Systems Chemicals
<table>
<tr><th>Chemical Name/Use</th><th>CAS Registry Number</th><th>Use</th><th>Quantity[1]</th></tr>
<tr><td colspan="4">Primary Drilling Fluids</td></tr>
<tr><td>Copolymer of acrylamide and sodium acrylate</td><td>25085-02-3</td><td>Shale inhibitor</td><td>0.33 ml/L</td></tr>
<tr><td>Drilling water/Water in Product</td><td>7732-18-5</td><td></td><td>321.06 ml/L</td></tr>
<tr><td>Glyoxal</td><td>107-22-2</td><td>Fluid loss stabilizer</td><td>1.25 ml/L</td></tr>
<tr><td>Methanol</td><td>67-56-1</td><td>Antimicrobial</td><td>1.25 ml/L</td></tr>
<tr><td>Glutaraldehyde</td><td>111-30-8</td><td>Antimicrobial</td><td>0.2 ml/L</td></tr>
<tr><td>Potassium chloride</td><td>7447-40-7</td><td>Brine</td><td>11.08 ml/L</td></tr>
<tr><td>Sodium carbonate</td><td>497-19-8</td><td>Buffer</td><td>0.42 ml/L</td></tr>
<tr><td>Sodium carboxymethyl cellulose</td><td>9004-32-4</td><td>Fluid loss stabilizer</td><td>1.25 ml/L</td></tr>
<tr><td>Sodium hydroxide</td><td>1310-73-2</td><td>pH stabilizer</td><td>0.09 ml/L</td></tr>
<tr><th>Chemical Name/Use</th><th>CAS Registry Number</th><th>Use</th><th>Quantity[1]</th></tr>
<tr><td>Starch</td><td>9005-25-8</td><td>Fluid loss stabilizer</td><td>1.33 ml/L</td></tr>
<tr><td>Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)</td><td>533-74-4</td><td>Fluid loss stabilizer</td><td>1.33 ml/L</td></tr>
<tr><td>Xanthan gum</td><td>11138-66-2</td><td>Viscosifier</td><td>0.91 ml/L</td></tr>
<tr><td>Methylisothiocyanate (MITC)[2]</td><td>556-61-6</td><td>NA</td><td>0 ml/L</td></tr>
<tr><td>Ethylene oxide/propylene oxide copolymer</td><td>9003-11-6</td><td>Defoamer</td><td>0.02 ml/L</td></tr>
</table></td></tr>
</table>

Polyalkylene	9038-95-3	Shale inhibitor	10.49 ml/L
Polypropylene glycol	25322-69-4	Defoamer	0.02 ml/L
Silicic acid, potassium salt	1312-76-1	Shale stabilizer	10.66 ml/L
Sodium chloride	7647-14-5	Additive	12.5 ml/L
Sodium polyacrylate	9003-04-7	Thinner	0.3 ml/L
Secondary Drilling Fluids			
Almond Hulls	NA*		NA
2- Propenoic acid, potassium salt, polymer w ith 2-propenamide	31212-13-2	Loss circulation	NA
Bentonite	1302-78-9	Weight additive	NA
Calcined petroleum coke	64743-05-1	Loss circulation	NA
Calcium Carbonate	471-34-1	pH stabilizer	NA
Cellophane	9005-81-6	Loss circulation	NA
Crystalline silica, cristobalite	14464-46-1	Weight additive	NA
Crystalline silica, quartz	14808-60-7	Bridging agent, weight additive, pH stabilizer, Loss circulation material	NA
Crystalline silica, tridymite	15468-32-3	Weight additive	NA
Walnut hulls	Mixture (1756)*	Loss circulation	NA
Wood fibre	Mixture (1757)*	Loss circulation	NA

[1] Based on maximum of combined muds assessed
[2] MITC is a breakdown product of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) and is not stored on site.
ml – millilitre L - litre
NA – quantity used varies with severity of loss
* Naturally occurring product
CAS = Chemical Abstracts Service

Report Title:	**Santos GLNG Gas Field Development Project Chemical Risk Assessment**
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Project Stage	**Scotia Project Area Stage 1 – Revision 2**
Date approved	3 November 2017
Fluid Systems Assessed	Appendix C1: #20 Crosslinked Gel Hydraulic Fracturing Fluid Please refer to Appendix Tables C1-1 through C1-5 of this Chemical Risk Assessment Report for information regarding exposure point concentrations.

Fluid System Chemicals Assessed

#20 Crosslinked Gel Hydraulic Fracturing Fluid Chemicals

Chemical Name/Use	CAS Registry Number	Use	Quantity[1]
#20 Crosslinked Gel Base Formulation			
Guar Gum	9000-30-0	Gelling Agent	0.252048%
Monoethanolamine borate	26038-87-9	Crosslinker	0.143000%
Acetic acid	64-19-7	pH Control	0.101000%
Sodium hydroxide	1310-73-2	pH Control	0.036200%
Lactose	63-42-3	Breaker	0.018700%
Cellulase enzyme	9012-54-8	Breaker	0.002080%
Guar Gum	9000-30-0	Gelling Agent	0.252048%
Monoethanolamine borate	26038-87-9	Crosslinker	0.143000%
Acetic acid	64-19-7	pH Control	0.101000%
Additives			
Potassium chloride	7447-40-7	Clay Stabalizer	1.830000%
Choline Chloride	67-48-1	Clay Stabalizer	1.160000%
Glutaraldehyde	111-30-8	Biocide	0.059300%
Methanol	67-56-1	Biocide	0.001980%
Tributyl tetradecyl phosphonium chloride	81741-28-8	Biocide	0.002600%
Ethylene glycol	107-21-1	Clay Stabalizer, Crosslinker	0.016900%

[1] Volume Percent in Treatment (%)

<table>
<tr><td>Report Title:</td><td>Santos GLNG Gas Field Development Project Chemical Risk Assessment</td></tr>
<tr><td>Main Author(s)</td><td>Tom Biksey, EHS Support LLC, Risk Assessor
Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor
Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist
Nigel Goulding, EHS Support LLC, Technical Review</td></tr>
<tr><td>Project Stage</td><td>Scotia Project Area Stage 1 – Revision 3</td></tr>
<tr><td>Date approved</td><td>December 2017</td></tr>
<tr><td>Fluid Systems Assessed</td><td>Appendix C2: Avaperm NF Drilling Fluid
Please refer to Section 3.2.1 of this Chemical Risk Assessment Report for information regarding exposure point concentrations.</td></tr>
<tr><td>Fluid System Chemicals Assessed</td><td># Avaperm NF Drilling Fluid Chemicals
<table>
<tr><th>Chemical Name/Use</th><th>CAS Registry Number</th><th>Use</th><th>Quantity[1]</th></tr>
<tr><td>Hexanedinitrile</td><td>111-69-3</td><td>Clay Inhibitor</td><td>0.25 to 0.5</td></tr>
<tr><td>Hydrochloric acid</td><td>7647-01-0</td><td>pH Correction</td><td>-</td></tr>
</table>
[1] Volume Percent in Treatment (%)</td></tr>
</table>

Report Title:	**Santos GLNG Gas Field Development Project Chemical Risk Assessment**
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Project Stage	**Scotia Project Area Stage 1 – Revision 4**
Date approved	February 2018
Fluid Systems Assessed	Appendix C3: DeltaFrac 140 with Clayfix II Plus Hydraulic Fracturing Fluid Please refer to Appendix Tables C1-1 through C1-5 of this Chemical Risk Assessment Report for information regarding exposure point concentrations.

Fluid System Chemicals Assessed

DeltaFrac 140 with Clayfix II Plus Hydraulic Fracturing Fluid Chemicals

Chemical Name/Use	CAS Registry Number	Use	Quantity[1]
Guar Gum	9000-30-0	Gelling Agent	0.153
Monoethanolamine borate	26038-87-9	Crosslinker	0.076
Acetic acid	64-19-7	pH Control	0.0323
Sodium hydroxide	1310-73-2	pH Control	0.00963
Sodium persulfate	7775-27-1	Breaker	0.00448
Sodium sulfate	7757-82-6	Fluid Additive	0.000004
Tetramethyl ammonium chloride	75-57-0	Clay Control Agent	0.0837
Tributyl tetradecyl phosphonium chloride	81741-28-8	Biocide	0.00277
N,N-Dimethylmethanamine	75-50-3	Clay Control Agent	0.000007
Lactose	63-42-3	Breaker	0.00647
Hemicellulase enzyme	9025-56-3	Breaker	0.00101
Trimethylammonium chloride	593-81-7	Clay Control Agent	0.000007

[1] Volume Percent in Treatment (%)

Report Title:	**Santos GLNG Gas Field Development Project Chemical Risk Assessment**
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Project Stage	**Scotia Project Area Stage 1 – Revision 5**
Date approved	June 2018
Fluid Systems Assessed	Appendix C4: Inhibited Star Shield Mud System Please refer to Tables 6-3 through 6-5 of this Chemical Risk Assessment Report for information regarding exposure point concentrations.

Fluid System Chemicals Assessed

Inhibited Star Shield Mud System Chemicals

Chemical Name/Use	CAS Registry Number	Use	Quantity[1]
Copolymer of acrylamide and sodium acrylate	25085-02-3	Shale inhibitor	0.117
Drilling water/Water in Product	7732-18-5		77.9
Glyoxal	107-22-2	Fluid loss stabilizer	0.0051
Methanol	67-56-1	Antimicrobial	0.0005
Pentanedial / Glutaraldehyde	111-30-8	Antimicrobial	0.05
Potassium chloride	7447-40-7	Brine	6.92
Sodium carbonate	497-19-8	Buffer	0.13
Sodium polyacrylate	9003-04-7	Fluid loss stabilizer	0.182
Sodium carboxymethyl cellulose	9004-32-4	Fluid loss stabilizer	0.5049
Sodium hydroxide	1310-73-2	pH stabilizer	0.0551
Starch	9005-25-8	Fluid loss stabilizer	0.757
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	Fluid loss stabilizer	0.0051
Barazan D/Xanthan gum	11138-66-2	Viscosifier	0.51
Ethylene oxide/propylene oxide copolymer	9003-11-6	Defoamer	0.002
Polypropylene glycol	25322-69-4	Defoamer	0.008
Silicic acid, potassium salt	1312-76-1	Shale stabilizer	3.71
Sodium chloride	7647-14-5	Additive	7.69
Calcium Carbonate	471-34-1	pH stabilizer	0.343
Vegetable Fibre	NA*	Loss control	1.114

[1] Mass Percent in Drilling Fluid
CAS = Chemical Abstracts Service
NA = Not available
* Naturally occurring product

Report Title:	**Santos GLNG Gas Field Development Project Maisey Stage 2 Chemical Risk Assessment**
Main Author(s)	Tom Biksey, EHS Support LLC, Risk Assessor Gary Long, EHS Support, Eco-toxicologist and Eco Risk Assessor Chris Bevan, PhD, DABT, CJB Consulting LLC, Toxicologist Nigel Goulding, EHS Support LLC, Technical Review
Leases or Tenures Assessed	Maisey PL1021
Date approved	12 December 2018
Fluid Systems Assessed	KCl Drilling Fluid Systems including: • 5% KCl/Polymer/PHPA Mud • KCl/Polymer Mud • Inhibited KCl/Polymer Mud with BORE-HIB • Inhibited KCl/Polymer Mud with Glycol • LCM Pill 1 Mud • LCM Pill 2 Mud Please refer to Table 6-7 Mass Balance Estimates for COPCs of this Chemical Risk Assessment Report for information regarding exposure point concentrations.

Fluid System Chemicals Assessed

KCL Drilling Fluid Systems Chemicals

Chemical Name/Use	CAS Registry Number	Use	Quantity[1]
Primary Drilling Fluids			
Copolymer of acrylamide and sodium acrylate	25085-02-3	Shale inhibitor	0.33 ml/L
Drilling water/Water in Product	7732-18-5		321.06 ml/L
Glyoxal	107-22-2	Fluid loss stabilizer	1.25 ml/L
Methanol	67-56-1	Antimicrobial	1.25 ml/L
Glutaraldehyde	111-30-8	Antimicrobial	0.2 ml/L
Potassium chloride	7447-40-7	Brine	11.08 ml/L
Sodium carbonate	497-19-8	Buffer	0.42 ml/L
Sodium carboxymethyl cellulose	9004-32-4	Fluid loss stabilizer	1.25 ml/L
Sodium hydroxide	1310-73-2	pH stabilizer	0.09 ml/L
Starch	9005-25-8	Fluid loss stabilizer	1.33 ml/L
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet)	533-74-4	Fluid loss stabilizer	1.33 ml/L
Xanthan gum	11138-66-2	Viscosifier	0.91 ml/L
Methylisothiocyanate (MITC)[2]	556-61-6	NA	0 ml/L
Ethylene oxide/propylene oxide copolymer	9003-11-6	Defoamer	0.02 ml/L
Polyalkylene	9038-95-3	Shale inhibitor	10.49 ml/L
Polypropylene glycol	25322-69-4	Defoamer	0.02 ml/L
Silicic acid, potassium salt	1312-76-1	Shale stabilizer	10.66 ml/L

Sodium chloride	7647-14-5	Additive	12.5 ml/L
Sodium polyacrylate	9003-04-7	Thinner	0.3 ml/L
Secondary Drilling Fluids			
Almond Hulls	NA*		NA
2- Propenoic acid, potassium salt, polymer w ith 2-propenamide	31212-13-2	Loss circulation	NA
Bentonite	1302-78-9	Weight additive	NA
Calcined petroleum coke	64743-05-1	Loss circulation	NA
Calcium Carbonate	471-34-1	pH stabilizer	NA
Cellophane	9005-81-6	Loss circulation	NA
Crystalline silica, cristobalite	14464-46-1	Weight additive	NA
Crystalline silica, quartz	14808-60-7	Bridging agent, weight additive, pH stabilizer, Loss circulation material	NA
Crystalline silica, tridymite	15468-32-3	Weight additive	NA
Walnut hulls	Mixture (1756)*	Loss circulation	NA
Wood fibre	Mixture (1757)*	Loss circulation	NA

[1] Based on maximum of combined muds assessed
[2] MITC is a breakdown product of Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione (Dazomet) and is not stored on site.
ml – millilitre L - litre
NA – quantity used varies with severity of loss
* Naturally occurring product
CAS = Chemical Abstracts Service

EHS Support

Santos GLNG Gas Field Development Project

Prepared for:
Santos GLNG

May 2019

Commercial in Confidence

consider it done

Chemical Risk Assessment Report – Maisey Stage 2: Water Treatment Chemicals

Prepared by:
EHS Support Pty Ltd



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ACRONYMS

µg/m^3	micrograms per cubic metre
ADI	acceptable daily intakes
AEA	Australian Environmental Agency
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BW	body weight (kg)
CAS	Chemical Abstracts Service
CEM	Conceptual Exposure Model
CF_{soil}	conversion factor for soil (1 x 10^{-6} kg/mg)
CF_{water}	correction factor for water (1 x 10^{-3} l/cm^3)
CICAD	Concise International Chemical Assessment Document
cm^2	square centimetres
cm^2/d	square centimetres per day
cm/hr	centimetre per hour
CMA	Cumulative Management Area
COPC	constituents of potential concern
CSG	coal seam gas
CS	Concentration of COPC in soil (mg/kg)
CW	Concentration of COPC in water (mg/l)
DEHP	Department of Environment and Heritage Protection
DoEE	Department of the Environment and Energy
dS/m	deciSiemen per metre
DTMR	Department of Transport and Main Roads
EA	Environmental Authority
EC	electrical conductivity
EC_{50}/LC_{50}	50 percent effective concentration/lethal concentration
EC_{10}	10 percent effective concentration
ECB	European Chemicals Bureau
ECHA	European Chemicals Agency
ECP	Contingency Plan for Emergency Environmental Incidents
ED	exposure duration (years)
EF	exposure frequency (days/year)
EIS	Environmental Impact Statement
EPC	exposure point concentrations
EPBC Act	Environmental Protection and Biodiversity Conservation Act
EPHC	Environment Protection and Heritage Council
EPI	Estimation Programs Interface
EPI Suite™	Estimation Programs Interface Suite™
ESAs	environmentally sensitive areas
ESLs	ecological screening levels
ET_{swim}	exposure time (hr/day or hours/hours)
EU	European Union
EV	environmental value

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GAB	Great Artesian Basin
GDE	groundwater dependent ecosystem
GFD	GLNG Field Development
GLNG	Gladstone Liquefied Natural Gas
GTP	Gas Transmission Pipeline
GWMP	Groundwater Management and Monitoring Plan
ha	hectares
HERA	Human and Environmental Risk Assessment
HI	hazard index
HILs	health investigation levels
HPV	High Production Volume
HQ	hazard quotient
I/LP	insignificant or low probability
IC	incomplete
IBC	intermediate bulk container
ILCR	increased lifetime cancer risks
IMAP	Inventory Multi-Tiered Assessment and Prioritisation
IR	ingestion rate (l/hr)
IR-S	ingestion rate of soil (mg/day)
IR-W	ingestion rate (litres/day)
IUCLID	International Uniform Chemical Information Database
IVMS	in-vehicle monitoring systems
IX	ion exchange
km^2	square kilometre
Kp	dermal permeability factor (Kp – cm/hr)
l/hr	litre per hour
LOAEL	lowest observed adverse effect level
LRTP	long-range transport potential
m	metres
m^2	square metres
m^3	cubic metres
mg/day	milligram per day
mg/kg	milligrams per kilogram
mg/kg/day	milligram per kilogram per day
mg/L	milligrams per litre
MITC	methylisothiocyanate
mL	millilitre
MNES	Matters of National Environmental Significance
NC Act	Nature Conservation Act
NEPC	National Environment Protection Council
NEPM	National Environment Protection (Assessment of Site Contamination) Measure
NHMRC	National Health and Medical Research Council
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level

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NOEC	no observed effect concentration
NRMMC	Natural Resource Management Ministerial Council
NSW	New South Wales
NWQMS	National Water Quality Management Strategy
OECD	Organisation for Economic Cooperation and Development
OH&S	Occupational, Health and Safety
ORNL/RAIS	Oak Ridge National Laboratory/Risk Assessment Information System
PAHs	polycyclic aromatic hydrocarbons
PBT	persistent (P), bioaccumulative (B) and toxic (T)
PL	Petroleum Lease
PNEC	predicted no-effects concentration
POD	point of departure
Pov	overall persistence
PPE	personal protective equipment
PRTR	Pollutant Release and Transfer Registers
QSAR	quantitative structure-activity relationship
RAIS	Risk Assessment Information System
RBA	relative bioavailability factor (unitless)
RBSLs	risk-based screening levels
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical Substances
RED	Re-registration Eligibility Decision
REs	regional ecosystems
RfCs	reference concentrations
RfDs	reference doses
RIVM	National Institute for Public Health and Environmental Protection
RO	Reverse Osmosis
RSLs	Regional Screening Levels
SA_{body}	total body skin surface area (cm^2/d)
SA_{exp}	exposed skin surface area available for contact (cm^2/d)
SAi	skin surface area available for contact for body part “i” (cm^2)
SAR	sodium adsorption ratio
SDS	safety data sheet
SF	slope factor
SIDS	Screening Information Data Set
SMS	Santos Management System
SR	sensitivity ratio
SRC	Syracuse Research Corporation
SSMP	Significant Species Management Plan
t*	time to reach steady state (hours)
TCs	tolerable concentrations
TDIs	tolerable daily intakes
TEC	Threatened Ecological Community
TI	Total intake of COPC (mg/kg/day)
ToR	Terms of Reference

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TRV	toxicity reference values
TSCATS	Toxic Substances Control Act Test Submissions
URF	unit reference factor
USEPA	United States Environment Protection Agency
VPD	vehicles per day
WA	Western Australia
WHO	World Health Organisation
WMF	Water Management Facility
WMP	Waste Management Plan
WQMP	Water Quality Management Plan
τ_{event}	lag time per event (hours/event)

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1.0 INTRODUCTION

Pursuant to the Santos Gladstone Liquefied Natural Gas (GLNG) Field Development Project (GFD Project) *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) approval (EPBC 2012/6615), Santos GLNG has prepared this risk assessment of the chemicals proposed to be used for water treatment.

Consistent with condition 36 of EPBC Approval (2012/6615), Santos GLNG will revise the current Chemical Risk Assessment and submit the revision under condition 39 to the Minister for approval under condition 29. Updates to this risk assessment will be conducted if changes to the chemical additives are proposed where a new or increased risk to matters of national environmental significance (MNES) is likely to occur.

This report incorporates the comments provided by the third-party reviewer(s) (**Appendix A**).

The location of water treatment activities associated with the Santos GLNG GFD Project Stage 2 – Water Treatment are shown in **Figure 1-1**. This includes the treatment of produced water from Maisey Petroleum Lease (PL) 1021 at the Santos GLNG's Roma Water Management Facilities (WMFs). The location of PL 1021 relative to the Roma WMF is shown on **Figure 1-2** to provide context.

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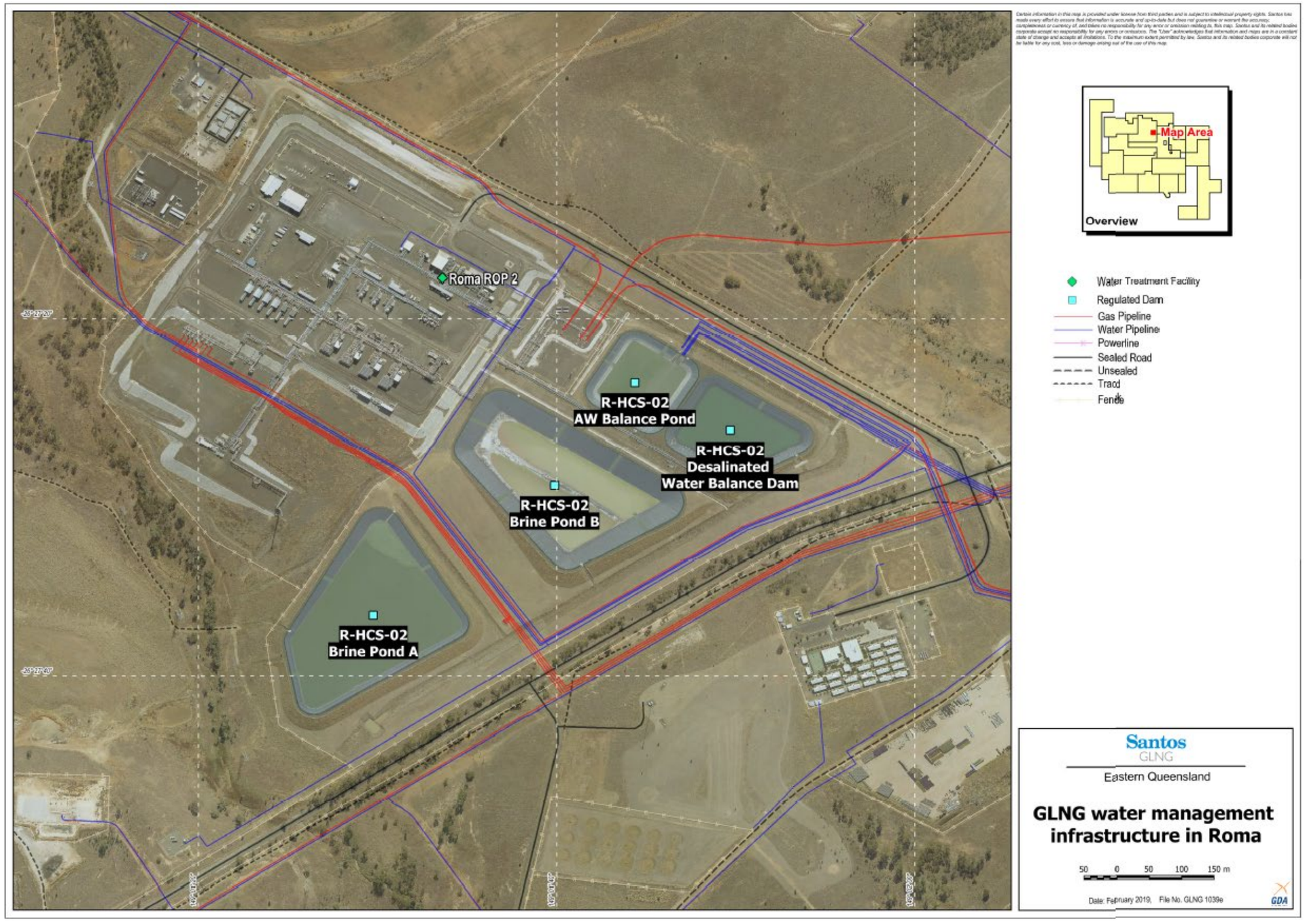

Figure 1-1 Santos GLNG GFD Project Stage 2 Water Treatment Facility

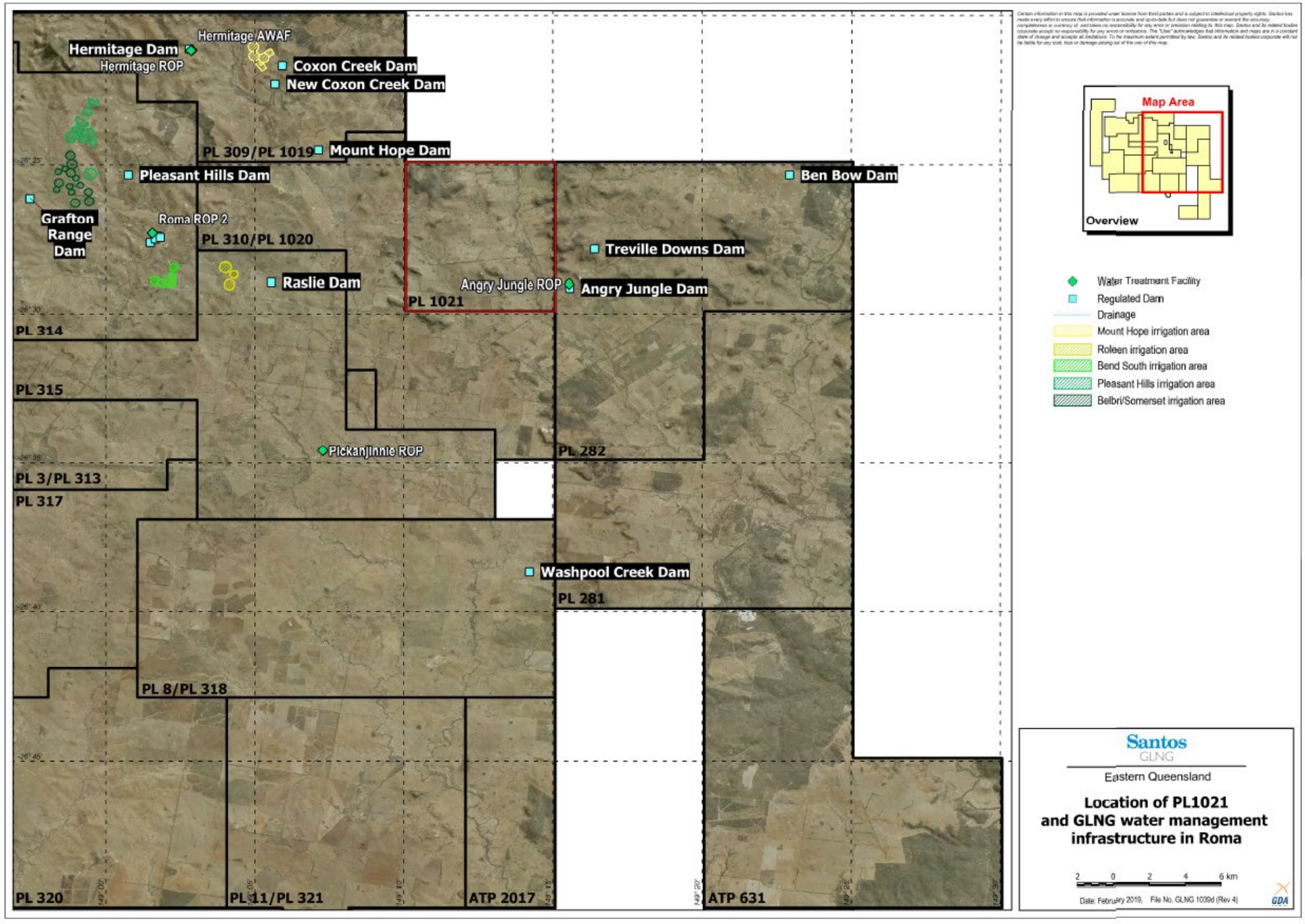

Figure 1-2 Location of Maisey PL 1021 relative to the Roma Water Management Facilities

The WMF uses reverse osmosis water treatment technology (including pre-treatment processes). The output of the WMF is a desalinated water stream and a waste / brine stream.

In accordance with approval conditions, a risk assessment is required for chemicals used for water treatment to determine their potential human health and environmental effects. This assessment will evaluate the incremental risks posed by the chemicals, including those that may reside in produced water following water treatment and in brine.

It is important to note that the life cycle of anthropogenic (drilling) and geo-genic constituents that may reside in produced water have already been assessed in the Maisey Project Stage 2 drilling chemical risk assessment. The outcomes of this assessment have been incorporated into **Section 8.5 – Cumulative Impacts**. Further, the risks posed by the water treatment chemicals that may reside at the point of final disposal of brine or solid salt is not included in this risk assessment. The storage of brine (and water treatment chemical that may reside in the brine) until that point in time, however, is included in this assessment.

The goal of the chemical risk assessment is to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially exposed MNES receptors. In addition, potential risks to non-MNES receptors (for example residents, agricultural workers and livestock) were assessed where an activity results in exposure to water resources that may contain entrained water treatment chemicals and there is potential for a complete exposure pathway to the non-MNES receptor.

Effects to terrestrial MNES and water resource MNES were also assessed via the identification of potentially complete exposure pathways to soils.

To achieve this goal, the chemical risk assessment, in accordance with best practice national or international standards and guidelines, was based on the following:

- *EPA ExpoBox (A Toolbox for Exposure Assessors)* (USEPA, 2016);
- *The OECD Environmental Risk Assessment Toolkit: Tools for Environmental Risk Assessment and Management* (Organisation for Economic Cooperation and Development [OECD], 2014); and
- Most recently published and approved guideline recommended by the Minister.

In addition, the chemical risk assessment incorporated the following best practice guidance:

- *Exposure draft: Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction* (CSG Risk Assessment Guidance Manual) (Department of the Environment and Energy [DoEE], 2017) including National Industrial Chemicals Notification and Assessment Scheme (NICNAS) evaluation and assessment of coal seam gas (CSG) chemicals;
- *National Environment Protection (Assessment of Site Contamination) Measure* (NEPM) (National Environment Protection Council [NEPC], 1999 as amended 2013); specifically, Volume 5: Schedule B4 Guideline on Site-Specific Health Risk Assessment;
- *Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards* (enHealth Subcommittee ["enHealth"] of the Australian Health Protection Principal Committee, 2012a); and
- *Australian Exposure Factor Guide* (enHealth Subcommittee ["enHealth"] of the Australian Health Protection Principal Committee, 2012b).

All risk assessment methods apply a hierarchy in the use of data for exposure and toxicological assessment to provide the least uncertainty in the risk assessment process. To facilitate this hierarchy, the United States Environmental Protection Agency's (USEPA's) EXPOsure toolBOX ("EPA ExpoBox") and the OECD Environmental Risk Assessment Toolkit provide a compendium of risk assessment tools that link to guidance, databases, models, key references and related resources. These

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tools are compatible with the various Australian guidance cited above. However, it is noted that the Australian guidance has precedence when there are differences between the tools.

The EPA ExpoBox specifically provides tools for exposure assessment. The problem formulation, conceptual exposure model (CEM) and the exposure assessment use these tools extensively in the approach to assessing exposure in the environmental media potentially affected by the WMF chemicals, the potential exposure pathways and receptors, and calculating exposure based on intake equations and exposure assumptions. The OECD Environmental Risk Assessment Toolkit broadly covers the various components of the risk assessment process; therefore, these tools were used in the hazard assessment, including preparation of the risk assessment dossiers (e.g., physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data from databases linked to the OECD eChemPortal) and in the exposure assessment to define default exposure parameters.

The EPA ExpoBox has been referenced as a framework that should be leveraged in the chemical risk assessment. EPA ExpoBox was developed by USEPA Office of Research and Development, as a compendium of exposure assessment tools that links to exposure assessment guidance, databases, models, key references and related resources. The toolbox provides a variety of exposure assessment resources organised into six Tool Sets, each containing a series of modules as shown in **Table 1-1**:

Table 1-1 EPA ExpoBox Tool Sets

Approaches	Media	Routes
• Direct Measurement (Point-of-Contact) • Indirect Estimation (Scenario Evaluation) • Exposure Reconstruction (Biomonitoring and Reverse Dosimetry)	• Air • Water and Sediment • Soil and Dust • Food • Aquatic Biota • Consumer Products	• Inhalation • Ingestion • Dermal
Tiers and Types	**Life Stages and Populations**	**Chemical Classes**
• Screening-Level and Refined • Deterministic and Probabilistic • Aggregate and Cumulative	• General Population • Residential Consumer • Occupational Workers • Life Stages • Highly Exposed	• Pesticides • Other Organics • Inorganics and Fibers • Nanomaterials

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For example, the inhalation module under the route tool set provides the following:

- Method used in the dose-response;
- Calculations for exposure concentrations and potential dose;
- Estimating media-specific concentrations;
- Exposure scenarios and potential receptors;
- Exposure factors; and
- Guidance and references.

The OECD Environmental Risk Assessment Toolkit provides access to practical tools on environmental risk assessment of chemicals. It describes the general work flow of environmental risk assessment and provides examples of risk assessment. The toolkit also provides links to relevant tools developed by OECD and member countries that can be used in each step of the work flow. The examples provide a roadmap of the process, showing the steps involved in each case and the tools that were used.

The OECD general risk assessment process for environmental risk assessment includes four steps: hazard identification, hazard characterisation, exposure assessment and risk characterisation. **Table 1-2** summarises the available tools for the risk assessment process.

Table 1-2 Summary of Available Tools for Risk Assessment

Categories		Links to Available Materials	Explanation
Hazard Assessment	Gathering existing information	OECD Existing Chemicals database	Organisation for Economic Cooperation and Development (OECD)-wide agreed hazard assessments elaborated in the OECD Co-operative Chemicals Assessment Programme.
		eChemPortal	Global Portal to Information on Chemical Substances.
		Manual for the Assessment of Chemicals (Chapter 2)	A set of guidance documents for (initial) risk assessment developed for the OECD Cooperative Chemicals Assessment Programme. See Chapter 2 for gathering data.
	Evaluating existing information	Manual for the Assessment of Chemicals (Chapter 3)	See Chapter 3.1 for determining the quality of existing data.
	Generating new data	Test guidelines	Test methods for assessing (hazard) properties of chemicals.
		The OECD Quantitative Structure-Activity Relationships [(Q)SAR] Project	Guidance and tools for filling data gaps by non-testing methods.
	Assessing the hazards	Manual for the Assessment of Chemicals (Chapter 4) and (Chapter 5)	Chapter 4 provides guidance assessing the hazards of chemical substances to man and the environment. Chapter 5 provides guidance on elaborating a hazard assessment report.
		Series on Testing and Assessment	Guidance documents and reports related to assessment of several inherent effects.
Exposure Assessment	General guidance for exposure assessment	Environmental Exposure Assessment Strategies for Existing Industrial Chemicals in OECD Member Countries	An overview of the approaches on environmental exposure assessment used in the late 1990s by OECD member countries.
		Manual for the Assessment of Chemicals (Chapter 6)	Guidance on reporting exposure information (Section 6.2) and on initial exposure assessment (Sections 6.3).
	Measuring or estimating releases to the environment	Emission Scenario Documents	Estimating emission of chemicals in specific industry and use categories.
		Global Portal to PRTR Information (PRTR net)	A gateway and databases of global information on Pollutant Release and Transfer Registers (PRTRs).
		Resource Centre for PRTR Release Estimation Techniques	
		Centre for PRTR Data	
	Environmental fate and pathways	Test guidelines	Test methods for assessing (hazard) properties of chemicals.

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Categories		Links to Available Materials	Explanation
		The OECD (Q)SAR Project	Guidance and tools for filling data gaps by non-testing methods.
		Pov and LRTP Screening Tool	A tool for screening overall persistence (Pov) and long-range transport potential (LRTP) of chemicals.
		Guidance Document on the Use of Multimedia Models for Estimating Overall Environmental Persistence and Long-range Transport	Guidance on the models estimating Pov and LRTP.
		EPI Suite™	The EPI (Estimation Programs Interface) Suite™ is a Windows®-based suite of physical/chemical property and environmental fate estimation programs developed by the USEPA's Office of Pollution Prevention Toxics and Syracuse Research Corporation (SRC).
	Measuring or estimating concentrations in the environment	Report on improving the use of monitoring data	The workshop report on the use of monitoring data in exposure assessment.
		Available tools and models for exposure assessment	A list of tools and models developed and used in OECD member countries for different tiers of exposure assessment.
Other Relevant Materials/ Risk Assessment of Specific Chemicals		New Chemical Assessment Comparisons and Implications for Work Sharing	Comparison of risk assessment of new chemicals.
		Policy Dialogue on Exposure Assessment	Comparison of approaches to exposure assessment in OECD member countries.
		Pesticide Testing and Assessment	Guidance documents on hazard and exposure assessment of pesticides and biocides respectively.
		Biocides	

The CSG Risk Assessment Guidance Manual (DoEE, 2017) references the USEPA and OECD tool boxes in developing their chemical risk assessment framework and tools to guide best practice for human health and environmental risk assessment. These tool boxes are all based on the principles contained within USEPA's risk assessment guidelines. As a toolbox, not all of the tools are to be utilised, rather only those tools that are appropriate to the chemical, its functional toxicity, and the exposure pathway being used for assessment should be used. As with all risk assessment methods, a hierarchy is applied in the use and assessment of data on exposure point concentrations and toxicity, with direct measurements and toxicity values provided by epidemiological studies providing the least uncertainty in the risk assessment process.

In addition to enHealth and NEPM guidance, the methods contained within the relevant sections of the CSG Risk Assessment Guidance Manual, the EPA ExpoBox Toolkit and the OECD Environmental Risk Assessment Toolkit will be utilised (as applicable) within the risk assessment.

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2.0 PROJECT SETTING

A detailed discussion of the Santos GLNG GFD Project development areas and project description are provided in the Project Description section (Chapter 4) of the Environmental Impact Statement (EIS) (URS, 2014).

This chemical risk assessment comprises the water treatment chemicals associated with the Project Stage 2 – Maisey Water Treatment Chemicals.

The general context of the proposed water treatment activities and MNES values is provided in the following sections; for additional detail, the EIS remains the point of reference.

This assessment has been developed specifically for assessment of the life cycle of chemicals associated with water treatment. The assessment of (raw / untreated) produced water or brines (including geogenic constituents) such as in pipelines and ponds and beneficial use was included in the previous version of the chemical risk assessment (EHS Support, 2018).

Water treatment will leverage existing transportation routes, chemicals storage areas, dams and water treatment facilities. Existing and proposed irrigation areas for beneficial reuse water are shown on **Figure 1-2**. Other beneficial use activities include stock watering and project use (such as construction, drilling and completions and dust suppression). A schematic of water treatment and management for Project Stage 2 – Maisey Water Treatment is provided in **Figure 2-1.** (Note: Coal seam water from Maisey PL1021 is referred to in this schematic as "Roma East Wells.")

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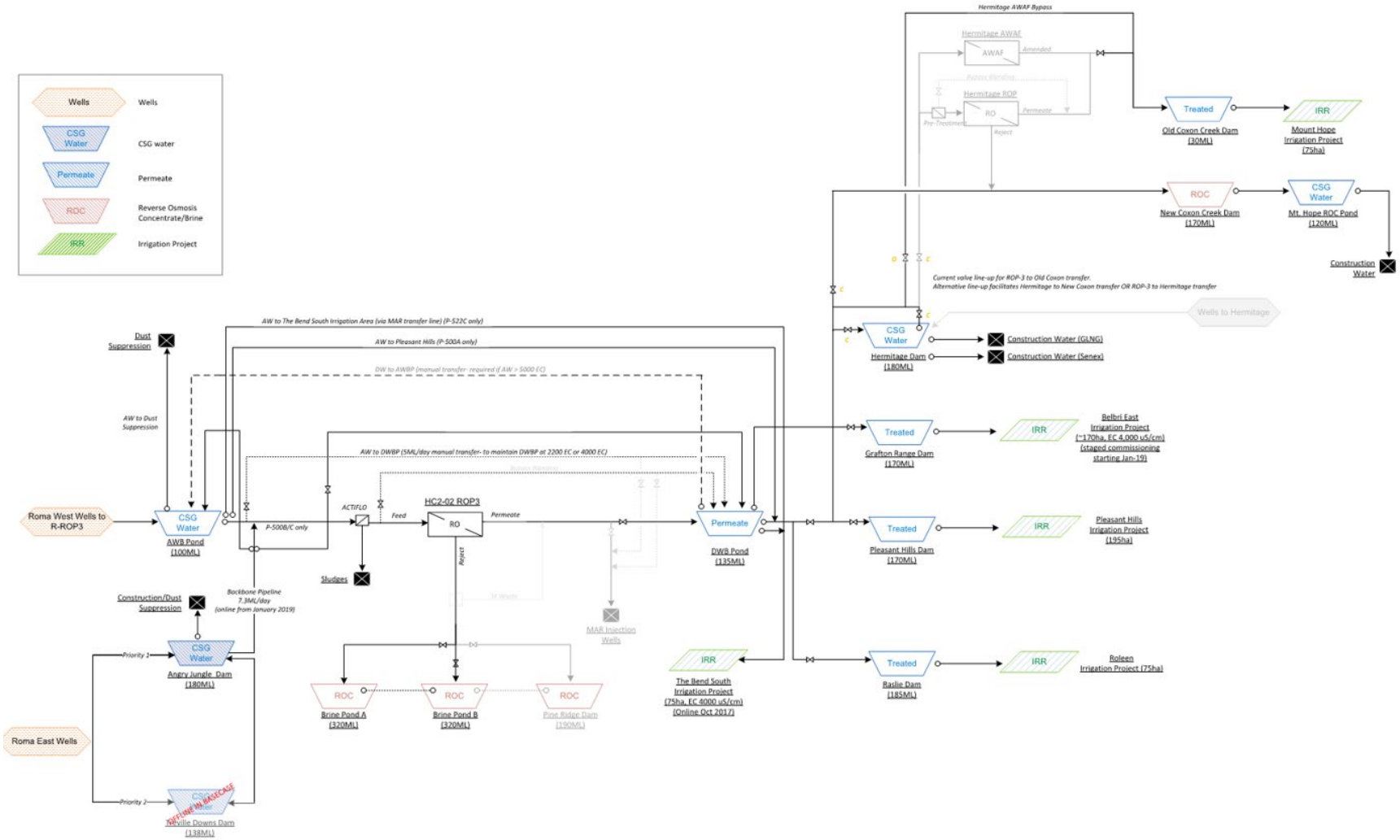

Figure 2-1 Santos Roma Water Treatment and Management Schematic

2.1 Overarching Management and Mitigation Strategies

Key plans integral to the management of the risk of impacts to MNES associated with chemical transportation, storage, use and management/monitoring of potential impacts are provided in **Table 2-1**. Select plans also specifically address the mitigation, management, monitoring and reporting of accidents. The plans list the actions to avoid accidents, to implement during accidents, and to take after accidents; in addition, the plans include procedures to monitor potential chemical-related affects from accidental and intentional releases (use of chemicals during treatment of produced water and beneficial reuse of permeate). The appendices of the EIS should be referenced for further detail on these documents.

Section 10.0 further discusses the risk management recommendations that address the mitigation, management, monitoring and reporting to ensure that existing controls are adequate to monitor and to continue to assess the potential hazards and risks.

In addition, Santos GLNG activities are undertaken in accordance with Commonwealth and State Regulations and relevant Australian Standards that include the transportation, storage and management of chemicals and management of associated environmental hazards. Key regulations include:

- Australian Dangerous Goods Code including requirements for driver and vehicle licencing and documentation;
- *Work Health and Safety Act* (2011);
- *Environmental Protection Act* (DEHP, 2016).) and provisions associated with General Environmental Duty, waste tracking and storage and handling of chemicals;
- *Sustainable Planning Act* (2009);
- *Petroleum and Gas (Production and Safety) Act;* and
- *Industrial Chemicals (Notification and Assessment) Act, 1989.*

The risk assessment program employed, which is consistent with the Australian and international guidance, will combine qualitative and quantitative chemical risk assessment methodologies to assess the potential risks posed by individual chemicals and the mixture of chemicals. The potential exposure pathways and risk to MNES receptors or a broader range of receptors associated with impacts to water resources will be identified and characterised through this chemical risk assessment process to inform the risk managers of the appropriate approaches for mitigation or elimination of risk in accordance with Australian Guidelines (e.g., draft guidance for ecological risk assessment provided by the Environment Protection Authority Victoria.

In the assessment of exposure pathways and risks, only authorised activities will be considered (activities authorised in the Environmental Authority and EPBC Act Approval). Where activities are specifically precluded (for example release or disposal of wastes to surface or ground waters) these will not be considered in the risk assessment. However, accidental releases and the potential for a complete exposure pathway to MNES receptors will be assessed, as applicable, in the hazard and exposure assessments.

Given that upstream development activities that beneficially reuse treated water occur over a short duration at any single location, site specific (site by site) management plans are not required. Rather a management framework is employed (with appropriate inspections and monitoring) to ensure that activities do not result in unacceptable risks to MNES receptors and water resources.

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Table 2-1 Summary of Key Management Plans and Risk Assessments

Plan or Risk Assessment	Description of Components in Document
CSG Waste Management Plan (WMP)	The Coal Seam Gas (CSG) WMP details Santos GLNG's proposed approach to the management of produced water and waste products and outlines proposed monitoring to ensure impacts to matters of national environmental significance (MNES) are firstly avoided and secondly minimised as far as practicable. The WMP details measures that will be implemented to avoid, mitigate and manage impacts to surface and groundwater resources including: • The engineering design of dams and WMF to avoid releases to the environment; • The presence of leak detection systems on dams (i.e., between the dual liner systems for brine dams); • The establishment of seepage / groundwater monitoring well infrastructure around dams; • The implementation of routine inspection and maintenance and monitoring; • Details the monitoring to measure the amount of produced water and waste products produced; • Detail the storage, management and disposal of produced water and waste products, including but not limited to: o Beneficial use such as dust suppression, construction, operational use and stock water; o Irrigation; and o Transfer to a licensed waste management facility. • Details the early warning indicators and trigger thresholds and limits for detecting impacts on surface and groundwater quality; and • Details the risk-based exceedance response actions and timeframes if early warning indicators or trigger thresholds are exceeded, including reporting.
Groundwater Management and Monitoring Plan (GWMP)	The GWMP has been developed to detail how Santos GLNG proactively manages and monitors potential adverse impacts to groundwater resources and groundwater dependent ecosystems (GDEs) including the following: • Details a groundwater monitoring network for the measurement of impacts on water resources directly or indirectly, including: o Provides for the early detection of changes in the groundwater regime in terms of amplitude and frequency of fluctuations in water pressure, water level and water quality and water quality in groundwater systems and changes in connectivity with surface water; o Monitoring relevant formations to determine hydraulic connectivity and provide for the early detection of impacts prior to reaching migration pathways to other formations; o Monitoring potential impacts on GDEs, including spring based and non-spring based ecosystems, and provides for early detection of impacts;

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Plan or Risk Assessment	Description of Components in Document
	○ Monitoring changes in water balance; and ○ Monitoring changes in water availability for water users and the environment. • Details a baseline monitoring data acquisition program; • Provides a rationale for design of the monitoring network; • Details early warning indicators, trigger thresholds and limits for detecting impacts on groundwater levels; and • Details a risk-based exceedance response if early warning indicators or trigger threshold values are exceeded.
Contingency Plan for Emergency Environmental Incidents (ECP)	The ECP has been prepared to satisfy the requirements of the relevant Santos GLNG Upstream Project Area and Gas Transmission Pipeline (GTP) Environmental Authorities (EAs) and Co-ordinator General's Evaluation Report. This plan complements the overarching Santos Management System (SMS), and includes the following objectives: • Facilitate compliance with relevant state and local government legislation, regulations and approvals; • Support the Santos Management Standards; • Provide a framework for Santos GLNG to: ○ Prepare for and respond to emergency environmental incidents; ○ Communicate with the appropriate parties in the event of emergency environmental incidents; ○ Investigate the cause of emergency environmental incidents that have occurred; ○ Implement remedial actions to reduce the likelihood of recurrence of similar emergency environmental incidents; and ○ Develop procedures and plans for the management of emergency environmental incidents as required during the Project lifetime.

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In combination with the avoidance and minimisation strategies, numerous other mitigation and management strategies are employed to ensure that chemicals are contained and do not pose an unacceptable risk. Common strategies employed include:

- Establish and / or use designated chemical storage areas and store chemicals in accordance with Australian Standards and regulatory requirements (Environmental Authority Conditions).
- Engineer and construct dams to achieve regulatory hydraulic performance requirements (Environmental Authority Conditions).
- Remove surplus chemicals at the end of treatment of produce water.
- Develop Waste Management Plans (WMPs) including management, monitoring and triggers for beneficial re-use and disposal.

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3.0 ENVIRONMENTAL SETTING

The following section describes the environmental setting as it relates to the water treatment chemical life cycle. Further details on the environmental setting as it relates to the broader area can be found in the Santos GLNG GFD EIS (URS, 2014) including the following chapters:

- Chapter 9 (Land Resources);
- Chapter 13 (Surface Water);
- Chapter 14 (Groundwater) and Appendix U2 (Water Resources [MNES]);
- Chapter 18 (Terrestrial Ecology) and Appendix U1 (MNES Flora and Fauna); and
- Chapter 19 (Aquatic Ecology).

As shown in **Figure 1-2** the key water treatment and associated beneficial use infrastructure that will be utilised as part of the Project are located in the following PL areas to the west of Maisey:

- PL309
  - Coxon Creek and New Coxon Creek Dams and
  - Mount Hope Irrigation Area
- PL315
  - Raslie Dam and
  - Roleen Irrigation Area
- PL314
  - Roma R-HCS02 Water Treatment Plant and supporting feed, water and brine dams;
  - Pleasant Hills Dam;
  - Granton Range Dam; and
  - Bend South, Pleasant Hills and Belbri/Somerset Irrigation Areas.

All water treatment infrastructure currently exists and has sufficient capacity to store and treat produced water. Following treatment, water will be primarily reused at existing irrigation projects, which are all on areas of livestock grazing (pastoral activities). Other beneficial uses include project use and stock watering.

The WMF and beneficial use areas, which are to the west of the Maisey Project Area (PL 1021), are located in the Upper Balonne Tributaries as shown in **Figure 3-1**. The receiving water environments in this upper catchment are highly ephemeral and episodic and are characterised by high variations in duration and volume of flows due to highly variable rainfall and runoff and high evaporation rates.

Prolonged baseflow does not occur in vicinity of the activities; however, semi-permanent / permanent pools are located downstream. Environmental values (EVs) identified for these surface water bodies include aquatic flora and fauna and the potential for stock watering associated with these pools. Aquaculture, water extraction and industrial use is absent, and no national important wetlands were identified.

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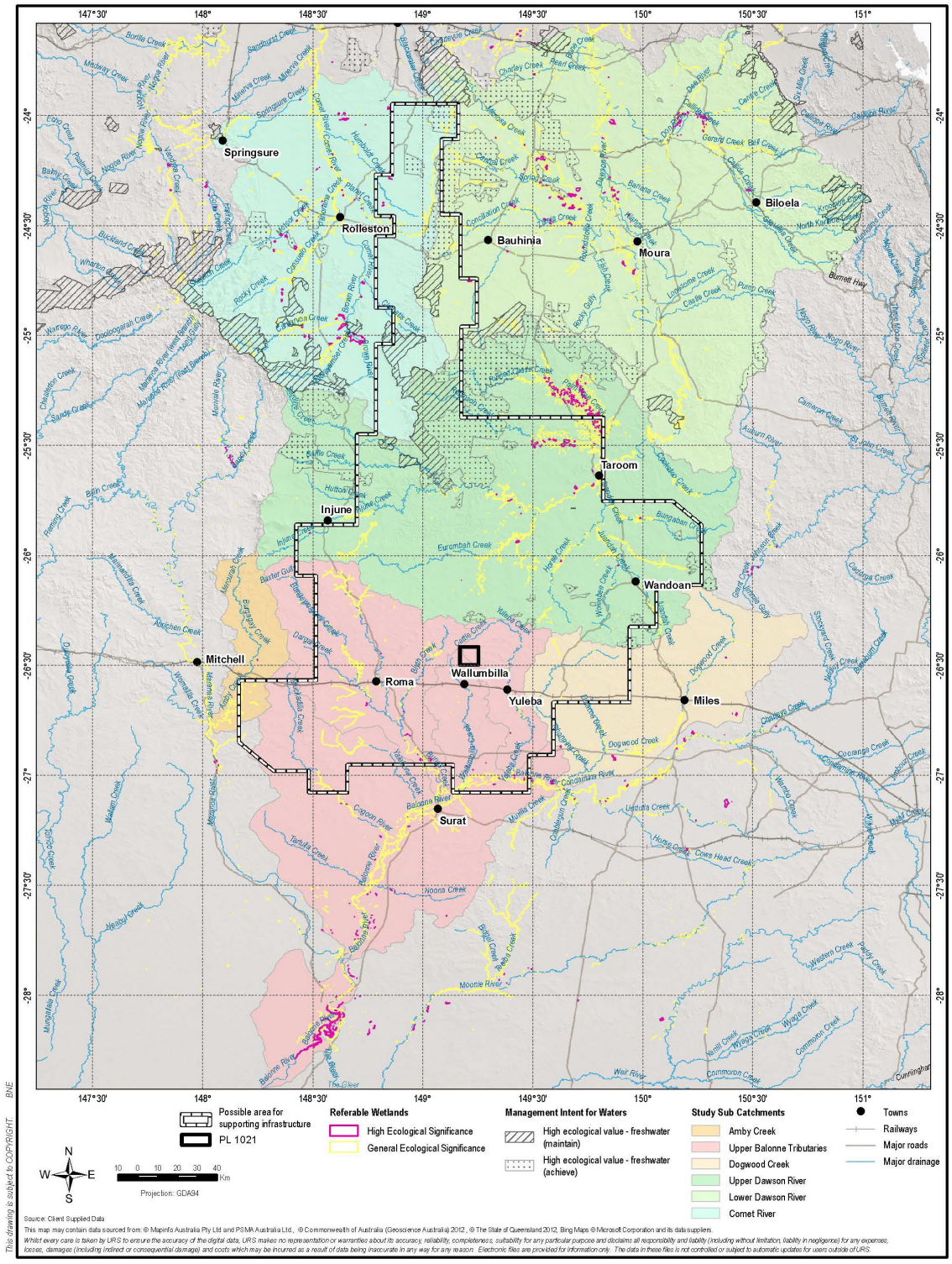

Santos GLNG Project

GFD PROJECT EIS

HIGH ECOLOGICAL VALUE AREAS AND WETLANDS

Figure 3-1 Catchments, Sub-Catchments, and High Ecological Value Areas and Wetlands

Consistent with the hydrogeology of the region, the area of water treatment infrastructure and beneficial use area is underlain by the Surat Basin. The main productive aquifers comprise the sandstone formations of the Great Artesian Basin (GAB) with minor areas comprising quaternary alluvial aquifer systems in unconsolidated sediments, and fractured basalt and sediment caps.

The petroleum tenures in which water management infrastructure are located fall within the Surat Cumulative Management Area (CMA), which provides a regulatory framework for assessing potential future cumulative affects associated with water extraction from petroleum activities and the development of management responses (monitoring, bore and baseline assessments and reporting). Water extracted from the alluvial aquifers in the Surat CMA are generally utilised for limited stock and domestic purposes; the deeper water-bearing units supply domestic, town water and stock watering, and are a source of baseflow watercourses from springs.

As shown in **Figure 3-2**, the primary use of registered bores in the area of the WMF and broader region is for watering of livestock and domestic supply. The regional direction of groundwater flow is to the south and southwest.

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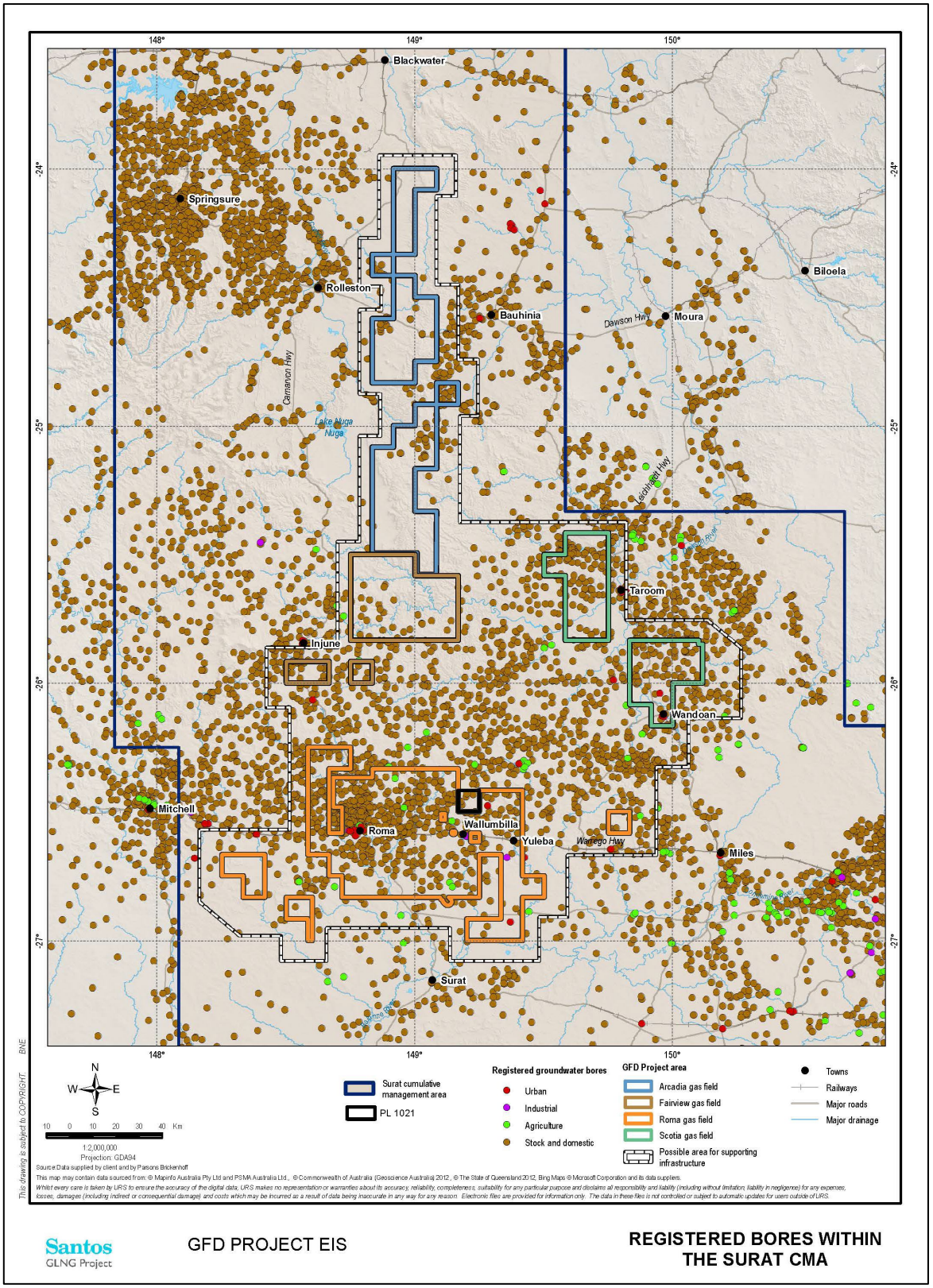

Figure 3-2 Groundwater Bores in and around the Roma WMF and Beneficial Use Areas

3.1 Ecological Values in the Water Management Infrastructure Areas

Based on the extent of historic clearing and grazing, the extent of remnant and regrowth vegetation is limited. **Figure 3-3** presents the MNES in and around the Roma irrigation areas, Roma water treatment plant and dams. WMF infrastructure, including the irrigation areas, are not located in areas identified as threatened ecological communities (TECs), but may be in proximity to them. There are no areas of GDE's identified within proximity of the irrigation areas as assessed in the Santos GLNG Gas field Development Project EIS. **Figure 3-4** presents the MNES within Belbri and Pleasant Hills areas, and **Figure 3-5** presents MNES within the Mount Hope area. Management and monitoring controls are presented in Section 9.0 and irrigation will be undertaken in accordance with the CSG Waste Management Plan (Santos GLNG, 2019).

Irrigation areas comprise fodder crops that are used for livestock grazing and are not considered suitable habitat for MNES fauna species.

Vertebrate fauna presence within the irrigation areas is likely to be limited to highly mobile species that are either herbivores foraging on plants supported by the irrigation or insectivores foraging on insects present on the plants supported by the irrigation. Species that are not highly mobile are not expected to utilise areas that are being irrigated.

An assessment of the likelihood of occurrence of EPBC Act and/or Nature Conservation Act (NC Act)-listed threatened flora and fauna and NC Act-listed Special Least Concern fauna potentially occurring in the Site(s) is summarised in **Table 3-1** (sources noted in **Section 3.0** and URS [2014]).

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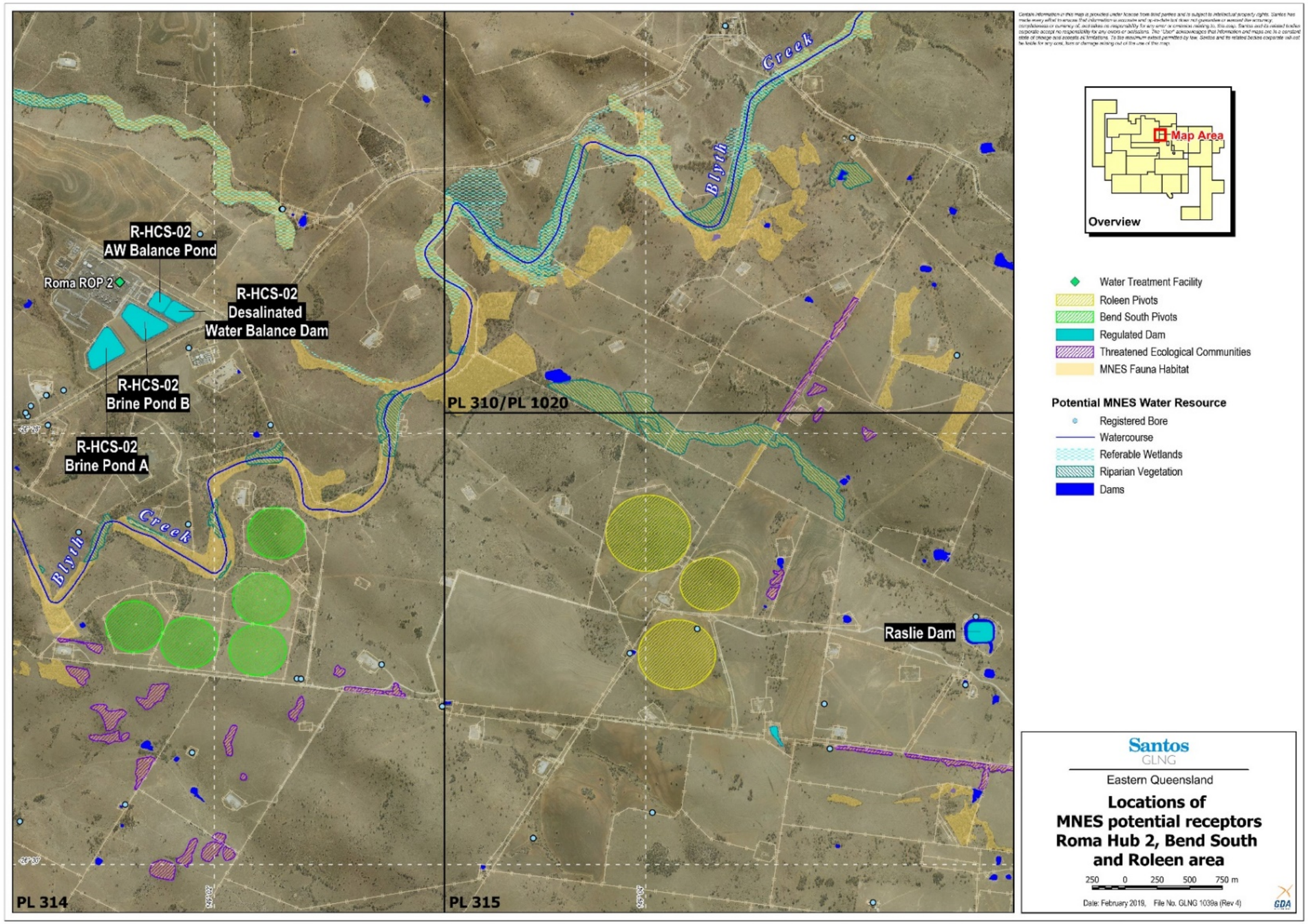

Figure 3-3 MNES around Roma Water Management Infrastructure

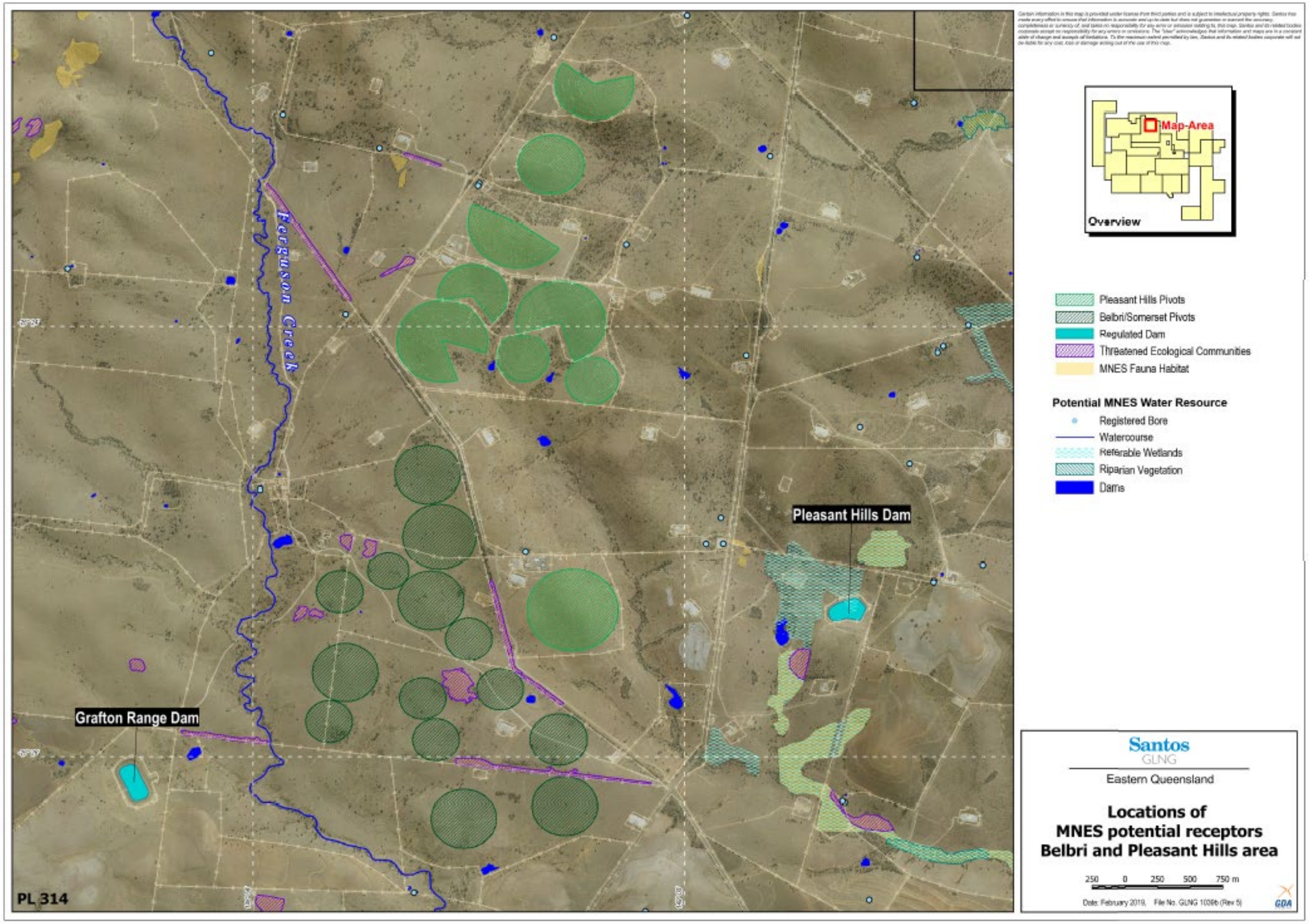

Figure 3-4 MNES around Belbri and Pleasant Hills Area

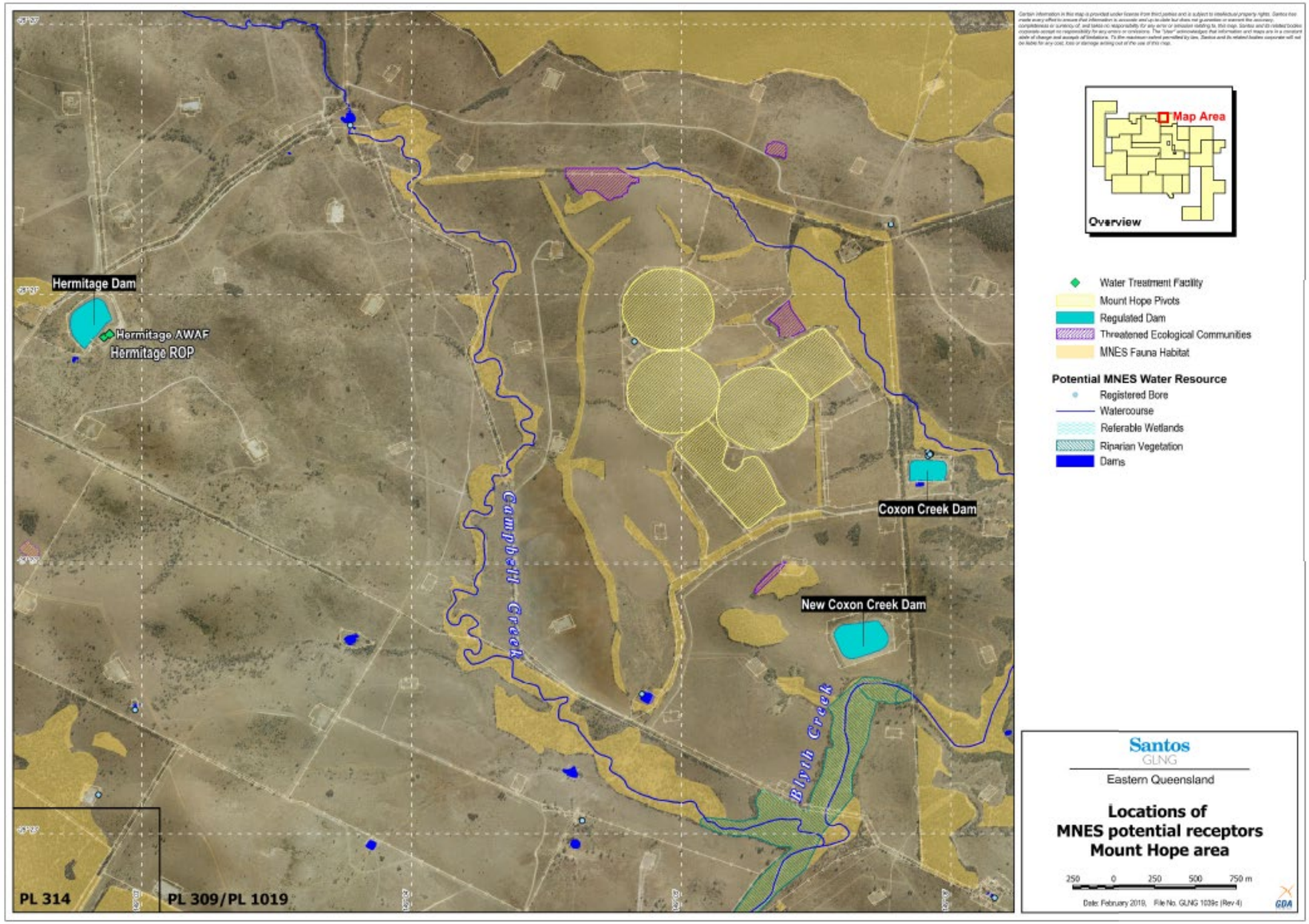

Figure 3-5 MNES around Mount Hope area

Table 3-1 Summary of Occurrence of EPBC Act and NC Act Species

Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
Apocynaceae	*Tylophora linearis* Slender Tylophora	E	E	Found in drier open forests and woodlands of *Eucalyptus, Callitris* and *Allocasuarina* species (DoEE, 2017b). It has been collected at numerous localities in New South Wales (NSW), principally on the western slopes of the Great Dividing Range from Temora to the Linton - Yetman area (ALA 2017). It is only known in Queensland from one specimen collected near Glenmorgan in 1960 (ALA 2017).	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A
Asteraceae	*Picris barbarorum* A hawkweed	-	V	Known to occur in grassy woodlands (ALA 2017). A record (ALA 2017) exists in roadside vegetation near Roma: this vegetation is regional ecosystem 11.9.7 and 11.9.10.	Potentially present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	Unlikely to ever occur. The proposed irrigation areas are located in areas where the historic open forest and woodlands have been replaced by exotic pasture grasses. It is extremely unlikely that this species would occur in the proposed irrigation areas and the likelihood of recruitment of this species to an irrigation area in the future is considered remote.

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
Asteraceae	*Rutidosis lanata* Red-soil Woolly Wrinklewort	-	V	Occurs along ecotones between dry sclerophyll woodland communities dominated by Brigalow (*Acacia harpophylla*), Gum-topped Box (*Eucalyptus woollsiana*), Narrow-leaved Red Ironbark (*Eucalyptus crebra*), Broad-leaved Ironbark (*E. fibrosa*) and Poplar Box (*E. populnea*) on clay, loam and sand (DSITI 2017c).	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A
Fabaceae	*Swainsona murrayana* Slender Darling-pea	V	V	This herbaceous species often grows in heavy soils, especially depressions, and is also found on grey and red to brown clay and clay-loam soils in Bladder Saltbush (*Atriplex vesicaria*) herbland, Black Box (*Eucalyptus largiflorens*) woodland and grassland communities and is frequently associated with *Maireana* species (DoEE 2017b). This species is known in Queensland from five specimens; one collected south of Surat in Brigalow Belt subregion 29 (Weribone High); and four from central western Queensland between Boulia, Birdsville and Longreach (ALA 2017).	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
Poaceae	*Dichanthium setosum* A bluegrass	V	LC	Occurs in Queensland and north-eastern NSW (ALA 2017). In Queensland, it is patchily recorded from Toowoomba in the south to the upper Burdekin River catchment in the north. It grows on basaltic black clays and hard-setting red-brown loams (DoEE 2017b) in woodland or open grassy woodland dominated by Brigalow (*Acacia harpophylla*) and/or eucalypt species (DSITI 2017c). In Queensland and NSW it has also been found in moderately disturbed areas such as cleared woodland, grassy roadside remnants and highly disturbed pasture (DoEE 2017b).	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A
Poaceae	*Homopholis belsonii* Belson's Panic	V	E	Occurs in northern NSW and the southern Brigalow Belt of Queensland (ALA 2017, DoEE *2017b). Within Queensland it principally occurs in Poplar Box* (Eucalyptus populnea*), Brigalow* (Acacia harpophylla*) and Belah* (Casuarina cristata*) dominated communities where it grows preferentially in shaded areas (DoEE 2017b).*	Potentially present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	Unlikely / Remote. The proposed irrigation is located in areas where the historic open forest and woodlands have been replaced by exotic pasture grasses. It is extremely unlikely that this species would occur in the proposed irrigation areas and the likelihood of recruitment of this species to an irrigation area in the future is considered remote.

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
Solanaceae	*Solanum stenopterum* Winged Nightshade	-	V	Inhabits grassland or woodlands of Belah (Casuarina cristata*) and Poplar Box (*Eucalyptus populnea*) on black, brown or red clay loam soils. It also grows on loamy ridges, along roadsides and in paddocks. (Bean 2004).*	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A
Surianaceae	*Cadellia pentastylis* Ooline	V	V	Occurs in *northern NSW and southern Queensland (DoEE 2017b). Within Queensland it occurs patchily from near Rockhampton westward to near Blackall and southward to the State border (ALA 2017) where it occurs on undulating plains, valley slopes, hillsides and scarps, often in association with Brigalow and SEVT communities (DoEE 2017b, Santos 2012). Potentially suitable RE within the Site include 11.9.5.*	Unlikely to be present. Although potentially suitable habitat is present in within the broader area the WMF sites are outside the known range of this species (ALA 2017).	N/A
Birds	*Calidris ferruginea* Curlew Sandpiper	CE	SLC	A migratory species usually encountered on coastal and near-coastal saline and freshwater wetlands (Pizzey and Knight 1997). Passage migrants are occasionally present on inland wetlands, and the species is sparsely recorded across inland Queensland (ALA 2017).	Unlikely to be present. Suitable habitat (shallow vegetated or open wetlands with a muddy substrate) is not present proximal to any of the WMF (including dams)	N/A

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Calyptorhynchus lathami Glossy Black-Cockatoo	-	V	Dependent on the fruits of several species of *Casuarina* and *Allocasuarina* spp. and occurs in a variety of forest types (Pizzey and Knight 2010, Garnett *et al*. 2011). It will visit isolated trees and remnant patches where food trees are present (Holmes 2012). Nesting habitat is hollow-bearing live or dead trees (Higgins 1999).	Potentially present. Potentially suitable habitat with food plants including *Casuarina cristata* is present in some areas proximal (within 10 km) of WMF. In the immediate vicinity of the WMF there are no foraging resources (*Casuarina spp.*), nesting or rooting resources. Glossy Black-Cockatoos are highly mobile and would potentially fly over these areas. .	Unlikely to ever occur. The proposed irrigation area does not contain foraging resources (*Casuarina spp.*), nesting or rooting resources. Glossy Black-Cockatoos are highly mobile and would potentially fly over the irrigation areas however there would be no inducement to stop or maintain presence in the irrigation area.
	Erythrotriorchis radiatus Red Goshawk	V	V	A highly mobile species with a large home range; breeding habitat is in intact tall forest associated with major drainage lines, especially near permanent water bodies and where there is high avian prey diversity, but the species could potentially forage much further away from these areas (Marchant and Higgins 1993).	Unlikely to be present. No riparian habitat with tall trees within the area of WMF (and dans) which could support this species, further these areas are outside the species known range.	N/A
	Geophaps scripta Squatter Pigeon (southern subspecies)	V	V	Inhabits grassy woodlands with open areas for foraging habitat usually within proximity to a nearby water source (Higgins and Davies 1996).	Unlikely to be present. The species was formerly known from the broader Roma – Wallumbilla area but there are no recent records and the species appears to be locally absent (BOOBOOK 2015).	N/A

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Grantiella picta Painted Honeyeater	V	V	Lives/breeds in woodlands and open forests with high densities of suitable food plants (i.e. mistletoes, family Loranthaceae) (Higgins, Peter and Steele 2001).	Unlikely to be present. Habitats containing mistletoe including Brigalow and eucalypt woodlands are present within the region but are not present within the vicinity of WMF.	N/A
	Rostratula australis Australian Painted Snipe	E	V	Forages at shallow edges and adjacent vegetated margins of freshwater wetlands (DoEE 2017b) and is able to use both artificial and natural ephemeral and permanent wetlands (Marchant and Higgins 1993).	Potentially present. Potentially suitable habitat is present at the WMF dams.	Potential to infrequently occur. The Australian Painted Snipe eats vegetation, seeds, insects, worms and molluscs, crustaceans and other invertebrates. They generally remain in dense cover when feeding, although may forage over nearby open areas such as ploughed land or grassland (Marchant & Higgins 1993). The species has the potential to utilise the irrigation areas for foraging from time to time when the irrigated grass is mature enough to provide cover. However the Australian Painted Snipe is a mobile and migratory species and the required foraging resources would only occur at the site intermittently.

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
Fish	*Maccullochella peelii* Murray Cod	V	-	In Queensland naturally-occurring populations of this species are confined to permanent water in riverine environments in the Condamine, Maranoa-Balonne, Weir and Moonie River catchments (Lintermans 2007).	Unlikely to be present. No suitable riverine habitat exists within the broader area and in close proximity to WMF.	N/A
Mammals	*Chalinolobus dwyeri* Large-eared Pied Bat	V	V	All known occurrences of this species are within or near forested landscapes with relatively high relief (DSITI 2017c). The species may be present in uplands with likely presence of appropriate geology (usually sandstone) providing essential habitat (caves, crevices, holes) and associated foraging habitat.	Unlikely to be present. Potentially suitable habitat (i.e. rock holes/crevices in rocky hills) is not present proximal to WMF and these areas are outside the known range of the species.	N/A
	Dasyurus hallucatus Northern Quoll	E	LC	Formerly widespread in south-central Queensland this species has declined markedly and is now confined to rugged and remote areas throughout its distribution (Burnett 2012). Forested uplands with high relief and/or containing abundant rock outcrops may support the species.	Unlikely to be present. The Site is within the species' historical range but potentially suitable den sites (i.e. rock holes/crevices) are present in the vicinity of WMF. Further, no recent records exist within the Site, with nearest recent records being in the Carnarvon Range (ALA 2017).	N/A

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Nyctophilus corbeni South-eastern Long-eared Bat	V	V	The distribution and habitat preferences of this species are very poorly known; it inhabits a range of dry forest types in south central Queensland (Reardon 2012).	Unlikely to be Present. No potentially suitable foraging and roosting habitat is present as remnant woodlands are not proximal to WMFs.	Potential to infrequently occur. The south-eastern long-eared bat hunts for insects in the air, from foliage and the ground. It eats beetles, bugs, moths, grasshoppers and crickets. The species is most abundant in vegetation that doesn't occur in the irrigation areas (a distinct canopy and a dense cluttered shrub layer). If it did utilise the irrigation areas for foraging it would be intermittent and most likely to occur in the air above the irrigation.
	Petauroides volans Greater Glider	V	LC	Occurs in eucalypt woodlands and open forest particularly those with mature trees containing large hollows (TSSC 2016).	Unlikely to be Present. Potentially present in proximal areas but not within the immediate vicinity of WMF's. No mature eucalypt trees are immediately adjacent to these facilities.	Unlikely to ever occur. The habitat requirements of mature eucalypt trees containing large hollows are not present in the irrigation areas.

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Phascolarctos cinereus Koala (combined populations of QLD, NSW and the ACT)	V	V	This species requires eucalypt woodland and forest habitat with suitable food trees (primarily *Eucalyptus* spp.) (DoEE 2017b). Woodlands containing food trees in riparian/alluvial areas are particularly favoured (Melzer et al. 2014). Potential food trees occurring within the Site include *Eucalyptus tereticornis*, *E. camaldulensis*, *E. populnea*, *E. melanophloia*, *E. orgadophila* and *E. crebra*.	Unlikely to be Present. Potentially present in proximal areas but not within the immediate vicinity of WMF's. No mature eucalypt trees are immediately adjacent to these facilities.	Unlikely to ever occur. The potential food trees do not occur in the irrigation areas.
Reptiles	*Acanthophis antarcticus* Common Death Adder	-	V	A widespread but patchily distributed snake (ALA 2017). Lives in woodlands, open forests and heathlands; requires abundant shelter/ambush predation cover e.g. low shrubs, rocks, logs, dense leaf litter (Wilson 2015).	Unlikely to be Present. Potentially present in proximal areas but not within the immediate vicinity of WMF's. Potentially suitable habitat with shelter sites (e.g. dense low shrubs, rock) is not present within the immediate vicinity of infrastructure.	Unlikely to ever occur. The required abundant shelter/ambush predation cover e.g. low shrubs, rocks, logs, dense leaf litter is not present in the irrigation areas.
	Aspidites ramsayi Woma	-	NT	A snake recorded from a variety of woodland and shrubland habitats in sub-humid to arid Australia (Wilson and Swan 2008). It preys on reptiles and small mammals. There are several records in the Roma area, including one from near Wallumbilla, ca. 10 km from the Site (ALA 2017).	Unlikely to be Present. Potentially present in proximal areas but not within the immediate vicinity of WMF's. Potentially suitable habitat (rock crevices, log piles, animal burrows) is not present within the immediate vicinity of infrastructure.	Unlikely to ever occur. Suitable habitat (rock crevices, log piles, animal burrows) are not present within the irrigation areas.

Commercial in Confidence

Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Delma torquata Collared Delma	V	V	Occupies a range of eucalypt woodlands and open forests; lives under surface rock and large woody debris (Wilson 2015). The Site is within the species' known range with several records from locations north-west of Roma (ALA 2017).	Unlikely to be Present. Potentially present in proximal areas but not within the immediate vicinity of WMF's . Eucalypt woodland with potentially suitable shelter sites (e.g. small rocks, woody debris) is not present within immediate vicinity of infrastructure.	Unlikely to ever occur. The suitable shelter sites required by the species (e.g. small rocks, woody debris) are not present in the irrigation areas.
	Denisonia maculata Ornamental Snake	V	V	Occurs in lowlands associated with the Dawson and Fitzroy catchments (DoEE 2017). Known southerly distribution limit is approximately Lake Nuga (ALA 2017). Lives in woodland and grassland with cracking clay soils, usually in close proximity to wet or seasonally wet areas e.g. billabongs, gilgais, floodplains, riparian corridors (DoEE 2017).	Unlikely to be present. Habitat with preferred substrate (e.g. deep cracking clay, gilgais) is present but WMF are not within the known range of the species (ALA 2017).	N/A
	Egernia rugosa Yakka Skink	V	V	Lives in a range of woodland and open forests dominated by Eucalyptus, Acacia and Callitris spp.; also grassland with regrowth trees (DoEE 2017). Requires suitable soils for burrows or shelters in sinkholes, abandoned rabbit warrens or large fallen/piled woody material (Eddie 2012).	Unlikely to be Present. Eucalypt woodland and non-remnant area with potentially suitable shelter sites (e.g. large logs, log piles) are present in proximal areas but no within the immediate vicinity of infrastructure.	Unlikely to ever occur. Suitable habitat (rock crevices, log piles, animal burrows) are not present within the irrigation areas.

Commercial in Confidence

Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Elseya albagula White-throated Snapping Turtle	CE	E	Occurs in the Fitzroy and Dawson River catchments where it requires permanent water in riverine environments (Limpus et al. 2011).	Unlikely to be present. No suitable riverine habitat is present near WMFs and the locations are not within the known range of the species.	N/A
	Furina dunmalli Dunmall's Snake	V	V	Occupies woodlands and open forests; may be reliant on presence of abundant fallen woody debris (Hobson 2012a).	Unlikely to be present. Potentially suitable foraging and shelter habitat is proximal to some of the WMF with remnant and regrowth REs However, none is present in the immediate vicinity of this infrastructure.	Unlikely to ever occur. Suitable habitat (e.g. small rocks, woody debris) are not present in the irrigation areas.
	Hemiaspis damelii Grey Snake	-	E	Associated usually with ephemeral waterbodies in woodlands and open forests on heavy cracking clays, where it shelters in soil cracks (Hobson 2012b). It is also known to use cleared areas where suitable shelter and foraging habitat exists.	Unlikely to be present. Potentially suitable foraging and shelter habitat is proximal to some of the WMF but none is present in the immediate vicinity of infrastructure.	Unlikely to ever occur. Grey snakes shelter under rocks, logs and other debris as well as in soil cracks. They feed on frogs and lizards during the night. Suitable habitat (e.g. small rocks, woody debris, soil cracks) are not present in the irrigation areas. In addition, food resources (frogs and lizards) are likely to be scarce in the irrigation areas.
	Rheodytes leukops Fitzroy River Turtle	V	V	The species is confined to the Fitzroy and Dawson River catchments where it requires permanent water in riverine environments (Limpus et al. 2011).	Unlikely to be present. No suitable riverine habitat is present within the area of WMFs	N/A

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Plant Family/ Animal Class	Scientific & Common Name	EPBC Act Status[1]	NC Act Status[1]	Distribution and Known Habitat Use	Likelihood of Occurrence adjacent to WMF (including Dams)	Likelihood of Presence and in Irrigation Areas
	Strophurus taenicauda Golden-tailed Gecko	-	NT	Lives in dry open forest and woodlands, especially those with well-developed shrub layer where it shelters in tree hollows and splits, and under loose bark (QMDC 2008).	Unlikely to be present. No potentially suitable habitat with shelter sites (e.g. trees with loose bark) is present in the immediate vicinity and surrounds of the WMF's. within parts of the Site.	Unlikely to ever occur. Shelter sites (e.g. trees with loose bark) are not present in the irrigation areas.
Insects	*Jalmenus eubulus* Pale Imperial Hairstreak	-	V	Usually associated with Brigalow (*Acacia harpophylla*) open forests and woodlands (Valentine and Johnson 2012).	Unlikely to ever occur. Habitat with suitable food plants (e.g. *Acacia harpophylla*) is not present in adjacent to WMFs.	Unlikely to ever occur. Habitat with suitable food plants (e.g. *Acacia harpophylla*) is not present in the irrigation areas.

[1] CE = Critically Endangered; E = Endangered; V = Vulnerable; NT = Near Threatened; SLC = Special Least Concern; LC = Least Concern

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4.0 WATER TREATMENT ACTIVITIES

The life cycle of chemicals used during the treatment of produced water at the WMF associated with the Project Stage 2 includes the following general categories:

- Transportation of chemicals from the supplier warehouse to the WMF;
- WMF operations, includes storage and treatment of waters (e.g., reverse osmosis and ion exchange);
- Beneficial reuse, which is post-treatment transfer (pipeline or trucking) and use of water for irrigation, project use (construction and dust suppression) and stock watering; and,
- Storage of brine post treatment.

Each life cycle stage is discussed in further detail in the subsequent sections.

4.1 Transport of Chemicals to and from the WMF

Vendor chemicals utilised at the WMF will be conveyed by truck from the supplier or storage warehouse to the WMF.

The specific routes followed will vary depending upon supplier location in relation to the WMF; however, the route will generally include a combination of State-controlled highways and regional connecting roads. The transportation will be conducted in accordance with relevant regulatory requirements. The roads utilised generally comprise two-lane, sealed and divided roads.

A map of Santos GLNG approved roads for chemical transport in the context of potential MNES receptors is provided in **Figure 5-1**.

4.2 WMF Treatment Operations

A range of chemicals is utilised at water management and treatment facilities. A combination of processes are used in the treatment of water:

1. Solids Removal: this can comprise settling (in aggregation dams) and chemical amendment and filtration within the water treatment plant. Any solids removed in the treatment process (outside of the dams) is placed directly into waste skips for transportation and off-site disposal.
2. Desalinisation (via reverse osmosis [RO]): conducted to remove both organic and inorganic constituents and/or chemicals utilised for treatment.
3. Ion Exchange: conducted for removal of selective ions (if needed).

In the process of desalinisation, a brine waste stream is generated that is discharged to a specially constructed brine dam. Waste water from periodic (i.e., monthly) backwashing and cleaning of the RO membranes is also sent to the brine dam.

Once treated, the effluent from the plant is typically transferred to water storage dams for blending with other water sources or direct reuse. Amendment to the water (i.e., the addition of macro and micro nutrients), will be primarily calcium to modify the sodium adsorption ratio prior to application and pH adjustment may occur (if necessary).

The water treatment chemicals utilised include polymers for flocculants for solids removal (these are primarily trapped in the removed solids), antiscalants, pH adjustment, and backwashing agents for the RO membranes.

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All chemicals are contained within engineered tanks and structures that include secondary containment, and after passing through the RO process they (or their breakdown products) are present in the effluent at low concentrations.

4.3 Beneficial Reuse

The beneficial use of produced water after treatment may include a range of purposes including:

- Dust suppression (spraying onto engineered surfaces such as road and construction areas);
- Operational reuse;
- Construction water;
- Stock watering; and
- Irrigation.

The majority of treated water is used beneficially for the irrigation of pasturelands and crops used as food supplements for cattle. The water is transferred via pipelines or trucking.

4.4 Chemical Residuals in Wastes

Two waste streams are generated from the water treatment process that will contain chemicals introduced into the process. These include the brine and backwash wastes that are subsequently stored in the engineered brine ponds and the filtration solids that are stored in sealed waste containers prior to off-site transportation and disposal.

Long-term management options are currently being evaluated for the wastes within the brine ponds, with these wastes currently contained and allowed to evaporate. The potential for exposures to these fluids is low as they are contained in a fenced facility with the ponds engineered to prevent leakage (double-lined ponds with leak detection), and routine inspection and monitoring is conducted to demonstrate that leakage is not occurring. On this basis, exposures to water treatment chemicals that may be entrained within brine are considered incomplete.

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5.0 PROBLEM FORMULATION AND ISSUE IDENTIFICATION

Problem formulation and issue identification in the chemical risk assessment process involves defining the bounds of the human health and environmental risk assessment to ensure the risk managers are informed properly and are utilising the best practices as identified previously. It identifies the key issues regarding the potential concern from the potential exposure to the individual, which are as follows:

1. What is the concern?
2. Why is it a concern?
3. What is the urgency of the concern?
4. What is the perception of the concern?

A description of the current environmental setting includes identifying potential receiving environments and susceptible or vulnerable populations, and the site-specific details of each of the components of exposure (i.e., source, transport, route, receptor) that are potentially complete exposure pathways. This step involves a CEM and assessment endpoints, and an analysis plan that outlines the goals, scope and complexity of the chemical risk assessment. Potential management options may be proposed to mitigate those hazards and exposures pathways that may be the most significant contributors to the overall risks.

5.1 Risk Assessment Scope

The scope of the risk assessment (bounds) will encompass the life cycle of the chemicals used in water treatment processes within the Santos GLNG GFD Project Stage 2 area as discussed in the preceding sections. Included in this assessment are:

- The transportation of chemicals from the warehouse to the WMF;
- Treatment of produced water at the WMF using chemicals for treatment and balancing/conditioning prior to beneficial reuse;
- Beneficial use of water that may contain low concentrations (residual) of water treatment chemicals, including the transfer of water to beneficial use locations;
- Disposal of waste solids from the filtration of water prior to treatment by the RO plant; and
- Storage of waste (brine and backwash waters) in the brine ponds that may contain entrained water treatment chemicals.

Potential environmental media affected by this life cycle includes soil, surface water, and groundwater. Susceptible receptors would include workers and associated community representatives that may be affected by the life cycle operations. In addition, environmental receptors include natural resources and ecological receptors.

Table 5-1 summarises the specific bounds of this chemical risk assessment.

Table 5-1 Bounds Defined Specific to Project

Life Cycle Stage	Bounds
Transportation of chemicals	The transportation route will include the road network traversed from the supplier to the WMF. Refer to **Figure 5-1** for a map of existing roads proposed to be used.
Beneficial Reuse	The beneficial reuse of treated produced water associated with the project. The treatment operations are constrained by the physical bounds of the WMF including the storage ponds for treated produced water and brine. Conveyance of treated produced water for beneficial use. Beneficial reuse of treated water which will comprise project reuse (dust suppression, construction activities, drilling and completions), irrigation and stock watering.

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Life Cycle Stage	Bounds
Disposal	Disposal of wastes from the water treatment process is limited to solids removed prior to treatment by RO. A combination of chemical flocculants/coagulants/polymers are used to aid in the removal of solids. These wastes are containerised on-site and transported off-site to a licenced facility for disposal. Brine wastes and backwash wastes are also produced from the RO process and are stored in the brine ponds. Alternatively backwash wastes could be transported off-site for disposal at a licenced facility.

RO = reverse osmosis
WMF = water management facility

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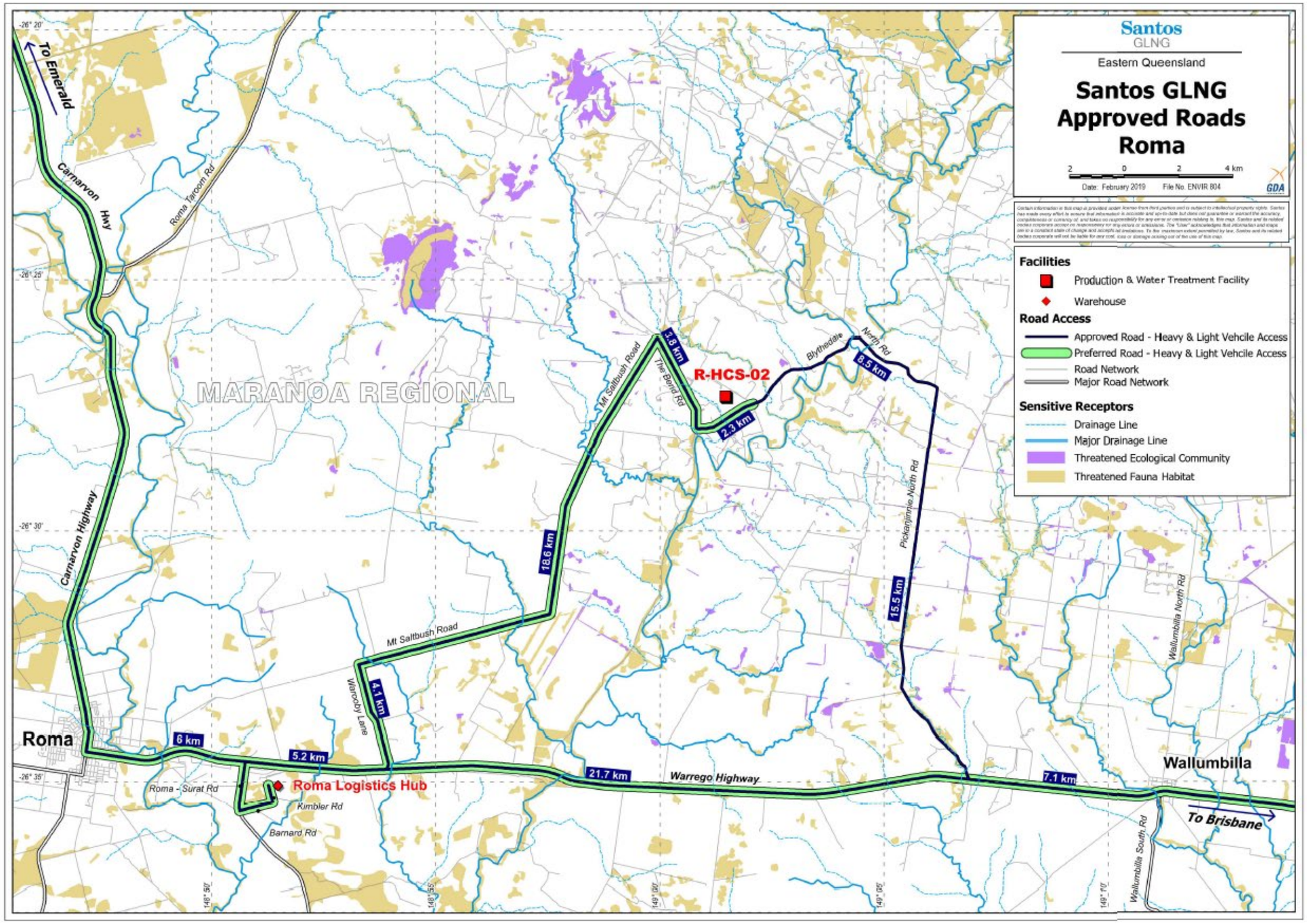

Figure 5-1 Existing Road Map

5.2 Key Issues

Identifying key issues that are amenable to a risk assessment evaluation is an integral part of the risk assessment process. This step includes identifying the issue or concern and discussing why it is a concern, what the urgency of the concern is, and what is the perception of the concern. As previously discussed, there are five primary life cycle stages of the chemicals in the produced water treatment process:

1. The transportation (including loading and unloading) of chemicals from the warehouse to the WMF;
2. Storage and the use of water treatment chemicals at the WMF and treated water storage;
3. Conveyance of treated water to beneficial use (with residual chemicals);
4. Beneficial reuse (with residual chemicals); and
5. Waste storage and disposal – backwash solids and brine wastes (with residual chemicals).

Whilst each life cycle generates concerns specific to its stage, concern over handling and management of chemicals to minimise potential harmful effects to human health and the environment is present in all five stages.

Therefore, cumulative assessment of potential risks is addressed for complete exposure pathways at each stage, as well as within a stage, for MNES and non-MNES receptors. Key issues for the life cycle of the use of chemicals are discussed in the following sections. These issues have been integrated into the CEM described below.

Cumulative assessment with other Santos GFD Project Stages is presented in **Section 8.5**.

5.3 Conceptual Exposure Model

An essential component of the risk assessment is the CEM that describes the chemical source(s), pathways of chemical migration through environmental media and the potential susceptible populations (both human and ecological) that may be exposed.

In the development of the CEM, current environmental setting and land uses, environmental fate and transport mechanisms, and life cycle stages of usage of chemicals and relevant receptors are evaluated to determine which pathways are potentially complete and identify potential receptors for those pathways.

5.3.1 Source - Chemicals of Potential Concern

In accordance with NEPM, enHealth, and DoEE guidance including NICNAS evaluations, the constituents of potential concern (COPCs) are identified as part of the Problem Formulation and Issue Identification (NEPM, 2012; enHealth, 2012a; DoEE, 2017). The approach for the identification of the COPCs also is outlined in the Approach – Indirect Estimation (Scenario Evaluation) step in ExpoBox (USEPA, 2016) and in the Hazard Assessment – Evaluating Existing Information step in the OECD (2014).

Safety data sheets (SDSs) for each of the WMF products are included in **Appendix B** of this report.

The COPCs addressed in this risk assessment include the chemicals used in the WMF currently planned for use. Additional WMF process and usage information for these COPCs is included in **Appendix C.**

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The vendor chemicals used in the Roma WMF will be considered as COPCs in this risk assessment for both qualitative and quantitative assessment. The WMF vendor chemicals present in these products, including their purpose and maximum quantity, are included in **Table 5-2**.

Table 5-2 Water Management Facility Chemicals

Proprietary Name	Chemical Name	CAS No.	Use	Approximate Quantity Stored On-Site (plant available storage)
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite Sodium Hydroxide	7681-52-9 1310-73-2	Oxidizing agent / disinfectant	15000 L
Hydrex 4129 (antiscalent)	Phosphonic Acid 1-Hydroxyethylene (1,1 diphosphonic acid) Diethylene triamine penta (methylene phosphonic acid) pentasodiun salt	13598-36-2 2809-21-4 22042-96-2	Antiscalant / scale inhibitor	2 x 1000 L (IBC)
Sodium Bisulphite	Sodium Bisulphite Water	7631-90-5 7732-18-5	Dechlorination	4 x 1000 L (IBC)
Ammonium Hydroxide 10-35%	Ammonia Water	7664-41-7 7732-18-5	Disinfectant	2 x 1000 L (IBC)
MAK MFC1 (multi floc coagulant)	Cationic Polymer Aluminium Hydroxychloride Water	n/a 1327-41-9 7732-18-5	Polymer / coagulant	2 x 1000 L (IBC)
MAK-SU Sulphuric Acid	Sulphuric Acid Water	7664-93-9 7732-18-5	pH adjustment	2 x 1000 L (IBC)
Sodium Hydroxide 50% (Caustic Soda)	Sodium Hydroxide Water	1310-73-2 7732-18-5	pH adjustment	2 x 1000 L (IBC)
Hydrex 4703 (Citrex)	Sodium Citrate Dihydrate Water	6132-04-3 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Hydrex 4705 (alkaline CIP)	Ethylenediaminetetraacetic Acid, tetrasodium salt Potassium Hydroxide Sodium Carbonate Water	64-02-8 1310-58-3 497-19-8 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Hydrex 4714 (CIP)	Hydrogen peroxide Acetic Acid Peroyxacetic Acid Water	7722-84-1 64-19-7 79-21-0 7732-18-5	Membrane cleaning	2 x 1000 L (IBC)
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate Water	12042-91-0 7732-18-5	Coagulant	20000 L

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Proprietary Name	Chemical Name	CAS No.	Use	Approximate Quantity Stored On-Site (plant available storage)
Hydrex 3502 (Actiflo Polymer)	Polyacrylamide (anionic)	9003-05-8	Actiflo polymer	1000 kg
Hydrex 69226 (Sludge Polymer)	Adipic Acid Cationic acrylamide copolymer	124-04-9 69418-26-4	Sludge polymer	1000 kg

CAS No = Chemical Abstracts Service Number
n/a = not available
IBC = intermediate bulk container
kg = kilogram
L = litre

5.3.1.1 Life Cycle Mass Balance

The conceptual framework for the typical mass balance for chemicals throughout the water treatment chemical life cycle is provided in the following text and is summarised in **Figure 5-2**. Additional WMF life cycle process and usage information is included in **Appendix C**.

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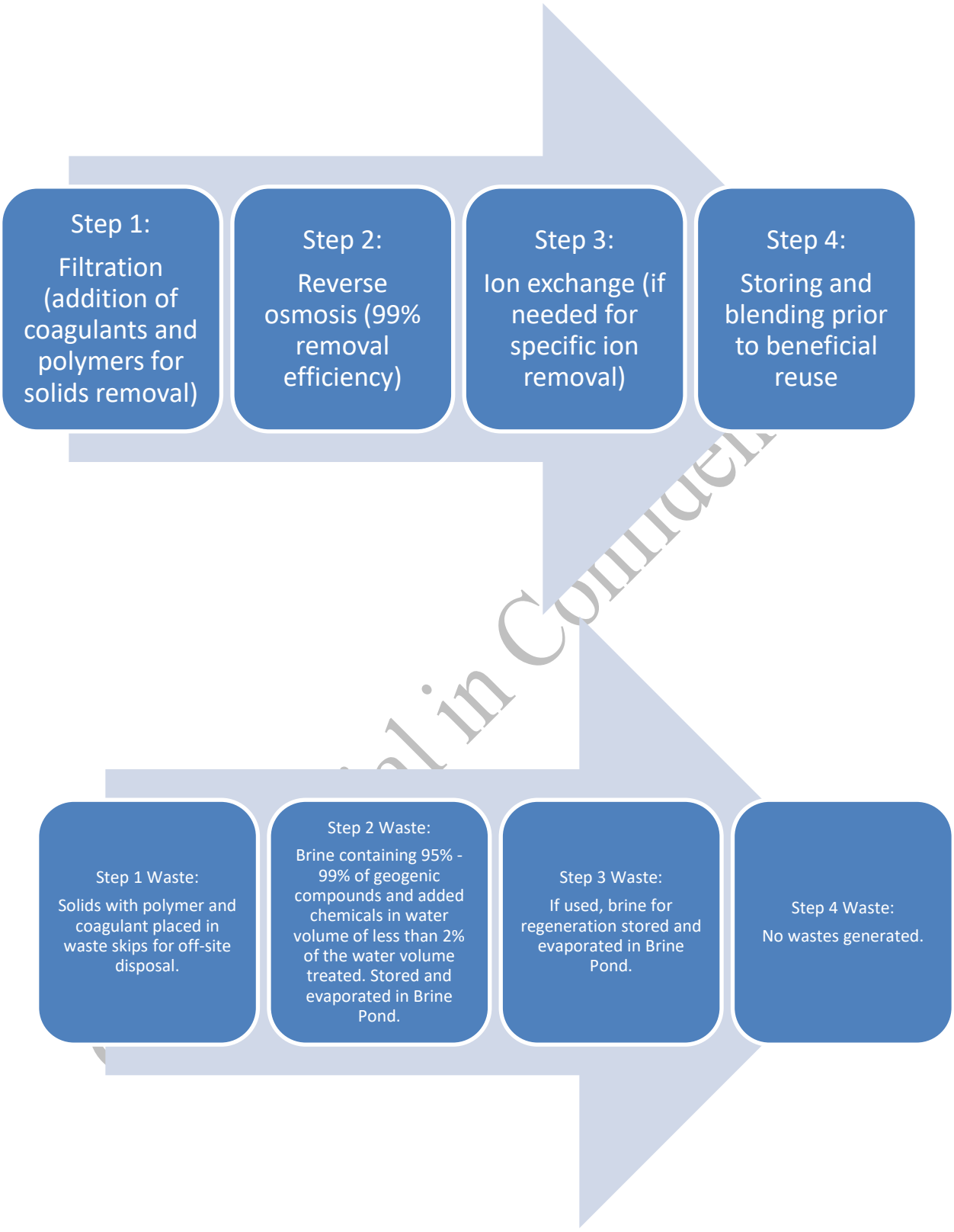

Figure 5-2 Typical Mass Balance for Water Treatment Facility Chemical Loss

- Step 1: Chemical additions at the WMF are conducted prior to treatment and to support suspended solids removal and to prevent fouling of the RO and ion exchange (IX) treatment equipment.
- Step 2: Post suspended solids removal, the chemicals are added and the water is treated by RO to reduce concentrations in the effluent by approximately 95 percent (with in many cases mass removal efficiencies greater than 99 percent). A high quality permeate (95 percent of the volume) is produced, with the low quality brine waste (5 percent of the volume and up to 99 percent of the chemical) piped to the brine pond for storage and evaporation. Larger molecules, such as the chemical additives described below, are preferentially removed by the RO process.
- Step 3: Ion exchange (if needed) is conducted for selective ion removal (e.g., fluoride). No chemical additions are conducted post RO and prior to IX treatment.
- Step 4: Storage of treated water and conveyance for beneficial reuse and storage of brine.

Permeate is stored in ponds that facilitate further mass reductions of organic constituents via biodegradation prior to conveyance and beneficial use. The permeate ponds have a holding time of greater than 5 days, and often greater than 20 days (based on throughput).

In terms of the brine waste generated from the process, the brine will be retained in ponds that will also result in additional biodegradation of organic chemicals. Brine is allowed to evaporate in these ponds to reduce the volume. No off-site transportation and disposal of brine is planned at this time. The only waste stream transported off-site for disposal are the solids generated in Step 1 of the treatment process.

5.3.2 Potential Receptors

During the water treatment, water conveyance and beneficial reuse processes, there is the potential for the human and environmental receptors to be exposed to water treatment chemicals.

Susceptible populations are those that have an increased health risk due to intrinsic biological factors including genetic factors, age and prior existing disease. Vulnerable populations include those that may be at higher risk due to environmental factors such as poverty, malnutrition, poor sanitation and climate change. There is the possibility that susceptible (e.g., the elderly or children) and/or vulnerable populations are located along the transportation route.

At the WMF, the potential for exposure of sensitive receptors (including MNES) during Project Stage 2 is considered low as these facilities are existing and are operational industrial facilities (and thereby provide no habitat value).The industrial activities and operation of equipment do not make it a setting conducive to incursion of fauna.

Human receptors that will be exposed are common for each of the chemical life cycle components. Based on an assessment of land use and an understanding of the project description provided in the EIS (URS, 2014), likely human exposure would include:

1. Workers at the WMF including operators, maintenance staff and supervisors.
2. First responders in contact with releases whilst responding to emergencies either at the WMF or along the transport or conveyance routes.
3. Trespassers who stray (either advertently or inadvertently) onto the WMF during operations. Trespassers would also have access to the road network and surface water features that receive runoff and/or releases from transportation accidents or site-related releases.
4. Agricultural workers/residents who have access to the road network; this cohort would also have access to surface water features that receive runoff and/or releases from conveyance or transportation related or site-related releases.
5. Agricultural workers at irrigation areas.

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6. Recreational users who have access to areas adjacent to the road network. Recreational users would also have access to surface water features that receive runoff and/or releases from conveyance / transportation related or site-related releases.

Fundamentally the probability of exposure to ecological receptors, and what ecological receptors have the potential to be exposed, is constrained by the constraints protocol that, as noted above, precludes activities from sensitive areas as shown below (Santos, 2016). This as a result constrains the ecological receptors that could be exposed as a result of activities at the WMF and beneficial reuse activities. However roads (where transportation of chemicals can occur) and pipelines (where treated water is conveyed) can transect sensitive ecological areas (including MNES).

The chemical risk assessment does include ecological receptors associated with the aquatic and terrestrial ecosystems and water resources. The hazard assessment, and the exposure assessment and risk characterisation, assesses the potential risks to these receptors based on both qualitative and quantitative methodologies. The qualitative assessment utilises the information presented in the dossiers on the relative toxicity of the aquatic and terrestrial flora and fauna to the chemical. This 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. A 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.

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Constraint Categories	Development Permitted	Constraint
No-go area	• No petroleum activities	• National parks [1] • Conservation parks • Forest reserves
		• Spring vents and/or spring complexes protected under the EPBC Act (i.e. spring where the listed TEC *The community of native species dependent on natural discharge of groundwater from the Great Artisan Basin* has been identified and/ or springs that support other EPBC listed threatened species)
		• 'Wetlands of High Ecological significance' also known as 'High conservation value wetlands' as detailed in the Map of Referrable Wetlands dataset (QLD) • Wetlands of International Importance (Ramsar)
High constraint area	• Low impact petroleum activities1 • Linear infrastructure1	• Watercourses
		• 'General ecologically significant wetlands' or 'Wetlands of other environmental value' as detailed in the Map of Referrable Wetlands dataset
		• All other spring vents / spring complexes (not protected under the EPBC Act)
		• Habitat for a species listed as critically endangered under the EPBC Act at the time of referral[3]
Moderate constraint area	• All petroleum activities2	• Constraints Basis Ranking 3 - MNES identified under the EPBC Act with a constraint basis ranking score between 10-14
		• Constraints Basis Ranking 2 - MNES identified under the EPBC Act with a constraint basis ranking score between 5-9
		• Constraints Basis Ranking 1 - MNES identified under the EPBC Act with a constraint basis ranking score between 0-4
Low constraint area	• All petroleum activities	• 'No Concern at Present' REs
		• Non-remnant vegetation
		• Existing Santos infrastructure
		• Existing roads, rail, pipeline and other infrastructure that would have to be considered during field development

[1] Definitions for these activities are provided in Section 6.0.

[2] All petroleum activities will be permitted within the moderate constraint area, however, disturbance will be avoided in accordance with the relevant MNES constraints ranking whereby patches with a higher MNES constraint basis ranking will be preferentially avoided over areas with a lower MNES constraint basis ranking.

[3] Habitat for species listed as critically endangered under the EPBC Act at the time of referral will be treated as a high constraint area irrespective of the constraints basis ranking. Infrastructure developments in these areas will be restricted to Low impact petroleum activities and linear infrastructure.

Constraint Category	Low impact petroleum activities	Linear Infrastructure	Wells & related petroleum activities	Petroleum activities
No Go area	No	No	No	No
High constraint area	Yes	Yes	No	No
Moderate constraint area	Yes[1]	Yes[1]	Yes[1]	Yes[1]
Low constraint area	Yes	Yes	Yes	Yes

[1] All petroleum activities will be permitted within the moderate constraint area, however, disturbances will be avoided in accordance with the relevant MNES constraints ranking whereby patches with a higher MNES constraint basis ranking will be preferentially avoided over areas with a lower MNES constraint basis ranking.

The following sections discuss the potential receptors for each phase of the life cycle.

5.3.3 Transport and Loading / Unloading of Chemicals to WMF

The primary concerns identified for the transport of chemical products from the supplier warehouse to the WMF are:

- Occupational exposure to workers during loading and offloading chemicals and from accidental spillage and release from storage containers. This may result in adverse health effects.
- Non-occupational exposures to other human receptors that may be in proximity to transport routes should accidental release occur. This may result in adverse health effects.
- The potential exposure to emergency first responders responding to an accident. This may result in adverse health effects.
- Non-occupational exposures to environmental receptors (such as terrestrial and aquatic fauna and flora, stock, and surface and groundwater resources). This may result in adverse effects to such environmental values.

However, the probability and potential for exposure to occur is considered low based on the following:

- Incident data provided by the Department of Transport and Main Roads (DTMR, 2015) for the region.
- Rate of containment equipment failure for the natural gas industry (URS, 2014).
- The containerisation (i.e., small package size for higher hazard chemicals) and storage / containment meeting all relevant Australian Standards.
- The utilisation of appropriate loading and unloading procedures, use of mechanical loading equipment.
- The use of applicable personal protective equipment (PPE).
- The use of a limited number of upgraded and approved roads (on tenure).

These factors combined ensure that there is a low potential for exposure to occur.

5.3.4 Storage and the Use of Water Treatment Chemicals and Treated Water Storage.

The primary concerns for the storage of chemicals, the use of chemicals in the treatment process at the WMF and subsequent storage of produced water (that may contain entrained residual chemicals) are:

- Occupational exposure to workers during the operational use of the chemicals and from accidental spillage and release from storage containers. This may result in adverse health effects.
- The potential exposure to emergency first responders responding to an incident at the WMF.
- Non-occupational exposures to environmental receptors (such as terrestrial and aquatic fauna and flora, stock, and surface and groundwater resources). This may result in adverse impacts to such environmental values.

However, the potential for exposure to occur is considered low based on the following:

- As with the potential occupational exposures during transport of chemicals, potential exposures during treatment activities are low due to the employment of mechanical equipment/processes and engineering controls (including secondary containment);
- Storages constructed in accordance with Australian standards and managed and monitored in accordance with regulatory requirements;
- The provision of spill clean-up kits on-site and the training of operational personnel on spill clean-ups;
- Fencing and preventing access to unauthorised persons;
- Training and, administrative management controls; and
- The use of applicable PPE.

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Engineered treated water storages have been constructed in accordance with Queensland Environmental Authority conditions and include minimum hydraulic performance requirements, leak detection systems, maximum operating limits and triggers for mandatory reporting and actions to reduce the storage volume and monitoring.

Potential exposures to chemicals in the treated water are potentially complete, and a combination of training, administrative management controls and PPE will be utilised if potential risks are determined to be unacceptable.

5.3.5 Conveyance of Treated Water to Beneficial Use

The conveyance of treated water from the WMF to dams and beneficial reuse locations is conducted via pipelines with the primary concerns associated with accidental releases which may result in:

- Occupational exposure to workers from as a result of pipeline failure or direct exposure to the water being beneficially reused. This may result in adverse health effects.
- The potential exposure to emergency first responders responding to an incident.
- Non-occupational exposures to environmental receptors (such as terrestrial and aquatic fauna and flora, stock, and surface and groundwater resources) from an accidental release associated with pipeline failure. This includes the potential for vertical or horizontal migration (surface or subsurface). This may result in adverse impacts to such environmental values.

However, the potential for exposure to occur is considered low based on the following:

- Pipelines are constructed in accordance with Australian standards and undergo inspection and testing prior to use.
- Pipelines are monitored and pressure drops and changes in flow result in alarms and shutdowns as needed.
- Routine inspections are conducted on pipelines and signage is provided to ensure subsidence or ground disturbance does not result in releases.
- Training and administrative management controls are provided for workers associated with pipeline activities and/or responses to a release.
- Applicable PPE is used.

5.3.6 Beneficial Reuse of Treated Water

Produced water will be transferred from the water treatment facility to beneficial use areas; these transfers will use pipelines for conveyance or will be trucked.

The primary concerns for beneficial use of treated water (that may contain residual entrained chemicals) are:

- Occupational exposure to workers as a result of pump, pipeline or equipment failure or direct exposure to the water being beneficially being reused. This may result in adverse health effects.
- The potential exposure to emergency first responders responding to an incident.
- Non-occupational exposures to environmental receptors (such as terrestrial and aquatic fauna and flora, stock, and surface and groundwater resources) from an accidental release associated with an equipment or pipeline failure or from the direct beneficial reuse activity. This includes the potential for vertical or horizontal migration (surface or subsurface). This may result in adverse impacts to such environmental values.

However, the potential for exposure to occur is considered low based on the following:

- Environmental Authority (EA) or Beneficial Use Approval conditions regulate project reuse, stock watering and irrigation;
- These regulate the quality of water, the application techniques and location of application and monitoring required;

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- Dust suppression and construction activities and discrete events with no pooling or run-off authorised;
- Irrigation areas are designed to manage the risk of pooling and run-off with a general deficit irrigation strategy employed; and
- Irrigation areas are fitted with monitoring bores to manage the risk of vertical and horizontal migration.

These factors combined ensure there is low potential for an exposure to occur.

5.3.7 Management of Wastes

The management of wastes is limited to containment of brine and backwash wastes in engineered dams and smaller volumes of pre-treatment wastes (suspended solids) that are containerised and then transported off-site for disposal.

The primary concerns for the storage of brine and the storage and/or transport for disposal of waste (that may contain residual entrained chemicals) are:

- Occupational exposure to workers due to accidental spillage as a result of an incident. This may result in adverse health effects.
- The potential exposure to emergency first responders responding to an incident.
- Non-occupational exposures to environmental receptors (such as terrestrial and aquatic fauna and flora, stock, and surface and groundwater resources) from an accidental release associated with the storage or transport of waste. This includes the potential for vertical or horizontal migration (surface or subsurface). This may result in adverse impacts to such environmental values.

However, the potential for exposure to occur is considered low based on the following:

- The management of wastes is limited to containment of brine and backwash wastes in engineered dams and small volumes of suspended solids that are containerised and then transported off-site for disposal. As described above, the brine storage dams are highly engineered structures – designed, constructed and operated in accordance with Queensland EA conditions to prevent leakage.
- The brine dams are contained within a fenced, manned facility.
- The brine dams are fitted with leak detection monitoring systems and leak collection. On this basis, ecological receptors and human receptors are specifically precluded from these areas.
- The potential for overtopping of dams during high rainfall events is considered low as Santos (in accordance with EA conditions) maintains the levels in dams at lower than normal levels during the wet season and continuously monitors and adjusts water levels (via pumping and rebalancing of water storage). Further, this monitoring would alert Santos operational staff and first responders to this low probability of release such that actions could be undertaken to mitigate risks.
- Mechanical equipment and processes limit the potential for occupational exposures to the brine and backwash materials.
- Training is provided and administrative management controls and applicable PPE are used.
- Only licenced waste transportation providers are used.

Approved and upgraded roads are used. These factors combined ensure there is low potential for an exposure to occur.

5.3.8 Summary of Potentially Complete Exposure Pathways

Based on the background information provided in **Section 5.3** and as shown in **Figure 5-3**, the potential modes of release include:

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- Transport of chemicals from a supplier/vendor or storage facility to the WMF;
- Handling of chemicals during the treatment and processing of produced water at the WMF;
- Storage and transport / conveyance of treated produced water (entrained water treatment chemicals) to the point of beneficial reuse;
- Beneficial use of treated water (entrained water treatment chemicals), in particular irrigation of water to land; and
- Storage of brine (and entrained water treatment chemicals) or accumulated salts (this is considered unlikely at this time as sufficient capacity exists in the brine dams for the brine to be retained on-site and allowed to evaporate). Ultimately a Brine Management Plan will be developed, if and as needed, documenting the final solution for accumulated materials.

Based on an evaluation of the life cycle of water treatment products and chemicals, environmental conditions in the areas of development, anticipated populations, and location selection, the following potentially complete exposure pathways were identified:

- Transportation of chemicals
  - Human and ecological receptor exposure to chemicals as a result of accidental release during transport from the supplier warehouse to the WMF.
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release during transportation.
- Use of water treatment chemicals
  - Human and ecological receptor exposure to chemicals as a result of accidental release of stored materials.
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release of stored materials.
- Recycling, disposal and beneficial reuse
  - Human and ecological receptor exposure to residual chemicals in the treated water transported / conveyed to beneficial use areas.
  - Human and ecological receptor exposure to residual chemicals in the treated water storage.
  - Human and ecological receptor exposure to residual chemicals in the treated water being beneficially reused.
- Transportation and storage of waste
  - Human and ecological receptor exposure to chemicals as a result of accidental release during transport of waste from WMF.
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release during transportation.
  - Human and ecological receptor exposure to chemicals as a result of accidental release of stored waste and/or brine.
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release of stored materials.
  - Human and ecological receptor exposure to chemicals as a result of accidental release of stored materials.
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release of stored materials.

These pathways, where applicable to the specific life cycle phases and COPCs, will be assessed further in the hazard assessment for the water treatment geogenic and vendor chemicals in the WMF.

The specific life cycle phases considered in this chemical risk assessment are discussed further in the hazard assessment and exposure assessment. Where applicable, cumulative assessment of potential risks is addressed for complete exposure pathways at each stage, as well as within a stage, for MNES and non-MNES receptors.

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	Lifecycle Primary Source	Water Management Facility Activities								
	Modes of Release	Transport of Chemicals to WMF	Storage and Use WMF Chemicals	Treated Water Storage	Conveyance Treated Water Beneficial Use	Irrigation Beneficial Reuse	Stockwater Benficial Reuse	Dust Supression Beneficial Reuse	Construction Beneficial Reuse	Operational & Waste Management
Affected Environment	Soils	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Surface Water	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Groundwater	No	No	No	No	No	No	No	No	No
	Report Section									
SOILS										
Ecological Receptors	Terrestrial flora	C	I/LP	C	C	C	C	C	C	C
	Terrestrial fauna	C	I/LP	C	C	C	C	C	C	C
	Aquatic flora[1]	IC	IC	IC	IC	IC	IC	IC	IC	IC
	Aquatic fauna[1]	IC	IC	IC	IC	IC	IC	IC	IC	IC
SURFACE WATER										
Ecological Receptors	Terrestrial flora	IC	IC	IC	IC	Cb	IC	IC	IC	IC
	Terrestrial fauna	IC	IC	IC	IC	Cb	Ca	IC	IC	IC
	Aquatic flora	C	I/LP	C	C	C	C	C	C	C
	Aquatic fauna	C	I/LP	C	C	C	C	C	C	C
GROUNDWATER										
Ecological Receptors	Terrestrial flora	IC	IC	IC	IC	IC	IC	IC	IC	IC
	Terrestrial fauna	IC	IC	IC	IC	IC	IC	IC	IC	IC
	Aquatic flora	IC	IC	IC	IC	IC	IC	IC	IC	IC
	Aquatic fauna	IC	IC	IC	IC	IC	IC	IC	IC	IC

NOTE

C	Complete exposure pathway
IC	Incomplete exposure pathway
I/LP	Insignificant / Low Probability Exposure Pathway
NA	Not a Matters of National Environmental Significance (MNES)
a	Livestock only
b	Surface ponding resulting from application of irrigation
1	While no direct pathway, the potential for leaching from soil to surface water and/or groundwater is addressed in Section 5.3 (Conceptual Exposure Model)

Figure 5-3 Conceptual Site Exposure Model for Water Treatment Activities

6.0 HAZARD ASSESSMENT

The hazard assessment evaluates the human health and environmental hazard of the chemicals identified in the problem formulation and issue identification step specific to the WMF chemicals identified previously.

The assessment of hazards is based on a qualitative and quantitative evaluation of the potential risks. The qualitative assessment includes assessing the potential for an impact to occur from an exposure to WMF chemicals, if such an exposure was to occur.

The quantitative assessment includes exposure to the chemicals that may occur during activities during the storage and treatment of chemicals and beneficial reuse of the treated water where operational activities include greater exposure to the environment, including direct releases to the environment (e.g., land application).

The assessment of risks was conducted in phases that progressively utilise more detailed levels of data collection and analysis. The phases include a qualitative evaluation, and the next phase initiates the quantitative risk assessment process and includes comparison of potential hazards of exposure of COPCs in environmental media to risk-based screening criteria for human and ecological receptors.

The specific steps in the hazard assessment combine the hazard identification in NEPM (2012) and enHealth (2012a) and the processes described above. These specific topics and the steps included in the hazard assessment are provided in the following:

- Human health and environmental hazards – The toxicology of the chemicals and the calculation of toxicological endpoints are assessed and calculated in the toxicity assessment. The proprietary nature of some of the WMF chemicals requires that rigorous research and analyses are conducted to prepare the risk assessment dossiers that are used in the hazard assessment. This research and analyses follow the best practice risk assessment methodology described above.
- Persistent, Bioaccumlative and Toxic (PBT) assessment – Chemical-specific information is compiled and compared to established Australian and European Union (EU) Registration, Evaluation, Authorisation and Restriction of Chemical Substances (REACH) criteria to provide an assessment of the overall hazard presented by the chemical utilising databases established by OECD. This relative ranking enables a comparison of chemicals based on the PBT findings and may facilitate the evaluation of alternative chemicals for use in water treatment.
- Soil and water guidelines – The development of the guidelines utilises the human health and environmental hazard information compiled in the risk assessment dossiers to calculate risk-based criteria for assessing human health and ecological exposure to the chemicals. The risk-based criteria are conservative guidelines to assess the degree of hazard of the chemical when released into the environment at a point of exposure for a human or ecological receptor.
- Qualitative and quantitative assessment – Activities that may result in accidental exposures to human and ecological receptors are assessed qualitatively and focus on the vendor chemicals. This assessment provides information to be used as a complement to the PBT assessment to provide a summary of human and ecological hazards that may occur from exposure to the chemicals; typically, this information informs first responders and health and safety personnel to the hazards that may be present when an accidental exposure occurs. In addition, some activities that may result in exposure are quantitatively evaluated in the hazard assessment by comparing concentrations of the chemicals in the environment resulting from these activities to the risk-based criteria. The quantitative evaluation assesses cumulative potential risks for complete exposure pathways at each stage, as well as within a stage, for MNES and non-MNES receptors. This screening enables a quick determination of the magnitude and severity of the potential exposure, and whether it warrants additional assessment in the detailed exposure assessment and risk characterisation phases of the chemical risk assessment.

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In the following sections, the qualitative and quantitative toxicological information to assess the potential risks is presented. The WMF chemicals are assessed either qualitatively based on appropriate safety, handling, and transportation guidance, or quantitatively based on applicable screening standards to evaluate the potential risks throughout the life cycle process.

6.1 Toxicity Assessment

Risk assessment dossiers were prepared for the chemicals contained in the chemicals products used in the WMF (**Table 5-2**). In general, the risk assessment dossiers include chemical identification, physical and chemical properties, environmental fate properties, human health and environmental hazard assessments, derivation of non-cancer and cancer screening levels, a PBT assessment, classification, labelling, handling and safety information. Additionally, disposal management, as well as regulatory status, are presented in the dossiers.

In addition to the guidance noted in **Section 5.0**, the data sources for the risk assessment dossiers included the Inventory Multi-Tiered Assessment and Prioritisation (IMAP) framework through NICNAS. The risk assessment dossiers were prepared in accordance with the Hazard Assessment – Gathering and Evaluating Existing Information and Assessing the Hazards and Exposure Assessment – Environmental Fate and Pathways Steps in OECD (OECD, 2014).

The EPA ExpoBox (USEPA, 2016) does not have a specific toxicity or hazard assessment tool, as it deals primarily with the exposure assessment process in the risk assessment framework. **Appendix D** presents the risk assessment dossiers specific to the WMF. **Table D-1** provides a salient summary of each of the chemicals in the dossiers. These dossiers will be updated as new or revised toxicological, regulatory, and physio-chemical information becomes available.

The primary source of information for physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data has been obtained from databases linked to the OECD eChemPortal (www.echemportal.org), which is part of the OECD Environmental Risk Assessment toolkit. In addition, data has been obtained from the following sources:

- Chemical and physical properties data:
  - TOXNET;
  - SDSs; and
  - Modelled data from USEPA (2011a) EPI Suite™ including full outputs.
- Environmental and human health drinking water guidelines:
  - Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection of aquatic ecosystems and stock watering (Australian and New Zealand Environment and Conservation Council [ANZECC] and Agriculture and Resource Management Council of Australia and New Zealand [ARMCANZ], 2000);
  - Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011, Update 2018);
  - World Health Organisation (WHO, 2017) Guidelines for Drinking-water Quality (Fourth Edition);
  - USEPA National Recommended Water Quality Criteria (2009) for protection of aquatic life and human health; and
  - Drinking-water Standards for New Zealand 2005 (Revised 2008, Ministry of Health).
- Human health toxicity data:
  - U.S. Toxic Substances Control Act Test Submissions 2.0 (TSCATS 2.0) database https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0;
  - Literature search (using PubMed and ToxLine); and
  - Internet search (i.e., Google Scholar).
- Ecological toxicological and environmental fate and transport data:
  - USEPA ECOTOX database;
  - Canada Screening Assessment Reports;

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- USEPA TSCATS database;
- Google Search (for regulatory agency documents such as USEPA RED (Re-registration Eligibility Decision) documents for pesticide applications);
- Comprehensive literature searches of peer-review journals; and
- Quantitative structure-activity relationship (QSAR) modelling (i.e., EPI Suite and PetroTox).

The ecological toxicological data was based on guidance provided by the European Chemicals Bureau (ECB) (2003) and by the National Environmental Protection Council (NEPC, 2013). Through this process, soil and water guideline values protective of ecological receptors were used as indicators of toxicity and therefore hazards, if based on toxicological data. Databases that were searched included:

- NEPM (2013);
- Risk Assessment Information System (RAIS);
- USEPA Ecological Soil Screening Levels (2011b);
- National Institute for Public Health and Environmental Protection (RIVM) Target and Intervention levels (1994);
- Soil guidelines (such as predicted no-effects concentration [PNEC] values) derived as part of a chemical assessment (e.g., International Uniform Chemical Information Database [IUCLID], 2011); and
- Concise International Chemical Assessment Document [CICAD]).

To ensure the reliability of the data, physico-chemical properties, environmental fate and transport mechanisms, and ecotoxicity and toxicology were evaluated for data quality to address data quality requirements (i.e., reliability) using the Klimisch scoring system (Klimisch et al., 1997). For in vitro studies and studies that do not have internationally accepted guidelines, the software tool ToxRTool (Schneider et al., 2009) has been used.

6.1.1 Human Health Toxicity Assessment

For human receptors, included in the risk assessment dossiers is a toxicity assessment to determine the relationship between the dose of a COPC taken into the body, and the probability that an adverse effect will result from that dose. Quantitative estimates of the potency of COPCs include two sets of toxicity values, one for genotoxic carcinogens and one for other non-genotoxic carcinogens and non-carcinogenic effects. For the assessment of genotoxic carcinogenic effects, a non-threshold toxicological mechanism was assumed and there was no level of exposure that does not pose a probability that an adverse effect will result from that dose. For toxicity criteria for non-genotoxic carcinogens and non-carcinogenic effects, it was assumed that there is a threshold effects level, below which adverse health effects are not expected to occur.

The assessment of carcinogenic effects was conducted following the review of the available data (utilising a weight of evidence approach) in relation to genotoxicity. Genotoxic carcinogens were evaluated based on a non-threshold dose-response relationship, quantified through the use of a unit reference factor (URF) for inhalation exposures and/or slope factor (SF) for oral and dermal exposures. The URF (expressed as 1/microgram per cubic metre [µg/m^3]) or SFs (expressed as 1/milligram per kilogram per day [mg/kg/day]) evaluated were upper-bound estimates of the excess cancer risk due to continuous exposure to a COPC averaged throughout the course of a 70-year lifetime. The referenced bases of URF and SFs were data from lifetime animal bioassays, although human data are used when available.

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Where carcinogenic effects were associated with a non-genotoxic mode of action (or where the insufficient weight of evidence was available to support a genotoxic mode of action), these effects were characterised based on a threshold. Other non-carcinogenic effects, such as organ damage, endocrine inhibitors, or reproductive effects, were evaluated on the basis of a threshold. The risk assessment dossiers provide the chemical-specific mode of action and non-carcinogenic effect used in the assessment of toxicology of each of the WMF chemicals. These threshold values were defined as reference concentrations (RfCs) or tolerable concentrations (TCs) for inhalation exposures and reference doses (RfDs) or acceptable daily intakes (ADIs)/tolerable daily intakes (TDIs) for oral and dermal exposures. These threshold values may be available for different durations of exposure ranging from acute to chronic exposures), with the focus of the assessment presented in this report on chronic exposures. A chronic RfC/TC or RfD/ADI/TDI was defined as the concentration or intake that all members of the public may be exposed to every day for a lifetime with no adverse health effects.

The threshold value was commonly derived from a point of departure (POD), defined as the lowest concentration that is associated with no (or the lowest) observed adverse health effects (no observed adverse effect level [NOAEL] or lowest observed adverse effect level [LOAEL] or a benchmark dose), determined from experimental animal studies (most common) or human studies (less common). The POD was then divided by a safety/uncertainty factor to obtain the threshold toxicity value. Uncertainty factors were typically factors of 10 that account for interspecies variation and sensitive human populations. Additional factors of 10 were included in the uncertainty factor if the RfC is based on the LOAEL instead of the NOAEL, or an experiment that included a less-than-lifetime exposure.

The assessment of toxicity of the COPCs was used to develop initial screening criteria for human health exposure scenarios and is presented in **Appendix D**. No carcinogenic compounds are present in the WMF chemicals to be use in the produce water treatment and as a result, only non-carcinogenic oral RfDs were calculated. A detailed discussion of the derivation of the oral reference dose and drinking water guideline values is presented in **Appendix D**. As applicable, the COPCs are included either in **Table 6-1** that presents the derivation of Oral Reference Dose and Drinking Water Guideline Values or **Table 6-2** that presents the Australian Drinking Water Guidance Values for the COPCs identified for the WMF.

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Table 6-1 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)
WMF Chemicals						
Cationic acrylamide copolymer (69418-26-4)	-[a]	-	-	-	-	-
Adipic acid (124-04-9)	2-yr rat dietary	Reduced body weight gain	250	100	2.5	8.8
Polyacrylamide (anionic) (9003-05-8)	2-yr rat dietary	No systemic effects.	5,000	100	50	175
Cationic polymer[b]	6-month rat dietary study	None	2,000	300	7	23

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)
Diethylene triamine penta(methylene phosphonic acid), sodium salt (22042-96-2)	90-day rat dietary	Changes in hematological parameters and bone density	82.5	300	0.3	1.0
(1-Hydroxyethylidene)-1,1-diphosphonic acid (2809-21-4)	2-yr rat dietary	No systemic toxicity	384	100	4	14
Peroxyacetic acid (79-21-0)	90-day rat oral gavage	Mortality, clinical signs, reduced body weights	23.4	300	0.08	0.3
Hydrogen peroxide (7722-84-1)	90-day rat drinking water	Reduced body weights, food consumption; duodenal hyperplasia	239	300	1.0	3.5
Phosphonic acid (13598-36-2)	OECD TG 422	Mortality; clinical signs; reduced body weights	250	300	0.8	3.0
Sodium bisulfite (7631-90-5)	2-yr rat dietary study	None	523	100	5	18
Sodium Citrate Dihydrate (6132-04-3)	2-yr rat dietary	Reduced body weight gain	1,837	100	18	63

Notes:
Refer to **Appendix D** for information on the key studies selected for oral reference dose and drinking water level development.
CAS = Chemical Abstracts Service
NOAEL = No observed adverse effect level
a No data.
B Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC] (CAS No. 26062-79-3).

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Table 6-2 Australian Drinking Water Screening Values

Constituent (CAS No.)	Drinking Water Screening Guideline	Drinking Water Screening Value
WMF Chemicals		
Acetic acid (64-19-7)	pH	6.5 to 8.5
Aluminium hydrochloride (1327-41-9)	Aluminum; chloride	0.2 mg/L (aesthetics); 250 mg/L (aesthetics)
Aluminium chlorohydrate (12042-91-0)	Aluminum; chloride	0.2 mg/L (aesthetics); 250 mg/L (aesthetics)
Ammonia (7664-41-7)	Ammonia	0.5 mg/L (aesthetics)
Ethylenediaminetetraacetic Acid, tetrasodium salt (64-02-8)	EDTA	0.25 mg/L
Potassium hydroxide (1310-58-3)	pH	6.5 to 8.5
Sodium carbonate (497-19-8)	Sodium; pH	180 mg/L (aesthetic); 6.5 to 8.5
Sodium hypochlorite (7681-52-9)	Chlorine	5 mg/L (health) and 0.6 mg/L (aesthetics)
Sodium hydroxide (1310-73-2)	Sodium; pH	180 mg/L (aesthetic); 6.5 to 8.5
Sulfuric acid (7664-93-9)	Sulfate	250 mg/L (aesthetics)

6.1.2 Characterisation of Ecological Effects

To evaluate the assessment endpoints and ecological values, measures of effects (or measurement endpoints) were developed that represent the COPC exposure levels that are conservative thresholds for adverse ecological effects. The Toxicity reference values (TRVs) were selected as measurement endpoints (conservative thresholds) for the evaluation of potential risks to aquatic and terrestrial ecological receptors that were potentially exposed to the chemicals used in the WMF. An effects evaluation was not conducted on the potential ecological effects of landscape maintenance activities, such as mowing, vehicle travel or agricultural activities. Physical stressors that are unrelated to the COPCs in the WMF water are not the focus of this assessment. The adverse ecological effects framework is consistent with the OECD and the environmental exposure assessment methods Exposure Assessment – Environmental Exposure Assessment Strategies for Existing Industrial Chemicals in Member Countries and Manual for the Assessment of Chemicals (Chapter 6) steps in OECD (OECD, 2014), as well as exposure assessments and potential hazards identified by OECD (1989) for extrapolating ecological effects from basic toxicological data.

The TRVs are based on COPC levels that imply no adverse effects or levels that represent the lowest concentration at which adverse effects may occur. The ecological risk assessment used two types of TRVs. The first TRV is a concentration-based TRV to evaluate the concentration of the selected COPC in the surface water and direct exposure by the aquatic ecological receptor. The second TRV is a dose-based TRV to evaluate the intake dose of the selected COPC from exposure to surface water by ingestion. These TRVs were selected based on the evaluation of the concentrations of COPCs in the

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WMF that would be representative of releases to environmental media and the nature of the exposure to the ecological receptors. For example, the potential risks to aquatic ecological receptors exposed to concentrations of the COPCs spilled into a surface water resource was assessed by comparing the exposure point concentration in the surface water to a concentration-based TRV (e.g., $PNEC_{water}$). Alternatively, if the potential exposure was based on a terrestrial ecological receptor drinking from a source of WMFs COPCs (e.g., irrigation water), then the potential risks were assessed based on a dose-based TRV.

A hierarchy was used to compile the TRV information as follows:

- Department of Environmental and Resource Management. Approval of Coal Seam Gas Water for Beneficial Use. Environmental Protection (Waste Management) Regulation 2000. Queensland Government. March 2010.
- ANZECC (2000) guidelines for fresh and marine water quality.
- Western Australia (WA) Department of Environment and Conservation. Assessment Levels for Soil, Sediment and Water. February 2010. Contaminated Site Management Series.
- International Guidance including USEPA, American Petroleum Institute and Oak Ridge National Laboratory/Risk Assessment Information System (ORNL/RAIS).

Where possible, existing water quality guidelines for protection of aquatic life were researched and compiled using the hierarchy outlined above. Where water quality guidelines are available, information on aquatic toxicity has been acquired from reported values that had already been through a screening process such as the OECD-Screening Information Data Set (SIDS) program or through an EU existing substances risk assessment. The data from these programs will be considered sufficiently reviewed as to not require further evaluation. Data reported as part of other equivalent peer-reviewed risk assessment programs (e.g. Human and Environmental Risk Assessment (HERA)0F1; USEPA High Production Volume (HPV) Challenge Program) was also considered in a similar fashion, although a certain level of expert judgement was required to evaluate the quality of these programs.

Aquatic toxicity information was also obtained via the European Chemicals Agency (ECHA) CHEM database. This database provides electronic public access to information on chemical substances manufactured or imported in Europe. The information originates from the registration dossiers submitted by companies to ECHA in the framework of REACH Regulation. If no data were available from the above sources or the available data were considered insufficient for TRV determinations, then toxicity information on SDSs was used, as well as read-across from available experimental data on structurally related substances, and predicted values from QSAR models.

6.1.2.1 Calculation of PNEC

The determination of 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 were developed to assess aquatic receptors, and PNECs for soil were developed for terrestrial receptors.

Calculation of PNEC for freshwater

The determination of PNECs for freshwater was conducted according to the guidance in the EU TGD (EU, 2003) and in the Environmental Risk Assessment Guidance Manual for Industrial Chemicals prepared by the AEA (2009).

[1] www.heraproject.com/

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The PNECs were determined by dividing the lowest toxicity value from a laboratory test by the relevant assessment factor. Results of long-term tests (expressed as EC_{10} [10 percent effective concentration] or NOEC [no observed effect concentration]) are preferred to those of short-term tests (EC_{50}/LC_{50} [50 percent effective concentration/lethal concentration]) because the results give a more realistic picture of effects on the organisms during their entire life cycle.

An assessment factor of 1,000 was applied to the lowest concentration if only acute toxicity data are available. As specified in the Environmental Risk Assessment Guidance Manual for Industrial Chemicals (AEA, 2009), the assessment factor was reduced to 100 if the following situations were applicable:

- Availability of data from a wide variety of species including those that are considered to represent sensitive species.
- Information from structurally similar compounds or QSAR, to suggest that the acute to chronic ratio is likely to be low.
- Information to suggest that the chemical acts in a non-specific or narcotic manner, with little interspecies variation in toxicity.
- Information to suggest that the release of the chemical is short-term or intermittent and that the chemical would not be persistent in the environment.

If chronic toxicity studies have been conducted on the test substance in addition to acute toxicity studies, then the NOEC or EC_{10} would be divided by assessment factors of 100, 50, or 10 depending on the following conditions:

- As assessment factor of 100 was used when a chronic NOEC was available from at least one species of fish or invertebrate representing one trophic level. The derived PNEC is the lowest value from either the lowest acute data or from the one derived from the chronic data.
- An assessment factor of 50 was used when a chronic NOEC was available from at least two species representing two trophic levels. The derived PNEC is the lowest value from either the lowest acute data or from the one derived from the chronic data.
- An assessment factor of 10 was used when chronic NOECs were available from three species representing three trophic levels.
- An assessment factor of 10 was applied to the lowest NOEC from two species representing two trophic levels if the data shows that the most sensitive species for which acute toxicity data was available have been tested chronically.

In the case of algae studies, the 72-hour (or longer) EC_{50} value was considered as equivalent to a short-term result and that a 72-hour (or longer) EC_{10} or NOEC value was the long-term result.

In cases when there were limited or no data available or the measured data for a species was unacceptable, values were estimated using QSAR.

The statistical extrapolation method was used if there was a large data set from long-term tests for different taxonomic groups.

Calculation of PNEC for sediment

If toxicity studies were available on sediment organisms, the PNEC was derived using the general approach described for calculating the PNEC for freshwater organisms.

If there were no toxicity data on sediment organisms, the equilibrium partitioning method was used to derive a PNEC. This method uses the $PNEC_{water}$ for aquatic organisms and the sediment/water partitioning coefficient as inputs. It is only applicable to non-ionic organic chemicals.

The following equation was used to estimate the $PNEC_{sed}$ using the equilibrium partitioning method:

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$$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$$

where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default in Australia]
$PNEC_{water}$ = Predicted no effect concentration in water (mg/L)

The suspended matter-water partition coefficient was estimated by first adjusting the organic carbon partition coefficient (K_{oc}) to the organic carbon content of natural sediments. This was accomplished using the following equation:

$$Kp_{sed} = K_{oc} \times f_{oc}$$

where:

Kp_{sed} = solid-water partition coefficient (L/kg)
K_{oc} = organic carbon partition coefficient (L/kg)
F_{oc} = fraction of organic carbon suspended sediment = 0.04 [recommended default from Mackay Level III]

The makeup of the sediment was assumed to be 80 percent water and 20 percent solids based on the Mackay Level III Fugacity Model. So, the suspended matter-water partition coefficient ($K_{sed\text{-}water}$) was estimated from Kp_{sed} using the following equation:

$$K_{sed\text{-}water} = 0.8 + (0.2 \times Kp_{sed})/1000 \times BD_{solid}$$

where:

$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
Kp_{sed} = solid-water partition coefficient (L/kg)
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

Calculation of PNEC for soil

If toxicity studies were available on soil organisms, the PNEC was derived using the general approach described for calculating the PNEC for freshwater organisms. Prior to deriving the PNEC value for soil, the $L(E)C_{50}$ or NOEC value was corrected for bioavailability of the test substance in soil by normalising the organic carbon content in soil using the following equation:

$$L(E)C_{50(std)} \text{ or } NOEC_{(std)} = L(E)C_{50(exp)} \text{ or } NOEC_{(exp)} \times Fom_{soil(std)}/Fom_{soil(exp)}$$

where:

$Fom_{soil(std)}$ = the fraction of organic matter in standard soil
$Fom_{soil(exp)}$ = the fraction of organic matter in experimental soil

The fraction of organic matter in standard soil in Australia is 1 percent[2].

The PNEC for soil was determined by dividing the lowest toxicity value from a laboratory test by the relevant assessment factor. If only acute toxicity tests are available, an assessment factor of 1,000 was

[2] www.scew.gov.au/node/941

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applied to the lowest L(E)C_{50} value. If long-term studies were available, an assessment factor of 100 was applied to the lowest NOEC for one test; 50 for additional tests on two species of two trophic levels; or 10 for additional tests for three species of three trophic levels.

If there were no toxicity data on soil organisms, the equilibrium partitioning method was used to derive a PNEC. This method uses the $PNEC_{water}$ for aquatic organisms and the soil/water partitioning coefficient as inputs. It is only applicable to non-ionic organic chemicals.

The following equation was used to estimate the $PNEC_{soil}$ using the equilibrium partitioning method:

$$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$$

It is preferable to use actual measured data in effects assessment and in the estimation of PNECs. However, when limited or no data were available (e.g. data for only one test species) or when the measured data for a species were unacceptable, then estimation using QSARs was considered. **Table 6-3** present the COPC, the endpoint, NOEC (mg/L), assessment factor, and the aquatic PNEC (mg/L). Refer to **Appendix D** and chemical-specific dossiers regarding the development of PNECs, or the rational for PNECs that do not have a calculated PNECs. The calculate PNEC concentrations for the solid spent muds are presented in **Table 6-4**.

Table 6-3 PNECs Water

Constituents	Endpoint	E(L)C_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
WMF Chemicals				
Acetic acid (64-19-7)	Acute fish or *Daphnia*	300.82	100	3.0
Acrylamide, (2-acryloyloxyethy)trimethylammonium chloride polymer (69418-26-4)	Acute fish	1-10	1,000	0.001-0.01
Adipic acid (124-04-9)	Chronic Daphnia	6.3	50	0.13
Aluminium hydroxychloride (1327-41-9)	-	-	-	0.0008[b]
Polyacrylamide (anionic) (9003-05-8)	Acute fish	100	1,000	0.1
Cationic polymer[c]	Acute fish	6.5	50	0.13
Aluminium chlorohydrate (12042-91-0)	-	-	-	0.0008[b]
Diethylene triamine penta(methylene phosphonic acid), sodium salt (22042-96-2)	Chronic fish	31	100	0.31
Ethylenediaminetetraacetic Acid, tetrasodium salt (64-02-8)	Chronic Daphnia	22	10	2.2
Ammonia (7664-41-7)	-	-	-	0.9[d]

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Constituents	Endpoint	E(L)C_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
Hydrogen peroxide (7722-84-1)	Chronic Daphnia and algae	0.63	50	0.013
(1-Hydroxyethylidene)-1,1-diphosphonic acid (2809-21-4)	Chronic Algae	6.75	50	0.14
Hydrogen peroxide (7722-84-1)	Chronic Daphnia and algae	0.63	50	0.013
Peroxyacetic acid (79-21-0)	Acute fish	0.002	10	0.0002
Phosphonic acid (13598-36-2)	Acute algae	153	100	1.5
Potassium hydroxide (1310-58-3)	-[a]	-	-	-
Sodium bisulfite (7631-90-5)	Chronic Daphnia	8.3	10	0.8
Sodium carbonate (497-19-8)	-[a]	-	-	-
Sodium citrate (6132-04-3)	Acute *Daphnia*	440	1,000	0.67
Sodium hypochlorite (7681-52-9)	-	-	-	0.003[e]
Sodium hydroxide (1310-73-2)	-[a]	-	-	-
Sulfuric acid (7664-93-9)	-[a]	-	-	-

[a] Not calculated (see risk dossiers for rationale).
[b] PNECwater for aluminium hydroxychloride and aluminium chlorhydrate is the ANZECC Water Quality Guideline – Freshwater Trigger Value for aluminium.
[c] Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC (CAS No. 26062-79-3).
[d] PNECwater for ammonia is the ANZECC Water Quality Guideline – Freshwater Trigger Value for total ammonia-N.
[e] PNECwater for sodium hypochlorite is the ANZECC Water Quality Guideline – Freshwater Trigger Value for chlorine (total residual).
E(L)C_{50} = effects/level concentration – 50%
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Appendix D** for information on the development of PNECs listed above.

Table 6-4 PNECs Soil

Constituents	Endpoint	E(L)C_{50} or NOEC (mg/kg dry wt)	Assessment Factor	$PNEC_{soil}$ (mg/kg dry wt)
WMF Chemicals				
Acetic acid (64-19-7)	-[b]	-	-	0.04
Cationic acrylamide copolymer (69418-26-4)	-[a]	-	-	-

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Constituents	Endpoint	E(L)C_{50} or NOEC (mg/kg dry wt)	Assessment Factor	$PNEC_{soil}$ (mg/kg dry wt)
Adipic acid (124-04-9)	-[b]	-	-	0.003
Aluminium hydroxychloride (1327-41-9)	-[a]	-	-	-
Polyacrylamide (anionic) (9003-05-8)	-[a]	-	-	-
Cationic polymer[c]	-[a]	-	-	-
Aluminium chlorohydrate (12042-91-0)	-[a]	-	-	-
Diethylene triamine penta(methylene phosphonic acid), sodium salt (22042-96-2)	-[b]	-	-	40
Ethylenediaminetetraacetic Acid, tetrasodium salt (64-02-8)	-[a]	-	-	-
Ammonia (7664-41-7)	-[b]	-	-	-
(1-Hydroxyethylidene)-1,1-diphosphonic acid (2809-21-4)	Terrestrial plant toxicity	960	100	9.6
Hydrogen peroxide (7722-84-1)	-[a]	-	-	-
Peroxyacetic acid (79-21-0)	Terrestrial plant toxicity	180	50	3.6
Phosphonic acid (13598-36-2)	-[a]	-	-	-
Potassium hydroxide (1310-58-3)	-[a]	-	-	-
Sodium bisulfite (7631-90-5)	-[a]	-	-	-
Sodium carbonate (497-19-8)	-[a]	-	-	-
Sodium Citrate Dihydrate (6132-04-3)	-[b]	-	-	0.003
Sodium hypochlorite (7681-52-9)	-[a]	-	-	-
Sodium hydroxide (1310-73-2)	-[a]	-	-	-
Sulfuric acid (7664-93-9)	-[a]	-	-	-

[a] not experimentally derived or calculated (see risk dossiers for rationale).
[b] Calculated using equilibrium partitioning method.
[c] Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC (CAS No. 26062-79-3).
E(L)C_{50} = effects/level concentration – 50%NOEC = no observable effects concentration

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PNEC = predicted no-effects concentration
$PNEC_{soil}$ = predicted no-effects concentration
Refer to **Appendix D** for information on the development of PNECs listed above.

6.1.2.2 Dose-Based TRV

The basic principles applied in human health toxicity assessments also apply to ecological toxicity assessments, however, carcinogenicity is rarely considered because of a lack of methodologies and the understanding of the modes of action of potential carcinogens on ecological receptors. The sources of TRVs are from the published literature, or the application of dose-response equations incorporating the relationship of the size of the selected receptor to the test species for the dose-response data.

For ecological receptors, the TRVs are calculated based on body weight (BW) scaling methodology that uses the NOAELs and LOAELs, which are daily dose levels normalised to the BW of the test animals (e.g. milligrams of chemical per kilogram BW/day). The use of toxicity data on a mg/kg/day basis allows the comparisons across toxicity tests and across test species with appropriate consideration for differences in body size. Studies have shown that numerous physiological functions such as metabolic rates, as well as responses to toxic chemicals, are a function of body size. Smaller animals have higher metabolic rates and usually are more resistant to toxic chemicals because of more rapid rates of detoxification. After a review of various dose-response models for wildlife, the allometric scaling method was developed using linear regression models of lethal dose versus body weight for a variety of chemicals to extrapolate toxicity between species (Sample and Arenal, 1999). To assess the sensitivity of the model, residuals from the allometric scaling were analysed using regression models. The patterns of sensitivity among mammalian species were relatively constant across chemical classes. The development of this allometric scaling model improved the extrapolation of toxicity effects between species, thus providing a more accurate assessment of potential ecological risks when data are limited for the specific species being assessed. The allometric scaling method was used to estimate the population-level effects on wildlife based on individual level of exposures (Sample et al., 1996).

For mammals, it has been shown that this allometric scaling relationship is best expressed in terms of BW raised to the ¾ power (bw3/4). Therefore, the dose for the selected ecological receptor is a function of the BW of the test species divided by the BW of the selected ecological receptor to the ¾ power and then is multiplied times the dose of the test species.

$$NOAEL_w = NOAEL_t \left(\frac{bw_t}{bw_w}\right)^{1/4}$$

The calculated TRVs for each of the mammalian ecological receptors evaluated in the ecological risk assessment are presented in the species-specific ecological risk models in the tables discussed in the ecological risk characterisation section (**Section 7.2**). Additionally, should avian receptors be identified, dose-based TRVs will be developed based on avian NOAELs; for COPCs with no avian NOAEL available, the corresponding mammalian NOAEL will be used to develop the dose-based TRV for the COPC.

The calculation of TRVs for other potential ecological receptors was considered in the ecological risk assessment; however, the quantitative assessment is based on the availability of ecotoxicological data to calculate TRVs. Mayfield et al. (2014) reference the lack of amphibian and reptile toxicological data and limited laboratory reptile models as challenges for calculation of TRVs.

6.2 PBT Assessment

The PBT substances assessment was conducted using the Australian and EU REACH Criteria methodology for all chemicals (ECHA, 2008; enHealth, 2012a) as part of the hazard assessment.

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The primary source of information for physico-chemical properties, environmental fate and transport parameters, ecological toxicological data, and mammalian toxicology data was obtained from databases linked to the OECD eChemPortal (www.echemportal.org), which is part of the OECD Environmental Risk Assessment toolkit. In addition, data was obtained from the sources presented in **Table 6-5**.

Table 6-5 Sources of PBT Assessment

Data	Sources
Chemical and physical properties data	TOXNET The Safety Datasheet (SDSs) Modelled data from USEPA (2011a) EPI Suite™
Environmental and human health drinking water guidelines	Australian and New Zealand Guidelines for Fresh and Marine Water Quality for protection of aquatic ecosystems and stock watering (ANZECC and ARMCANZ, 2000) Australian Drinking Water Guidelines (NHMRC and NRMMC, 2011, Update 2018) World Health Organisation (WHO, 2006) Guidelines for Drinking-water Quality (Third Edition) USEPA National Recommended Water Quality Criteria (2009) for protection of aquatic life and human health Drinking-water Standards for New Zealand 2005 (Revised 2008, Ministry of Health)
Human health toxicity data	U.S. Toxic Substances Control Act Test Submissions 2.0 (TSCATS 2.0) database https://catalog.data.gov/dataset/toxic-substances-control-act-test-submissions-2-0-tscats-2-0 Literature search (using PubMed and ToxLine) Internet search (i.e., Google Scholar)
Ecological toxicological and environmental fate and transport data	USEPA ECOTOX database Canada Screening Assessment Reports USEPA TSCATS database Google Search (for regulatory agency documents such as USEPA RED (Re-registration Eligibility Decision) documents for pesticide applications) Literature search of peer-review journals SDSs QSAR modelling (i.e., EPI Suite and PetroTox)
Ecological toxicological data (soil and water guidelines)	European Chemicals Bureau (ECB) (2003) National Environmental Protection Council (NEPC) (2013) Risk Assessment Information System (RAIS) USEPA Eco Soil Screening Levels (2011b) National Institute for Public Health and Environmental Protection (RIVM) Target and Intervention levels (1994) International Uniform Chemical Information Database [IUCLID], Concise International Chemical Assessment Document [CICAD]

The PBT assessments for each COPC are included in the dossiers presented in **Appendix D**. **Table 6-6** presents a summary of the PBT Assessment for the COPCs for the WMF chemicals. If one of the PBT criteria are met for each PBT categories as defined by the Australian and EU REACH Criteria, then it will satisfy the designation for that category.

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Table 6-6 PBT Assessment

Substance	P/vP criteria fulfilled?	B/vB criteria fulfilled?	T criteria fulfilled?	Overall conclusion
WMF Chemicals				
Acetic acid (64-19-7)	No (screening data available)	No (acetate is naturally found in biological organisms)	No (experimental data available)	Not PBT (based on screening and experimental data; naturally found in organisms)
Cationic acrylamide copolymer (69418-26-4)	Yes (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (based on polymer, physico-chemical properties)
Adipic acid (124-04-9)	No (screening data available)	No (screening data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Aluminium hydroxychloride (1327-41-9)	Not applicable (ionic species ubiquitous in environment)	No (screening and experimental data available)	Yes (experimental data available)	Not PBT (based on screening/experimental data and ubiquitous inorganic salt)
Ammonia (7664-41-7)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (experimental data available)	Not PBT (ubiquitous ionic species and experimental data)
Polyacrylamide (anionic) (9003-05-8)	Yes (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (polymer, physico-chemical properties)	No (based on polymer, physico-chemical properties)
Cationic polymer*	Yes (physico-chemical properties)	No (physico-chemical properties)	No (screening data available)	Not PBT (based on physico-chemical properties and screening data)
Aluminium chlorohydrate (12042-91-0)	Not applicable (ionic species ubiquitous in environment)	No (screening and experimental data available)	Yes (experimental data available)	Not PBT (based on screening/experimental data and ubiquitous inorganic salt)
Diethylene triamine penta(methylene phosphonic acid), sodium salt (22042096-2)	Yes (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Ethylenediaminetetraacetic Acid, tetrasodium salt (64-02-8)	Yes (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
(1-hydroxyethylidene)-1,1-diphosphonic acid (2809-21-4)	Yes (screening data available)	No (experimental data available)	No (experimental data available)	Not PBT (based on screening and experimental data)
Hydrogen peroxide (7722-84-1)	No (screening data available)	No (screening data available)	No (experimental data available)	Not PBT (based on screening and experimental data)

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Substance	P/vP criteria fulfilled?	B/vB criteria fulfilled?	T criteria fulfilled?	Overall conclusion
Peroxyacetic acid (79-21-0)	No (screening data available)	No (screening data available)	Yes (experimental data available)	Not PBT (based on screening and experimental data)
Phosphonic acid (13598-36-2)	Not applicable (ionic species ubiquitous in environment)	No (dissociates to ionic species; essential ions to biological systems)	No (screening data available)	Not PBT (based on screening data and ubiquitous ionic species)
Potassium hydroxide (1310-58-3)	Not applicable (ionic species from inorganic salt is ubiquitous in environment)	No (ionic species)	No experimental data available)	Not PBT (based on experimental data and ionic species)
Sodium bisulfite (7631-90-5)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)
Sodium carbonate (497-19-8)	Not applicable (ionic species from inorganic salt is ubiquitous in environment)	No (ionic species)	No experimental data available)	Not PBT (based on experimental data and ionic species)
Sodium Citrate Dihydrate (6132-04-3)	No (screening data available)	No (screening data available)	No (screening data available)	Not PBT (based on screening data)
Sodium hypochlorite (7681-52-9)	Not applicable (ionic species)	No (ionic species)	Yes (experimental data available)	Not PBT (based on screening data and ionic species)
Sodium hydroxide (1310-73-2)	Not applicable (ionic species from inorganic salt is ubiquitous in environment)	No (ionic species)	No experimental data available)	Not PBT (based on experimental data and ionic species)
Sulfuric acid (7664-93-9)	Not applicable (ionic species ubiquitous in environment)	No (essential ions to biological systems; actively regulated)	No (screening data available)	Not PBT (based on screening data and ubiquitous inorganic salt)

Notes:
B/vB = bioaccumulative
P/vP = persistent
PBT = Persistent, Bioaccumulative and Toxic
QSAR = quantitative structure activity relationship
T = toxic
*Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC] (CAS No. 26062-79-3).

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6.3 Data Used in Risk Assessment

This section presents a description of the data used in the risk assessment.

6.3.1 Vendor WMF Chemicals

Information provided by the vendor on the products shipping, storage, and operations quantities; product usage and fate and transport; and chemical and physical properties discussed in **Appendix C** were used to evaluate the WMF chemicals (**Table C-1)**. Estimated concentrations of the WMF chemicals were calculated for the following scenarios: accidental release to surface water and soil during transportation and permeate release to soils during irrigation.

For the transportation releases to surface water the mass or volume of the product during transport was multiplied by the percentage of the COPC within the product. In the majority of cases, if a range was provided for a COPC, the maximum percentage was used to calculate the COPC concentration in the release. Additionally, three release concentrations of COPCs were calculated to evaluate the potential for release to different size water bodies and account for potential dilution of COPCs: 100-percent, 25-percent, and 5-percent. To calculate the potential concentration of COPCs in soil from a release during transportation, 100-percent surface water concentration was multiplied by the transportation release area (assumed to be 0.25 hectare) to a depth of 0.15 m divided by the mass of soil per hectare.

The concentrations of COPCs in permeate and brine were determined based on chemical and physical properties of the COPCs as well as the fate and transport of the products within the WMF system. Additional detail on the assumptions used for estimation for each COPC is provided in **Table C-1**.

Similar to the transportation scenario, the COPC concentrations in soil from an incidental release from the permeate pond and water applied during irrigation was calculated. To calculate the COPC concentrations in soil incidental release of permeate from the 135 ML permeate pond, the permeate concentration was multiplied by the release area (1 hectare) to a depth of 0.15 m and divided by the mass of soil per hectare.

The concentration of the irrigated agricultural soil was calculated by assuming a volume of irrigated soil per hectare (1,000 m^2 area by 0.15 m depth), soil density (1,400 kg/m^3), and irrigation rate (8 ML per hectare per year, 20 years). The irrigation rate of 8 ML is a conservative high number. The exposure point concentration (EPC) for the irrigated agricultural soils is calculated by multiplying the concentration of COPCs in the diluted initial produced water times volume of irrigated water applied by hectare divided by the mass of soil per hectare.

6.4 Life Cycle Component Assessment

The life cycle component assessment will include the qualitative assessment of life cycle stages of the WMF from the transportation to the WMF, mixing and use, and reuse of the WMF chemicals; the quantitative assessment of life cycle components will be management and beneficial reuse.

6.4.1 Qualitative Assessment

The qualitative assessment includes exposure to the vendor chemicals that may occur during activities that do not intentionally result in a release to the environment, but where a potential release may occur. These potential releases primarily are focused on the vendor chemicals used in the transportation and WMF activities. Potential exposure to vendor chemicals may occur as a result of release from shipping containers and storage tanks either during transport from supplier warehouse to the WMF, and storage and preparation of products at the WMF.

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Table 6-7 presents a summary of potential human health and ecological hazards that should be considered for the potential receptors identified in **Section 5.3.5**. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and SDSs are available to emergency responders, health and safety managers, and environmental hazard clean-up teams. In addition, **Table 6-1** and **Table 6-2** present the Oral Reference Dose and Drinking Water Guideline Values, and **Table 6-3** present the ecological endpoint, NOEC, and the aquatic PNEC. Note that the level of toxicity was obtained from the risk assessment dossiers in **Appendix D**.

Table 6-7 Summary of Human and Ecological Hazards

Chemical Name	CAS No.	Australian Dangerous Goods Code	Human Health Hazard	Ecological Hazard
WMF Chemicals				
Acetic acid	64-19-7	Class 9 [corrosive substance]	Corrosive; respiratory irritant	Low concern
Cationic acrylamide copolymer	69418-26-4	-[a]	Low concern	Moderate concern
Adipic acid	124-04-9	-	Low concern	Moderate concern
Aluminium hydrochloride	1327-41-9	-	Low concern	Very toxic to aquatic life. Very toxic to aquatic life with long lasting effects.
Ammonia [<35% solution]	7664-41-7	Class 8 [corrosive substance]*	Corrosive; respiratory irritant	Very toxic to aquatic life.
Polyacrylamide (anionic)	9003-05-8	-	Low concern	Low concern
Cationic polymer[b]	-	*	Low concern	Toxic to aquatic life. Toxic to aquatic life with long lasting effects.
Aluminium chlorohydrate	12042-91-0	-	Low concern	Very toxic to aquatic life. Very toxic to aquatic life with long lasting effects.**
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	Class 8 [corrosive substance]	Low concern	Low concern
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	-	Severe eye irritant	Low concern
(1-Hydroxyethylidene)-1,1-diphosphonic acid	2809-21-4	Class 8 [corrosive substance]	Severe eye irritant.	Harmful to aquatic life.
Hydrogen peroxide	7722-84-1	Class 5.1 [oxidising liquid]	Corrosive; respiratory irritant	Toxic to aquatic life. Harmful to aquatic life with long lasting effects.

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Chemical Name	CAS No.	Australian Dangerous Goods Code	Human Health Hazard	Ecological Hazard
Peroxyacetic acid	79-21-0	Class 5.2 [organic peroxide]*	Corrosive; respiratory irritant	Very toxic to aquatic life. Very toxic to aquatic life with long lasting effects.
Phosphonic acid	13598-36-2	Class 8 [corrosive substance]	Corrosive; respiratory irritant	Low concern
Potassium hydroxide	1310-58-3	Class 8 [corrosive substance]	Corrosive	Low concern
Sodium bisulfite	7631-90-5	-	Low concern	Moderate concern
Sodium carbonate	497-19-8	-	Low concern	Low concern
Sodium citrate	6132-04-3	-	Low concern	Low concern
Sodium hypochlorite	7681-52-9	Class 8 [corrosive substance]*	Corrosive	Very toxic to aquatic life. Toxic to aquatic life with long lasting effects.
Sodium hydroxide	1310-73-2	Class 8 [corrosive substance]	Corrosive	Low concern
Sulfuric acid	7664-93-9	Class 8 [corrosive substance]	Corrosive	Low concern

[a]No code required.
[b]Identity unknown. Read-across to polydiallyldimethylammonium chloride [polyDADMAC] (CAS No. 26062-79-3).
*Environmentally hazardous substance.
**Based on dissolved aluminium, pH>6.5.

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6.4.2 Quantitative Assessment

The quantitative assessment determines the exposure to the vendor chemicals that may occur during activities associated with the storage, transport / conveyance, disposal, and beneficial reuse of water (and residual entrained water treatment chemicals). These exposures may include operational activities where planned direct releases to the environment may occur (e.g., irrigation and dust suppression). The quantitative evaluation assesses cumulative potential risks for complete exposure pathways by summing the individual chemical risks. To evaluate the potential for human and environmental hazards associated with the water treatment chemicals, the empirical and theoretical datasets discussed in **Section 6.3** were first compared to applicable risk-based screening criteria.

6.4.2.1 Vendor Chemicals from WMF in Treated Water

For the quantitative assessment, the EPCs were developed for a transportation release scenario, release from the permeate pond as well as irrigation using permeate. In addition to the development of the EPCs discussed in **Section 6.3.1**, an irrigation scenario was also evaluated where permeate is blended on a 1:1 ratio with produced water from CSG wells.

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 biodegradation information for WMF chemicals is provided in **Table 6-8.**

Table 6-8 Biodegradation of WMF Chemicals

Chemical Name	Biodegradation Rates
Acetic acid	Readily biodegradable (half-life = 15 days)[a]
Cationic acrylamide copolymer	Not biodegradable.
Adipic acid	Readily biodegradable (half-life = 15 days)[a]
Aluminium hydroxychloride	Dissociates completely in aqueous media
Ammonia	Dissociates completely in aqueous media
Polyacrylamide (anionic)	Not biodegradable.
Diethylene triamine penta(methylene phosphonic acid), sodium salt	Not biodegradable.
EDTA Tetrasodium salt	Not readily biodegradable.
Hydrochloric acid	Dissociates completely in aqueous media
(1-Hydroxyethylidene)-1,1-diphosphonic acid	Not biodegradable.
Hydrogen peroxide	Degradation processes equivalent to readily biodegradable (half-life = 15 days)[a]
Peroxyacetic acid	Readily biodegradable (half-life = 15 days)[a]
Phosphonic acid	Dissociates completely in aqueous media
Potassium hydroxide	Dissociates completely in aqueous media
Sodium bisulfite	Dissociates completely in aqueous media
Sodium carbonate	Dissociates completely in aqueous media
Sodium Citrate Dihydrate	Readily biodegradable (half-life = 15 days)[a]
Sodium hypochlorite	Dissociates completely in aqueous media
Sodium hydroxide	Dissociates completely in aqueous media
Sulfuric acid	Dissociates completely in aqueous media

*Identity of polymer is unknown. Read-across to polydiallyldimethylammonium chloride (polyDADMAC)

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Tables 1 through **5** present the comparison of the potentially complete exposure scenarios to drinking water levels and PNECs for aquatic and terrestrial receptors. **Table 6-9** presents a summary of the transportation release scenarios and the risk ratios developed for each constituent under the different transportation scenarios. The risk ratio is calculated by dividing a constituent concentration by the applicable risk-based screening level. If the ratio of exceedance of screening levels is greater than 1.0, there is an unacceptable level of risk associated with this exposure scenario.

The $PNEC_{water}$ and $PNEC_{soil}$ risk ratios exceeded 10 for every COPC in each scenario. Based on the screening, there is a potential for adverse impacts to surface water resources and associated aquatic flora and fauna as well as terrestrial ecological receptors from a potential release of WMF chemicals during transport indicating the requirement for management controls.

No risk ratios exceeded the target of 1.0 for the exposure scenarios associated with permeate (storage, transport / conveyance and use of treated water). The cumulative risk ratios for human, aquatic, and terrestrial receptors for each exposure scenario are presented in **Table 6-10.** Therefore, there are no

anticipated adverse effects to releases of permeate to the environment (either accidental during storage, conveyance or beneficial reuse).

Table 6-9 Summary of Cumulative Risk Ratios for Transportation Scenario PNEC Comparison

Chemical Name	CAS Number	Risk Ratios That Exceed $PNEC_{water}$			Risk Ratios That Exceed $PNEC_{Soil}$
		100%	25%	5%	
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	1.1E+06	2.7E+05	5.4E+04	1.6E+04
Acetic Acid	64-19-7	6.7E+04	1.7E+04	3.3E+03	5.0E+06
Adipic Acid	124-04-9	9.6E+03	2.4E+03	4.8E+02	4.2E+05
Aluminium Hydroxychloride	1327-41-9	6.3E+08	1.6E+08	3.1E+07	NA
Ammonia	7664-41-7	3.9E+05	9.7E+04	1.9E+04	NA
Cationic acrylamide copolymer	69418-26-4	2.3E+07	5.6E+06	1.1E+06	NA
Cationic Polymer	n/a	2.3E+06	5.8E+05	1.2E+05	NA
Aluminium chlorohydrate	12042-91-0	6.3E+09	1.6E+09	3.1E+08	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	4.2E+05	1.0E+05	2.1E+04	3.3E+03
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	5.7E+04	1.4E+04	2.8E+03	NA
Hydrogen Peroxide	7722-84-1	2.3E+07	5.8E+06	1.2E+06	NA
Peroxyacetic Acid	79-21-0	5.0E+08	1.3E+08	2.5E+07	2.8E+04
Phosphonic Acid	13598-36-2	3.3E+04	8.3E+03	1.7E+03	NA
Polyacrylamide (anionic)	9003-05-8	2.5E+05	6.3E+04	1.3E+04	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	6.3E+05	1.6E+05	3.1E+04	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	2.3E+05	5.7E+04	1.1E+04	3.3E+07
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	1.0E+09	2.5E+08	5.0E+07	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA

NA = not applicable

Table 6-10 Summary of Cumulative Risk Ratios of Permeate and Relevant Screening Levels

Permeate Scenario	Exceed Drinking Water	Risk Ratios That Exceed $PNEC_{water}$	Risk Ratios That Exceed $PNEC_{soil}$	
			Incidental Release to Soil	Irrigation
Permeate (storage, conveyance and beneficial use)	4.4E-02	1.1E-01	5.7E-04	8.6E-02

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Permeate Scenario	Exceed Drinking Water	Risk Ratios That Exceed $PNEC_{water}$	Risk Ratios That Exceed $PNEC_{soil}$	
			Incidental Release to Soil	Irrigation
Permeate Blended with Produced Water (storage, conveyance and beneficial use)	2.2E-02	8.9E-02	3.6E-02	4.3E-02

6.5 Hazard Assessment Summary

The hazard assessment evaluated the human health and environmental hazard of the chemicals identified based on a qualitative and quantitative evaluation of the potential risks. Risk assessment dossiers were prepared for the chemicals to compile the information for the hazard assessment including summaries and tables.

The PBT assessment conducted on the WMF chemicals identified no PBT substances.

Potential human health and ecological hazards were summarized; where a potential hazard exists, information in the risk assessment dossiers and SDSs are available to emergency responders, health and safety managers, and environmental hazard clean-up teams.

A comparison of potentially complete exposure scenarios to drinking water levels and PNECs using risk ratios for aquatic and terrestrial receptors was conducted for the storage and use of water treatment chemicals including transportation release scenarios; $PNEC_{water}$ and $PNEC_{soil}$ risk ratios exceeded 10 for every COPC in each scenario. Potential for adverse impacts to surface water resources and ecological receptors would require management controls.

There were no unacceptable risks for the exposure scenarios associated with water treatment chemicals that may be entrained in permeate, including storage, conveyance / trucking and beneficial; therefore, there are no anticipated adverse effects to releases of permeate to the environment (either accidental or beneficial reuse).

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7.0 EXPOSURE ASSESSMENT

The exposure assessment comprises an evaluation of surface and subsurface exposure pathways and mass balance calculation to identify the amount of each chemical used in the process, and the estimated or actual potential exposure point concentration in the affected media (e.g., soil, groundwater, air).

For the chemicals selected as COPCs, fate and transport modelling was used to characterise the degradation of chemicals over time and their potential transport (e.g., in groundwater) or partitioning into other phases. The assessment of exposure in the qualitative risk assessment process involves the evaluation of the data available for the project, the details associated with the surrounding environment, the nature of the exposure identified, and the potential mobility of the COPC.

For an exposure pathway to be considered complete, there must be all of the following:

- Source of COPC – how the chemical got into the environment and which environmental media are affected.
- A transport media – how the chemical moves or migrates through the environment from one location to another, or from one environmental medium to another.
- An exposure point – how organisms can come into contact with the chemicals (e.g., direct contact or via the food web).
- An exposure route – how the chemical could enter the organism (e.g., inhalation, ingestion or dermal contact).

For each potential complete exposure pathway for both human health and environmental receptors (i.e., terrestrial and aquatic), each of the above steps is evaluated. If any one of these steps (source, transport media, exposure point or route) was not present, the exposure pathway was incomplete and further assessment of risks was not required. The assessment of potential risks is evaluated further if there is a complete exposure pathway. Thus, even if the COPC was a PBT, if there is no threshold concentration at the point of exposure, the potential risk to environmental and human receptors is considered acceptable and would not require mitigated measures.

The exposure assessment information was compiled from the enHealth (2012b) Australian Exposure Factors Guidance. In addition, as noted in enHealth guidance (2012a), guidance from WHO and USEPA were used to supplement the Australian guidance, as appropriate. The exposure assessment calculations presented in the enHealth guidance (2012a) were used to estimate intake of the COPCs by the receptors.

The exposure assessment also utilised the tools presented in the Routes – Ingestion and Dermal, Tiers and Types – Aggregate and Cumulative, and Lifestages and Populations – General Population, Residential, Occupational, or Potentially Highly Exposed Populations steps in ExpoBox (USEPA, 2016) and in the Exposure Assessment – General Guidance for Exposure Assessment step in OECD (OECD, 2014).

As discussed in the CEM, the potentially complete exposure pathways for exposure to chemicals utilised at the WMF are as follows:

Based on an evaluation of the life cycle of water treatment products and chemicals, environmental conditions in the areas of development, anticipated populations, and location selection, the following potentially complete exposure pathways were identified:

- Transportation of chemicals
  - Human and ecological receptor exposure to chemicals as a result of accidental release during transport from the supplier warehouse to the WMF and
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release during transportation.
- Use of water treatment chemicals

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- Human and ecological receptor exposure to chemicals as a result of accidental release of stored materials and
- Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release of stored materials.

- Storage, conveyance and beneficial reuse
  - Human and ecological receptor exposure to residual chemicals in the treated water being beneficially reused.
- Transportation and storage of waste
  - Human and ecological receptor exposure to chemicals as a result of accidental release during transport of waste from WMF;
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release during transportation;
  - Human and ecological receptor exposure to chemicals as a result of accidental release of stored waste and/or brine; and
  - Human and ecological receptors exposed to surface water bodies that received runoff from an accidental release of stored materials.

Potential exposures to chemical additives utilised in the lifecycle of water treatment chemical were evaluated qualitatively in **Section 6.4.1**. The potential for exposure to COPCs via potential exposures to residual COPCs in permeate beneficial reuse via direct contact by trespassers, workers, and agricultural workers and non-MNES (mammals and avian receptors) will be evaluated quantitatively in the following sections. These exposure concentrations are considered representative of accidental release scenarios from permeate storages and transport / conveyance.

7.1 Exposure Point Concentrations

The following section discusses the EPCs for the WMF chemicals.

7.1.1 EPC for Vendor WMF Chemicals

The EPCs for the WMF chemicals were discussed in **Section 6.3.1**. Additionally, an EPC was calculated for the scenario where permeate is blended with produced water at a ratio of 1:1. Refer to **Appendix C** for the EPCs for each exposure scenario for the WMF chemicals.

7.2 Exposure Equations

In accordance with the 2016 ToR (Santos GLNG, 2018), calculation of intake of COPCs in the WMF chemicals was performed for the potentially complete exposure pathways using the equations presented below (enHealth, 2012; NEPM, 2012; USEPA, 2016):

- Ingestion of soil:
  - Intake (mg/kg-day) = $\frac{CS \times IR - S \times EF \times ED \times RBA \times CFsoil}{BW \times AT}$
- Dermal contact with soil:
  - Intake (mg/kg-day) = $\frac{CS \times EF \times ED \times SAexp \times AF \times ABS \times CFsoil}{BW \times AT}$
- Ingestion of water:
  - Intake (mg/kg-day) = $\frac{CW \times IR - W \times EF \times ED \times ETswim}{BW \times AT}$

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- Dermal contact with water:
  - For inorganics:
    - Intake (mg/kg-day) = $\frac{CW \times EV \times EF \times ED \times SAbody \times Kp \times ETswim \times CFwater}{BW \times AT}$
  - For Organics:
    - Intake (mg/kg-day) = $\frac{DAevent \times EF \times ED \times EV \times SAbody}{BW \times AT}$
    - Where:
      - If ET <= t*, then
        - DA_{event} (µg/cm^2-event) =

$$2 \times FA \times Kp \times CW \times CFwater \times \sqrt{\frac{6 \times \tau_{event} \times ET_{swim}}{\pi}}$$

      - If ET > t*, then
        - DA_{event} (µg/cm^2-event) =

$$FA \times Kp \times CW \times CFwater \times \left[\frac{ETswim}{(1+B)} + 2 \times \tau_{event} \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

where:

CS = concentration in soil (mg/kg)
IR-S = ingestion rate of soil (mg/day)
RBA = relative bioavailability factor (unitless)
EF = exposure frequency (day/year)
ED = exposure duration (years)
CFsoil = conversion factor for soil (1 x 10-6 kg/mg)
AT = averaging time (days)
BW = body weight (kg)
AF = soil adherence factor (mg/cm2)
ABS = absorption factor (unitless)
EV = event frequency (events/day)
SAexp = exposed skin surface area available for contact (cm2/d)
CW = concentration in water (mg/l)
IR-W = ingestion rate of water (l/hr)
SAbody = total body skin surface area (cm2/d)
Kp = dermal permeability factor (Kp – cm/hr)
ETswim = exposure time (hr/day or hours/hours)
CFwater = correction factor (1 x 10-3 l/cm3)
t* = time to reach steady state (hours)
τevent = lag time per event (hours/event)
B = dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (unitless)

Terrestrial receptors evaluated in the ecological risk assessment include domesticated livestock, large mammalian wildlife and small mammalian wildlife. Beef cattle were used to evaluate domesticated livestock, kangaroos evaluated for large mammalian wildlife, and dingos for small mammalian wildlife.

The estimate for dose-based or intake rates for the assessment endpoints for wildlife representing domestic livestock and native mammalian species used the following general equation:

$$TI = \frac{CW \times IR\text{-}W \times EF \times ED}{BW \times ED \times 365\ days/year}$$

where:

TI = Total intake of COPC (mg/kg/day)

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CW = Concentration of COPC in water (mg/l)
IR-W = Ingestion rate (litres/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg).

To estimate the intake for the assessment endpoint for wildlife representing secondary and tertiary consumers (Northern Quoll and avian receptors), the following general equation was used:

$$TI = \frac{[(Csoil \times IRsoil) + (Cfood \times IRfood x PRfood) + (Cwater \times IRwater)] \times HR}{BW}$$

where:
TI = Total intake of substance (mg/kg/day)
C_{soil} = Concentration of substance in soil (mg/kg)
IR_{soil} = Soil ingestion rate (kg/day)
C_{food} = Concentration of substance in food (mg/kg)
IR_{food} = Food ingestion rate (kg/day)
PR_{food} = Prey ratio (unitless)
C_{water} = Concentration of substance in water (mg/l)
IR_{water} = Water ingestion rate (l/day)
HR = Home range ratio (unitless)
BW = Body weight (kg)

As COPC concentrations are not anticipated to be present in drinking water for ecological receptors (fauna), the water component of the intake equation above is effectively zero. Therefore, intake of COPCs in soils will be estimated based on consumption of soil and food by ecological receptors.

7.2.1 Exposure Assumptions

The following sections present the exposure assumptions utilised to estimate potential exposures for both human health and ecological receptors. The exposure assumptions are presented in **Tables 6** through **13** for both human and ecological receptors.

7.2.1.1 Human Health

Human health exposure assumptions were determined by review of enHealth Exposure Factors (enHealth, 2012b) and NEPM (2013). Where default exposure assumptions were not available in enHealth and NEPM guidance, USEPA (EPA ExpoBox; USEPA, 2016) and the OECD (2014) exposure factor defaults were used to supplement the enHealth and NEPM recommendations. Where default values were not available, best professional judgement and site-specific knowledge were utilised to provide anticipated exposure assumptions.

Table 6 presents the exposure assumptions for the trespasser scenario. The trespasser receptor exposure pathway includes a small child to teenager that may come into contact with the ponded irrigation water (or stored irrigation water) exposure scenario for approximately 20 days/year for a 10-year period with potential incidental ingestion (of 25 millilitres [mL] of water) and dermal contact with exposed surface area (e.g., the time-weighted average of the child surface area of the head, forearms, hands, lower legs, and feet) for one half hour. The weighted soil adherence factor was calculated for these body parts for this receptor using equations from enHealth (2012b) and EPA ExpoBox (2016):

Surface Area Weighted Soil Adherence Factor:

$$\text{Weighted AF} = \frac{(AF_1)(SA_1) + (AF_2)(SA_2) + \cdots + (AF_i)(SA_i)}{SA_1 + SA_2 + \cdots + SA_i}$$

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where:

AF = Adherence factor of soil to skin (mg/cm2-event)
AFi = Overall adherence factor of soil to skin (mg/cm2-event)
SAi = skin surface area available for contact with body part "i" (cm2)

Workers exposure pathway includes an adult applying irrigated water to irrigation areas may come into contact with ponded irrigation water or soils during application for and exposure frequency (EF) of 2 days/year, an exposure duration (ED) of 1 year with potential incidental ingestion (330 mg/day) and dermal contact with soils on exposed skin area. An incidental ingestion rate of 25 mL of water per day is also assumed. The workers are assumed to have exposed faces, forearms, and hands; it is assumed a worker applying irrigation water would wear long pants and shoes. Using these body parts, weighted soil adherence factors were calculated for the worker. **Table 7** presents the worker exposure scenario assumptions.

The agricultural worker exposure pathway includes potential contact with irrigated soils through agricultural activity. Based on the size of the irrigation area, extensive ground cover in irrigated areas and the use of automated self-propelled centre pivots, the agricultural worker is assumed to potentially come into contact with soils for an EF of 4 days/year, for an ED of 35 years with potential incidental ingestion (100 mg/day; **Table 8**).

Similar to the worker, the agricultural worker is assumed to wear shoes and long pants whilst working the soil; therefore, the surface area and weighted soil adherence factor were calculated for exposure to the face, forearms, and hands. Chemical-specific parameters utilised in the in-take equations are presented in **Tables 14** and **15**.

This scenario is also considered to be conservatively representative of exposure accidental releases noting that the duration of exposure would likely be significantly less.

7.2.1.2 Ecological Receptors

The exposure assumptions for cattle, kangaroos, dingos, Northern Quoll, and avian receptor are presented in **Table 9**, **10**, **11, 12 and 13**, respectively. Water ingestion and BW were obtained from the following: livestock cattle from CSIRO (2007); kangaroo from Dawson (1995); and dingo from Fleming et al. (2001). The water ingestion rate (IR) for kangaroo assumed that although they may go extended periods without water (getting water from the grasses they eat); they would conservatively take advantage of the presence of surface water to replenish themselves, up to three litres per event. Dingoes in general drink one litre of water a day in the summer and about half a litre a day in winter (Dawson, 1995), a rate of 0.75 litres per day was selected as an average.

EF and ED were based on professional judgement that incorporated operational considerations for the frequency and duration of the potential for exposure to the gas operations in the three scenarios, and a conservative estimate of potential for domestic livestock and mammalian wildlife to be exposed. The use of EF and duration replaced the use of a home range ratio that is commonly used in intake modelling equations for ecological receptors. This was because the exposure of the domestic livestock and mammalian wildlife was not considered habitat-driven, as they would normally forage and breed in the operational areas, but similar to a 'trespasser' exposure scenario used in the human health risk assessment scenarios. Home range is used appropriately when the exposure is within the habitat of the potentially exposed species. However, the cattle, kangaroo, and dingo would not normally forage and breed in the operational areas.

The exposure assumptions also recognise that the ponding of irrigation water will be only a temporary activity, with operational controls and activities limiting the occurrence of livestock and wildlife entry and exposures. The receptors were assumed to obtain drinking water from the ponded irrigation water

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only on occasions when they inadvertently entered on to the operational area of a unique modelled irrigation area as follows:

- Kangaroo – this receptor exposure pathway includes kangaroos that may come in contact with the above grade water exposure scenarios for an EF of 1 to 7 days/year for a 1-year period with the potential for incidental ingestion (watering).
- Dingo – this receptor exposure pathway includes dingos that may come in contact with the above grade water exposure scenarios for an EF of 1 to 7 days/year for a 1-year period with the potential for incidental ingestion (watering); note that average ponded water is estimated to be 3 days due to evaporation.

In addition to the previous receptors, stock watering may occur with permeate (or a mixture with produced water). This exposure pathway includes livestock cattle that may come in contact with the irrigation water through stock watering EF of 1 to 7 days/year for a 1-year period with the potential for incidental ingestion (watering).

The Northern Quoll and Cattle Egret were selected as ecological endpoints for potential exposure to COPCs in soils irrigated with permeate and produced water. The habitat of the Northern Quoll vary, including, but not limited to open dry sclerophyll forest and woodland, riparian woodland, low dry vine thicket, sugarcane farms and urban areas (Begg 1981; Braithwaite & Griffiths 1994; Pollock 1999; Oakwood 2008). The Northern Quoll was used as a surrogate for small mammal exposures in pasture areas. The Cattle Egret habitat is primarily pasture areas. Life history input values for ingestion rates, body weight, home range and dietary composition are presented below. **Table 12** summarises the assumptions for the Northern Quoll; **Table 13** presents the assumptions for the Cattle Egret.

The diet of the Northern Quoll is opportunistic and consists primarily of invertebrates (e.g., grasshoppers, beetles, termites, crustaceans). A variety of vertebrates (e.g., mammals, birds, reptiles, frogs) and even fruit or nectar may also be consumed. They are also known to feed on carrion and human refuse. (Pollock 1999; Oakwood 2008). For this evaluation, the diet is conservatively assumed to be comprised 50 % of earthworms (corresponding to a prey ratio of 0.5) to link the potential COPC in the soil and the feeding habits of the Northern Quoll. The home range of the Northern Quoll ranges from 10 ha to 1000 ha, depending upon proximity to forest or vegetative cover (Begg 1981; King 1989; Schmitt et al. 1989; Braithwaite & Griffiths 1994; Oakwood 2002). For this evaluation, a home range of 10 ha was utilised as a conservative assumption for the Norther quoll. Therefore, as the beneficial reuse irrigation area ranges over 100s of hectare, a home range ratio of 1.0 is conservatively assumed.

Food consumption in mammalian receptors is assumed to correspond to body weight and was calculated utilising the following equation (USEPA, 1993):

$$F = \frac{(0.621 \times BW^{0.564})}{(1 - W)}$$

where:

F = food intake in grams of fresh weight per day (g/day)
BW = body mass of animal (g)
W = mass fraction of water in the food (0.8 for insectivores)

Using the above equation and a body weight of 800 g, the ingestion rate is estimated to be 2.74 g/day (0.00274 kg/day). Therefore, the ingestion rate of earthworms is assumed to be 0.00137 kg/day and of soil is 0.000274 kg/day.

Cattle Egrets feed mostly on grasshoppers during the breeding season. They are, however, known to consume other insects including cicadas, centipedes, spiders, cattle ticks, frogs (including cane toads), lizards (particularly skinks) and small mammals (Marchant & Higgins 1990). For this evaluation, the

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diet is conservatively assumed to be comprised 50 percent of earthworms (corresponding to a prey ratio of 0.5) to link the potential COPCs in the soil and the feeding habits of the Cattle Egret. Similar to the Northern Quoll, food consumption in avian receptors is assumed to correspond to body weight and was calculated utilising the following equation (USEPA, 1993):

$$F = \frac{(0.648 \times BW^{0.651})}{(1 - W)}$$

where:

F = food intake in grams of fresh weight per day (g/day)
BW = body mass of animal (g)
W = mass fraction of water in the food (0.8 for herbivores)

Based on a body weight of 34 g, an ingestion rate of 157 g/day (0.157 kg/day) was calculated. Consumption of soil is assumed to be 20 % of the food ingestion rate; therefore, the soil ingestion rate for the Cattle Egret is 31 g/day (0.031 kg/day).

The cattle egret occurs in grasslands, wooded lands and terrestrial wetlands, and it has been observed in low-lying poorly drained pastures with an abundance of high grass. It is commonly associated with the habitats of farm animals, particularly cattle, but also pigs, sheep, horses and deer. It uses predominately shallow, open and fresh wetlands including meadows and swamps with low emergent vegetation and abundant aquatic flora. They have sometimes been observed in swamps with tall emergent vegetation (Marchant & Higgins 1990; Morton et al. 1989). Based on the variability of the habitat consisting of grasslands, wood lands and wetlands, the home range ratio was conservatively estimated to be 0.5.

7.3 Exposure Assessment Summary

This exposure assessment comprised an evaluation of potential surface and subsurface exposure pathways including accidental releases scenarios. The scenarios were developed based on the following activities:

- Transport of water treatment chemicals;
- Use of water treatment chemicals;
- Storage, conveyance / transport and beneficial use of water (entrained water treatment chemicals); and
- Storage, transport and disposal of waste.

The receptors considered include trespassers, workers, agricultural workers and environmental receptors (MNES and non-MNES).

Based on each exposure scenario and relevant to each receptor, the assessment calculated:

- actual starting concentrations for vendor chemicals – presented as Estimated Vendor Chemical Concentrations), or
- mass balance and / or fate and transport modelling to calculate End Point Concentrations (EPCs).

The outcomes of this exposure assessment provides the input parameters (i.e. Estimated Vendor Chemical Concentrations and / or End Point Concentrations) that are required for Section 8 of the assessment (Risk Characterisation). The estimated Vendor Chemical Concentrations or calculated End Point Concentrations are presented in:

- Appendix C (Table C-1)
- Tables 1 to 5
- Table 16 to 35

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8.0 RISK CHARACTERISATION

The purpose of the risk characterisation is to provide a conservative estimate of the potential risk resulting from exposure to COPCs identified from the water treatment chemicals. This step includes characterising environmental and human health risk based on the identification of the following:

- Complete exposure pathways and hazard identification for each of the processes involving chemicals and exposure assessment;
- The level of risk for COPCs by exposure pathway, route, and cumulative; and
- Uncertainty in quality and estimates of risk are included in the step.

The risk characterisation evaluates the toxicity of the individual substances and characterises the cumulative risks of the COPCs assessed for specific exposure pathways identified in the CEM.

Threshold risk estimates were based on the ratio of the intake of each COPC for each exposure pathway and exposure route divided by the appropriate toxicity criteria to produce a hazard quotient (HQ). The HQs for all exposure pathways for each COPC are summed for each receptor to produce a hazard index (HI). The target risk level of threshold risk estimates is an HI of 1 (enHealth, 2012a; NEPM, 2013). For non-threshold risk estimates, risks are identified as the additional probability of an individual developing cancer over a lifetime as a result of exposure. The estimated intake of each COPC for each exposure pathway and exposure route are multiplied by the appropriate risk criteria to estimate the increased lifetime cancer risks (ILCR). The ILCRs for all exposure pathways and COPCs are summed to produce a total ILCR. The target risk level for non-threshold risk estimates is an ILCR for single and multiple COPCs is 1 x 10^{-5} (enHealth, 2012a; NEPM, 2013).

The risk characterisation also identified the main or significant contributors to the overall risk assessment by the relevant exposure pathways. It included an evaluation of the overall quality of the assessment and the degree of confidence in the estimates of risks and the conclusions from the results. This was based on an uncertainty analysis and sensitivity analysis. The outcomes are presented in the sections below.

8.1 Human Receptors

The following sections discuss the potential hazards from exposure to COPCs from the water treatment chemicals.

8.1.1 Trespasser

Table 16 through **Table 19** present the risk calculations for trespasser from exposure to COPCs. No adverse effects are predicted for the trespasser based on the potentially complete exposure pathways identified for water treatment chemicals (**Table 8-1**).

Table 8-1 Summary of Cumulative HI for the Trespasser

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Stored or Ponded Irrigation Water – Permeate	2.1E-06
Stored or Ponded Irrigation Water – Permeate Blended with Produced Water	1.0E-06
Soils Irrigated with Permeate	5.4E-06
Soils Irrigated with Permeate Blended with Produced Water	2.7E-06

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8.1.2 Worker

Table 20 through **Table 23** present the risk calculations for worker from exposure to COPCs. No adverse effects are predicted for the worker based on the potentially complete exposure pathways identified for the water treatment chemicals (**Table 8-2**).

Table 8-2 Summary of Cumulative HI for the Worker

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Stored or Ponded Irrigation Water – Permeate	1.2E-07
Stored or Ponded Irrigation Water – Permeate Blended with Produced Water	6.2E-08
Soils Irrigated with Permeate	7.2E-07
Soils Irrigated with Permeate Blended with Produced Water	3.6E-07

8.1.3 Agricultural Worker

Table 24 and **Table 25** present the risk calculations for agricultural worker from exposure to COPCs chemicals. No adverse effects are predicted for the worker based on the potentially complete exposure pathways identified for the water treatment chemicals (**Table 8-3**).

Table 8-3 Summary of Cumulative HI for the Agricultural Worker

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Soils Irrigated with Permeate	8.4E-07
Soils Irrigated with Permeate Blended with Produced Water	4.2E-07

8.2 Ecological Receptors

The following sections discuss the risk estimates for the ecological receptors identified in the CEM. The derived dose-based TRVs for the ecological receptors are presented in **Appendix E**.

8.2.1 Kangaroo

Table 26 and **Table 27** present the calculated risk estimates for the kangaroo for potential exposures to COPCs. The cumulative HI for the kangaroo in the water treatment chemicals exposure scenarios did not exceed the risk threshold levels (**Table 8-4**).

Table 8-4 Summary of Cumulative HI for the Kangaroo Scenario

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Permeate (i.e. Stored or Ponded)	4.4E-04
Permeate Blended with Produced Water	2.2E-04

8.2.2 Dingo

Table 28 and **Table 29** present the calculated risk estimates for the dingo for potential exposures to COPCs from water treatment chemicals. The cumulative HI for the dingo in the water treatment chemicals exposure scenarios did not exceed the risk threshold levels (**Table 8-5**).

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Table 8-5 Summary of Cumulative HI for the Dingo Scenario

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Permeate (Stored or Ponded)	2.1E-04
Permeate Blended with Produced Water (Stored or Ponded)	1.1E-04

8.2.3 Cattle

Table 30 and **Table 31** present the calculated risk estimates for the cattle in the livestock watering scenario for potential exposures to COPCs in the livestock watering scenario for water treatment chemicals. The cumulative HI for the cattle in the water treatment chemical exposure scenarios did not exceed the risk threshold levels (**Table 8-6**).

Table 8-6 Summary of Cumulative HI for the Cattle Scenario

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Permeate	2.8E-06
Permeate Blended with Produced Water	1.4E-06

8.2.4 Northern Quoll

Tables 32 and **33** present the calculated risk estimates for the Northern Quoll for potential exposures to COPCs from water treatment chemicals. The cumulative HI for the Northern Quoll in the two exposure scenarios did not exceed the risk threshold levels (**Table 8-7**).

Table 8-7 Summary of Cumulative HI for the Northern Quoll Scenario

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Soils Irrigated with Permeate	4.2E-06
Soils Irrigated with Permeate Blended with Produced Water	2.1E-06

8.2.5 Cattle Egret

Tables 34 and **35** present the calculated risk estimates for the Cattle Egret for potential exposures to COPCs from water treatment chemicals. The cumulative HI for the Cattle Egret in water treatment chemical exposure scenarios did not exceed the risk threshold levels (**Table 8-8**).

Table 8-8 Summary of Cumulative HI for the Avian Receptor Scenario

Scenario	Cumulative HI (Target HI = 1.0)
WMF Chemicals	
Soils Irrigated with Permeate	1.0E-06
Soils Irrigated with Permeate Blended with Produced Water	5.2E-07

8.3 Sensitivity Analysis

A sensitivity analysis was performed to assess the range of potential risks from exposure to chemicals in the previous chemical risk assessment (EHS Support, 2018). The sensitivity analysis was performed

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for the prey ratios of the avian receptor (Cattle Egret) due to the elevated HI level for exposure to COPCs.

The use of 0.5 prey ratio was considered over conservative because documented feeding habits of the avian receptors included primarily flying insects and other prey species not associated with ingestion of soil. However, the assumption that 50 percent of the prey species included earth worms was conservative association with the presences of COPCs in the soil.

To evaluate the uncertainty in this assumption and to provide a range of potential risk associated with this assumption, a sensitivity analysis was conducted with a range of prey ratios. The results of the sensitivity analysis indicate that there is less than a two-fold difference in the range of prey ratios selected. A sensitivity ratio (SR) to evaluate the sensitivity of the prey ratio was previously conducted (EHS Support, 2018).

An SR equal to one would indicate that for a one-unit increase in the input variable of interest, the model output increases by one unit. An SR equal to zero indicates that changes in the input variable do not change the model output. The SR for the prey ratio ranges from 0.38 to 0.72 for a range of input options for the Cattle Egret. Therefore, the prey ratio is a sensitive variable for the calculation of the potential risks to exposure to COPCs in the WMF processes.

8.4 Uncertainty Analysis

The procedures and assumptions used to assess potential human health risks in this and similar human health risk assessments 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 chemicals in environmental media to the assessment of exposure and toxicity, and risk characterisation.

The NEPM (2013) risk assessment guidance notes that uncertainty results from the lack of knowledge about the correct value, such as specific exposure assumptions or estimates of EPCs. The term "uncertainty" is often used in risk assessment to describe what are, in reality, two conceptually different terms: uncertainty and variability. Uncertainty can be described as the lack of a precise knowledge resulting in a fundamental data gap. Variability describes the natural heterogeneity of a population. Uncertainty can sometimes be reduced or eliminated through further measurements or study. By contrast, variability is inherent in what is being observed. Although variability can be better understood, it cannot be reduced through further measurement or study, although it may be more precisely defined. However, the additional cost of further data collection may become disproportional to the reduction in uncertainty.

The human health risk assessment approach to presenting the potential risks is consistent with the goal of representing the high end of the possible risk distribution, which is generally considered to be greater than the 90th percentile. Further, these estimates are based on numerous and often conservative assumptions and, in the absence of definitive information, assumptions are used to ensure that actual sites risks are not underestimated. The cumulative effect of these assumptions can result in an analysis with an overall conservativeness greater than the individual components.

Accordingly, it is important to note that the risks presented here are based on numerous conservative assumptions in order to be protective of human health and to ensure that the risks presented here are more likely to be overestimated rather than underestimated.

The following discussion provides an evaluation of uncertainty throughout the data acquisition and evaluation process and analysis and estimate of risk. The analysis of uncertainty follows the guidelines in NEPM (2012a) and enHealth (2012) and includes the following:

- What aspects of the problem formulation, and specifically the Conceptual Site Model, are uncertain and how has that uncertainty been accounted for;

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- Evaluation of the uncertainty and variability in the data used in the chemical risk assessment;
- The degree of risks relative to the exposure assumptions with potential risks close to or slightly exceeding indicating a higher degree of uncertainty in the analysis; and
- The extent of missing or incomplete information and factors affecting exposure assumptions and parameters.

Table 8-9 Evaluation of Uncertainty

Risk Assessment Section	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment – Sample Collection	Representativeness of sample based on collection methods.	Low	Low potential to underestimate risks.
Hazard Assessment – Sample Analysis	Uncertainty related to accuracy/precision of laboratory analytical methods.	Low	Low potential to underestimate risks.
Hazard Assessment – Non Detected constituents	Evaluated using detection limits.	Low	Low potential to overestimate or underestimate risks.
Hazard Assessment – Chemical additive COPC concentrations	The concentrations of COPCs in the water treatment process were estimated based on previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with Santos GLNG 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 COPCs evaluated in the quantitative risk assessment were assumed to be 100 percent of mass used in the water treatment process. This is a conservative assumption for chemicals that may degrade rapidly or volatilise.	Medium	This assumption may overestimate the calculated risks to receptors.
Fate and Transport Groundwater Model	The use of conservative model assumptions and scenarios and dilution as the primary mechanism of decreasing concentrations of chemical additives.	Low to Medium	Low to medium potential to overestimate risk.
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.
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.

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Risk Assessment Section	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
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 – Chemical-Specific Parameters	Empirical data were not available for certain chemical-specific parameters (e.g., dermal permeability coefficient). These parameters were estimated based on equations in literature reviews.	Low	Low potential to overestimate or estimate risks.
Toxicity Values	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.
Cumulative Risk (Within a Project Stage)	The use of the HI for ecological receptors may not accurately assess the range of dose-response relationships (i.e., slopes and intercepts) and modes of action.	Low	Low potential to underestimate or overestimate risk.

8.5 Cumulative Impacts

The potential for cumulative impacts associated with the activities proposed within this Maisey (Project Stage 2 – Water Treatment Chemicals) Water Quality Management Plan and the following approved plans have been considered and assessed:

- Scotia (Project Stage 1) Water Quality Management Plan - drilling fluids and hydraulic fracturing fluids and
- Maisey (Project Stage 2) Water Quality Management Plan – drilling fluids.

Each assessment is presented in detail below:

Maisey Project Stage 2 – Water Treatment and Scotia Project Stage 1 – Drilling & Hydraulic Fracturing

The Maisey Project Stage 2 and Scotia Project Stage 1 areas are separated by a distance of approximately 100km (**Figure 8-1**). Further, the project stages occur at different points in time. Given that the Maisey and Scotia development do not overlap spatially or temporally, the potential for cumulative impacts is remote.

This outcome is further supported by the following details:

- Scotia Project Stage 1 does not include water treatment; therefore there is no potential for cumulative impact from water treatment chemicals.
- Maisey Stage 2 – Water treatment does not include drilling and/or completion chemicals; therefore there is no potential for cumulative impact from drilling and/or completion chemicals.
- The Maisey and Scotia areas are in different surface water catchments; therefore there is no potential for interaction and therefore have cumulative impacts from Maisey water treatment and Scotia drilling and completion chemicals.
- Modelling undertaken for the Scotia Drilling and Completion chemicals demonstrate the subsurface migration/transport is limited to less than 90m; therefore, there is no potential for

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Scotia Drilling and Completion chemicals to interact and therefore have cumulative impacts with Maisey Water Treatment Chemicals.

- The transportation of drilling and completion chemicals to Scotia occurs on different regional road to that of water treatment chemicals to the WFM for Maisey. There is the potential for limited interaction of state or federal roads within the State of Queensland. The transportation of chemicals to the WMF, or several WMFs, may utilise common major roads; however, the probability of multiple accidents and associated releases in identical locations (based on the number of truck movements) is considered to have a very low probability.

Maisey Project Stage 2 – Water Treatment and Maisey Project Stage 2 – Drilling

The Maisey Project Stage 2 – Water Treatment and Maisey Project Stage 2 - Drilling occur generally within the same region (**Figure 1-2**). Further, there is the potential for treated water to be directly used on the Maisey tenure (where drilling is being undertaken). Therefore the water treatment and drilling activities (at least initially) will occur at similar points in time, leading to the potential for cumulative impacts.

An assessment of the potential for cumulative impacts is presented below:

- The transportation of drilling chemicals to wells within the Maisey Petroleum Lease PL1021 will occur on a network of regional roads (i.e. from Roma and Brisbane) and local roads and tracks with PL1021. The Maisey Water Treatment Chemicals however will be limited to the approved roads as described above. It is therefore rare that trucks transporting water treatment chemicals and trucks carrying drilling chemicals will be in the same location, except for the regional roads. Given the (low) incident rate on trucking incidents on such roads, it is even more unlikely that both trucks would have an accident and release chemicals at the same location. Therefore the potential for cumulative impacts to a local receptor is considered remote.
- This outcome was supported by the groundwater fate and transport modelling (See **Appendix D**; EHS Support, 2018) that showed that the maximum potential transport distance within a sandstone aquifer is no greater than 90 m; therefore, development of wells at a minimum of 500 m spacing will mitigate any potential for cumulative impacts either between wells, or between wells and beneficial reuse activities (e.g. irrigation) that will occur approximately 30 km in distance in Roma West. The storage and use of drilling chemicals will occur within Maisey PL1021, which is within the Yuleba and Wallumbilla Creek Catchments. The storage and use of water treatment chemicals will occur within PL315 which is within the Blyth Creek catchment. The potential for surface / surface water related cumulative impacts is considered low.
- The Maisey Drilling Chemical Risk Assessment assessed the risk of irrigating and beneficially using produced water including geogenic and anthropogenic (drilling) chemicals. Given the outcomes of this Water Treatment Chemical Risk Assessment, the water treatment chemicals at the point of beneficial use pose no significant increase in risk. Geogenic constituents and drilling chemical additives remain the risk drivers but the treatment technologies employed in water treatment will similarly remove these constituents and the beneficial use of water will pose no significant increase in risk.
- The Maisey Drilling Chemical Risk Assessment assessed the risk of storing produced water including geogenic and anthropogenic (drilling) chemicals. Given the outcomes of this Water Treatment Chemical Risk Assessment, the water treatment chemicals at the point storage pose significant increase in risk. Geogenic constituents and drilling chemical additives remain the risk drivers.

Given that Maisey Project Stage 2 Drilling Fluid chemicals may be entrained within produced water and subsequently transported to the WMF, these chemicals are also removed by the treatment systems and as such no additional risk is provided in the beneficial use activities, including irrigation areas.

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In the context of the multiple projects (as described above) there is considered limited potential for cumulative impacts. Whilst there is the potential for cumulative impact from Maisey Project Stage 2 and Maisey Project Stage 2 – Drilling Chemicals, it is considered that there is negligible incremental risk posed by the use of water treatment chemicals and the existing (and proposed) management and monitoring controls are appropriate to ensure that the risk to MNES (and non MNES) receptors remains low.

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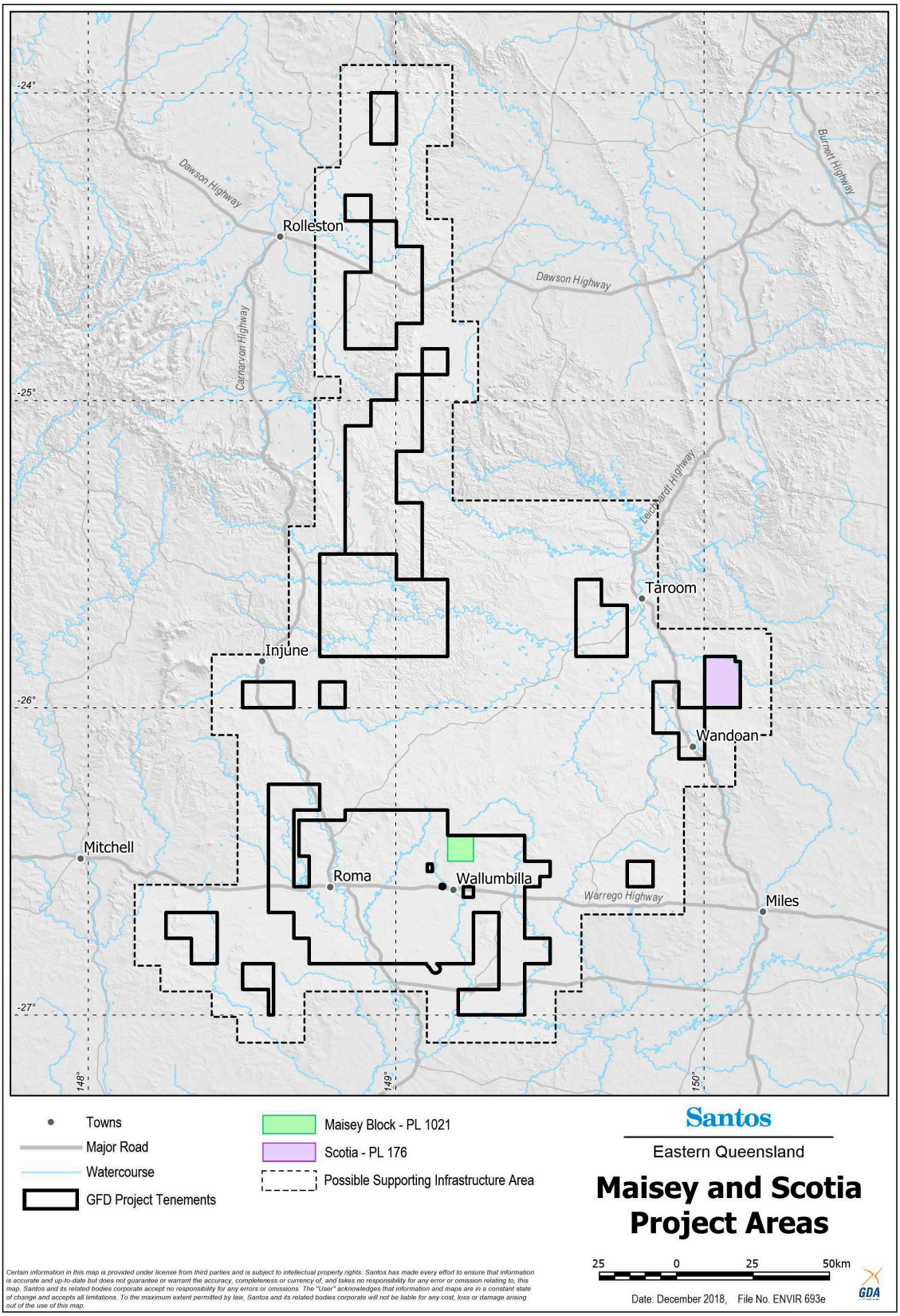

Figure 8-1 Locations of Project Stage 1 (Scotia) and Project Stage 2 (Maisey)

8.6 Risk Characterization Summary

The risk characterisation provided a conservative estimate of the potential risk resulting from exposure to COPCs identified from the water treatment chemicals via direct intake of permeate or irrigated soils.

For human receptors, there were no adverse effects (cumulative HI greater than 1) predicted for the trespasser, site worker, and agricultural worker based on the potentially complete exposure pathways to permeate or irrigated soils for water treatment chemicals.

For ecological receptors, the kangaroo, dingo, and cattle receptors did not have cumulative HI for exposure to permeate that exceeded risk threshold levels, and the Northern Quoll and Cattle Egret did not have cumulative HI for exposure to irrigated soils that exceeded the risk threshold levels.

The risk characterisation is considered to conservatively assess the potential for human and ecological receptors from accidental releases during storage, transport and use of treated water.

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9.0 RISK MANAGEMENT

Risk management provides recommendations for mitigation, management, monitoring and reporting. This section will firstly assess the adequacy of existing controls (used in **Section 5.0** to address issue identification) and provide recommendations for additional mitigation and management if required.

A framework for inspection and monitoring will be provided including activities conducted to verify and validate the assumptions contained within the risk assessment and the potential for impacts on other environmental media. The CSG Waste Management Plan (Project Stage 2 – Maisey) presents in Table 5 early warning threshold triggers and limits for detecting and managing potential impacts to MNES. This includes storage, transport and use of treated water. Based on an unwanted event, a series of management actions are implemented to address potential impacts.

A schedule for update and review of the plan will be provided in accordance with Condition 29(g) of the EPBC Approval for the GFD Project.

A weight of evidence approach has been used to evaluate the potential risks to human health and the environment including MNES and non-MNES receptors both qualitatively and quantitatively. The key findings are presented in the risk assessment and are summarised in **Section 9.0**.

The life cycle of the WMF chemicals was assessed specifically for WMF operations and included:

- Transportation of chemicals from the supplier warehouse to the WMF;
- Storage and usage of chemicals within water treatment operations at the WMF;
- Storage, transport and beneficial reuse of treated water; and
- Storage and / or disposal of waste.

The WMF chemicals within the life cycle (i.e., transportation, storage, usage, and disposal) may result in potential exposure to human receptors and the environment through accidental releases. These potential releases, whilst unexpected, are considered to have a very low probability of occurrence based on the Santos GLNG commitment to managing risk, existing legislative requirements and the on-going mitigating of potential impacts. The majority of chemicals used were identified to pose an unacceptable risk if the chemical products were released to surface water with limited dilution.

Santos GLNG key plans applicable to the management and mitigation of risks associated with chemical usage were summarised in **Section 2.1.** Key plans integral to the management of impacts on the environment (including chemical usage), management of risks associated with chemical transportation, storage, and use, and management/monitoring of potential impacts in the environment were summarised **Table 2-1**.

Santos GLNG has developed and implemented a range of systems and plans to control the transportation and storage of chemicals during field development and operational activities. This includes effective traffic management, in Vehicle Monitoring Systems (IVMS) and routing to minimise the potential for accidents and spill management planning and response equipment. Consistent with the assessment contained within the EIS (URS, 2014) these systems and processes are considered effective in lowering the probability of occurrence of consequence associated with the transportation incidents.

To address the rare, but unexpected, potential release of the WMF chemicals during transportation, storage and usage, a qualitative assessment was conducted during the transportation, storage, and usage of the WMF chemicals. Critical health and ecological hazards were compiled for the WMF chemicals to indicate which of the WMF chemicals required special consideration with regard to the potential to be a hazard if accidently released. Where a potential hazard exists, additional information is provided in the risk assessment dossiers and SDS is available to emergency responders, health and safety managers, and environmental hazard clean-up teams.

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The human health and ecological hazard mitigation information provided in the risk assessment dossiers and SDS primarily focuses on safe handling, transportation, and worker protection.

In addition, as noted above, Santos GLNG has implemented comprehensive management plans to ensure that the WMF operations are conducted safely and with minimal potential for accidental exposures to human receptors or the environment to occur.

The beneficial reuse of the WMF permeate or permeate blended with produced water is a key component of Santos GLNG management of produced water. These activities are conducted in accordance with conditions contained within Environmental Authorities granted and Beneficial Use Approvals.

The chemical used in the treatment of produced water were evaluated using risk-based screening criteria, and exposure intake modelling, for human health and the environment, including the potential for MNES and non-MNES resources. Based on this comprehensive risk assessment, the findings indicated that there was a low potential risk from the storage, transport and beneficial reuse of permeate. No adverse impacts to aquatic receptors, soil consortia, human health and ecological receptors were identified in the quantitative assessment of residual water treatment chemicals in the treated water.

In combination with the avoidance of these sensitive areas, numerous strategies are employed to ensure that chemicals are contained to the work area. Common strategies employed include:

- Establishment of designated storage areas;
- Provision of secondary containment structures for drums and totes in accordance with legislative requirements and Australian Standards;
- Engineering of storage pits and produced water dams to manage the risk of seepage and leakage
- Control of surface water (run-on & runoff) at WMF;
- Removal of surplus chemicals from the WMF; and
- Development of WMPs and beneficial reuse alternatives that involve management of residuals away from areas of potentially sensitive environmental receptors.

Specific monitoring procedures will be implemented for a broader perspective on potential hazards and risks identified in this chemical risk assessment:

- Incident monitoring including internal incident monitoring reports;
- Periodic inspections of compliance and implementation of the risk management recommendations;
- In-vehicle monitoring systems (IVMSs) pursuant to the transportation life cycle and other applicable requirements for transportation; and
- Occupational, Health and Safety (OH&S) monitoring to ensure compliance with worker safety and standard practice of operations.

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10.0 SUMMARY, CONCLUSIONS AND MITIGATION COMMITTMENTS

This risk assessment was conducted to specifically cover chemical usage associated with produced water treatment at the WMF associated with Project Stage 2 – Water Treatment (**Figure 1-1**). These activities will include treatment of produced water from Maisey Petroleum Lease (PL) 1021 in Santos GLNG's existing Roma WMFs, once the wells are brought on-line. The location of PL1021 relative to the Roma WMF is shown on **Figure 1-2** to provide context.

The goal of the chemical risk assessment is to demonstrate that potential risks have been eliminated or reduced as much as is reasonably practicable to potentially expose non-MNES (i.e. human receptors) and MNES including terrestrial and aquatic ecological receptors, as well as water resources.

A 'best practice risk assessment methodology' was utilised using the EPA ExpoBox and the OECD Environmental Risk Assessment Toolkit. This provided a compendium of risk assessment tools that links to guidance, databases, models, key references and related resources. These tools provided input throughout the risk assessment and ensured the risk assessment met the goals of the assessment and uncertainty in the risk assessment is minimised.

The following provides a salient summary of the outcome of the qualitative and quantitative chemical risk assessment conducted for the WMF chemicals.

- PBT assessment – based on Australian and EU REACH Criteria methodology, no chemicals were identified as PBT.
- Human health and ecological hazards – the potential hazards were summarized for exposure to chemicals from in advertent potential release; where a potential hazard exists, information in the risk assessment dossiers and SDSs are available to emergency responders, health and safety managers, and environmental hazard clean-up teams.
- Transportation release scenario - comparison of potential EPCs from a release to human health drinking water levels and ecological PNECs had risk ratios exceeding 10 for all chemicals and potential for adverse impacts to surface water resources and ecological receptors would require management controls.
- Permeate accidental release – there were no unacceptable risks for exposure scenarios associated with permeate based on comparison of potential EPCs to human health drinking water levels and ecological PNECs; therefore, there are no anticipated adverse effects to releases of permeate to the environment.
- Permeate beneficial – storage, transport and reuse - there were no adverse effects (cumulative HI greater than 1) predicted for the trespasser, site worker, and agricultural worker based on the potentially complete exposure pathways to permeate or irrigated soils for water treatment chemicals; the kangaroo, dingo, and cattle receptors did not have cumulative HI for exposure to permeate that exceeded risk threshold levels, and the Northern Quoll and Cattle Egret did not have cumulative HI for exposure to irrigated soils that exceeded the risk threshold levels.

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10.1 WMF chemicals

The life cycle of the WMF chemicals was assessed specifically for the WMF operations and included:

- Transportation of chemicals from the supplier warehouse to the WMF;
- Storage and usage of chemicals within the operations at the WMF;
- Storage, transport and beneficial reuse of treated water; and
- Management of Wastes (small volumes of solids removed from the water prior to treatment and the storage of brine that may contain entrained water treatment chemicals).

Based on the outcomes of this assessment, in the event of overland flow from irrigation activities and subsequent discharge into surface water resources, there were no potentially unacceptable risks to aquatic receptors from the chemicals used in water treatment. However, based on the assessment of cumulative impacts, it should be noted that the salinity / quality of the irrigation water (associated with

geogenic constituents as assessed as part of the Maisey drilling fluid chemical risk assessment) may be incompatible with the aquatic species present. The increase in risk from the addition of water treatment chemicals is negligible. Management controls are required to mitigate the risk of irrigation water runoff into adjacent surface water bodies.

COMMITMENT:

Despite the absence of risk associated with WMF Chemicals, the potential exists for geogenic constituents within produced water to impact on aquatic receptors. This risk was carried into the Waste Management Plan (Maisey Stage 2) to ensure that risks to MNES are minimised. Specifically, Table 5 (Santos GLNG, 2019) presents early warning threshold triggers and limits for detecting impacts to aquatic receptors during the storage of produced water in ponds. Management responses include reducing storage in ponds and remediation of liners. The qualitative assessment of the potential for a complete exposure pathway listed the critical human and ecological hazards that warrant consideration during the transport of the WMF chemicals from the warehouse to the WMF, and during the preparation of the chemicals for use in the treatment process. Where a potential hazard exists, additional information is provided in the chemical risk assessment dossiers and SDSs. These documents are available to emergency responders, health and safety managers, and environmental hazard clean-up teams.

COMMITMENT:

- **All chemical transport vehicles are to travel on approved roads and driver behaviour is to be monitored by an IVMS.**
- **SDSs and chemical risk assessment dossiers are available to emergency responders, health and safety managers, and environmental hazard clean-up teams.**
- **All chemicals at the water treatment facility will be stored and managed in contained areas in accordance with legislative and regulatory requirements to prevent releases to the environment.**

A PBT substances assessment was conducted on the WMF chemicals proposed for use in the produced water treatment program. There were no PBT substances identified in this assessment.

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11.0 SCHEDULE FOR REVIEW

In accordance with approval conditions, this plan will be reviewed at a minimum interval of every three years from the date of approval, until Project Stage 2 activities are complete.

The review will assess the adequacy of the Plan to determine whether there is a new or increased risk to MNES and assess adequacy of the monitoring and mitigation measures committed to within the Plan. This review will be based on:

- The remaining project activities;
- The availability of new chemical information (as presented in the dossiers); and
- The inclusion of new chemicals.

Where a new or increased impact to MNES is identified, the Plan will be submitted to the Minister for approval in accordance with approval conditions.

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TABLES

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Table 1
Comparison of Theoretical Transport Concentrations of COPCs to PNECs (Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Estimated Vendor Transport Concentration (mg/l) Exposure Scenario			PNEC aquatic (mg/l)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk) Exposure Scenario		
		100%	25%	5%		100%	25%	5%
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	150000	37,500	7,500	1.40E-01	1.1E+06	2.7E+05	5.4E+04
Acetic Acid	64-19-7	200000	50,000	10,000	3.00E+00	6.7E+04	1.7E+04	3.3E+03
Adipic Acid	124-04-9	1250	312.5	62.5	1.30E-01	9.6E+03	2.4E+03	4.8E+02
Aluminium Hydroxychloride	1327-41-9	500000	125,000	25,000	8.00E-04	6.3E+08	1.6E+08	3.1E+07
Ammonia	7664-41-7	350000	87,500	17,500	9.00E-01	3.9E+05	9.7E+04	1.9E+04
Cationic acrylamide copolymer	69418-26-4	22500	5,625	1,125	1.00E-03	2.3E+07	5.6E+06	1.1E+06
Cationic Polymer	n/a	300000	75,000	15,000	1.30E-01	2.3E+06	5.8E+05	1.2E+05
Aluminium chlorohydrate	12042-91-0	5000000	1,250,000	250,000	8.00E-04	6.3E+09	1.6E+09	3.1E+08
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	130000	32,500	6,500	3.10E-01	4.2E+05	1.0E+05	2.1E+04
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	125000	31,250	6,250	2.20E+00	5.7E+04	1.4E+04	2.8E+03
Hydrogen Peroxide	7722-84-1	300000	75,000	15,000	1.30E-02	2.3E+07	5.8E+06	1.2E+06
Peroxyacetic Acid	79-21-0	100000	25,000	5,000	2.00E-04	5.0E+08	1.3E+08	2.5E+07
Phosphonic Acid	13598-36-2	50000	12,500	2,500	1.50E+00	3.3E+04	8.3E+03	1.7E+03
Polyacrylamide (anionic)	9003-05-8	25000	6,250	1,250	1.00E-01	2.5E+05	6.3E+04	1.3E+04
Potassium Hydroxide	1310-58-3	25000	6,250	1,250	-	NA	NA	NA
Sodium Bisulphite	7631-90-5	500000	125,000	25,000	8.00E-01	6.3E+05	1.6E+05	3.1E+04
Sodium Carbonate	497-19-8	200000	50,000	10,000	-	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	100000	25,000	5,000	4.40E-01	2.3E+05	5.7E+04	1.1E+04
Sodium Hydroxide	1310-73-2	1000000	250,000	50,000	-	NA	NA	NA
Sodium Hypochlorite	7681-52-9	3000000	750000	150000	3.00E-03	1.0E+09	2.5E+08	5.0E+07
Sulphuric Acid	7664-93-9	340000	85,000.000	17,000.000	-	NA	NA	NA
					Cumulative Ratio:	8.4E+09	2.1E+09	4.2E+08

Notes:
mg/l = milligrams per liter
- indicates PNEC not available. Refer to risk dossiers for discussion on PNEC development.
NA - not applicable

Table 2
Comparison of Theoretical Concentrations of COPCs in Soil from Release During Transport to PNECs (Solid)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Soil From Release During Transport (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)
				Soil
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	150000	9.6E+00	1.6E+04
Acetic Acid	64-19-7	200000	4.0E-02	5.0E+06
Adipic Acid	124-04-9	1250	3.0E-03	4.2E+05
Aluminium Hydroxychloride	1327-41-9	500000	-	NA
Ammonia	7664-41-7	350000	-	NA
Cationic acrylamide copolymer	69418-26-4	22500	-	NA
Cationic Polymer	n/a	300000	-	NA
Aluminium chlorohydrate	12042-91-0	5000000	-	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	130000	4.0E+01	3.3E+03
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	125000	-	NA
Hydrogen Peroxide	7722-84-1	300000	-	NA
Peroxyacetic Acid	79-21-0	100000	3.6E+00	2.8E+04
Phosphonic Acid	13598-36-2	50000	-	NA
Polyacrylamide (anionic)	9003-05-8	25000	-	NA
Potassium Hydroxide	1310-58-3	25000	-	NA
Sodium Bisulphite	7631-90-5	500000	-	NA
Sodium Carbonate	497-19-8	200000	-	NA
Sodium Citrate Dihydrate	6132-04-3	100000	3.0E-03	3.3E+07
Sodium Hydroxide	1310-73-2	1000000	-	NA
Sodium Hypochlorite	7681-52-9	3000000	-	NA
Sulphuric Acid	7664-93-9	340000	-	NA
			Cumulative Ratio:	3.9E+07

Notes:
mg/kg = milligrams per kilogram
- indicates PNEC not available. Refer to risk dossiers for discussion on PNEC development.
NA - not applicable
a/ Refer to text on development of estimated vendor chemical concentrations in soil.

Table 3
Comparison of Theoretical Concentrations of COPCs to Drinking Water Guidelines
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Estimated Permeate Concentration (mg/l)	Estimated Permeate Vendor Chemical Concentrations Including Biodegredation (mg/l)		Drinking Water Screening Level (mg/l)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)	
			Exposure Scenario			Exposure Scenario	
			Permeate	Permeate Mixed with Produced Water (a)		Permeate	Permeate Mixed with Produced Water
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.009	0.009	0.005	1.40E+01	6.4E-04	3.2E-04
Acetic Acid	64-19-7	NA	NA	NA	-	NA	NA
Adipic Acid	124-04-9	NA	NA	NA	8.80E+00	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	2.00E-01	NA	NA
Ammonia	7664-41-7	0.0175	0.0175	0.0088	5.00E-01	3.5E-02	1.8E-02
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	-	NA	NA
Cationic Polymer	n/a	NA	NA	NA	7.00E+00	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	2.00E-01	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0078	0.0078	0.0039	1.00E+00	7.8E-03	3.9E-03
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	2.50E-01	NA	NA
Hydrogen Peroxide	7722-84-1	NA	NA	NA	3.50E+00	NA	NA
Peroxyacetic Acid	79-21-0	NA	NA	NA	3.00E-01	NA	NA
Phosphonic Acid	13598-36-2	0.00	0.00	0.002	3.00E+00	1.0E-03	5.0E-04
Polyacrylamide (anionic)	9003-05-8	NA	NA	NA	1.75E+02	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	-	NA	NA
Sodium Bisulphite	7631-90-5	NA	NA	NA	1.80E+01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	1.80E+02	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	NA	NA	6.30E+01	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	1.80E+02	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	6.00E-01	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	2.50E+02	NA	NA
					Cumulative Ratio:	4.4E-02	2.2E-02

Notes:
mg/l = milligrams per liter
- indicates Drinking Water Screening Level not available. Refer to risk dossiers for discussion.
NA - not applicable
a/ Permeate mixed at ratio of 1:1 with produced water.

Table 4
Comparison of Theoretical Concentrations of COPCs to PNECs (Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Estimated Permeate Concentration (mg/l)	Estimated Permeate Vendor Chemical Concentrations Including Biodegredation (mg/l)		PNEC aquatic (mg/l)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)	
			Exposure Scenario			Exposure Scenario	
			Permeate	Permeate Mixed with Produced Water (a)		Permeate	Permeate Mixed with Produced Water
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.009	0.009	0.009	1.40E-01	6.4E-02	6.4E-02
Acetic Acid	64-19-7	NA	NA	NA	3.00E+00	NA	NA
Adipic Acid	124-04-9	NA	NA	NA	1.30E-01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	8.00E-04	NA	NA
Ammonia	7664-41-7	0.0175	0.0175	NA	9.00E-01	1.9E-02	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	1.00E-03	NA	NA
Cationic Polymer	n/a	NA	NA	NA	1.30E-01	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	8.00E-04	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0078	0.0078	0.0078	3.10E-01	2.5E-02	2.5E-02
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	2.20E+00	NA	NA
Hydrogen Peroxide	7722-84-1	NA	NA	NA	1.30E-02	NA	NA
Peroxyacetic Acid	79-21-0	NA	NA	NA	2.00E-04	NA	NA
Phosphonic Acid	13598-36-2	0.00	0.00	NA	1.50E+00	2.0E-03	NA
Polyacrylamide (anionic)	9003-05-8	NA	NA	NA	1.00E-01	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	-	NA	NA
Sodium Bisulphite	7631-90-5	NA	NA	NA	8.00E-01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	-	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	NA	NA	4.40E-01	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	-	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	3.00E-03	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	-	NA	NA
					Cumulative Ratio:	1.1E-01	8.9E-02

Notes:
mg/l = milligrams per liter
- indicates PNEC not available. Refer to risk dossiers for discussion on PNEC development.
NA - not applicable
a/ Permeate mixed at ratio of 1:1 with produced water.

Table 5
Comparison of Theoretical Concentrations of COPCs to PNECs (Solid)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Permeate in Soil From Release (mg/kg)	Estimated Vendor Chemical Concentration in Permeate Blended with Produced Water in Soil From Release (mg/kg)	Estimated Vendor Chemical Concentration in Soil After 20 Years Irrigation with Permeate (mg/kg)	Estimated Vendor Chemical Concentrationin Soil After 20 Years Irrigation (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = elevated potential risk)			
							Permeate Release to Soil	Permeate Blended with Produced Water Release to Soil	Soil Irrigated with Permeate	Soil Irrigated with Permeate Blended with Produced Water
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0045	0.29	0.69	0.34	9.6E+00	4.7E-04	3.0E-02	7.1E-02	3.6E-02
Acetic Acid	64-19-7	NA	NA	NA	NA	4.0E-02	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	NA	NA	NA	3.0E-03	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA	-	NA	NA	NA	NA
Ammonia	7664-41-7	0.00875	0.56	1.33	0.67	-	NA	NA	NA	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	NA	NA	NA	-	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA	-	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0039	0.25	0.59	0.30	4.0E+01	9.8E-05	6.3E-03	1.5E-02	7.4E-03
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA	-	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	NA	NA	NA	-	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	NA	NA	NA	3.6E+00	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.002	0.096	0.23	0.11	-	NA	NA	NA	NA
Polyacrylamide (anionic)	9003-05-8	NA	NA	NA	NA	-	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	NA	NA	NA	-	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA	-	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	NA	NA	NA	3.0E-03	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA	-	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA	-	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA	-	NA	NA	NA	NA
					Cumulative Ratio:		5.7E-04	3.6E-02	8.6E-02	4.3E-02

Notes:
mg/kg = milligrams per kilogram
- indicates PNEC not available. Refer to risk dossiers for discussion on PNEC development.
NA - not applicable
a/ Refer to text on development of estimated vendor chemical concentrations in soil.

Table 6
Trespasser Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Water	Ingestion	IR	Ingestion rate	l/hr	0.025	enHealth, 2012
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		BW	Body weight	kg	51	(c) enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
	Dermal	SA	Surface area for contact (total body)	cm^2	4,700	(d) enHealth, 2012, USEPA, 2016
		Kp	Dermal permeability factor	cm/h	chemical-specific	USEPA, 2016
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		EV	Event Frequency	events/day	1.0	USEPA, 2016
		BW	Body weight	kg	51	(c) enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
		CF	Conversion factor	l/cm^3	1.0E-03	enHealth, 212
Soil	Ingestion	IR	Ingestion rate	mg/day	100	enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact (exposed)	cm^2/day	4,700	(d) enHealth, 2012, USEPA, 2016
		ABS	Absorption Factor	unitless	chemical-specific	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ
		ED	Exposure duration	yr	10	BPJ
		BW	Body weight	kg	51	(c) enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
		AF	Soil Adherence Factor	mg soil/cm^2 skin	0.07	(f) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 212

a/ Units:

l/hr = litres per hour
hr/day = hours per day
day/yr = days per year
yr = year
kg = kilogram
cm^2 = square centimetre
cm/h = centimetre per hour
l/cm^3 = litre per cubic centimetre
cm^2/day = square centimetre per day
mg soil/cm^2 skin = milligrams soil per square centimetre skin
kg/mg = kilogram per milligram

b/ References:

enHealth, 2012:
enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommetee 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)

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

Table 7
Worker Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Water	Ingestion	IR	Ingestion rate	l/hr	0.025	enHealth, 2012
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	1	BPJ
		BW	Body weight	kg	85	(c) enHealth, 2012
		LT	Lifetime	yr	79	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 212
	Dermal	SA	Surface area for contact (total body)	cm^2	2,936	(d) enHealth, 2012, USEPA, 2016
		Kp	Dermal permeability factor	cm/h	chemical-specific	USEPA, 2016
		ET	Exposure time	hr/day	0.5	enHealth, 2012
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	85	BPJ
		EV	Event Frequency	events/day	1	USEPA, 2016
		BW	Body weight	kg	79	(c) enHealth, 2012
		LT	Lifetime	yr	3,650	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	25,550	enHealth, 2012
		AT-C	Averaging time - cancer	days	2,936	enHealth, 212
		CF	Conversion factor	l/cm^3	1.0E-03	enHealth, 212
Soil	Ingestion	IR	Ingestion rate	mg/day	330	USEPA, 2016
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	1	BPJ
		BW	Body weight	kg	85	(c) enHealth, 2012
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		LT	Lifetime	yr	79	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	365	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact (exposed)	cm^2/day	2,936	(d) enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	2	BPJ
		ED	Exposure duration	yr	1	BPJ
		BW	Body weight	kg	85	(c) enHealth, 2012
		LT	Lifetime	yr	79	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	365	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		ABS	Absorption factor	unitless	chemical-specific	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm^2 skin	0.21	(e) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012

a/ Units:

mg/day = milligrams per day
day/yr = days per year
yr = year
kg = kilogram
mg soil/cm^2 skin = milligrams soil per square centimetre skin
kg/mg = kilogram per milligram
cm^2 = square centimetre
cm^2/day = square centimetre per day

b/ References:

USEPA, 2016
USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at http://www.epa.gov/expobo›

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

BPJ: Best Professional Judgement

c/ Male exposure factor used based on enHealth recommendation.

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.

Table 8
Agricultural Worker Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Media	Exposure Route	Parameter Code	Parameter Definition	Units	Parameter Value	Source
Soil	Ingestion	IR	Ingestion rate	mg/day	100	enHealth, 2012
		EF	Exposure frequency	day/yr	4	BPJ
		ED	Exposure duration	yr	35	BPJ
		BW	Body weight	kg	85	(c) enHealth, 2012
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012
		LT	Lifetime	yr	79	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact	cm^2/day	5,664	(d) enHealth, 2012, USEPA, 2016
		EF	Exposure frequency	day/yr	4	BPJ
		ED	Exposure duration	yr	35	BPJ
		BW	Body weight	kg	85	(c) enHealth, 2012
		LT	Lifetime	yr	79	(c) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012
		ABS	Absorption factor	unitless	chemical-specific	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm^2 skin	0.08	(e) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012

a/ Units:

mg/day = milligrams per day
day/yr = days per year
yr = year
kg = kilogram
mg soil/cm^2 skin = milligrams soil per square centimetre skin
kg/mg = kilogram per milligram
cm^2 = square centimetre
cm^2/day = square centimetre per day

b/ References:

USEPA, 2016
USEPA. (2016). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at http://www.epa.gov/expobox
enHealth, 2012:
enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommetee of the Australian Health Protection Principal Committee, Canberra
BPJ: Best Professional Judgement

c/ Male exposure factor used.

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.

Table 9
Cattle Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	86	API, 2004
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	454	API, 2004
	AT-NC	Averaging time - noncancer	days	365	API, 2004

a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram

b/ References:
API, 2004
API. (2004). Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons, Regulatory Analysis and Scientific Affairs No. 4733 July 2004.
BPJ - Best Professional Judgement

Table 10
Kangaroo Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	3	Fleming, 2001
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	25	Fleming, 2001
	AT-NC	Averaging time - noncancer	days	365	Fleming, 2001

a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram

b/ References:
Fleming, 2001
Fleming, Peter; Laurie Corbett, Robert Harden, Peter Thomson (2001). Managing the Impacts of Dingoes and Other Wild Dogs. Commonwealth of Australia: Bureau of Rural Sciences.
BPJ - Best Professional Judgement

Table 11
Dingo Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR	Ingestion rate	l/day	0.75	Dawson, 1995
	EF	Exposure frequency	day/yr	7	BPJ
	ED	Exposure duration	yr	1	BPJ
	BW	Body weight	kg	13	Dawson, 1995
	AT-NC	Averaging time - noncancer	days	365	Dawson, 1995

a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram

b/ References:
Dawson, 1995
Dawson, Terence J. (1995). Kangaroos: Biology of the Largest Marsupials. Cornell University Press, Ithaca, New York. Second printing: 1998. ISBN 0-8014-8262-3.
BPJ - Best Professional Judgement

Table 12
Mammal Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

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.
	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.
	HR	Home Range ratio	unitless	1	The home range for Northern quoll varies from 10 ha to 1000 ha, depending upon habitat. Given that the beneficial reuse irrigation area is 100s of hectares, a conservative home range ratio of 1 is assumed.
	BW	Body weight	kg	0.80	Average body weight from Menkhorst & Knight 2001 and Oakwood 2008. Weight ranges from 0.7 kg to 0.1 kg.

a/ Units:
mg/day = milligrams per day
kg/day = kilograms per day
kg = kilogram

b/ References:

USEPA, 1993
USEPA. (1993) Wildlife Exposure Factors Handbook United States Environmental Protection Agency
Office of Research and Development. EPA/600/R-93/187. December 1993.
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.
Menkhorst, Peter; Knight, Frank (2001). A field guide to the mammals of Australia.
South Melbourne, Australia: Oxford University Press. pp. 194–195. ISBN 019550870X.

Table 13
Avian Receptor Exposure Assumptions
WMF Chemicals
Santos GLNG Gas Field Development Project

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Cattle Egret					
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 evalution, 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 calcualted using USEPA T-REX model equations.
	HR	Home Range ratio	unitless	0.5	BPJ
	BW	Body weight	kg	0.390	Siegfried, 1969
	PR	Prey Ratio	untiless	0.50	The cattle egret mainly consumes insects; a prey ratio of 0.5 is conservatively assumed and likely overestimates potential consumption of worms.

a/ Units:
kg/day = milligrams per day
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
W.R. Siegfried (1969) Energy Metabolism of the Cattle Egret, ZoologicaAfricana, 4:2, 265-273, DOI: 10.1080/00445096.1969.11447375

Table 14
Chemical-Specific Parameters
WMF Chemicals
Santos GLNG Gas Field Development Project

Chemical Name	CAS Number	RBA (unitless)	Source	FA (unitless)	Source (a)	Kp (cm/hour)	Source (a)	Dermal Absorption Factor (unitless)	Source (a)	t* (hours)	Source (a)	tau_{event} (hours/event)	Source (a)	B (unitless)	Source (a)
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	1.0	enHealth, 2012	1.0	USEPA, 2018	5.45E-07	Risk Dossier, calculated (b)	1.0	enHealth, 2012	3.59E+00	calculated (b)	1.50E+00	calculated (b)	3.01E-06	calculated (b)
Acetic Acid	64-19-7	1.0	enHealth, 2012	1.0	USEPA, 2018	5.64E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	5.47E-01	calculated (b)	2.28E-01	calculated (b)	1.68E-03	calculated (b)
Adipic Acid	124-04-9	1.0	enHealth, 2012	1.0	USEPA, 2018	2.77E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	1.66E+00	calculated (b)	6.91E-01	calculated (b)	1.29E-03	calculated (b)
Aluminium Hydroxychloride	1327-41-9	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Ammonia	7664-41-7	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	1.31E-01	calculated (b)	NA	calculated (b)
Cationic acrylamide copolymer	69418-26-4	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Cationic Polymer	n/a	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Aluminium chlorohydrate	12042-91-0	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	9.96E-01	calculated (b)	NA	calculated (b)
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	1.41E+01	calculated (b)	NA	calculated (b)
Hydrogen Peroxide	7722-84-1	1.0	enHealth, 2012	1.0	USEPA, 2018	9.41E-05	Risk Dossier, calculated (b)	1.0	enHealth, 2012	3.91E-01	calculated (b)	1.63E-01	calculated (b)	2.11E-04	calculated (b)
Peroxyacetic Acid	79-21-0	1.0	enHealth, 2012	1.0	USEPA, 2018	2.42E-04	Risk Dossier, calculated (b)	1.0	enHealth, 2012	6.72E-01	calculated (b)	2.80E-01	calculated (b)	8.13E-04	calculated (b)
Phosphonic Acid	13598-36-2	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	3.02E-01	calculated (b)	NA	calculated (b)
Polyacrylamide (anionic)	9003-05-8	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	NA	calculated (b)	NA	calculated (b)
Potassium Hydroxide	1310-58-3	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	2.16E-01	calculated (b)	NA	calculated (b)
Sodium Bisulphite	7631-90-5	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	4.02E-01	calculated (b)	NA	calculated (b)
Sodium Carbonate	497-19-8	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	4.12E-01	calculated (b)	NA	calculated (b)
Sodium Citrate Dihydrate	6132-04-3	1.0	enHealth, 2012	1.0	USEPA, 2018	2.62E-06	Risk Dossier, calculated (b)	1.0	enHealth, 2012	1.12E+01	calculated (b)	4.66E+00	calculated (b)	1.73E-05	calculated (b)
Sodium Hydroxide	1310-73-2	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	1.76E-01	calculated (b)	NA	calculated (b)
Sodium Hypochlorite	7681-52-9	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	2.74E-01	calculated (b)	NA	calculated (b)
Sulphuric Acid	7664-93-9	1.0	enHealth, 2012	1.0	USEPA, 2018	NA	Risk Dossier, calculated (b)	1.0	enHealth, 2012	NA	calculated (b)	3.72E-01	calculated (b)	NA	calculated (b)

Notes:
a/ References:
USEPA, 2018
USEPA. (2018). EPA-Expo-Box (A Toolbox for Exposure Assessors). Available at
http://www.epa.gov/expobox
enHealth, 2012:
enHealth. (2012). Australian Exposure Factor Guidance. enHealth Subcommetee of the Australian
Health Protection Principal Committee, Canberra, Australia.
b/ Calculated parameters are calculated based on equations in USEPA ExpoBox (USEPA Risk Assessment Guide for Superfund, Part E, Supplemental Guidance for Dermal Risk Assessment, October 2007). Refer to text for further discussion.
NA - not applicable

Table 15
Summary of Calculated Chemical-Specific Properties
WMF Chemicals
Santos GLNG Gas Field Development Project

Chemical Name	Cas Number	Log Kow	MW (g/mol)	Calculated log Kp	Calculated Kp (cm/hr)	B	tau_{event} (hours/event)	b	c	t*	FA
1-Hydroxyethylidene-(1,1-diphosphonic acid)	2809-21-4	-3.5	206.03	-6.3E+00	5.4E-07	3.0E-06	1.5E+00	3.0E-01	3.3E-01	3.6E+00	1
Acetic acid	64-19-7	-0.17	60.1	-3.2E+00	5.6E-04	1.7E-03	2.3E-01	3.0E-01	3.3E-01	5.5E-01	1
Adipic Acid	124-04-9	0.093	146.1	-3.6E+00	2.8E-04	1.3E-03	6.9E-01	3.0E-01	3.3E-01	1.7E+00	1
Aluminium hydroxychloride	1327-41-9	NA	variable	NA	NA	NA	NA	NA	NA	NA	1
Ammonia	7664-41-7	NA	17	NA	NA	NA	1.3E-01	NA	NA	NA	1
Polyacrylamide (anionic)	9003-05-8	NA	1,000,000 to >50,000,000	NA	NA	NA	NA	NA	NA	NA	1
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
cationic polymer	n/a	NA	variable	NA	NA	NA	NA	NA	NA	NA	1
Aluminium chlorohydrate	12042-91-0	NA	174.45	NA	NA	NA	1.0E+00	NA	NA	NA	1
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	-3.4	NA	NA	NA	NA	NA	NA	NA	NA	1
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	380.2	NA	NA	NA	1.4E+01	NA	NA	NA	1
Hydrogen peroxide	7722-84-1	-1.57	34	-4.0E+00	9.4E-05	2.1E-04	1.6E-01	3.0E-01	3.3E-01	3.9E-01	1
Peroxyacetic Acid	79-21-0	-0.59	76.1	-3.6E+00	2.4E-04	8.1E-04	2.8E-01	3.0E-01	3.3E-01	6.7E-01	1
Phosphonic acid	13598-36-2	NA	81.99	NA	NA	NA	3.0E-01	NA	NA	NA	1
Potassium hydroxide	1310-58-3	NA	56.1	NA	NA	NA	2.2E-01	NA	NA	NA	1
Sodium Bisulphite	7631-90-5	NA	104.1	NA	NA	NA	4.0E-01	NA	NA	NA	1
Sodium carbonate	497-19-8	NA	106	NA	NA	NA	4.1E-01	NA	NA	NA	1
Sodium citrate	6132-04-3	-1.72	294.1	-5.6E+00	2.6E-06	1.7E-05	4.7E+00	3.0E-01	3.3E-01	1.1E+01	1
sodium hydroxide	1310-73-2	NA	40	NA	NA	NA	1.8E-01	NA	NA	NA	1
sodium hypochlorite	7681-52-9	NA	74.44	NA	NA	NA	2.7E-01	NA	NA	NA	1
Sulphuric acid	7664-93-9	NA	98.1	NA	NA	NA	3.7E-01	NA	NA	NA	1

Notes:
b, c = Correlation coefficients which have been fitted to the Flynn's data to give Equation 3.8
K_p = Dermal permeability coefficient of compounds in water (cm/hr)
K_{ow} = Octanol/water partition coefficient of the non-ionized species (dimensionless)
B = Dimensionless ratio of the permeability coefficient of a compound through the stratum corneum relative to its permeability coefficient across the viable epidermis (ve)
^{t}event = Lag time per event (hr/event)
t* = Time to reach steady-state (hr)
FA = Fraction absorbed
MW = Molecular weight (g/mole)
NA = not available/applicable

Table 16
Risk Estimates for Trespasser from Residual Vendor Chemicals in Permeate Used for Irrigation
(Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Permeate CW (mg/l)	ET≤t*	DA_{event} (µg/cm2-event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.009	Yes	1.2E-11	4.0E+00	1.2E-07	5.9E-11	3.0E-08	1.5E-11
Acetic Acid	64-19-7	NA	Yes	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	Yes	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.0175	Yes	NA	1.4E-01	2.4E-07	NA	1.6E-06	NA
Cationic acrylamide copolymer	69418-26-4	NA	Yes	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	Yes	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0078	Yes	NA	3.0E-01	1.0E-07	NA	3.5E-07	NA
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	Yes	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	No	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	Yes	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.00	Yes	NA	8.0E-01	4.0E-08	NA	5.0E-08	NA
Polyacrylamide (anionic)	9003-05-8	NA	Yes	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	Yes	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	Yes	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	Yes	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	Yes	NA	7.1E+01	NA	NA	NA	NA
							Expsure Pathway HI:	**2.1E-06**	**1.5E-11**
								Cumulative HI:	**2.1E-06**

Notes:
CADD = chronic average daily dose
CW = concentration in water
EPC = exposure point concentration
ET = exposure time
t* = time to reach steady state (hours)
DA_{event} = final absorbed dose
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
cm^2 = square centimetre
µg = micrograms

Table 17
Risk Estimates for Trespasser from Residual Vendor Chemicals in Permeate Used for Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Permeate With Produced Water CW (mg/l)	ET≤t*	DA_{event} (µg/cm2-event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0045	Yes	5.9E-12	4.0E+00	6.0E-08	3.0E-11	1.5E-08	7.4E-12
Acetic Acid	64-19-7	NA	Yes	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	Yes	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.0088	Yes	NA	1.4E-01	1.2E-07	NA	8.2E-07	NA
Cationic acrylamide copolymer	69418-26-4	NA	Yes	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	Yes	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0039	Yes	NA	3.0E-01	5.2E-08	NA	1.7E-07	NA
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	Yes	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	No	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	Yes	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.0015	Yes	NA	8.0E-01	2.0E-08	NA	2.5E-08	NA
Polyacrylamide (anionic)	9003-05-8	NA	Yes	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	Yes	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	Yes	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	Yes	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	Yes	NA	7.1E+01	NA	NA	NA	NA
							Expsure Pathway HI:	**1.0E-06**	**7.4E-12**
								Cumulative HI:	**1.0E-06**

Notes:
CADD = chronic average daily dose
CW = concentration in water
EPC = exposure point concentration
ET = exposure time
t* = time to reach steady state (hours)
DA_{event} = final absorbed dose
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
cm^2 = square centimetre
µg = micrograms

Table 18
Risk Estimates for Trespasser from Vendor Chemicals with Surface Soils From Irrigation (Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.686	4.0E+00	7.4E-08	2.4E-07	1.8E-08	6.1E-08
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	1.333	1.4E-01	1.4E-07	4.7E-07	1.0E-06	3.3E-06
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.594	3.0E-01	6.4E-08	2.1E-07	2.1E-07	7.0E-07
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.229	8.0E-01	2.5E-08	8.1E-08	3.1E-08	1.0E-07
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**1.3E-06**	**4.2E-06**
						Cumulative HI:	**5.4E-06**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 19
Risk Estimates for Trespasser from Vendor Chemicals with Surface Soils From Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.34	4.0E+00	3.7E-08	1.2E-07	9.2E-09	3.0E-08
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.67	1.4E-01	7.2E-08	2.4E-07	5.0E-07	1.6E-06
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.30	3.0E-01	3.2E-08	1.1E-07	1.1E-07	3.5E-07
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.11	8.0E-01	1.2E-08	4.0E-08	1.5E-08	5.0E-08
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**6.3E-07**	**2.1E-06**
						Cumulative HI:	**2.7E-06**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 20
Risk Estimates for Worker from Residual Vendor Chemicals in Permeate Used for Irrigation
(Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Permeate CW (mg/l)	ET≤t*	DA_{event} (µg/cm2-event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.009	Yes	1.2E-11	4.0E+00	7.3E-09	2.2E-12	1.8E-09	5.5E-13
Acetic Acid	64-19-7	NA	Yes	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	Yes	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.0175	Yes	NA	1.4E-01	1.4E-08	NA	9.9E-08	NA
Cationic acrylamide copolymer	69418-26-4	NA	Yes	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	Yes	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0078	Yes	NA	3.0E-01	6.3E-09	NA	2.1E-08	NA
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	Yes	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	No	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	Yes	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.00	Yes	NA	8.0E-01	2.4E-09	NA	3.0E-09	NA
Polyacrylamide (anionic)	9003-05-8	NA	Yes	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	Yes	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	Yes	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	Yes	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	Yes	NA	7.1E+01	NA	NA	NA	NA
							Expsure Pathway HI:	**1.2E-07**	**5.5E-13**
								Cumulative HI:	**1.2E-07**

Notes:
CADD = chronic average daily dose
CW = concentration in water
EPC = exposure point concentration
ET = exposure time
t* = time to reach steady state (hours)
DA_{event} = final absorbed dose
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
cm^2 = square centimetre
µg = micrograms

Table 21
Risk Estimates for Worker from Residual Vendor Chemicals in Permeate Used for Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Permeate CW (mg/l)	ET≤t*	DA_{event} (µg/cm2-event)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
					RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.005	Yes	5.9E-12	4.0E+00	3.6E-09	1.1E-12	9.1E-10	2.8E-13
Acetic Acid	64-19-7	NA	Yes	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	Yes	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.0088	Yes	NA	1.4E-01	7.1E-09	NA	4.9E-08	NA
Cationic acrylamide copolymer	69418-26-4	NA	Yes	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	Yes	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	Yes	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0039	Yes	NA	3.0E-01	3.1E-09	NA	1.0E-08	NA
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	Yes	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	No	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	Yes	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.00	Yes	NA	8.0E-01	1.2E-09	NA	1.5E-09	NA
Polyacrylamide (anionic)	9003-05-8	NA	Yes	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	Yes	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	Yes	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	Yes	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	Yes	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	Yes	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	Yes	NA	7.1E+01	NA	NA	NA	NA
							Expsure Pathway HI:	**6.2E-08**	**2.8E-13**
								Cumulative HI:	**6.2E-08**

Notes:
CADD = chronic average daily dose
CW = concentration in water
EPC = exposure point concentration
ET = exposure time
t* = time to reach steady state (hours)
DA_{event} = final absorbed dose
mg/l = milligrams per liter
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
cm^2 = square centimetre
µg = micrograms

Table 22
Risk Estimates for Worker from Vendor Chemicals with Surface Soils From Irrigation (Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.686	4.0E+00	1.5E-08	2.7E-08	3.6E-09	6.8E-09
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	1.333	1.4E-01	2.8E-08	5.3E-08	2.0E-07	3.7E-07
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.594	3.0E-01	1.3E-08	2.4E-08	4.2E-08	7.9E-08
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.229	8.0E-01	4.9E-09	9.1E-09	6.1E-09	1.1E-08
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**2.5E-07**	**4.7E-07**
						Cumulative HI:	**7.2E-07**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 23
Risk Estimates for Worker from Vendor Chemicals with Surface Soils From Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.343	4.0E+00	7.3E-09	1.4E-08	1.8E-09	3.4E-09
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.667	1.4E-01	1.4E-08	2.6E-08	9.9E-08	1.9E-07
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.297	3.0E-01	6.3E-09	1.2E-08	2.1E-08	3.9E-08
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.114	8.0E-01	2.4E-09	4.5E-09	3.0E-09	5.7E-09
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**1.3E-07**	**2.3E-07**
						Cumulative HI:	**3.6E-07**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 24
Risk Estimates for Agricultural Worker from Vendor Chemicals with Surface Soils From Irrigation (Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.686	4.0E+00	8.8E-09	4.0E-08	2.2E-09	1.0E-08
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	1.333	1.4E-01	1.7E-08	7.8E-08	1.2E-07	5.5E-07
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.594	3.0E-01	7.7E-09	3.5E-08	2.6E-08	1.2E-07
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.229	8.0E-01	2.9E-09	1.3E-08	3.7E-09	1.7E-08
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**1.5E-07**	**6.9E-07**
						Cumulative HI:	**8.4E-07**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 25
Risk Estimates for Agricultural Worker from Vendor Chemicals with Surface Soils From Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.343	4.0E+00	4.4E-09	2.0E-08	1.1E-09	5.0E-09
Acetic Acid	64-19-7	NA	-	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.5E+00	NA	NA	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	5.7E-02	NA	NA	NA	NA
Ammonia	7664-41-7	0.667	1.4E-01	8.6E-09	3.9E-08	6.0E-08	2.7E-07
Cationic acrylamide copolymer	69418-26-4	NA	-	NA	NA	NA	NA
Cationic Polymer	n/a	NA	2.0E+00	NA	NA	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	5.7E-02	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.297	3.0E-01	3.8E-09	1.7E-08	1.3E-08	5.8E-08
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	7.1E-02	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.0E+00	NA	NA	NA	NA
Peroxyacetic Acid	79-21-0	NA	8.0E-02	NA	NA	NA	NA
Phosphonic Acid	13598-36-2	0.114	8.0E-01	1.5E-09	6.7E-09	1.8E-09	8.3E-09
Polyacrylamide (anionic)	9003-05-8	NA	5.0E+01	NA	NA	NA	NA
Potassium Hydroxide	1310-58-3	NA	-	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.0E+00	NA	NA	NA	NA
Sodium Carbonate	497-19-8	NA	5.1E+01	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+01	NA	NA	NA	NA
Sodium Hydroxide	1310-73-2	NA	5.1E+01	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	1.7E-01	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	7.1E+01	NA	NA	NA	NA
					Exposure Pathway HI:	**7.6E-08**	**3.4E-07**
						Cumulative HI:	**4.2E-07**

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose

Table 26
Risk Estimates for Kangaroo from Vendor Chemicals in Permeate Used for Irrigation
(Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.009	6.7E-01	2.1E-05	3.1E-05
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E-01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.0175	NA	4.0E-05	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E-01	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0078	5.0E-02	1.8E-05	3.6E-04
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.7E-01	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.3E-02	NA	NA
Phosphonic Acid	13598-36-2	0.003	1.3E-01	6.9E-06	5.2E-05
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+00	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.3E-01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.0E+00	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**4.4E-04**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 27
Risk Estimates for Kangaroo from Vendor Chemicals in Permeate Used for Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0045	6.7E-01	1.0E-05	1.6E-05
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E-01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.0088	NA	2.0E-05	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E-01	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0039	5.0E-02	9.0E-06	1.8E-04
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.7E-01	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.3E-02	NA	NA
Phosphonic Acid	13598-36-2	0.002	1.3E-01	3.5E-06	2.6E-05
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+00	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.3E-01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.0E+00	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**2.2E-04**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 28
Risk Estimates for Dingo from Vendor Chemicals in Permeate Used for Irrigation
(Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0090	6.7E-01	1.0E-05	1.5E-05
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E-01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.0175	NA	1.9E-05	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E-01	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.00780	5.0E-02	8.6E-06	1.7E-04
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.7E-01	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.3E-02	NA	NA
Phosphonic Acid	13598-36-2	0.003	1.3E-01	3.3E-06	2.5E-05
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+00	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.3E-01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.0E+00	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**2.1E-04**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 29
Risk Estimates for Dingo from Vendor Chemicals in Permeate Used for Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0045	6.7E-01	5.0E-06	7.5E-06
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E-01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.00875	NA	9.7E-06	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E-01	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.0039	5.0E-02	4.3E-06	8.6E-05
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.7E-01	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.3E-02	NA	NA
Phosphonic Acid	13598-36-2	0.002	1.3E-01	1.7E-06	1.2E-05
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+00	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.3E-01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.0E+00	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**1.1E-04**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 30
Risk Estimates for Livestock Watering from Vendor Chemicals in Permeate Used for Irrigation
(Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0090	6.4E+01	3.3E-05	5.1E-07
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E+01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.0175	NA	6.4E-05	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E+02	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.00780	1.4E+01	2.8E-05	2.1E-06
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	4.0E+01	NA	NA
Peroxyacetic Acid	79-21-0	NA	3.9E+00	NA	NA
Phosphonic Acid	13598-36-2	0.003	4.2E+01	1.1E-05	2.6E-07
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+02	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.7E+01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.1E+02	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**2.8E-06**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 31
Risk Estimates for Livestock Watering from Vendor Chemicals in Permeate Used for Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC Day 0	Toxicity	Total Intake	Hazard Quotient
		CW (mg/l)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.0045	6.4E+01	1.6E-05	2.6E-07
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	4.2E+01	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.0088	NA	3.2E-05	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	3.3E+02	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.00390	1.4E+01	1.4E-05	1.0E-06
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	4.0E+01	NA	NA
Peroxyacetic Acid	79-21-0	NA	3.9E+00	NA	NA
Phosphonic Acid	13598-36-2	0.002	4.2E+01	5.4E-06	1.3E-07
Polyacrylamide (anionic)	9003-05-8	NA	8.3E+02	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	8.7E+01	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	3.1E+02	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**1.4E-06**

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value

Table 32
Risk Estimates for Small Mammal from Vendor Chemicals with Surface Soils From Irrigation (Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.686	3.1E+02	2.3E-04	7.5E-07
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.0E+02	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	1.33	NA	4.6E-04	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	1.6E+03	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.59	6.7E+01	2.0E-04	3.0E-06
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.9E+02	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.9E+01	NA	NA
Phosphonic Acid	13598-36-2	0.23	2.0E+02	7.8E-05	3.8E-07
Polyacrylamide (anionic)	9003-05-8	NA	4.1E+03	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	4.3E+02	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.5E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**4.2E-06**

Notes:
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
TRV = toxicity reference value

Table 33
Risk Estimates for Small Mammal from Vendor Chemicals with Surface Soils From Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.343	3.1E+02	1.2E-04	3.8E-07
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.0E+02	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.67	NA	2.3E-04	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	1.6E+03	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.30	6.7E+01	1.0E-04	1.5E-06
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	1.9E+02	NA	NA
Peroxyacetic Acid	79-21-0	NA	1.9E+01	NA	NA
Phosphonic Acid	13598-36-2	0.11	2.0E+02	3.9E-05	1.9E-07
Polyacrylamide (anionic)	9003-05-8	NA	4.1E+03	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	4.3E+02	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.5E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**2.1E-06**

Notes:
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
TRV = toxicity reference value

Table 34
Risk Estimates for Avian Receptor from Vendor Chemicals with Surface Soils From Irrigation (Permeate)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.686	4.0E+00	1.2E-01	3.1E-02
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.4E+02	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	1.33	NA	2.4E-01	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	1.9E+03	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.59	8.0E+01	1.1E-01	1.3E-03
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	2.3E+02	NA	NA
Peroxyacetic Acid	79-21-0	NA	2.3E+01	NA	NA
Phosphonic Acid	13598-36-2	0.23	2.4E+02	4.1E-02	1.7E-04
Polyacrylamide (anionic)	9003-05-8	NA	4.9E+03	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.1E+02	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	2.1E+01	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**3.2E-02**

Notes:
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
TRV = toxicity reference value

Table 35
Risk Estimates for Avian Receptor from Vendor Chemicals with Surface Soils From Irrigation
(Permeate Blended with Produced Water)
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	EPC	Toxicity	Total Intake	Hazard Quotient
		CS (mg/kg)	TRVs		Incidental Ingestion
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	0.343	4.0E+00	6.2E-02	1.5E-02
Acetic Acid	64-19-7	NA	NA	NA	NA
Adipic Acid	124-04-9	NA	2.4E+02	NA	NA
Aluminium Hydroxychloride	1327-41-9	NA	NA	NA	NA
Ammonia	7664-41-7	0.67	NA	1.2E-01	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA
Cationic Polymer	n/a	NA	1.9E+03	NA	NA
Aluminium chlorohydrate	12042-91-0	NA	NA	NA	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	0.30	8.0E+01	5.4E-02	6.7E-04
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	NA	NA	NA	NA
Hydrogen Peroxide	7722-84-1	NA	2.3E+02	NA	NA
Peroxyacetic Acid	79-21-0	NA	2.3E+01	NA	NA
Phosphonic Acid	13598-36-2	0.11	2.4E+02	2.1E-02	8.5E-05
Polyacrylamide (anionic)	9003-05-8	NA	4.9E+03	NA	NA
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA
Sodium Bisulphite	7631-90-5	NA	5.1E+02	NA	NA
Sodium Carbonate	497-19-8	NA	NA	NA	NA
Sodium Citrate Dihydrate	6132-04-3	NA	1.8E+03	NA	NA
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA
Sodium Hypochlorite	7681-52-9	NA	2.1E+01	NA	NA
Sulphuric Acid	7664-93-9	NA	NA	NA	NA
				Cumulative:	**1.6E-02**

Notes:
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
TRV = toxicity reference value

APPENDIX A THIRD PARTY REVIEW COMMENTS

Commercial in Confidence

Reviewer Comment/Response
Santos GLNG Gas Field Development Project
Chemical Risk Assessment Report

Reviewer	Section #	Page #	Paragraph/ Table #	Comment	EHS Support response to comments
Review comments provided 26 February 2019 (review of report dated February 2019)					
Jackie Wright	General			The Chemical Risk Assessment report has been significantly revised to address comments provided by The Australia Department of the Environment and Energy. Specifically the scope of the assessment has been reduced to only address chemicals proposed to be used for water treatment. relevant to Santos GLNG GFD Project Stage 2 - Water Treatment.	
Jackie Wright	2.1	8	Heading	This appears to be a paragraph no a heading. It is not clear what the heading for Section 2.1 should be.	Section 2 was revised including subheadings.
Jackie Wright	2.1	8	Start of second last paragraph	This would read better as "The risk assessment presented, which is consistent with …." This paragraph along with the next paragraph relate to the scope of the assessment - it would be really helpful if there was a section up front that combined the objectives of the assessment as well as these paragraphs - these paragraphs seem out of place in Section 2.1. There is a risk assessment scope and bounds of the assessment in Section 5.1. It would be good to have this as a separate clear section earlier in the report.	Section 2 was revised including reording the paragraphs to clarify process and to address the comment. In addition, Section 5 was revised.
Jackie Wright	2.1	10	Table 2.1	Check for formatting - bullet points missing	Table was formatted.
Jackie Wright	4.2	33	General	Is there a flow diagram that shows the water treatment process options - would assist in understanding this process if available	Flow diagram and process description added to Section 2.0
Jackie Wright	5.3.1.2	42	Section	It is possible to include a comment in relation to whether overtopping of dams could occur during high rainfall events - such that there may be a release to the environment.	Discussion of overtopping of dams was added as a bullet point under Section 5.3.7
Jackie Wright	5.3.3	49	Figure 5-3	This is not readable - make the page with this table landscape	The figure was reformatted to landscape
Jackie Wright	5.3.4.2	51	last dot point	Trespassers are included yet earlier in the document it was stated that only legal activities would be considered	Only authorised activities were considered (activities authorised in the Environmental Authority and EPBC Act Approval); however, the beneficial reuse for irrigation (authorised activity) may exposed potential trespassers.
Jackie Wright	5.3.5	52	first sub-point below second dot poin	should be "beneficially reused"	Correction made.
Jackie Wright	5.3.5	52	last paragraph	includes the comment that the assessment will include qualitative and quantitative assessments - it would be good to include a definition of what a qualitative assessment involves, and what a quantitative assessment involves	The qualitative and quantitative definitions were provided in the last paragraph to clarify what they involve.

Reviewer Comment/Response
Santos GLNG Gas Field Development Project
Chemical Risk Assessment Report

Reviewer	Section #	Page #	Paragraph/ Table #	Comment	EHS Support response to comments
Jackie Wright	Sections 6.1 and 6.2	--	Tables of toxicity data	The chemicals listed in the water treatment products have been checked against the tables listed in these sections (see next tab). There are some chemicals not listed in some of the tables which need to be included - and hydrochloric acid is included yet not listed as a chemical in the water treatment process (and no detail included as to why it has been included in some tables). The information included in all the tables needs to be double checked to ensure all the water treatment chemicals are addressed.	The tables were reviewed and compared to the WMF chemicals and were revised including remove hydrochloric acid and add hydrogen peroxide/dialuminum chloride pentahydroxide.
Jackie Wright	6.1.1	56	Table 6-1	Heading for column 2 should really be Key Study (as it would be the key study identified to derive the guideline - and there are likely to be many other studies) It would be good to include footnotes that indicate which source is used for the values adopted din the table - or if this is in an appendix then reference the appendix	The table was revised and footnote added to risk dossier appendix.
Jackie Wright	6.1.1	56 and 57	Table 6-1 and 6-2	It may read better if these tables were in the reverse order - or include the health based criteria in Table 6-1 and include the relevant details consistent with other drinking water criteria, and leave Table 6-2 as pH and aesthetic criteria.	Clarification was provided noting that Table 6 1 presented derived Oral Reference Dose and derived Drinking Water Guideline Values and Table 6 2 presented the Australian Drinking Water Guidance Values for the COPCs identified for the WMF.
Jackie Wright	6.1.2	62 and 63	Table 6-3 and 6-4	Please include footnotes that indicate the source of the specific values listed in the tables - or if this detail is in an appendix then reference the appendix	Foonote added to risk dossier appendix for both Table 6-3 and Table 6-4
Jackie Wright	6.1.2	62	Table 6-3	Cationic polymer has note "b" that needs to be superscript	Superscript added.
Jackie Wright	6.4.2	72	Text at bottom of page	The term risk ratio is not defined any where in the report and is introduced here - include a definition of what this is and how it is calculated to make sure this is clear	Test was included regarding risk ratio and what is acceptable/unacceptable.
Jackie Wright	6.4.2	73	Tables 6-9 and 6-10	These tables present calculated risk ratios - the column headings need to indicate that the values in the tables are risk ratios - using the term exceed X is unclear. The tables could also include what is an acceptable risk ratio for reference. Please include a footnote to Table 6-10 where the mode detailed assessment of the chemicals in the permeate is included (Appendix C and which tables)	Revised title to Table 6-9 and added text regarding acceptable/unacceptable level of work. Revised column headers for Table 6-9 and 6-10 to include risk ration.
Jackie Wright	9.1	92	Section	It is really unclear why there is reference to geogenic constituents in the conclusions - which are barely mentioned or assessed in the report. It is my understanding the scope is limited to the water treatment chemicals - review wording and revise as relevant	The geogenic constituents were assessed in the report based on reference to the Maisey Drilling CRA Report; and were not the focus of this CRA report.

APPENDIX B SAFETY DATA SHEETS

Commercial in Confidence

1. IDENTIFICATION

Product Name	**Aluminium Chlorohydrate Liquid - Water Treatment Grade**
Other Names	ALUMINIUM CHLORIDE, BASIC; Aluminium hydroxy chlorosulphate; Aluminium hydroxychloride; Polyaluminium chlorosulphate
Uses	No Data Available
Chemical Family	No Data Available
Chemical Formula	No Data Available
Chemical Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Product Description	No Data Available

Contact Details of the Supplier of this Safety Data Sheet

Organisation	Location	Telephone
Redox Pty Ltd	2 Swettenham Road Minto NSW 2566 Australia	+61-2-97333000
Redox Pty Ltd	11 Mayo Road Wiri Auckland 2104 New Zealand	+64-9-2506222
Redox Inc.	2132A E. Dominguez Street Carson CA 90810 USA	+1-424-675-3200
Redox Chemicals Sdn Bhd	No. 8, Block G, Ground Floor, Taipan 2 Jalan PJU 1A/3 Ara Damansara 47301, Petaling Jaya, Selangor, Malaysia	+60-3-7843-6833

Emergency Contact Details

For emergencies only; DO NOT contact these companies for general product advice.

Organisation	Location	Telephone
Poisons Information Centre	Westmead NSW	1800-251525 131126
Chemcall	Australia	1800-127406 +64-4-9179888
Chemcall	Malaysia	+64-4-9179888
Chemcall	New Zealand	0800-243622 +64-4-9179888
National Poisons Centre	New Zealand	0800-764766
CHEMTREC	USA & Canada	1-800-424-9300 CN723420 +1-703-527-3887

2. HAZARD IDENTIFICATION

Poisons Schedule (Aust) Not scheduled

Globally Harmonised System

Hazard Classification Hazardous according to the criteria of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS)

Hazard Categories		Serious Eye Damage/Irritation - Category 1 Corrosive to Metals - Category 1	
Pictograms			
Signal Word		Danger	
Hazard Statements		**H290**	May be corrosive to metals.
		H318	Causes serious eye damage.
Precautionary Statements	Prevention	**P234**	Keep only in original container.
		P280	Wear protective gloves/protective clothing.
	Response	**P305 + P351 + P338**	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
		P310	Immediately call a POISON CENTER or doctor/physician.
	Storage	**P406**	Store in corrosive resistant container with a resistant inner liner.

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Entity	Formula	CAS Number	Proportion
Water	No Data Available	7732-18-5	50.00 - 52.00 %
Aluminium chlorohydrate	No Data Available	1327-41-9	48.00 - 50.00 %

4. FIRST AID MEASURES

Description of necessary measures according to routes of exposure

Swallowed	Rinse mouth with water. Give water to drink. Do NOT induce vomiting. Neutralization may be accomplished by using aluminum hydroxide gel or milk of magnesia. Seek medical attention.
Eye	Immediately flush eyes with plenty of water for 15 minutes, holding eyelids open. In all cases of eye contamination, it is a sensible precaution to seek medical advice.
Skin	Remove contaminated clothing. Flush affected area with plenty of water. If irritation persists, seek medical attention
Inhaled	Remove victim from exposure to fresh air. If not breathing, apply artificial respiration. If breathing is difficult, give oxygen. Seek medical attention if effects persist.
Advice to Doctor	Treat symptomatically based on judgement of doctor and individual reactions of patient.
Medical Conditions Aggravated by Exposure	No information available on medical conditions aggravated by exposure to this product.

5. FIRE FIGHTING MEASURES

General Measures	If safe to do so, remove containers from the path of fire.
Flammability Conditions	Non-flammable liquid.
Extinguishing Media	In case of fire, use appropriate extinguishing media most suitable for surrounding fire conditions.
Fire and Explosion Hazard	Non-Combustible.
Hazardous Products of Combustion	If mix with Sodium Hypochlorite (NaOCl) can produce toxic chlorine gas.
Special Fire Fighting Instructions	Clear fire area of all non-emergency personnel. Stay upwind. Keep out of low areas. Eliminate ignition sources. Move fire exposed containers from fire area if it can be done without risk. Do NOT allow fire fighting water to reach waterways, drains or sewers. Store fire fighting water for treatment.
Personal Protective Equipment	Fire fighters should wear a positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots and gloves) or chemical splash suit.
Flash Point	No Data Available
Lower Explosion Limit	No Data Available
Upper Explosion Limit	No Data Available
Auto Ignition Temperature	No Data Available
Hazchem Code	No Data Available

6. ACCIDENTAL RELEASE MEASURES

General Response Procedure	Eliminate all sources of ignition. Increase ventilation. Avoid walking through spilled product as it may be slippery. Use clean, non-sparking tools and equipment.
Clean Up Procedures	Soak up spilled product using absorbent non-combustible material such as sand or soil. Avoid using sawdust or cellulose. When saturated, collect the material and transfer to a suitable, labelled chemical waste container and dispose of promptly.
Containment	Stop leak if safe to do so.
Decontamination	Neutralize with slake lime, soda ash or calcium carbonate. Wash affected area with water.
Environmental Precautionary Measures	Do not allow product to reach drains, sewers or waterways. If product does enter a waterway, advise the Environmental Protection Authority or your local Waste Authority.
Evacuation Criteria	Clear area of all unprotected personnel
Personal Precautionary Measures	Personnel involved in the clean up should wear full protective clothing as listed in section 8.

7. HANDLING AND STORAGE

Handling	Ensure an eye bath and safety shower are available and ready for use. Observe good personal hygiene practices and recommended procedures. Wash thoroughly after handling. Take precautionary measures against static discharges by bonding and grounding equipment. Avoid contact with eyes, skin and clothing. Do not inhale product fumes. The usual precaution for handling with acidity chemical should be observed. Transfer: Use feeding pump with non-acid property.
Storage	Store in a cool, dry, well-ventilated area. Keep containers tightly closed when not in use. Inspect regularly for deficiencies such as damage or leaks. Protect against physical damage. Store away from incompatible materials as listed in section 10. In a storage tank lined with non corrosive material. This product is not classified dangerous for transport according to The Australian Code for the Transport of Dangerous Goods By Road and Rail.
Container	Store in original packaging as approved by manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

General	No exposure standard has been established for this product by the Australian Safety and Compensation Council (ASCC). NOTE: The exposure value at the TWA is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week. These exposure standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine

	dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity
Exposure Limits	No Data Available
Biological Limits	No information available on biological limit values for this product.
Engineering Measures	A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area.
Personal Protection Equipment	RESPIRATOR: No respirator generally required (AS1715/1716). EYES: Chemical safety goggles (AS1336/1337). HANDS: Protective gloves (AS2161). CLOTHING: Long-sleeved protective clothing and rubber boots (AS3765/2210).
Work Hygienic Practices	Avoid contact with eyes and skin. Avoid prolonged or repeated exposure. Always wash hands before smoking, eating, drinking or using the toilet.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Clear to Slightly Hazy Liquid
Odour	No Data Available
Colour	Clear to Slightly Hazy
pH	3.5 - 5.0
Vapour Pressure	No Data Available
Relative Vapour Density	No Data Available
Boiling Point	No Data Available
Melting Point	No Data Available
Freezing Point	No Data Available
Solubility	Very soluble
Specific Gravity	No Data Available
Flash Point	No Data Available
Auto Ignition Temp	No Data Available
Evaporation Rate	No Data Available
Bulk Density	No Data Available
Corrosion Rate	No Data Available
Decomposition Temperature	No Data Available
Density	No Data Available
Specific Heat	No Data Available
Molecular Weight	No Data Available
Net Propellant Weight	No Data Available
Octanol Water Coefficient	No Data Available
Particle Size	No Data Available
Partition Coefficient	No Data Available
Saturated Vapour Concentration	No Data Available
Vapour Temperature	No Data Available
Viscosity	No Data Available
Volatile Percent	No Data Available
VOC Volume	No Data Available
Additional Characteristics	Un-ignitable, incombustible, non-oxidative, non-self reactive and inactive liquid of extreme stability.
Potential for Dust Explosion	Product is a liquid.
Fast or Intensely Burning Characteristics	No Data Available
Flame Propagation or Burning Rate of Solid Materials	No Data Available

Non-Flammables That Could Contribute Unusual Hazards to a Fire	No Data Available
Properties That May Initiate or Contribute to Fire Intensity	No Data Available
Reactions That Release Gases or Vapours	No Data Available
Release of Invisible Flammable Vapours and Gases	No Data Available

10. STABILITY AND REACTIVITY

General Information	Non-combustible liquid
Chemical Stability	tends to gradually hydrolyze to a white turbid solution and lose the effectiveness, when it is kept long as diluted solution of less than 3% Aluminium oxide.
Conditions to Avoid	None known.
Materials to Avoid	Strong bases, such as Sodium Hydroxide (NaOH), Calcium carbonate (CaCO3), Sodium Hypochlorite (NaOCl).
Hazardous Decomposition Products	If mix with Sodium Hypochlorite (NaOCl) can produce toxic chlorine gas.
Hazardous Polymerisation	Has not been reported.

11. TOXICOLOGICAL INFORMATION

General Information	Acute oral toxicity: LD50 oral, rat > 12.79 gm/kg
EyeIrritant	May cause serious eye damage.
Inhalation	Irritating to respiratory system.
Carcinogen Category	No Data Available

12. ECOLOGICAL INFORMATION

Ecotoxicity	The chemical is decomposed into aluminum hydroxide (Al(OH)3) and hydrochloric acid (HCl) by hydrolysis.
Persistence/Degradability	No Data Available
Mobility	No Data Available
Environmental Fate	No Data Available
Bioaccumulation Potential	No Data Available
Environmental Impact	No Data Available

13. DISPOSAL CONSIDERATIONS

General Information	If utilisation or recycling of the product is not possible, it should be disposed of in accordance with all local, state and federal regulations. All empty packaging should be disposed of in accordance with Local, State, and Federal Regulations or recycled/reconditioned at an approved facility. Dispose of the chemical after neutralization with a chemical like slake lime, calcium carbonate or soda ash.
Special Precautions for Land Fill	Contact a specialist disposal company or the local waste regulator for advice. Incinerate at an approved site following all local regulations. This material may be suitable for approved landfill.

14. TRANSPORT INFORMATION

Land Transport (Australia)
ADG

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (Malaysia)
ADR Code

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (New Zealand)
NZS5433

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (United States of America)
US DOT

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Sea Transport
IMDG

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available
EMS	No Data Available
Marine Pollutant	No

Air Transport
IATA

Proper Shipping Name	Aluminium Chlorohydrate Liquid – Water Treatment Grade
Class	No Data Available
Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

15. REGULATORY INFORMATION

General Information	No Data Available
Poisons Schedule (Aust)	Not scheduled

Environmental Protection Authority (New Zealand)
Hazardous Substances and New Organisms Amendment Act 2015

Approval Code	Not Assessed

National/Regional Inventories

Australia (AICS)	Listed
Canada (DSL)	Not Determined
Canada (NDSL)	Not Determined
China (IECSC)	Not Determined
Europe (EINECS)	Not Determined
Europe (REACh)	Not Determined
Japan (ENCS/METI)	Not Determined

Korea (KECI)	Not Determined
Malaysia (EHS Register)	Not Determined
New Zealand (NZIoC)	Not Determined
Philippines (PICCS)	Not Determined
Switzerland (Giftliste 1)	Not Determined
Switzerland (Inventory of Notified Substances)	Not Determined
Taiwan (NCSR)	Not Determined
USA (TSCA)	Not Determined

16. OTHER INFORMATION

Related Product Codes	ALCHHY5000, ALCHHY5100, ALCHHY5200, ALCHHY5500, ALCHHY8000, ALCHHY9000, ALCHHY4000, ALCHHY3100, ALCHHY3110, ALCHHY3130, ALCHHY3200, ALCHHY3115
Revision	1
Revision Date	17 Jul 2014
Key/Legend	**<** Less Than **>** Greater Than **AICS** Australian Inventory of Chemical Substances **atm** Atmosphere **CAS** Chemical Abstracts Service (Registry Number) **cm²** Square Centimetres **CO2** Carbon Dioxide **COD** Chemical Oxygen Demand **deg C (°C)** Degrees Celcius **EPA (New Zealand)** Environmental Protection Authority of New Zealand **deg F (°F)** Degrees Farenheit **g** Grams **g/cm³** Grams per Cubic Centimetre **g/l** Grams per Litre **HSNO** Hazardous Substance and New Organism **IDLH** Immediately Dangerous to Life and Health **immiscible** Liquids are insoluable in each other. **inHg** Inch of Mercury **inH2O** Inch of Water **K** Kelvin **kg** Kilogram **kg/m³** Kilograms per Cubic Metre **lb** Pound **LC50** LC stands for lethal concentration. LC50 is the concentration of a material in air which causes the death of 50% (one half) of a group of test animals. The material is inhaled over a set period of time, usually 1 or 4 hours. **LD50** LD stands for Lethal Dose. LD50 is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals. **ltr** or **L** Litre **m³** Cubic Metre **mbar** Millibar **mg** Milligram **mg/24H** Milligrams per 24 Hours **mg/kg** Milligrams per Kilogram **mg/m³** Milligrams per Cubic Metre **Misc** or **Miscible** Liquids form one homogeneous liquid phase regardless of the amount of either component present. **mm** Millimetre **mmH2O** Millimetres of Water **mPa.s** Millipascals per Second **N/A** Not Applicable **NIOSH** National Institute for Occupational Safety and Health **NOHSC** National Occupational Heath and Safety Commission **OECD** Organisation for Economic Co-operation and Development **Oz** Ounce **PEL** Permissible Exposure Limit

Pa Pascal
ppb Parts per Billion
ppm Parts per Million
ppm/2h Parts per Million per 2 Hours
ppm/6h Parts per Million per 6 Hours
psi Pounds per Square Inch
R Rankine
RCP Reciprocal Calculation Procedure
STEL Short Term Exposure Limit
TLV Threshold Limit Value
tne Tonne
TWA Time Weighted Average
ug/24H Micrograms per 24 Hours
UN United Nations
wt Weight

1. IDENTIFICATION

Product Name	**Ammonia Aqueous 10-35%**
Other Names	Ammonia Aqua; Ammonia Solution; Ammonia Water; AMMONIUM HYDROXIDE; Ammonium Hydroxide (Nh4oh); Ammonium Liquor; Aqueous Ammonia
Uses	Cleaning compounds; Water treatment; Photographic developer; Manufacture of ammonium compounds.
Chemical Family	No Data Available
Chemical Formula	A mixture of NH3 (and possibly NH4OH) in H2O
Chemical Name	Ammonia Aqueous 10-35%
Product Description	No Data Available

Contact Details of the Supplier of this Safety Data Sheet

Organisation	Location	Telephone
Redox Pty Ltd	2 Swettenham Road Minto NSW 2566 Australia	+61-2-97333000
Redox Pty Ltd	11 Mayo Road Wiri Auckland 2104 New Zealand	+64-9-2506222
Redox Inc.	2132A E. Dominguez Street Carson CA 90810 USA	+1-424-675-3200
Redox Chemicals Sdn Bhd	No. 8, Block G, Ground Floor, Taipan 2 Jalan PJU 1A/3 Ara Damansara 47301, Petaling Jaya, Selangor, Malaysia	+60-3-7843-6833

Emergency Contact Details

For emergencies only; DO NOT contact these companies for general product advice.

Organisation	Location	Telephone
Poisons Information Centre	Westmead NSW	1800-251525 131126
Chemcall	Australia	1800-127406 +64-4-9179888
Chemcall	Malaysia	+64-4-9179888
Chemcall	New Zealand	0800-243622 +64-4-9179888
National Poisons Centre	New Zealand	0800-764766
CHEMTREC	USA & Canada	1-800-424-9300 CN723420 +1-703-527-3887

2. HAZARD IDENTIFICATION

Poisons Schedule (Aust) 6

Globally Harmonised System

Hazard Classification Hazardous according to the criteria of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS)

Hazard Categories			Skin Corrosion/Irritation - Category 1C Specific Target Organ Toxicity (Single Exposure) - Category 3 Acute Hazard To The Aquatic Environment - Category 1
Pictograms			
Signal Word			Danger
Hazard Statements		**H314**	Causes severe skin burns and eye damage.
		H335	May cause respiratory irritation.
		H400	Very toxic to aquatic life.
Precautionary Statements	Prevention	**P260**	Do not breathe fume/gas/mist/vapours/spray.
		P264	Wash exposed skin thoroughly after handling.
		P271	Use only outdoors or in a well-ventilated area.
		P273	Avoid release to the environment.
		P280	Wear protective gloves/protective clothing/eye protection/face protection.
	Response	**P301 + P330 + P331**	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
		P303 + P361 + P353	IF ON SKIN (or hair): Remove/take off immediately all contaminated clothing. Rinse skin with water/shower.
		P363	Wash contaminated clothing before reuse.
		P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
		P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
		P310	Immediately call a POISON CENTER or doctor/physician.
		P391	Collect spillage.
	Storage	**P403 + P233**	Store in a well-ventilated place. Keep container tightly closed.
		P405	Store locked up.
	Disposal	**P501**	Dispose of contents/container in accordance with local / regional / national / international regulations.

National Transport Commission (Australia)

Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Environmental Protection Authority (New Zealand)

Hazardous Substances and New Organisms Amendment Act 2015

HSNO Classifications	Health Hazards	**6.1D**	Substances that are acutely toxic - Harmful
		8.1A	Substances that are corrosive to metals
		8.2C	Substances that are corrosive to dermal tissue UN PGIII
		8.3A	Substances that are corrosive to ocular tissue
	Environmental Hazards	**9.1A**	Substances that are very ecotoxic in the aquatic environment
		9.3C	Substances that are harmful to terrestrial vertebrates

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Entity	Formula	CAS Number	Proportion
Water	H2O	7732-18-5	65.0 - 90.0 %
Ammonium Hydroxide	Nh4oh	1336-21-6	10.0 - 35.0 %

4. FIRST AID MEASURES

Description of necessary measures according to routes of exposure

Swallowed Immediately rinse mouth with water. If swallowed, do NOT induce vomiting. Give a glass of water. Seek immediate medical assistance.

Eye If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Informations Centre or a doctor, or for at least 15 minutes.

Skin If split on large areas of skin or hair, immediately drench with running water and remove clothing. Continue to wash skin ad hair with plenty of water (and soap if material is insoluble) until advised to stop by the Poisons Information Centre or a doctor.

Inhaled Remove victim from exposure - avoid becoming a casualty. Remove contaminated clothing and loosen remaining clothing. Allow patient to assume most comfortable position and keep warm. Keep at rest until fully recovered. If patient finds breathing difficult and develops a bluish discolouration of the skin (which suggests a lack of oxygen in the blood - cyanosis), ensure airways are clear of any obstruction and have a qualified person give oxygen through a face mask. Apply artificial respiration if patient is not breathing. Seek immediate medical advice.

Advice to Doctor Treat symptomatically. Can cause corneal burns. Following exposure, the patient should be kept under medical supervision for at least 48 hours.

Medical Conditions Aggravated by Exposure No information available on medical conditions aggravated by exposure to this product.

5. FIRE FIGHTING MEASURES

General Measures If safe to do so, remove containers from the path of fire.

Flammability Conditions Flammable ammonia gas will be liberated at all temperatures, which can be explosive between 16- 25% in air. Addition to concentrated mineral acids will cause instant boiling and a possible explosion. If involved in a fire, wear self contained breathing apparatus and full protective clothing. Keep containers cool with water spray and if safe to do so remove containers from path of fire.

Extinguishing Media Use water fog (if unavailable water spray), foam, carbon dioxide or dry chemical powder. If involved in a fire, keep containers cool with water spray.

Fire and Explosion Hazard Non combustible material. May form flammable vapour mixtures with air. Avoid ignition sources. Caution should be exercised when opening storage containers or vessels. Flammable concentrations of ammonia gas can accumulate in the head space.

Hazardous Products of Combustion Ammonia: The main products of combustion in air, at or above 780 Deg C are nitrogen and water with small amounts of nitrogen dioxide and ammonium nitrate. Ammonia decomposes into flammable hydrogen gas at approximately 450 Dec C. May for flammable mixtures with air. The presence of oil or other combustible material will increase fire hazard. Fatalities have occurred as a result of the explosive nature of the ammonia gas. If involved in a fire, keep containers cool with water spray. If safe to do so, remove containers from the path of fire.

Special Fire Fighting Instructions Clear fire area of all non-emergency personnel. Stay upwind. Keep out of low areas. Eliminate ignition sources. Move fire exposed containers from fire area if it can be done without risk. Do NOT allow fire fighting water to reach waterways, drains or sewers. Store fire fighting water for treatment.

Personal Protective Equipment Fire fighters should wear a positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, trousers, boots and gloves) or chemical splash suit.
Please note: Structural fire fighters uniform will provide limited protection.

Flash Point No Data Available

Lower Explosion Limit No Data Available

Upper Explosion Limit No Data Available

Auto Ignition Temperature No Data Available

2R

Hazchem Code

6. ACCIDENTAL RELEASE MEASURES

General Response Procedure	Avoid accidents, clean up immediately. May be slippery when spilt. Eliminate all sources of ignition. Increase ventilation. Isolate the danger area. Use clean, non-sparking tools and equipment. Shut off all possible sources if ignition.
Clean Up Procedures	Contain-prevent run off into drains and waterways. Use absorbent (soil, sand or other inert material). Neutralise with dilute acid. Collect and seal in properly labelled containers or drums for disposal.
Containment	Stop leak if safe to do so.
Environmental Precautionary Measures	Do not allow product to reach drains, sewers or waterways. If product does enter a waterway, advise the Environmental Protection Authority or your local Waste Authority.
Evacuation Criteria	Evacuate all unnecessary personnel.
Personal Precautionary Measures	Personnel involved in the clean up should wear full protective clothing as listed in section 8.

7. HANDLING AND STORAGE

Handling	This material is a Schedule Poison S6 and must be stored, maintained and used in accordance with the relevant regulations. Ensure an eye bath and safety shower are available and ready for use. Observe good personal hygiene practices and recommended procedures. Wash thoroughly after handling. Take precautionary measures against static discharges by bonding and grounding equipment. Exercise caution when opening storage containers or vessels. Caution should be exercised when opening storage containers or vessels. Flammable concentrations of ammonia gas can accumulate in the head space. Avoid contact with eyes, skin and clothing. Do not inhale product dust/fumes. Ammonia is considered a pollutant, avoid run off into drains or waterways. Caution, flammable vapours may accumulate in confines spaces. Keep material away from sparks, flames and other ignition sources. Post 'NO SMOKING' signs in area of use. Avoid release of gas into workplace air. Empty containers contain residue which may be hazardous. Transport: Not to be loaded with Class 1, 4.3, 5.1, 5.2, 6*,7, Foodstuff and foodstuff empties. * where the Class 6 substance is a cyanide and the Class 8 substance is an acid.
Storage	Store in a cool, dry, well-ventilated area. Keep containers tightly closed when not in use. Inspect regularly for deficiencies such as damage or leaks. Protect against physical damage. Store away from incompatible materials as listed in section 10. Limit quantity of material in storage. Restrict access to storage area. Post appropriate warning signs. Keep storage area separate from populated work areas. Inspect periodically for deficiencies. Consider leak detection and alarm systems, as required. Store in a cool, dry, well-ventilated area, out of direct sunlight, away from heat and ignition sources. Store away from incompatible materials such as oxidizing materials and strong acids. Structural materials and lighting and ventilation systems in storage area should be corrosion resistant. Store product below 25 degrees C. Protect from damage. This product has a UN classification of 2672 and a Dangerous Goods Class 8 (Corrosive) according to The Australian Code for the Transport of Dangerous Goods By Road and Rail.
Container	Container type/packaging must comply with all applicable local legislation. Store in original packaging as approved by manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

General	No exposure standard has been established for this product by the Australian Safety and Compensation Council (ASCC). However, exposure standard for: Ammonia: 8hr TWA=17mg/m3 (25 ppm), 15 min STEL=24mg/m3 (35 ppm). NOTE: The exposure value at the TWA is the average airborne concentration of a particular substance when calculated over a normal 8 hour working day for a 5 day working week. These exposure standards are guides to be used in the control of occupational health hazards. All atmospheric contamination should be kept to as low a level as is workable. These exposure standards should not be used as fine dividing lines between safe and dangerous concentrations of chemicals. They are not a measure of relative toxicity.
Exposure Limits	No Data Available
Biological Limits	No information available on biological limits for this product.

Engineering Measures	Ensure ventilation is adequate and that air concentration of ammonia is controlled below exposure standard. This can be achieved via process enclosures, local exhaust ventilation or while wearing respirator or air-supplied mask. Keep containers closed when not in use. A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area.
Personal Protection Equipment	RESPIRATOR: If engineering controls and work practices are not effective in controlling exposure to ammonia, then wear suitable personal protective equipment. Have appropriate personal protective equipment available for use in emergencies such as spills or fire. If respiratory protection is required, institute a complete respiratory protection program including selection, fit testing, training, maintenance, inspection, cleaning and evaluation (AS1715/1716). EYES: Chemical safety goggles. A face shield may be necessary (AS1336/1337). HANDS: Chemical resistant, impervious gloves (AS2161). CLOTHING: Long-sleeved coveralls and safety boots (AS3765/2210).
Work Hygienic Practices	No Data Available

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Liquid
Appearance	Liquid
Odour	Sharp, Irritating
Colour	Colourless
pH	11.7 1% Aqueous solution
Vapour Pressure	6.9 psi - 10.5 psi (@ No Data Available)
Relative Vapour Density	0.6 Air = 1
Boiling Point	18 - 37 °C
Melting Point	No Data Available
Freezing Point	No Data Available
Solubility	Miscible in water
Specific Gravity	0.88 - 0.92
Flash Point	No Data Available
Auto Ignition Temp	No Data Available
Evaporation Rate	No Data Available
Bulk Density	No Data Available
Corrosion Rate	No Data Available
Decomposition Temperature	No Data Available
Density	No Data Available
Specific Heat	No Data Available
Molecular Weight	35.05 g/mol
Net Propellant Weight	No Data Available
Octanol Water Coefficient	No Data Available
Particle Size	No Data Available
Partition Coefficient	No Data Available
Saturated Vapour Concentration	No Data Available
Vapour Temperature	No Data Available
Viscosity	No Data Available
Volatile Percent	100%
VOC Volume	No Data Available
Additional Characteristics	Flammability limits: 16-25% Odour threshold: 0.6-53 ppm (detection) ; 0.7-55 ppm (recognition)
Potential for Dust Explosion	Product is a liquid.
Fast or Intensely Burning Characteristics	No Data Available
Flame Propagation or Burning Rate of Solid Materials	No Data Available

Non-Flammables That Could Contribute Unusual Hazards to a Fire	No Data Available
Properties That May Initiate or Contribute to Fire Intensity	No Data Available
Reactions That Release Gases or Vapours	No Data Available
Release of Invisible Flammable Vapours and Gases	No Data Available

10. STABILITY AND REACTIVITY

General Information	Corrosive Liquid.
Chemical Stability	May form explosive compounds with mercury, halogens, and hypochlorites. Reacts exothermically with strong mineral acids .
Conditions to Avoid	Avoid exposure to heat. Avoid exposure to light.
Materials to Avoid	Incompatible with peroxides, metal salts, acids, and reducing agents.
Hazardous Decomposition Products	Hydrogen.
Hazardous Polymerisation	Reactivity: Reacts violently with acids. Corrosive to copper, nickel, tin, zinc, and their alloys.

11. TOXICOLOGICAL INFORMATION

General Information	Oral LD50 (rat): 350 mg/kg Inhalation Human TCLO: 408ppm. (400 - 700 ppm causes severe irritation. 2000 - 3000 ppm may be fatal within 30 minutes. 10,000 ppm is immediately fatal). CHRONIC EFFECTS: Chronic exposure to ammonia may cause chemical pneumonitis and kidney damage. Repeated or prolonged exposure may result in bronchitis.
EyeIrritant	A severe eye irritant. Corrosive to eyes; contact can cause corneal burns. Contamination of eyes can result in permanent injury.
Ingestion	Corrosive. Swallowing can result in nausea, vomiting, diarrhoea, abdominal pain and chemical burns to the gastrointestinal tract.
Inhalation	Breathing in mists or aerosols will produce respiratory irritation. Inhalation of high concentrations may result in shortness of breath, chest pain, severe headache and lung damage including pulmonary oedema. Effects may be delayed.
SkinIrritant	Contact with skin will result in severe irritation. Corrosive to skin - may cause skin burns.
Chronic	
Other	Chronic over exposure to ammonia may cause chemical pneumontis and kidney damage
Carcinogen Category	No Data Available

12. ECOLOGICAL INFORMATION

Ecotoxicity	Toxic to aquatic organisms. Fish 96hr LC50 (rainbow trout): 0.53 mg/L (for ammonia)
Persistence/Degradability	Ammonia is readily oxidised to nitrite, which is very toxic to aquatic organisms.
Mobility	No information available on mobility for this product.
Environmental Fate	Do not contaminate waterways.
Bioaccumulation Potential	No information available on bioaccumulation for this product.
Environmental Impact	No Data Available

13. DISPOSAL CONSIDERATIONS

General Information	Dispose of in accordance with all local, state and federal regulations. All empty packaging should be disposed of in accordance with Local, State, and Federal Regulations or recycled/reconditioned at an approved facility.
Special Precautions for Land Fill	Contact a specialist disposal company or the local waste regulator for advice. This should be done in accordance with 'The Hazardous Waste Act'.

14. TRANSPORT INFORMATION

Land Transport (Australia)
ADG

Proper Shipping Name	AMMONIA SOLUTION
Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
EPG	37 Toxic And/Or Corrosive Substances Non-Combustible
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available

Land Transport (Malaysia)
ADR Code

Proper Shipping Name	AMMONIA SOLUTION
Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
EPG	37 Toxic And/Or Corrosive Substances Non-Combustible
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available

Land Transport (New Zealand)
NZS5433

Proper Shipping Name	AMMONIA SOLUTION
Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
EPG	37 Toxic And/Or Corrosive Substances Non-Combustible
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available

Land Transport (United States of America)
US DOT

Proper Shipping Name	AMMONIA SOLUTION

Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
ERG	154 Substances - Toxic and/or Corrosive (Non-Combustible)
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available

Sea Transport
IMDG Code

Proper Shipping Name	AMMONIA SOLUTION
Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available
EMS	FA,SB
Marine Pollutant	Yes

Air Transport
IATA

Proper Shipping Name	AMMONIA SOLUTION
Class	8 Corrosive Substances
Subsidiary Risk(s)	No Data Available
UN Number	2672
Hazchem	2R
Pack Group	III
Special Provision	No Data Available

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

15. REGULATORY INFORMATION

General Information	No Data Available
Poisons Schedule (Aust)	6

Environmental Protection Authority (New Zealand)
Hazardous Substances and New Organisms Amendment Act 2015

Approval Code	HSR001526

National/Regional Inventories

Australia (AICS)	Listed
Canada (DSL)	Not Determined
Canada (NDSL)	Not Determined
China (IECSC)	Not Determined
Europe (EINECS)	Not Determined
Europe (REACh)	Not Determined
Japan (ENCS/METI)	Not Determined
Korea (KECI)	Not Determined
Malaysia (EHS Register)	Not Determined
New Zealand (NZIoC)	Listed
Philippines (PICCS)	Not Determined
Switzerland (Giftliste 1)	Not Determined
Switzerland (Inventory of Notified Substances)	Not Determined
Taiwan (NCSR)	Not Determined
USA (TSCA)	Not Determined

16. OTHER INFORMATION

Related Product Codes	AMAQUB1000, AMAQUB1200, AMAQUB1201, AMAQUB2500, AMAQUB2501, AMAQUB2600, AMAQUB5000, AMAQUB5001, AMAQUB6000, AMAQUE0700, AMAQUE0701, AMAQUE0800, AMAQUE0900, AMAQUE1000, AMAQUE1001, AMAQUE1002, AMAQUE1003, AMAQUE1004, AMAQUE1005, AMAQUE1006, AMAQUE1007, AMAQUE1008, AMAQUE1009, AMAQUE1010, AMAQUE1011, AMAQUE1012, AMAQUE1100, AMAQUE1200, AMAQUE1300, AMAQUE1400, AMAQUE1500, AMAQUE1600, AMAQUE2000, AMAQUE2001, AMAQUE2500, AMAQUE3000, AMAQUE4000, AMAQUE4500, AMAQUE5200, AMAQUE5700, AMAQUE5800, AMAQUE5900, AMAQUE6000, AMAQUE6100, AMAQUE6200, AMAQUE6300, AMAQUE6301, AMAQUE6302, AMAQUE6303, AMAQUE6400, AMAQUE6500, AMAQUE6600, AMAQUE6700, AMAQUE6800, AMAQUE6900, AMAQUE7000, AMAQUE7200, AMAQUE7300, AMAQUE7800, AMAQUE7900, AMAQUE8000, AMAQUE8200, AMAQUE8300, AMAQUE8500, AMAQUI1000, AMAQUI1001, AMAQUI4000, AMAQUI5800, AMAQUI6000, AMAQUI6100, AMAQUI6400, AMAQUI7000, AMAQUI7500, AMAQUE5000, AMAQUE8400, AMAQUE1800, AMAQUE1801, AMAQUE1802, AMAQUE1803, AMAQUE1804, AMAQUE1805, AMAQUE1806, AMAQUE1807, AMAQUE1808, AMAQUE1809, AMAQUE1810, AMAQUE1811, AMAQUE1812, AMAQUE1813, AMAQUE1814, AMAQUE1815, AMAQUE1816, AMAQUE1817, AMAQUE1818, AMAQUE1819, AMAQUE1820, AMAQUE1821, AMAQUE1822, AMAQUE1823, AMAQUE1824, AMAQUE1825, AMAQUE1826, AMAQUE1827, AMAQUE1828, AMAQUE1829, AMAQUE1830, AMAQUE1831, AMAQUE1832, AMAQUE1833, AMAQUE1834, AMAQUE6304, AMAQUE1835, AMAQUI7070, AMAQUI5000, AMAQUE8201, AMAQUE8301, AMAQUE7901, AMAQUI7001, AMAQUI7501, AMAQUB7000, AMAQUB7001, AMAQUE1050, AMAQUE5500, AMAQUE5501, AMAQUE1843, AMAQUE8202, AMAQUE1015, AMAQUE1836, AMAQUE5521, AMAQUI7002
Revision	3
Revision Date	15 Apr 2015
Key/Legend	**<** Less Than **>** Greater Than **AICS** Australian Inventory of Chemical Substances **atm** Atmosphere **CAS** Chemical Abstracts Service (Registry Number) **cm²** Square Centimetres **CO2** Carbon Dioxide **COD** Chemical Oxygen Demand **deg C (°C)** Degrees Celcius **EPA (New Zealand)** Environmental Protection Authority of New Zealand **deg F (°F)** Degrees Farenheit

g Grams
g/cm³ Grams per Cubic Centimetre
g/l Grams per Litre
HSNO Hazardous Substance and New Organism
IDLH Immediately Dangerous to Life and Health
immiscible Liquids are insoluable in each other.
inHg Inch of Mercury
inH2O Inch of Water
K Kelvin
kg Kilogram
kg/m³ Kilograms per Cubic Metre
lb Pound
LC50 LC stands for lethal concentration. LC50 is the concentration of a material in air which causes the death of 50% (one half) of a group of test animals. The material is inhaled over a set period of time, usually 1 or 4 hours.
LD50 LD stands for Lethal Dose. LD50 is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals.
ltr or **L** Litre
m³ Cubic Metre
mbar Millibar
mg Milligram
mg/24H Milligrams per 24 Hours
mg/kg Milligrams per Kilogram
mg/m³ Milligrams per Cubic Metre
Misc or **Miscible** Liquids form one homogeneous liquid phase regardless of the amount of either component present.
mm Millimetre
mmH2O Millimetres of Water
mPa.s Millipascals per Second
N/A Not Applicable
NIOSH National Institute for Occupational Safety and Health
NOHSC National Occupational Heath and Safety Commission
OECD Organisation for Economic Co-operation and Development
Oz Ounce
PEL Permissible Exposure Limit
Pa Pascal
ppb Parts per Billion
ppm Parts per Million
ppm/2h Parts per Million per 2 Hours
ppm/6h Parts per Million per 6 Hours
psi Pounds per Square Inch
R Rankine
RCP Reciprocal Calculation Procedure
STEL Short Term Exposure Limit
TLV Threshold Limit Value
tne Tonne
TWA Time Weighted Average
ug/24H Micrograms per 24 Hours
UN United Nations
wt Weight

CoogeeChemicals

Elite Chemicals

SAFETY DATA SHEET

Product Name **CALCIUM CHLORIDE 30% W/W TECH GRADE**

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Supplier name	**COOGEE CHEMICALS**
Address	Cnr of Patterson and Kwinana Beach Roads, Kwinana, WA, 6167, AUSTRALIA
Telephone	(08) 9439 8200
Fax	(08) 9439 8300
Emergency	1800 800 655
Email	businessrelations@coogee.com.au
Web site	www.coogee.com.au
Synonym(s)	30% W/W CALCIUM CHLORIDE • CALCIUM (II) CHLORIDE • ELITE CALCIUM CHLORIDE 30% W/W
Use(s)	WATER TREATMENT CHEMICAL
SDS date	27 September 2013

2. HAZARDS IDENTIFICATION

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

RISK PHRASES

R36	Irritating to eyes.

SAFETY PHRASES

S2	Keep out of reach of children.
S22	Do not breathe dust.
S24	Avoid contact with skin.

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

UN number	None Allocated	**DG class**	None Allocated
Packing group	None Allocated	**Subsidiary risk(s)**	None Allocated
Hazchem code	None Allocated		

3. COMPOSITION/ INFORMATION ON INGREDIENTS

Ingredient	Identification	Classification	Content
CALCIUM CHLORIDE ANHYDROUS	CAS: 10043-52-4 EC: 233-140-8	Xi;R36	30 to 60%
NON HAZARDOUS INGREDIENTS	Not Available	Not Available	Remainder

4. FIRST AID MEASURES

Eye	If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.
Inhalation	If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.
Skin	If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.
Ingestion	For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

Advice to doctor Treat symptomatically.

First aid facilities Eye wash facilities and safety shower should be available.

5. FIRE FIGHTING MEASURES

Flammability Non flammable. May evolve toxic gases (chlorides) when heated to decomposition.

Fire and explosion Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

Extinguishing Use an extinguishing agent suitable for the surrounding fire.

Hazchem code None Allocated

6. ACCIDENTAL RELEASE MEASURES

Personal precautions Wear Personal Protective Equipment (PPE) as detailed in Section 8 of this SDS. Clear area of all unprotected personnel. Ventilate area where possible. Contact emergency services where appropriate.

Environmental precautions Prevent product from entering drains and waterways.

Methods of cleaning up Contain spillage, then cover/absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

References See Sections 8 and 13 for exposure controls and disposal.

7. STORAGE AND HANDLING

Storage Store in a cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use.

Handling Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure standards No exposure standard(s) allocated.

Biological limits No biological limit allocated.

Engineering controls Avoid inhalation. Use in well ventilated areas.

PPE

- **Eye / Face** Wear splash-proof goggles.
- **Hands** Wear PVC or rubber gloves.
- **Body** Wear coveralls.
- **Respiratory** Where an inhalation risk exists, wear a Type B (Inorganic gases and vapours) respirator. If spraying, wear a Type B-Class P1 (Inorganic gases/vapours and Particulate) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance COLOURLESS TO PALE TAN COLOURED LIQUID
Odour ODOURLESS
Flammability NON FLAMMABLE

Flash point	NOT RELEVANT
Boiling point	100°C to 105°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT RELEVANT
pH	7.5 to 8.5
Vapour density	NOT AVAILABLE
Specific gravity	1.29 to 1.31
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE
% Volatiles	NOT AVAILABLE

10. STABILITY AND REACTIVITY

Chemical stability	Stable under recommended conditions of storage.
Conditions to avoid	Avoid heat, sparks, open flames and other ignition sources.
Material to avoid	Incompatible with acids (eg. nitric acid), methyl vinyl ether, zinc/ galvanised metals, bromine trifluoride, boron oxide and calcium oxide.
Hazardous Decomposition Products	May evolve toxic gases (chlorides) when heated to decomposition.
Hazardous Reactions	Polymerization is not expected to occur.

11. TOXICOLOGICAL INFORMATION

Health Hazard Summary	May be harmful - irritant. Use safe work practices to avoid eye or skin contact and inhalation. Due to the low vapour pressure of this product, an inhalation hazard is not anticipated unless sprayed.
Eye	Irritant. Contact may result in irritation, lacrimation, pain and redness. May result in burns with prolonged contact.
Inhalation	Low irritant. Over exposure may result in irritation of the nose and throat, with coughing. Due to the low vapour pressure, an inhalation hazard is not anticipated with normal use.
Skin	Irritant. Contact may result in irritation, redness, rash and dermatitis. Prolonged or repeated contact may result in burns.
Ingestion	May be harmful. Ingestion may result in gastrointestinal irritation, possible burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea.
Toxicity data	CALCIUM CHLORIDE ANHYDROUS (10043-52-4)

LD50 (ingestion)	1000 mg/kg (rat)
LD50 (intraperitoneal)	210 mg/kg (mouse)
LD50 (intravenous)	42 mg/kg (mouse)
LD50 (subcutaneous)	823 mg/kg (mouse)
LDLo (ingestion)	1384 mg/kg (rabbit)
LDLo (intravenous)	150 mg/kg (guinea pig)
LDLo (subcutaneous)	249 mg/kg (cat)
TDLo (intravenous)	20 mg/kg/1 hour (woman)

12. ECOLOGICAL INFORMATION

Toxicity	No information provided.
Persistence and degradability	No information provided.
Bioaccumulative potential	No information provided.

Mobility in soil No information provided.

Other adverse effects No information provided.

13. DISPOSAL CONSIDERATIONS

Waste disposal For small amounts absorb with sand, vermiculite or similar and dispose of to an approved landfill site. Contact the manufacturer for additional information if larger amounts are involved. Prevent contamination of drains and waterways as aquatic life may be threatened and environmental damage may result.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
UN number	None Allocated	None Allocated	None Allocated
Proper shipping name	None Allocated	None Allocated	None Allocated
DG class/ Division	None Allocated	None Allocated	None Allocated
Subsidiary risk(s)	None Allocated	None Allocated	None Allocated
Packing group	None Allocated	None Allocated	None Allocated

Hazchem code None Allocated

15. REGULATORY INFORMATION

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Inventory Listing(s) **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Product Name **CALCIUM CHLORIDE 30% W/W TECH GRADE**

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
GHS	Globally Harmonized System
IARC	International Agency for Research on Cancer
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
PEL	Permissible Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
REACH	Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Revision history

Revision	Description
1.0	Initial SDS Creation
0.1	Standard SDS Review

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

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Revision: 1
SDS Date: 27 September 2013

End of SDS

Coogee Chemicals Caustic Soda 50%

Coogee Chemicals

Chemwatch: **1735895**
Version No: **4.1.1.1**
Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 4

Issue Date: **12/02/2015**
Print Date: **07/04/2015**
Initial Date: **Not Available**
S.GHS.AUS.EN

SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

Product Identifier

Product name	Coogee Chemicals Caustic Soda 50%
Proper shipping name	SODIUM HYDROXIDE SOLUTION
Other means of identification	Not Available

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Laboratory applications.

Details of the manufacturer/importer

Registered company name	Coogee Chemicals
Address	Cnr of Patterson and Kwinana Beach Roads Kwinana WA Australia
Telephone	+61 8 9439 8200
Fax	+61 8 9439 8300
Website	www.coogee.com.au
Email	businessrelations@coogee.com.au

Emergency telephone number

Association / Organisation	Coogee Chemicals
Emergency telephone numbers	1800 800 655
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture

HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the Model WHS Regulations and the ADG Code.

CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	1	
Body Contact	4	
Reactivity	0	
Chronic	0	

0 = Minimum
1 = Low
2 = Moderate
3 = High
4 = Extreme

Poisons Schedule	S6
GHS Classification [1]	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1A, Serious Eye Damage Category 1
Legend:	*1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI*

Label elements

GHS label elements



SIGNAL WORD **DANGER**

Hazard statement(s)

H290	May be corrosive to metals
H314	Causes severe skin burns and eye damage
H318	Causes serious eye damage

Supplementary statement(s)

Continued...

Not Applicable

Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.

Precautionary statement(s) Storage

P405	Store locked up.

Precautionary statement(s) Disposal

P501	Dispose of contents/container to authorised chemical landfill or if organic to high temperature incineration

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
1310-73-2	50	sodium hydroxide
7732-18-5	50	water

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye Contact	If this product comes in contact with the eyes: ▸ Immediately hold eyelids apart and flush the eye continuously with running water. ▸ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. ▸ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes. ▸ Transport to hospital or doctor without delay. ▸ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact	If skin or hair contact occurs: ▸ Immediately flush body and clothes with large amounts of water, using safety shower if available. ▸ Quickly remove all contaminated clothing, including footwear. ▸ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre. ▸ Transport to hospital, or doctor.
Inhalation	▸ If fumes or combustion products are inhaled remove from contaminated area. ▸ Lay patient down. Keep warm and rested. ▸ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. ▸ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. ▸ Transport to hospital, or doctor. ▸ Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema. ▸ Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs). ▸ As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested. ▸ Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. **This must definitely be left to a doctor or person authorised by him/her.** (ICSC13719)
Ingestion	▸ For advice, contact a Poisons Information Centre or a doctor at once. ▸ Urgent hospital treatment is likely to be needed. ▸ 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 airway and prevent aspiration. ▸ Observe the patient carefully. ▸ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. ▸ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. ▸ Transport to hospital or doctor without delay.

Indication of any immediate medical attention and special treatment needed

For acute or short-term repeated exposures to highly alkaline materials:

- Respiratory stress is uncommon but present occasionally because of soft tissue edema.
- Unless endotracheal intubation can be accomplished under direct vision, cricothyroidotomy or tracheotomy may be necessary.
- Oxygen is given as indicated.
- The presence of shock suggests perforation and mandates an intravenous line and fluid administration.
- Damage due to alkaline corrosives occurs by liquefaction necrosis whereby the saponification of fats and solubilisation of proteins allow deep penetration into the tissue.

Alkalis continue to cause damage after exposure.

INGESTION:

- Milk and water are the preferred diluents

No more than 2 glasses of water should be given to an adult.

- Neutralising agents should never be given since exothermic heat reaction may compound injury.

* Catharsis and emesis are absolutely contra-indicated.

Continued...

* Activated charcoal does not absorb alkali.
* Gastric lavage should not be used.
Supportive care involves the following:
- Withhold oral feedings initially.
- If endoscopy confirms transmucosal injury start steroids only within the first 48 hours.
- Carefully evaluate the amount of tissue necrosis before assessing the need for surgical intervention.
- Patients should be instructed to seek medical attention whenever they develop difficulty in swallowing (dysphagia).

SKIN AND EYE:
- Injury should be irrigated for 20-30 minutes.

Eye injuries require saline. [Ellenhorn & Barceloux: Medical Toxicology]

SECTION 5 FIREFIGHTING MEASURES

Extinguishing media

	▸ Water spray or fog. ▸ Foam.

Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.

Advice for firefighters

Fire Fighting	▸ Alert Fire Brigade and tell them location and nature of hazard. ▸ Wear full body protective clothing with breathing apparatus.
Fire/Explosion Hazard	▸ Non combustible. ▸ Not considered a significant fire risk, however containers may burn.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Minor Spills	▸ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material. ▸ Check regularly for spills and leaks.
Major Spills	▸ Clear area of personnel and move upwind. ▸ Alert Fire Brigade and tell them location and nature of hazard.
	Personal Protective Equipment advice is contained in Section 8 of the MSDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	▸ Avoid all personal contact, including inhalation. ▸ Wear protective clothing when risk of exposure occurs.
Other information	▸ Store in original containers. ▸ Keep containers securely sealed.

Conditions for safe storage, including any incompatibilities

Suitable container	▸ **DO NOT** use aluminium, galvanised or tin-plated containers ▸ Lined metal can, lined metal pail/ can. ▸ Plastic pail.
Storage incompatibility	▸ Avoid strong acids, acid chlorides, acid anhydrides and chloroformates. ▸ Avoid contact with copper, aluminium and their alloys.



+	X	+	X	O	+

X — Must not be stored together
0 — May be stored together with specific preventions
+ — May be stored together

PACKAGE MATERIAL INCOMPATIBILITIES

Not Available

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sodium hydroxide	Sodium hydroxide	Not Available	Not Available	2 mg/m3	Not Available

Continued...

EMERGENCY LIMITS

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sodium hydroxide	Sodium hydroxide	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sodium hydroxide	250 mg/m3	10 mg/m3
water	Not Available	Not Available

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
Personal protection	
Eye and face protection	▸ Safety glasses with unperforated side shields may be used where continuous eye protection is desirable, as in laboratories; spectacles are not sufficient where complete eye protection is needed such as when handling bulk-quantities, where there is a danger of splashing, or if the material may be under pressure. ▸ Chemical goggles.whenever there is a danger of the material coming in contact with the eyes; goggles must be properly fitted.
Skin protection	See Hand protection below
Hands/feet protection	▸ Elbow length PVC gloves ▸ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots. The selection of suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer.
Body protection	See Other protection below
Other protection	▸ Overalls. ▸ PVC Apron.
Thermal hazards	Not Available

Recommended material(s)

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:
"Forsberg Clothing Performance Index".
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
Coogee Chemicals Caustic Soda 50%

Material	CPI
BUTYL	A
NEOPRENE	A
NAT+NEOPR+NITRILE	C
NATURAL RUBBER	C
NATURAL+NEOPRENE	C
NEOPRENE/NATURAL	C
NITRILE	C
NITRILE+PVC	C
PE	C
PE/EVAL/PE	C
PVA	C
PVC	C
SARANEX-23	C
SARANEX-23 2-PLY	C
TEFLON	C
VITON	C
VITON/CHLOROBUTYL	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

Respiratory protection

Particulate. (AS/NZS 1716 & 1715, EN 143:000 & 149:001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.
Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	-AUS P2	-	-PAPR-AUS / Class 1 P2
up to 50 x ES	-	-AUS / Class 1 P2	-
up to 100 x ES	-	-2 P2	-PAPR-2 P2 ^

^ - Full-face
A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Continued...

Information on basic physical and chemical properties

Appearance	Clear highly alkaline liquid with slight odour; mixes with water.

Physical state	Liquid	**Relative density (Water = 1)**	1.52
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Applicable
pH (as supplied)	14	**Decomposition temperature**	Not Available
Melting point / freezing point (°C)	12	**Viscosity (cSt)**	Not Available
Initial boiling point and boiling range (°C)	142	**Molecular weight (g/mol)**	Not Applicable
Flash point (°C)	Not Applicable	**Taste**	Not Available
Evaporation rate	Not Available	**Explosive properties**	Not Available
Flammability	Not Applicable	**Oxidising properties**	Not Available
Upper Explosive Limit (%)	Not Applicable	**Surface Tension (dyn/cm or mN/m)**	Not Available
Lower Explosive Limit (%)	Not Applicable	**Volatile Component (%vol)**	50 (%wt)
Vapour pressure (kPa)	Not Available	**Gas group**	Not Available
Solubility in water (g/L)	Miscible	**pH as a solution**	Not Available
Vapour density (Air = 1)	Not Available	**VOC g/L**	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▸ Unstable in the presence of incompatible materials. ▸ Product is considered stable.
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	Inhaling corrosive bases may irritate the respiratory tract. Symptoms include cough, choking, pain and damage to the mucous membrane.
Ingestion	Ingestion of alkaline corrosives may produce burns around the mouth, ulcerations and swellings of the mucous membranes, profuse saliva production, with an inability to speak or swallow. Both the oesophagus and stomach may experience burning pain; vomiting and diarrhoea may follow.
Skin Contact	The material can produce severe chemical burns following direct contact with the skin. Sodium hydroxide causes burns which may take time to manifest and cause pain, thus care should be taken to avoid contamination of gloves and boots.
Eye	If applied to the eyes, this material causes severe eye damage. Direct eye contact with corrosive bases can cause pain and burns.
Chronic	Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue.

	TOXICITY	IRRITATION
Coogee Chemicals Caustic Soda 50%	Not Available	Not Available
sodium hydroxide	TOXICITY	IRRITATION
	Oral (rabbit) LD50: 325 mg/kg[1]	Eye (rabbit): 0.05 mg/24h SEVERE
		Eye (rabbit):1 mg/24h SEVERE
		Eye (rabbit):1 mg/30s rinsed-SEVERE
		Skin (rabbit): 500 mg/24h SEVERE
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg[2]	Not Available
Legend:	*1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's msds. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*	

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

Continued...

	conjunctivitis.
WATER	No significant acute toxicological data identified in literature search.

Acute Toxicity	⊘	Carcinogenicity	⊘
Skin Irritation/Corrosion	✔	Reproductivity	⊘
Serious Eye Damage/Irritation	✔	STOT - Single Exposure	⊘
Respiratory or Skin sensitisation	⊘	STOT - Repeated Exposure	⊘
Mutagenicity	⊘	Aspiration Hazard	⊘

Legend: ✔ – *Data required to make classification available*
✘ – *Data available but does not fill the criteria for classification*
⊘ – *Data Not Available to make classification*

CMR STATUS

Not Applicable

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

Prevent, by any means available, spillage from entering drains or water courses.
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
sodium hydroxide	LOW	LOW
water	LOW	LOW

Bioaccumulative potential

Ingredient	Bioaccumulation
sodium hydroxide	LOW (LogKOW = -3.8796)
water	LOW (LogKOW = -1.38)

Mobility in soil

Ingredient	Mobility
sodium hydroxide	LOW (KOC = 14.3)
water	LOW (KOC = 14.3)

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	▸ Containers may still present a chemical hazard/ danger when empty. ▸ Return to supplier for reuse/ recycling if possible.

SECTION 14 TRANSPORT INFORMATION

Labels Required



Marine Pollutant	NO
HAZCHEM	2R

Land transport (ADG)

UN number	1824
Packing group	II
UN proper shipping name	SODIUM HYDROXIDE SOLUTION
Environmental hazard	No relevant data
Transport hazard class(es)	Class: 8 Subrisk: Not Applicable

Continued...

Special precautions for user	Special provisions	Not Applicable
	Limited quantity	1 L

Air transport (ICAO-IATA / DGR)

UN number	1824	
Packing group	II	
UN proper shipping name	Sodium hydroxide solution	
Environmental hazard	No relevant data	
Transport hazard class(es)	ICAO/IATA Class	8
	ICAO / IATA Subrisk	Not Applicable
	ERG Code	8L
Special precautions for user	Special provisions	A3A803
	Cargo Only Packing Instructions	855
	Cargo Only Maximum Qty / Pack	30 L
	Passenger and Cargo Packing Instructions	851
	Passenger and Cargo Maximum Qty / Pack	1 L
	Passenger and Cargo Limited Quantity Packing Instructions	Y840
	Passenger and Cargo Limited Maximum Qty / Pack	0.5 L

Sea transport (IMDG-Code / GGVSee)

UN number	1824	
Packing group	II	
UN proper shipping name	SODIUM HYDROXIDE SOLUTION	
Environmental hazard	Not Applicable	
Transport hazard class(es)	IMDG Class	8
	IMDG Subrisk	Not Applicable
Special precautions for user	EMS Number	F-A , S-B
	Special provisions	Not Applicable
	Limited Quantities	1 L

SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

sodium hydroxide(1310-73-2) is found on the following regulatory lists	"Australia Exposure Standards","Australia Inventory of Chemical Substances (AICS)","Australia Hazardous Substances Information System - Consolidated Lists"
water(7732-18-5) is found on the following regulatory lists	"Australia Inventory of Chemical Substances (AICS)"

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	*Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)*

SECTION 16 OTHER INFORMATION

Other information

Ingredients with multiple cas numbers

Continued...

Name	CAS No
sodium hydroxide	12200-64-5, 1310-73-2

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net/references

The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 3502**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Potable Water Treatment

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Technologies (Australia) Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards Not classified.

Health hazards Not classified.

Environmental hazards Not classified.

Label elements, including precautionary statements

Hazard symbol(s) None.

Signal word None.

Hazard Statement(s) The mixture does not meet the criteria for classification.

Precautionary Statement(s)

Prevention Observe good industrial hygiene practices.

Response Wash hands after handling.

Storage Store away from incompatible materials.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Other hazards which do not result in classification None known.

Supplemental information None.

3. Composition/information on ingredients

Mixture

The components are not hazardous or are below required disclosure limits.

4. First-aid measures

Description of necessary first aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Wash off with soap and water. Get medical attention if irritation develops and persists.

Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Personal protection for first-aid responders	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.
Symptoms caused by exposure	Direct contact with eyes may cause temporary irritation.
Medical attention and special treatment	Treat symptomatically.

5. Fire-fighting measures

Extinguishing media	
Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	Material can be slippery when wet. During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for fire fighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Use water spray to cool unopened containers.
Hazchem Code	None.
General fire hazards	No unusual fire or explosion hazards noted.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	Keep unnecessary personnel away. For personal protection, see section 8. Slippery when wet.
For emergency responders	Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.
Methods and materials for containment and cleaning up	Stop the flow of material, if this is without risk. Following product recovery, flush area with water. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling	Material can be slippery when wet. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Protect from sunlight. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Store in cool, dry place.

8. Exposure controls and personal protection

Control parameters	Follow standard monitoring procedures.
Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection	Wear safety glasses with side shields (or goggles) and a face shield. Chemical goggles and face shield are recommended.
Skin protection	
Hand protection	Chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.
Other	Wear suitable protective clothing. Chemical resistant gloves.

Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Granular.
Physical state	Solid.
Form	Solid.
Colour	White
Odour	Odourless.
pH	Not available.
Melting point/freezing point	Not available.
Initial boiling point and boiling range	Not available.
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not available.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit – upper (%)	Not available.
Vapour pressure	Not available.
Vapour density	Not available.
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not applicable
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other physical and chemical parameters	
Bulk density	750 kg/m3
Density	0.75 g/cm³
Explosive properties	Not explosive.
Oxidising properties	Not oxidising.
Percent volatile	0 %
VOC (Weight %)	0 %

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Heat, flames and sparks. Contact with incompatible materials. None under normal conditions.
Incompatible materials	Strong oxidising agents.

Hazardous decomposition products Toxic gas.

11. Toxicological information

Information on possible routes of exposure

Inhalation No adverse effects due to inhalation are expected.

Skin contact No adverse effects due to skin contact are expected.

Eye contact Direct contact with eyes may cause temporary irritation.

Ingestion Expected to be a low ingestion hazard.

Symptoms related to exposure Direct contact with eyes may cause temporary irritation.

Product	Species	Test results
HYDREX 3502		
Acute		
Oral		
Solid		
LC50	Rat	> 2000 mg/kg

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation Prolonged skin contact may cause temporary irritation.

Serious eye damage/irritation Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitisation

Respiratory sensitisation Not a respiratory sensitizer.

Skin sensitisation This product is not expected to cause skin sensitisation.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not available.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Other information This product has no known adverse effect on human health.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test results
HYDREX 3502			
Aquatic			
Crustacea	EC50	Daphnia	212 mg/l, 48 hours
Fish	LC50	Danio (Danio)	357 mg/l, 96 hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Mobility in soil No data available for this product.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods Collect and reclaim or dispose in sealed containers at licensed waste disposal site.

Residual waste Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

ADG

Not regulated as dangerous goods.

RID

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not applicable.

15. Regulatory information

Safety, health and environmental regulations

National regulations This Safety Data Sheet was prepared in accordance with Australia Model Code of Practice for the preparation of Safety Data Sheets for Hazardous Chemicals (23/12/2011).

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix F

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 5

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 6

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

High Volume Industrial Chemicals (HVIC)

Not listed.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date	29-September-2016
Disclaimer	Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.
Revision information	Product and Company Identification: Product Review

SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 4129**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Reverse Osmosis Antiscalant

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Technologies (Australia) Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards	Corrosive to metals	Category 1
Health hazards	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 1
Environmental hazards	Not classified.	

Label elements, including precautionary statements

Hazard symbol(s)



Corrosion

Signal word Danger

Hazard Statement(s) May be corrosive to metals. Causes skin irritation. Causes serious eye damage.

Precautionary Statement(s)

Prevention Keep only in original container. Wash hands thoroughly after handling. Wear eye protection/face protection. Wear protective gloves.

Response IF ON SKIN: Wash with plenty of soap and water. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTRE or doctor/physician. Specific treatment (see First aid measures on this label). If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash before reuse. Absorb spillage to prevent material damage.

Storage Store in corrosive resistant/metal container with a resistant inner liner.

Disposal Dispose of waste and residues in accordance with local authority requirements.

Other hazards which do not result in classification None known.

Supplemental information None.

3. Composition/information on ingredients

Mixture

Identity of chemical ingredients	CAS number and other unique identifiers	Concentration of ingredients
Organic phosphonate #1	Proprietary	10 - < 20
Organic phosphonate #2	Proprietary	10 - < 20
Phosphonic acid	13598-36-2	1 - < 5
Other components below reportable levels		70 - < 80

4. First-aid measures

Description of necessary first aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention immediately.

Ingestion Rinse mouth. Get medical attention if symptoms occur.

Personal protection for first-aid responders Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

Symptoms caused by exposure Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.

Medical attention and special treatment Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media Not available.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for fire fighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions Move containers from fire area if you can do so without risk.

Hazchem Code None.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8.

For emergency responders Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.

Environmental precautions Avoid discharge into drains, water courses or onto the ground.

Methods and materials for containment and cleaning up	Prevent entry into waterways, sewer, basements or confined areas. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb spillage to prevent material damage. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling	Avoid forming spray/aerosol mists. Do not get this material in contact with eyes. Avoid contact with eyes, skin, and clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in a cool, dry place out of direct sunlight. Store in corrosive resistant container with a resistant inner liner. Keep only in the original container. Store away from incompatible materials (see Section 10 of the SDS). Store in cool, dry place.

8. Exposure controls and personal protection

Control parameters	Follow standard monitoring procedures.
Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Exposure guidelines	No exposure standards allocated.
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection	Wear safety glasses with side shields (or goggles) and a face shield. Chemical goggles and face shield are recommended.
Skin protection	
Hand protection	Chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.
Other	Wear appropriate chemical resistant clothing. Chemical resistant gloves.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment. Avoid forming spray/aerosol mists.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Clear.
Physical state	Liquid.
Form	Liquid.
Colour	Yellow.
Odour	Slight. Acrylic.
pH	2 - 3
Melting point/freezing point	0 °C (32 °F)
Initial boiling point and boiling range	>= 100 °C (>= 212 °F)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.

Upper/lower flammability or explosive limits

Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit – upper (%)	Not available.

Vapour pressure	Not available.
Vapour density	Not available.
Solubility(ies)	
Solubility (water)	100 %
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other physical and chemical parameters	
Density	1200.00 kg/m3
Explosive properties	Not explosive.
Miscible (water)	100 %
Oxidising properties	Not oxidising.
Specific gravity	1.18 - 1.24

10. Stability and reactivity

Reactivity	May be corrosive to metals.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Strong oxidising agents. Metals.
Hazardous decomposition products	Hydrogen cyanide (hydrocyanic acid).

11. Toxicological information

Information on possible routes of exposure

Inhalation	No adverse effects due to inhalation are expected.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye damage.
Ingestion	Expected to be a low ingestion hazard.
Symptoms related to exposure	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. Skin irritation. May cause redness and pain.

Product	Species	Test results
HYDREX 4129		
Acute		
Dermal		
LD50	Rabbit	31760 mg/kg estimated

Product	Species	Test results
Oral		
LD50	Rat	>= 8900 mg/kg Calculated

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/irritation Causes serious eye damage.

Respiratory or skin sensitisation

Respiratory sensitisation Not a respiratory sensitizer.

Skin sensitisation This product is not expected to cause skin sensitisation.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not available.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure Not classified.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test results
HYDREX 4129			
Aquatic			
Acute			
Crustacea	LC50	Daphnia	> 100 mg/l, 48 hours (Daphnia magna)
Fish	LC50	Fish	> 100 mg/l, 96 hours (Oncorhynchus Mykiss)

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil No data available for this product.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.

Residual waste Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

ADG

UN number 3265

UN proper shipping name Corrosive liquid, acidic, organic, n.o.s. (Organic Phosphonate)

Transport hazard class(es)

Class 8

Subsidiary risk	-
Packing group	III
Environmental hazards	Not available.
Hazchem Code	2X
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

RID

UN number	3265
UN proper shipping name	Corrosive liquid, acidic, organic, n.o.s. (Organic Phosphonate)
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Label(s)	8
Packing group	III
Environmental hazards	No.
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IATA

UN number	3265
UN proper shipping name	Corrosive liquid, acidic, organic, n.o.s. (Organic Phosphonate)
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Packing group	III
Environmental hazards	No.
ERG Code	8L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Other information	
Passenger and cargo aircraft	Allowed with restrictions.
Cargo aircraft only	Allowed with restrictions.

IMDG

UN number	3265
UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Organic Phosphonate)
Transport hazard class(es)	
Class	8
Subsidiary risk	-
Packing group	III
Environmental hazards	
Marine pollutant	No
EmS	F-A, S-B
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

ADG



IATA; IMDG; RID



15. Regulatory information

Safety, health and environmental regulations

National regulations This Safety Data Sheet was prepared in accordance with Australia Model Code of Practice for the preparation of Safety Data Sheets for Hazardous Chemicals (23/12/2011).

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Phosphonic acid (CAS 13598-36-2)	For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Australia Medicines & Poisons Appendix F

Phosphonic acid (CAS 13598-36-2)	applies to all preparations in any concentration Avoid contact with eyes., Avoid contact with skin.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Organic phosphonate #1 (CAS Proprietary)	applies to all preparations in any concentration Exception may apply, see the regulation for relevance.

Australia Medicines & Poisons Schedule 5

Phosphonic acid (CAS 13598-36-2)	Exception was applied to data.

Australia Medicines & Poisons Schedule 6

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

High Volume Industrial Chemicals (HVIC)

Not listed.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 30-September-2016

Disclaimer	Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.
Revision information	Product and Company Identification: Product Review Composition / Information on Ingredients: Ingredients Physical & Chemical Properties: Multiple Properties Ecological Information: Ecotoxicity Transport Information: Material Transportation Information Material Attributes & Uses; Experimental Data: Experimental Data

SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 4703**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Membrane Cleaner

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Technologies (Australia) Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards	Not classified.	
Health hazards	Acute toxicity, oral	Category 4
	Skin corrosion/irritation	Category 2
	Serious eye damage/eye irritation	Category 2A
	Specific target organ toxicity following single exposure	Category 3 respiratory tract irritation
Environmental hazards	Not classified.	

Label elements, including precautionary statements

Hazard symbol(s)



Exclamation mark

Signal word Warning

Hazard Statement(s) Harmful if swallowed. Causes skin irritation. Causes serious eye irritation. May cause respiratory irritation.

Precautionary Statement(s)

Prevention Avoid breathing mist or vapour. Wash hands thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Wear protective gloves. Wear eye/face protection.

Response	IF SWALLOWED: Call a POISON CENTRE or doctor/physician if you feel unwell. IF ON SKIN: Wash with plenty of soap and water. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a POISON CENTRE or doctor/physician if you feel unwell. Specific treatment (see First aid measures on this label). Rinse mouth. If skin irritation occurs: Get medical advice/attention. If eye irritation persists: Get medical advice/attention. Take off contaminated clothing and wash before reuse.
Storage	Store in cool place. Store in a well-ventilated place. Keep container tightly closed. Protect from sunlight.
Disposal	Dispose of contents/container to an appropriate treatment and disposal facility in accordance with applicable laws and regulations, and product characteristics at time of disposal.
Other hazards which do not result in classification	None known.
Supplemental information	7 % of the mixture consists of component(s) of unknown acute oral toxicity.

3. Composition/information on ingredients

Mixture

Identity of chemical ingredients	CAS number and other unique identifiers	Concentration of ingredients
Citric acid	77-92-9	10 - < 20
Other components below reportable levels		80 - < 90

4. First-aid measures

Description of necessary first aid measures

Inhalation	Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTRE or doctor/physician if you feel unwell.
Skin contact	Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Get medical advice/attention if you feel unwell.
Personal protection for first-aid responders	If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance.
Symptoms caused by exposure	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. May cause respiratory irritation. Skin irritation. May cause redness and pain.
Medical attention and special treatment	Provide general supportive measures and treat symptomatically. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for fire fighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Hazchem Code	None.
General fire hazards	No unusual fire or explosion hazards noted.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Avoid breathing mist or vapour. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8.
For emergency responders	Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.
Environmental precautions	Avoid discharge into drains, water courses or onto the ground.
Methods and materials for containment and cleaning up	Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water. Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling	Avoid forming spray/aerosol mists. Avoid breathing mist or vapour. Avoid contact with eyes, skin, and clothing. Do not taste or swallow. When using, do not eat, drink or smoke. Provide adequate ventilation. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls and personal protection

Control parameters	Follow standard monitoring procedures.
Occupational exposure limits	No exposure limits noted for ingredient(s).
Biological limit values	No biological exposure limits noted for the ingredient(s).
Exposure guidelines	No exposure standards allocated.
Appropriate engineering controls	Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection	Wear safety glasses with side shields (or goggles) and a face shield. Chemical goggles and face shield are recommended. Face shield is recommended.
Skin protection	
Hand protection	Chemical resistant gloves.
Other	Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended. Chemical resistant gloves.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment. Avoid forming spray/aerosol mists.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Clear.
Physical state	Liquid.
Form	Liquid.
Colour	Colourless to Pale yellow.

Odour	Odourless.
pH	3.9 - 4.3
Melting point/freezing point	Not available.
Initial boiling point and boiling range	> 100 °C (> 212 °F)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit – upper (%)	Not available.
Vapour pressure	< 1 hPa
Vapour density	Not available.
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other physical and chemical parameters	
Density	1.09 - 1.21 g/cm3
Percent volatile	> 50 %
Specific gravity	1.09 - 1.21

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Hazardous polymerisation does not occur.
Conditions to avoid	Contact with incompatible materials. None under normal conditions.
Incompatible materials	Strong oxidising agents. Alkalies.
Hazardous decomposition products	Hydrogen cyanide (hydrocyanic acid). No dangerous reaction known under conditions of normal use.

11. Toxicological information

Information on possible routes of exposure

Inhalation	May cause irritation to the respiratory system.
Skin contact	Causes skin irritation.
Eye contact	Causes serious eye irritation.
Ingestion	Harmful if swallowed.
Symptoms related to exposure	Severe eye irritation. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. May cause respiratory irritation. Skin irritation. May cause redness and pain.
Acute toxicity	In high concentrations, vapours are anaesthetic and may cause headache, fatigue, dizziness and central nervous system effects. Harmful if swallowed. May cause respiratory irritation.

Product	Species	Test results
HYDREX 4703		
Acute		
Oral		
LD50	Rat	>= 5000 mg/kg Calculated

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation Causes skin irritation.

Serious eye damage/irritation Causes serious eye irritation.

Respiratory or skin sensitisation

Respiratory sensitisation Not a respiratory sensitizer.

Skin sensitisation This product is not expected to cause skin sensitisation.

Germ cell mutagenicity No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity Not available.

Reproductive toxicity This product is not expected to cause reproductive or developmental effects.

Specific target organ toxicity - single exposure May cause respiratory irritation.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test results
HYDREX 4703			
Aquatic			
Acute			
Crustacea	EC50	Daphnia	>= 100 mg/l, 48 hours Calculated
Fish	LC50	Fish	>= 100 mg/l, 48 hours Calculated

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential No data available.

Mobility in soil No data available for this product.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.

Residual waste Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Empty containers should be taken to an approved waste handling site for recycling or disposal. Since emptied containers may retain product residue, follow label warnings even after container is emptied.

14. Transport information

ADG

Not regulated as dangerous goods.

RID

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

15. Regulatory information

Safety, health and environmental regulations

National regulations

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix F

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 5

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 6

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

High Volume Industrial Chemicals (HVIC)

Citric acid (CAS 77-92-9) 1000 - 9999 TONNES See the regulation for additional information.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	No
Korea	Existing Chemicals List (ECL)	No
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	No

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 04-October-2016

Disclaimer Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.

Revision information

Product and Company Identification: Product Review
Composition / Information on Ingredients: Ingredients
Physical & Chemical Properties: Multiple Properties
Toxicological Information: Toxicological Data
Ecological Information: Ecotoxicity
Regulatory Information: United States

SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 4705**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Reverse Osmosis Membrane Cleaner

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Solutions & Technologies Australia Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact Person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards	Not classified.	
Health hazards	Skin corrosion/irritation	Category 1B
	Serious eye damage/eye irritation	Category 1
	Specific target organ toxicity, single exposure	Category 3 respiratory tract irritation
Environmental hazards	Not classified.	

Label elements, including precautionary statements

Hazard symbol(s)



Corrosion Exclamation mark

Signal word Danger

Hazard statement(s) Causes severe skin burns and eye damage. Causes serious eye damage. May cause respiratory irritation.

Precautionary statement(s)

Prevention Do not breathe mist or vapor. Wash hands thoroughly after handling. Use only outdoors or in a well-ventilated area. Wear protective gloves/protective clothing/eye protection/face protection.

Response IF SWALLOWED: Rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTER or doctor/physician. Specific treatment (see First aid measures on this label). Wash contaminated clothing before reuse.

Storage Store in a well-ventilated place. Keep container tightly closed.

Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Other hazards which do not result in classification	None known.
Supplemental information	None.

3. Composition/information on ingredients

Mixture

Identity of chemical ingredients	CAS number and other unique identifiers	Concentration of ingredients
Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	10 - < 20
Potassium hydroxide	1310-58-3	1 - < 5
Other components below reportable levels		80 - < 90

4. First-aid measures

Description of necessary first aid measures

Inhalation	Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTER or doctor/physician if you feel unwell.
Skin contact	Take off immediately all contaminated clothing. Rinse skin with water/shower. Call a physician or poison control center immediately. Chemical burns must be treated by a physician. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control center immediately.
Ingestion	Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.
Personal protection for first-aid responders	If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.
Symptoms caused by exposure	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause respiratory irritation.
Medical attention and special treatment	Provide general supportive measures and treat symptomatically. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim under observation. Symptoms may be delayed.

5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for fire fighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Move containers from fire area if you can do so without risk.
Hazchem code	None.
General fire hazards	No unusual fire or explosion hazards noted.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel
Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist or vapor. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

For emergency responders
Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.

Environmental precautions
Avoid discharge into drains, water courses or onto the ground.

Methods and materials for containment and cleaning up
Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling
Avoid forming spray/aerosol mists. Do not breathe mist or vapor. Do not get in eyes, on skin, or on clothing. Avoid prolonged exposure. Provide adequate ventilation. Wear appropriate personal protective equipment. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities
Protect from sunlight. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Store in cool, dry place.

8. Exposure controls and personal protection

Control parameters
Follow standard monitoring procedures.

Occupational exposure limits

Australia. National Workplace OELs (Workplace Exposure Standards for Airborne Contaminants, Appendix A)

Components	Type	Value
Potassium hydroxide (CAS 1310-58-3)	Ceiling	2 mg/m3

US. ACGIH Threshold Limit Values

Components	Type	Value
Potassium hydroxide (CAS 1310-58-3)	Ceiling	2 mg/m3

UK. EH40 Workplace Exposure Limits (WELs)

Components	Type	Value
Potassium hydroxide (CAS 1310-58-3)	STEL	2 mg/m3

Biological limit values
No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls
Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection
Wear safety glasses with side shields (or goggles) and a face shield. Chemical goggles and face shield are recommended.

Skin protection

Hand protection
Chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.

Other
Wear appropriate chemical resistant clothing. Chemical resistant gloves.

Respiratory protection
In case of insufficient ventilation, wear suitable respiratory equipment. Avoid forming spray/aerosol mists.

Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Clear.
Physical state	Liquid.
Form	Liquid.
Color	Brown.
Odor	Not significant.
pH	10.4 - 11.2
Melting point/freezing point	Not available.
Initial boiling point and boiling range	> 212 °F (> 100 °C)
Flash point	Not available.
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit - upper (%)	Not available.
Vapor pressure	0 hPa estimated
Vapor density	Not available.
Solubility(ies)	
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.
Other physical and chemical parameters	
Explosive properties	Not explosive.
Oxidizing properties	Not oxidizing.
Specific gravity	1.23 - 1.27

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	Hazardous polymerization does not occur.
Conditions to avoid	Excessive heat. Contact with incompatible materials. Strong acids. Oxidizing, avoid contact with reducing agents. Freezing.
Incompatible materials	Strong oxidizing agents. This product may react with reducing agents.
Hazardous decomposition products	Upon decomposition this product emits acrid dense smoke with carbon dioxide, carbon monoxide, water and other products of combustion. Potassium oxides.

11. Toxicological information

Information on possible routes of exposure

Inhalation	May cause irritation to the respiratory system. Prolonged inhalation may be harmful.
Skin contact	Causes severe skin burns.
Eye contact	Causes serious eye damage.
Ingestion	Causes digestive tract burns.
Symptoms related to exposure	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause respiratory irritation.
Acute toxicity	May cause respiratory irritation.

Product	Species	Test Results
HYDREX 4705		
Acute		
Dermal		
LD50	Rat	4960 mg/l Calculated
Inhalation		
LC50	Rat	12 mg/l, 4.5 hours Calculated
Oral		
LD50	Rat	>= 2000 mg/kg Calculated

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation	Causes severe skin burns and eye damage.
Serious eye damage/irritation	Causes serious eye damage.
Respiratory or skin sensitization	
Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	Not available.
Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	May cause respiratory irritation.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity The product is not classified as environmentally hazardous. However, this does not exclude the possibility that large or frequent spills can have a harmful or damaging effect on the environment.

Product		Species	Test Results
HYDREX 4705			
Aquatic			
Acute			
Crustacea	EC50	Daphnia	>= 300 mg/l, 48 hours Calculated
Fish	LC50	Fish	>= 300 mg/l, 96 hours Calculated

* Estimates for product may be based on additional component data not shown.

Persistence and degradability	No data is available on the degradability of this product.
Bioaccumulative potential	No data available.

Mobility in soil	No data available for this product.
Other adverse effects	No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Dispose of contents/container in accordance with local/regional/national/international regulations.
Residual waste	Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).
Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

ADG

Not regulated as dangerous goods.

RID

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

Safety, health and environmental regulations

National regulations	This Safety Data Sheet was prepared in accordance with Australia Model Code of Practice for the preparation of Safety Data Sheets for Hazardous Chemicals (23/12/2011).

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Potassium hydroxide (CAS 1310-58-3)	For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Australia Medicines & Poisons Appendix F

Potassium hydroxide (CAS 1310-58-3)	in preparations Irritant. Avoid contact with eyes., Avoid contact with skin., Wash hands after use. in solid preparations Corrosive., May produce severe burns., Attacks skin and eyes. Wear eye protection when mixing or using., Wear protective gloves when mixing or using., Do not mix with hot water. liquid preparations Corrosive., May produce severe burns., Attacks skin and eyes. Wear eye protection when mixing or using., Wear protective gloves when mixing or using.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 5

Potassium hydroxide (CAS 1310-58-3)	in preparations being: (a) solid preparations the pH of which in a 10 g/L aqueous solution is more than 11.5; (b) liquid or semi-solid preparations the pH of which is more than 11.5 Exception may apply, see the regulation for relevance.

Australia Medicines & Poisons Schedule 6

Potassium hydroxide (CAS 1310-58-3)	applies to all preparations in any concentration Exception may apply, see the regulation for relevance.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

High Volume Industrial Chemicals (HVIC)

Potassium hydroxide (CAS 1310-58-3)	1000 - 9999 TONNES See the regulation for additional information.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 10-06-2016

Disclaimer Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.

Revision information

Product and Company Identification: Product Review
Hazards Identification: US Hazard Categories
Composition / Information on Ingredients: Ingredients
Physical & Chemical Properties: Multiple Properties
Toxicological Information: Toxicological Data
Ecological Information: Ecotoxicity
Transport Information: Proper Shipping Name/Packing Group
Regulatory Information: United States
GHS: Classification

SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 4714**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Membrane Cleaner

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Solutions & Technologies Australia Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards	Oxidising liquids	Category 2
	Corrosive to metals	Category 1
Health hazards	Acute toxicity, oral	Category 4
	Acute toxicity, dermal	Category 1
	Skin corrosion/irritation	Category 1
	Serious eye damage/eye irritation	Category 1
	Specific target organ toxicity following single exposure	Category 3 respiratory tract irritation
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
	Hazardous to the aquatic environment, long-term hazard	Category 2

Label elements, including precautionary statements

Hazard symbol(s)



Flame over circle | Skull and crossbones | Corrosion | Environment

Signal word Danger

Hazard Statement(s) May intensify fire; oxidiser. May be corrosive to metals. Harmful if swallowed. Fatal in contact with skin. Causes severe skin burns and eye damage. Causes serious eye damage. May cause respiratory irritation. Toxic to aquatic life. Toxic to aquatic life with long lasting effects.

Precautionary Statement(s)

Prevention	Keep away from heat. Keep/Store away from clothing/flammable/combustible materials. Take any precaution to avoid mixing with combustiblesFlammables Keep only in original container. Do not breathe mist or vapour. Do not get in eyes, on skin, or on clothing. Wash hands thoroughly after handling. Do not eat, drink or smoke when using this product. Use only outdoors or in a well-ventilated area. Avoid release to the environment. Wear protective gloves/protective clothing/eye protection/face protection.
Response	IF SWALLOWED: rinse mouth. Do NOT induce vomiting. IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower. IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Immediately call a POISON CENTRE or doctor/physician. Specific treatment (see First aid measures on this label). Remove/Take off immediately all contaminated clothing. Wash contaminated clothing before reuse. In case of fire: Use water for extinction. Absorb spillage to prevent material damage.
Storage	Store in a well-ventilated place. Keep container tightly closed. Store in corrosive resistant/metal container with a resistant inner liner.
Disposal	Dispose of contents/container in accordance with local/regional/national/international regulations.
Other hazards which do not result in classification	None known.
Supplemental information	None.

3. Composition/information on ingredients

Mixture

Identity of chemical ingredients	CAS number and other unique identifiers	Concentration of ingredients
Hydrogen peroxide	7722-84-1	20 - < 30
Acetic acid	64-19-7	10 - < 20
Peroxyacetic Acid	79-21-0	5 - < 10
Other components below reportable levels		60 - < 70

4. First-aid measures

Description of necessary first aid measures

Inhalation	Remove victim to fresh air and keep at rest in a position comfortable for breathing. Call a POISON CENTRE or doctor/physician if you feel unwell.
Skin contact	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes. Rinse skin with water/shower. Call a physician or poison control centre immediately. Chemical burns must be treated by a physician. Wash contaminated clothing before reuse.
Eye contact	Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control centre immediately.
Ingestion	Call a physician or poison control centre immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Do not use mouth-to-mouth method if victim ingested the substance. Induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device.
Personal protection for first-aid responders	Take off immediately all contaminated clothing. Contact with combustible material may cause fire. If you feel unwell, seek medical advice (show the label where possible). Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Show this safety data sheet to the doctor in attendance. Wash contaminated clothing before reuse. Discard any shoes or clothing items that cannot be decontaminated.
Symptoms caused by exposure	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause respiratory irritation.
Medical attention and special treatment	Provide general supportive measures and treat symptomatically. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim warm. Keep victim under observation. Symptoms may be delayed.

5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	Alcohol resistant foam. Powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	Greatly increases the burning rate of combustible materials. Containers may explode when heated. During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for fire fighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	In case of fire and/or explosion do not breathe fumes. In case of fire: Stop leak if safe to do so. Move containers from fire area if you can do so without risk.
Hazchem Code	None.
General fire hazards	May intensify fire; oxidiser. Contact with combustible material may cause fire.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Keep away from clothing and other combustible materials. Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist or vapour. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8.
For emergency responders	Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.
Environmental precautions	Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.
Methods and materials for containment and cleaning up	Use water spray to reduce vapours or divert vapour cloud drift. Eliminate all ignition sources (no smoking, flares, sparks, or flames in immediate area). Keep combustibles (wood, paper, oil etc) away from spilled material. Ventilate the contaminated area. Wear appropriate protective equipment and clothing during clean-up. Prevent entry into waterways, sewer, basements or confined areas. Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb spillage to prevent material damage. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal. Following product recovery, flush area with water. Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination. Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling	Avoid forming spray/aerosol mists. Keep away from heat. Take any precaution to avoid mixing with combustibles. Keep away from clothing and other combustible materials. Do not breathe mist or vapour. Do not get in eyes, on skin, or on clothing. Do not taste or swallow. Avoid prolonged exposure. When using, do not eat, drink or smoke. Provide adequate ventilation. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Avoid release to the environment. Wash contaminated clothing before reuse. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Keep away from heat. Store in a cool, dry place out of direct sunlight. Store in corrosive resistant container with a resistant inner liner. Keep only in the original container. Store in a well-ventilated place. Do not store near combustible materials. Store away from incompatible materials (see Section 10 of the SDS). Store in cool, dry place.

8. Exposure controls and personal protection

Control parameters Follow standard monitoring procedures.

Occupational exposure limits

Australia. National Workplace OELs (Workplace Exposure Standards for Airborne Contaminants, Appendix A)

Components	Type	Value
Acetic acid (CAS 64-19-7)	STEL	37 mg/m3 15 ppm
	TWA	25 mg/m3 10 ppm
Hydrogen peroxide (CAS 7722-84-1)	TWA	1.4 mg/m3 1 ppm

Australia. OELs. (Adopted National Exposure Standards for Atmospheric Contaminants in the Occupational Environment)

Components	Type	Value
Acetic acid (CAS 64-19-7)	STEL	37 mg/m3 15 ppm
	TWA	25 mg/m3 10 ppm
Hydrogen peroxide (CAS 7722-84-1)	TWA	1.4 mg/m3 1 ppm

US. ACGIH Threshold Limit Values

Components	Type	Value	Form
Acetic acid (CAS 64-19-7)	STEL	15 ppm	
	TWA	10 ppm	
Hydrogen peroxide (CAS 7722-84-1)	TWA	1 ppm	
Peroxyacetic Acid (CAS 79-21-0)	STEL	0.4 ppm	Inhalable fraction and vapor.

UK. EH40 Workplace Exposure Limits (WELs)

Components	Type	Value
Hydrogen peroxide (CAS 7722-84-1)	STEL	2.8 mg/m3 2 ppm
	TWA	1.4 mg/m3 1 ppm

Germany. DFG MAK List (advisory OELs). Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (DFG)

Components	Type	Value
Acetic acid (CAS 64-19-7)	TWA	25 mg/m3 10 ppm
Hydrogen peroxide (CAS 7722-84-1)	TWA	0.71 mg/m3 0.5 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection Chemical goggles and face shield are recommended. Wear safety glasses with side shields (or goggles).

Skin protection	
Hand protection	Chemical resistant gloves. Suitable gloves can be recommended by the glove supplier. Be aware that the liquid may penetrate the gloves. Frequent change is advisable.
Other	Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended. Chemical resistant gloves.
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment. Avoid forming spray/aerosol mists.
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Keep from contact with clothing and other combustible materials. Remove and wash contaminated clothing promptly. Keep away from food and drink. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance	Clear.
Physical state	Liquid.
Form	Liquid.
Colour	Colourless.
Odour	Pungent.
pH	< 2
Melting point/freezing point	-40 °C (-40 °F)
Initial boiling point and boiling range	>= 105 °C (>= 221 °F)
Flash point	74.0 - 83.0 °C (165.2 - 181.4 °F) Closed cup Non flammable aqueous solution
Evaporation rate	Not available.
Flammability (solid, gas)	Not applicable.
Upper/lower flammability or explosive limits	
Flammability limit - lower (%)	Not available.
Flammability limit - upper (%)	Not available.
Explosive limit - lower (%)	Not available.
Explosive limit – upper (%)	Not available.
Vapour pressure	32 hPa
Vapour density	Not available.
Solubility(ies)	
Solubility (water)	100 %
Partition coefficient (n-octanol/water)	-0.52
Auto-ignition temperature	Not available.
Decomposition temperature	> 60 °C (> 140 °F)
Viscosity	Not available.
Other physical and chemical parameters	
Density	1100.00 kg/m3
Explosive properties	Not explosive.
Oxidising properties	May intensify fire; oxidiser.
Specific gravity	1.05 - 1.15

10. Stability and reactivity

Reactivity	Greatly increases the burning rate of combustible materials. May be corrosive to metals.

Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Heat. Avoid temperatures exceeding the decomposition temperature. Avoid temperatures exceeding the flash point. Contact with incompatible materials.
Incompatible materials	Strong oxidising agents. Combustible material. Reducing Agents. Metals.
Hazardous decomposition products	Oxygen.

11. Toxicological information

Information on possible routes of exposure

Inhalation	May cause irritation to the respiratory system. Prolonged inhalation may be harmful.
Skin contact	Fatal in contact with skin. Causes severe skin burns.
Eye contact	Causes serious eye damage.
Ingestion	Causes digestive tract burns. Harmful if swallowed.
Symptoms related to exposure	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result. May cause respiratory irritation.
Acute toxicity	In high concentrations, vapours are anaesthetic and may cause headache, fatigue, dizziness and central nervous system effects. Fatal in contact with skin. Harmful if swallowed. May cause respiratory irritation.

Product	**Species**	**Test results**
HYDREX 4714		
Acute		
Dermal		
Liquid		
LD50	Rabbit	> 1.1 mg/kg
Inhalation		
Mist		
LC50	Rat	> 4 mg/m³, 4 hours
Oral		
Liquid		
LD50	Rat	> 300 mg/kg

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation	Causes severe skin burns and eye damage.
Serious eye damage/irritation	Causes serious eye damage.

Respiratory or skin sensitisation

Respiratory sensitisation	Not a respiratory sensitizer.
Skin sensitisation	This product is not expected to cause skin sensitisation.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.

Carcinogenicity

ACGIH Carcinogens

Hydrogen peroxide (CAS 7722-84-1)	A3 Confirmed animal carcinogen with unknown relevance to humans.
Peroxyacetic Acid (CAS 79-21-0)	A4 Not classifiable as a human carcinogen.

IARC Monographs. Overall Evaluation of Carcinogenicity

Hydrogen peroxide (CAS 7722-84-1)	3 Not classifiable as to carcinogenicity to humans.

Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	May cause respiratory irritation.

Specific target organ toxicity - repeated exposure Not classified.

Aspiration hazard Not an aspiration hazard.

Chronic effects Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity Toxic to aquatic life with long lasting effects.

Product		Species	Test results
HYDREX 4714			
Aquatic			
Acute			
Crustacea	EC50	Daphnia	14 mg/l, 48 hours
Fish	LC50	Fish	21 mg/l, 96 hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Partition coefficient n-octanol / water (log Kow)
-0.52

Mobility in soil No data available for this product.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Residual waste Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

ADG

UN number 3149

UN proper shipping name HYDROGEN PEROXIDE AND PEROXYACETIC ACID MIXTURE with acid(s), water and not more than 5% peroxyacetic acid, STABILIZED

Transport hazard class(es)

Class 5.1

Subsidiary risk 8

Packing group II

Environmental hazards Not available.

Hazchem Code 2P

Special precautions for user Read safety instructions, SDS and emergency procedures before handling.

RID

UN number 3149

UN proper shipping name HYDROGEN PEROXIDE AND PEROXYACETIC ACID MIXTURE with acid(s), water and not more than 5% peroxyacetic acid, STABILIZED

Transport hazard class(es)

Class 5.1

Subsidiary risk 8

Label(s)	5.1+8
Packing group	II
Environmental hazards	No.
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IATA

UN number	3149
UN proper shipping name	Hydrogen peroxide and peroxyacetic acid mixture stabilized with acid(s), water and not more than 5% peroxyacetic acid
Transport hazard class(es)	
Class	5.1
Subsidiary risk	8
Packing group	II
Environmental hazards	No.
ERG Code	5C
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Other information	
Passenger and cargo aircraft	Allowed with restrictions.
Cargo aircraft only	Allowed with restrictions.

IMDG

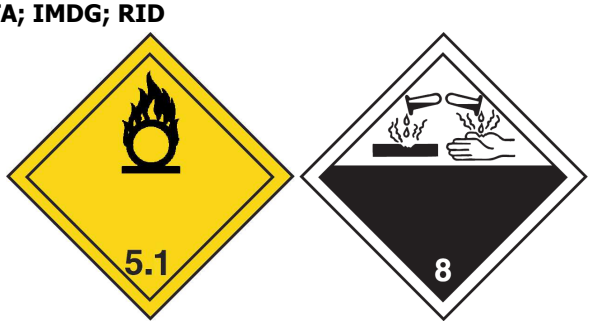
UN number	3149
UN proper shipping name	HYDROGEN PEROXIDE AND PEROXYACETIC ACID MIXTURE, with acid(s), water and not more than 5% peroxyacetic acid, STABILIZED
Transport hazard class(es)	
Class	5.1
Subsidiary risk	8
Packing group	II
Environmental hazards	
Marine pollutant	No.
EmS	F-H, S-Q
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not established.

ADG



IATA; IMDG; RID



15. Regulatory information

Safety, health and environmental regulations

National regulations This Safety Data Sheet was prepared in accordance with Australia Model Code of Practice for the preparation of Safety Data Sheets for Hazardous Chemicals (23/12/2011).

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Acetic acid (CAS 64-19-7)	For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.
Hydrogen peroxide (CAS 7722-84-1)	For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., Urgent hospital treatment is likely to be needed. (Note - the words 'at once' to be added to instruction A)., If swallowed, do NOT induce vomiting., Immediately give a glass of water., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If
Peroxyacetic Acid (CAS 79-21-0)	For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes wash out immediately with water., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. For advice, contact a Poisons information Centre (Phone eg Australia 131 - 126; New Zealand 03 - 4747 - 000) or a doctor (at once)., If swallowed, do NOT induce vomiting., If in eyes, hold eyelids apart and flush the eye continuously with running water. Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes., If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water.

Australia Medicines & Poisons Appendix F

Acetic acid (CAS 64-19-7)	in concentrations Corrosive. Avoid contact with eyes., Avoid contact with skin., Avoid breathing dust (or) vapour (or) spray mist.
Hydrogen peroxide (CAS 7722-84-1)	applies to all preparations in any concentration Corrosive. Attacks eyes - protect eyes when using., Avoid contact with skin. applies to all preparations in any concentration Irritant. Attacks eyes - protect eyes when using. applies to all preparations in any concentration Irritant. Avoid contact with eyes.

Peroxyacetic Acid (CAS 79-21-0)	applies to all preparations in any concentration Corrosive. Avoid contact with eyes., Avoid contact with skin., Avoid breathing dust (or) vapour (or) spray mist.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Acetic acid (CAS 64-19-7)	for therapeutic use

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 5

Acetic acid (CAS 64-19-7)	in preparations Exception may apply, see the regulation for relevance.
Hydrogen peroxide (CAS 7722-84-1)	in hair dye preparations. Exception was applied to data. in other [unspecified] preparations Exception was applied to data.
Peroxyacetic Acid (CAS 79-21-0)	in concentrations

Australia Medicines & Poisons Schedule 6

Acetic acid (CAS 64-19-7)	Exception may apply, see the regulation for relevance.
Hydrogen peroxide (CAS 7722-84-1)	Exception may apply, see the regulation for relevance.
Peroxyacetic Acid (CAS 79-21-0)	> 10 Exception was applied to data.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

Australia National Pollutant Inventory (NPI): Threshold quantity

Acetic acid (CAS 64-19-7)	10 TONNES/YR Threshold Category: 1

High Volume Industrial Chemicals (HVIC)

Acetic acid (CAS 64-19-7)	1000 - 9999 TONNES See the regulation for additional information.
Hydrogen peroxide (CAS 7722-84-1)	10000 - 99999 TONNES See the regulation for additional information.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Hydrogen peroxide (CAS 7722-84-1)	WASTES THAT CONTAIN, CONSIST OF OR ARE CONTAMINATED WITH PEROXIDES

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 07-March-2017

Disclaimer Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.

SAFETY DATA SHEET

1. Identification

Product identifier **HYDREX 6926**

Other means of identification None.

Recommended use of the chemical and restrictions on use

Recommended use Not available.

Restrictions on use PROFESSIONAL USE ONLY

Details of manufacturer or importer

Manufacturer

Supplier Veolia Water Technologies (Australia) Pty Ltd.

Address 92 - 94 Ordish Road
Dandenong South, Victoria, 3175
Australia

Contact person Hydrex Technical Manager

Telephone +61 39554 5048

Fax +61 39544 5090

e-mail hydrex.australia@veolia.com

Global Emergency Contact +1-760-476-3960 (Code:333239)

Australian Emergency Contact: +61 39554 5048 (Office hours)

2. Hazard(s) identification

Classification of the hazardous chemical

Physical hazards Not classified.

Health hazards Not classified.

Environmental hazards Hazardous to the aquatic environment, acute hazard Category 2

Label elements, including precautionary statements

Hazard symbol(s) None.

Signal word None.

Hazard Statement(s) Toxic to aquatic life.

Precautionary Statement(s)

Prevention Avoid release to the environment.

Response Wash hands after handling.

Storage Store away from incompatible materials.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Other hazards which do not result in classification None known.

Supplemental information None.

3. Composition/information on ingredients

Mixture

Identity of chemical ingredients	CAS number and other unique identifiers	Concentration of ingredients
Cationic acrylamide copolymer	69418-26-4	80 - < 90

Adipic Acid	124-04-9	1 - < 5
Other components below reportable levels		10 - < 20

4. First-aid measures

Description of necessary first aid measures

Inhalation	Move to fresh air. Call a physician if symptoms develop or persist.
Skin contact	Wash off with soap and water. Get medical attention if irritation develops and persists.
Eye contact	Rinse with water. Get medical attention if irritation develops and persists.
Ingestion	Rinse mouth. Get medical attention if symptoms occur.
Personal protection for first-aid responders	Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.
Symptoms caused by exposure	Direct contact with eyes may cause temporary irritation.
Medical attention and special treatment	Treat symptomatically.

5. Fire-fighting measures

Extinguishing media

Suitable extinguishing media	Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).
Unsuitable extinguishing media	Not available.
Specific hazards arising from the chemical	Material can be slippery when wet. During fire, gases hazardous to health may be formed.
Special protective equipment and precautions for fire fighters	Self-contained breathing apparatus and full protective clothing must be worn in case of fire.
Fire fighting equipment/instructions	Use water spray to cool unopened containers.
Hazchem Code	None.
General fire hazards	No unusual fire or explosion hazards noted.
Specific methods	Use standard firefighting procedures and consider the hazards of other involved materials.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures

For non-emergency personnel	Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8. Slippery when wet.
For emergency responders	Keep unnecessary personnel away. Use personal protection recommended in Section 8 of the SDS.
Environmental precautions	Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.
Methods and materials for containment and cleaning up	Prevent product from entering drains. Stop the flow of material, if this is without risk. Following product recovery, flush area with water. For waste disposal, see section 13 of the SDS.

7. Handling and storage

Precautions for safe handling	Material can be slippery when wet. Avoid prolonged exposure. Provide adequate ventilation. Wear appropriate personal protective equipment. Avoid release to the environment. Observe good industrial hygiene practices.
Conditions for safe storage, including any incompatibilities	Protect from sunlight. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Store in cool, dry place.

8. Exposure controls and personal protection

Control parameters	Follow standard monitoring procedures.

Occupational exposure limits

US. ACGIH Threshold Limit Values

Components	Type	Value
Adipic Acid (CAS 124-04-9)	TWA	5 mg/m3

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Individual protection measures, for example personal protective equipment (PPE)

Eye/face protection Wear safety glasses with side shields (or goggles) and a face shield. Chemical goggles and face shield are recommended.

Skin protection

Hand protection Chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.

Other Wear suitable protective clothing. Chemical resistant gloves.

Respiratory protection In case of insufficient ventilation, wear suitable respiratory equipment.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

Hygiene measures Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Solid.

Form Solid.

Colour Not available.

Odour Not available.

pH Not available.

Melting point/freezing point Not available.

Initial boiling point and boiling range Not available.

Flash point Not available.

Evaporation rate Not available.

Flammability (solid, gas) Not available.

Upper/lower flammability or explosive limits

Flammability limit - lower (%) Not available.

Flammability limit - upper (%) Not available.

Explosive limit - lower (%) Not available.

Explosive limit – upper (%) Not available.

Vapour pressure Not available.

Vapour density Not available.

Solubility(ies)

Solubility (water) Not available.

Partition coefficient (n-octanol/water) Not available.

Auto-ignition temperature Not available.

Decomposition temperature Not available.

Viscosity Not available.

Other physical and chemical parameters

Bulk density	700 kg/m3
Explosive properties	Not explosive.
Oxidising properties	Not oxidising.
Specific gravity	0.7
pH of 1% Solution	3.5 - 4.5

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Strong oxidising agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on possible routes of exposure

Inhalation	Prolonged inhalation may be harmful.
Skin contact	No adverse effects due to skin contact are expected.
Eye contact	Direct contact with eyes may cause temporary irritation.
Ingestion	Expected to be a low ingestion hazard.
Symptoms related to exposure	Direct contact with eyes may cause temporary irritation.

Product	Species	Test results
HYDREX 6926		
Acute		
Dermal		
Solid		
Presumed Non-Toxic		
Oral		
Solid		
LD50	Rat	> 5000 mg/kg

* Estimates for product may be based on additional component data not shown.

Skin corrosion/irritation	Prolonged skin contact may cause temporary irritation.
Serious eye damage/irritation	Direct contact with eyes may cause temporary irritation.
Respiratory or skin sensitisation	
Respiratory sensitisation	Not a respiratory sensitizer.
Skin sensitisation	This product is not expected to cause skin sensitisation.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	Not available.
Reproductive toxicity	This product is not expected to cause reproductive or developmental effects.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	Not an aspiration hazard.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity Toxic to aquatic life.

Product		Species	Test results
HYDREX 6926			
Aquatic			
Acute			
Crustacea	EC50	Daphnia	10 - 100 mg/l, 48 hours
Fish	LC50	Fish	1 - 10 mg/l, 96 hours

* Estimates for product may be based on additional component data not shown.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Mobility in soil No data available for this product.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal methods Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Residual waste Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

ADG

Not regulated as dangerous goods.

RID

Not regulated as dangerous goods.

IATA

Not regulated as dangerous goods.

IMDG

Not regulated as dangerous goods.

Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code Not available.

15. Regulatory information

Safety, health and environmental regulations

National regulations This Safety Data Sheet was prepared in accordance with Australia Model Code of Practice for the preparation of Safety Data Sheets for Hazardous Chemicals (23/12/2011).

Australia Medicines & Poisons Appendix A

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix B

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix C

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix D

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix E

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix F

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix G

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix H

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix I

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix J

Poisons schedule number not allocated.

Australia Medicines & Poisons Appendix K

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 2

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 3

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 4

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 5

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 6

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 7

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 8

Poisons schedule number not allocated.

Australia Medicines & Poisons Schedule 9

Poisons schedule number not allocated.

High Volume Industrial Chemicals (HVIC)

Not listed.

Importation of Ozone Deleting Substances (Customs(Prohibited imports) Regulations 1956, Schedule 10)

Not listed.

National Pollutant Inventory (NPI) substance reporting list

Not listed.

Prohibited Carcinogenic Substances

Not regulated.

Prohibited Substances (National Model Regulation for the control of Workplace Hazardous Substances, Schedule 2 NOHSC:1005 (1994) as amended)

Not listed.

Resricted Importation of Organochlorine Chemicals (Customs(Prohibited Imports) Regulations 1956, Schedule 9)

Not listed.

Restricted Carcinogenic Substances

Not regulated.

International regulations

Stockholm Convention

Not applicable.

Rotterdam Convention

Not applicable.

Kyoto protocol

Not applicable.

Montreal Protocol

Not applicable.

Basel Convention

Not applicable.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information

Issue date 03-November-2016

Disclaimer Veolia Water Technologies is not able to anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use and or non respect of Veolia Water Technologies' requirement.

HYDROCHLORIC ACID 32%

Coogee Chemicals

Chemwatch: **48-4484**
Version No: **3.1.1.1**
Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: **3**

Issue Date: **17/07/2015**
Print Date: **30/07/2015**
Initial Date: **Not Available**
S.GHS.AUS.EN

SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

Product Identifier

Product name	HYDROCHLORIC ACID 32%
Proper shipping name	HYDROCHLORIC ACID
Other means of identification	Not Available

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Acidifier, Chemical intermediate, Laboratory reagent, Pickling and anodising metals, scale remover.

Details of the manufacturer/importer

Registered company name	Coogee Chemicals
Address	Cnr of Patterson and Kwinana Beach Roads Kwinana WA Australia
Telephone	+61 8 9439 8200
Fax	+61 8 9439 8300
Website	www.coogee.com.au
Email	businessrelations@coogee.com.au

Emergency telephone number

Association / Organisation	Coogee Chemicals
Emergency telephone numbers	1800 800 655
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture

HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the Model WHS Regulations and the ADG Code.

CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	3	
Body Contact	3	
Reactivity	1	
Chronic	1	

0 = Minimum
1 = Low
2 = Moderate
3 = High
4 = Extreme

Poisons Schedule	S6
GHS Classification [1]	Metal Corrosion Category 1, Acute Toxicity (Oral) Category 4, Acute Toxicity (Inhalation) Category 2, Skin Corrosion/Irritation Category 1A, Serious Eye Damage Category 1
Legend:	*1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI*

Label elements

GHS label elements



SIGNAL WORD **DANGER**

Hazard statement(s)

H290	May be corrosive to metals
H302	Harmful if swallowed
H330	Fatal if inhaled
H314	Causes severe skin burns and eye damage

Continued...

H318	Causes serious eye damage

Supplementary statement(s)

Not Applicable

Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P271	Use only outdoors or in a well-ventilated area.

Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.

Precautionary statement(s) Storage

P403+P233	Store in a well-ventilated place. Keep container tightly closed.
P405	Store locked up.

Precautionary statement(s) Disposal

P501	Dispose of contents/container to authorised chemical landfill or if organic to high temperature incineration

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
7647-01-0	32	hydrochloric acid
7732-18-5	balance	water

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye Contact	If this product comes in contact with the eyes: ▸ Immediately hold eyelids apart and flush the eye continuously with running water. ▸ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. ▸ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes. ▸ Transport to hospital or doctor without delay. ▸ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact	If skin or hair contact occurs: ▸ Immediately flush body and clothes with large amounts of water, using safety shower if available. ▸ Quickly remove all contaminated clothing, including footwear. ▸ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre. ▸ Transport to hospital, or doctor.
Inhalation	▸ If fumes or combustion products are inhaled remove from contaminated area. ▸ Lay patient down. Keep warm and rested. ▸ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. ▸ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. ▸ Transport to hospital, or doctor, without delay.
Ingestion	▸ For advice, contact a Poisons Information Centre or a doctor at once. ▸ Urgent hospital treatment is likely to be needed. ▸ 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 airway and prevent aspiration. ▸ Observe the patient carefully. ▸ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. ▸ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. ▸ Transport to hospital or doctor without delay.

Indication of any immediate medical attention and special treatment needed

Treat symptomatically.
For acute or short term repeated exposures to strong acids:

- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling
- Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
- Strong acids produce a coagulation necrosis characterised by formation of a coagulum (eschar) as a result of the dessicating action of the acid on proteins in specific tissues.

INGESTION:

- Immediate dilution (milk or water) within 30 minutes post ingestion is recommended.
- **DO NOT** attempt to neutralise the acid since exothermic reaction may extend the corrosive injury.
- Be careful to avoid further vomit since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
- Charcoal has no place in acid management.
- Some authors suggest the use of lavage within 1 hour of ingestion.

Continued...

SKIN:
- Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
- Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:
- Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjuctival cul-de-sacs. Irrigation should last at least 20-30 minutes. **DO NOT** use neutralising agents or any other additives. Several litres of saline are required.
- Cycloplegic drops, (1% cyclopentolate for short-term use or 5% homatropine for longer term use) antibiotic drops, vasoconstrictive agents or artificial tears may be indicated dependent on the severity of the injury.
- Steroid eye drops should only be administered with the approval of a consulting ophthalmologist).

[Ellenhorn and Barceloux: Medical Toxicology]

SECTION 5 FIREFIGHTING MEASURES

Extinguishing media

	▸ Water spray or fog. ▸ Foam.

Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.

Advice for firefighters

Fire Fighting	▸ Alert Fire Brigade and tell them location and nature of hazard. ▸ Wear full body protective clothing with breathing apparatus. |HCl can liberate highly flammable hydrogen gas when in contact with certain metals.
Fire/Explosion Hazard	▸ Non combustible. ▸ Not considered to be a significant fire risk.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Minor Spills	▸ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material. ▸ Check regularly for spills and leaks.
Major Spills	▸ Clear area of personnel and move upwind. ▸ Alert Fire Brigade and tell them location and nature of hazard.
	Personal Protective Equipment advice is contained in Section 8 of the MSDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	▸ Avoid all personal contact, including inhalation. ▸ Wear protective clothing when risk of exposure occurs.
Other information	▸ Store in original containers. ▸ Keep containers securely sealed.

Conditions for safe storage, including any incompatibilities

Suitable container	▸ **DO NOT** use aluminium or galvanised containers ▸ Lined metal can, lined metal pail/ can. ▸ Plastic pail.
Storage incompatibility	▸ Inorganic acids are generally soluble in water with the release of hydrogen ions. The resulting solutions have pH's of less than 7.0. |Incompatible with oxidizing agents eg. hypochlorites, alkalis, most metals etc, alcohols and amines.



X X + X X +

X — Must not be stored together
0 — May be stored together with specific preventions
+ — May be stored together

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	hydrochloric acid	Hydrogen chloride	Not Available	Not Available	7.5 mg/m3 / 5 ppm	Not Available

EMERGENCY LIMITS

Continued...

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
hydrochloric acid	Hydrogen chloride; (Hydrochloric acid)	Not Available	Not Available	Not Available
hydrochloric acid	Deuterochloric acid; (Deuterium chloride)	1.8 ppm	22 ppm	100 ppm

Ingredient	Original IDLH	Revised IDLH
hydrochloric acid	100 ppm	50 ppm
water	Not Available	Not Available

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
Personal protection	
Eye and face protection	▸ Chemical goggles. ▸ Full face shield may be required for supplementary but never for primary protection of eyes.
Skin protection	See Hand protection below
Hands/feet protection	▸ Wear chemical protective gloves, e.g. PVC. ▸ Wear safety footwear or safety gumboots, e.g. Rubber ▸ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.
Body protection	See Other protection below
Other protection	▸ Overalls. ▸ PVC Apron.
Thermal hazards	Not Available

Recommended material(s)

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:
"Forsberg Clothing Performance Index".
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
HYDROCHLORIC ACID 32%

Material	CPI
BUTYL	A
NEOPRENE	A
BUTYL/NEOPRENE	C
HYPALON	C
NAT+NEOPR+NITRILE	C
NATURAL RUBBER	C
NATURAL+NEOPRENE	C
NEOPRENE/NATURAL	C
NITRILE	C
NITRILE+PVC	C
PE/EVAL/PE	C
PVA	C
PVC	C
SARANEX-23	C
VITON	C
VITON/NEOPRENE	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

Respiratory protection

Type B-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.
Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	B-AUS P2	-	B-PAPR-AUS / Class 1 P2
up to 50 x ES	-	B-AUS / Class 1 P2	-
up to 100 x ES	-	B-2 P2	B-PAPR-2 P2 ^

^ - Full-face
A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Colourless to slightly yellow corrosive liquid with pungent acidic odour; miscible with water.

Continued...

Physical state	Liquid	**Relative density (Water = 1)**	1.161
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Available
pH (as supplied)	<1	**Decomposition temperature**	Not Available
Melting point / freezing point (°C)	<-20	**Viscosity (cSt)**	Not Available
Initial boiling point and boiling range (°C)	109	**Molecular weight (g/mol)**	Not Applicable
Flash point (°C)	Not Applicable	**Taste**	Not Available
Evaporation rate	as for water	**Explosive properties**	Not Available
Flammability	Not Applicable	**Oxidising properties**	Not Available
Upper Explosive Limit (%)	Not Applicable	**Surface Tension (dyn/cm or mN/m)**	Not Available
Lower Explosive Limit (%)	Not Applicable	**Volatile Component (%vol)**	100
Vapour pressure (kPa)	2	**Gas group**	Not Available
Solubility in water (g/L)	Miscible	**pH as a solution (1%)**	Not Available
Vapour density (Air = 1)	1.3	**VOC g/L**	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▸ Contact with alkaline material liberates heat
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	Corrosive acids can cause irritation of the respiratory tract, with coughing, choking and mucous membrane damage. There may be dizziness, headache, nausea and weakness.
Ingestion	Ingestion of acidic corrosives may produce burns around and in the mouth, the throat and oesophagus. Immediate pain and difficulties in swallowing and speaking may also be evident.
Skin Contact	The material can produce chemical burns following direct contact with the skin. Skin contact with acidic corrosives may result in pain and burns; these may be deep with distinct edges and may heal slowly with the formation of scar tissue.
Eye	The material can produce chemical burns to the eye following direct contact. Vapours or mists may be extremely irritating.
Chronic	Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure. Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and/or ulceration of mouth lining.

HYDROCHLORIC ACID 32%	**TOXICITY**	**IRRITATION**
	Not Available	Not Available
hydrochloric acid	**TOXICITY**	**IRRITATION**
	Inhalation (rat) LC50: 3124 ppm/1h[2]	Eye (rabbit): 5mg/30s - mild
	Oral (rat) LD50: 900 mg/kg[2]	
water	**TOXICITY**	**IRRITATION**
	Oral (rat) LD50: >90000 mg/kg[2]	Not Available
Legend:	*1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's msds. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*	

HYDROCHLORIC ACID 32%	Inhalation (Rat) LC50: 4.2-4.7 mg/l/1h
HYDROCHLORIC ACID	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound.
WATER	No significant acute toxicological data identified in literature search.

Continued...

Acute Toxicity	✔	**Carcinogenicity**	⊘
Skin Irritation/Corrosion	✔	**Reproductivity**	⊘
Serious Eye Damage/Irritation	✔	**STOT - Single Exposure**	⊘
Respiratory or Skin sensitisation	⊘	**STOT - Repeated Exposure**	⊘
Mutagenicity	⊘	**Aspiration Hazard**	⊘

Legend: ✔ *– Data required to make classification available*
✘ *– Data available but does not fill the criteria for classification*
⊘ *– Data Not Available to make classification*

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

Prevent, by any means available, spillage from entering drains or water courses.
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
hydrochloric acid	LOW	LOW
water	LOW	LOW

Bioaccumulative potential

Ingredient	Bioaccumulation
hydrochloric acid	LOW (LogKOW = 0.5392)
water	LOW (LogKOW = -1.38)

Mobility in soil

Ingredient	Mobility
hydrochloric acid	LOW (KOC = 14.3)
water	LOW (KOC = 14.3)

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	▸ Containers may still present a chemical hazard/ danger when empty. ▸ Return to supplier for reuse/ recycling if possible.

SECTION 14 TRANSPORT INFORMATION

Labels Required



Marine Pollutant	NO
HAZCHEM	2R

Land transport (ADG)

UN number	1789
Packing group	II
UN proper shipping name	HYDROCHLORIC ACID
Environmental hazard	No relevant data
Transport hazard class(es)	Class: 8 Subrisk: Not Applicable
Special precautions for user	Special provisions: Not Applicable Limited quantity: 1 L

Air transport (ICAO-IATA / DGR)

UN number	1789
Packing group	II
UN proper shipping name	Hydrochloric acid

Continued...

Environmental hazard	No relevant data
Transport hazard class(es)	ICAO/IATA Class: 8 ICAO / IATA Subrisk: Not Applicable ERG Code: 8L
Special precautions for user	Special provisions: A3A803 Cargo Only Packing Instructions: 855 Cargo Only Maximum Qty / Pack: 30 L Passenger and Cargo Packing Instructions: 851 Passenger and Cargo Maximum Qty / Pack: 1 L Passenger and Cargo Limited Quantity Packing Instructions: Y840 Passenger and Cargo Limited Maximum Qty / Pack: 0.5 L

Sea transport (IMDG-Code / GGVSee)

UN number	1789
Packing group	II
UN proper shipping name	HYDROCHLORIC ACID
Environmental hazard	Not Applicable
Transport hazard class(es)	IMDG Class: 8 IMDG Subrisk: Not Applicable
Special precautions for user	EMS Number: F-A , S-B Special provisions: Not Applicable Limited Quantities: 1 L

Transport in bulk according to Annex II of MARPOL 73 / 78 and the IBC code

Source	Ingredient	Pollution Category
IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk	hydrochloric acid	Z

SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

HYDROCHLORIC ACID(7647-01-0) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards
Australia Hazardous Substances Information System - Consolidated Lists
Australia Inventory of Chemical Substances (AICS)
International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs

WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (hydrochloric acid; water)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	*Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)*

SECTION 16 OTHER INFORMATION

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net

Continued...

The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

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end of SDS

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **MAK-MFC1**

Synonym(s) MAK MFC1

1.2 Uses and uses advised against

Use(s) WASTE WATER COAGULANT

1.3 Details of the supplier of the product

Supplier name **MAK INDUSTRIAL WATER SOLUTIONS PTY LTD**

Address 2/24 Mercantile Way, Malaga, Western Australia, 6090, AUSTRALIA

Telephone +61 8 9249 8007

Fax +61 8 9249 8004

Email service.wa@makwater.com.au

Website http://makwater.com.au

1.4 Emergency telephone number(s)

Emergency +61 8 9249 8007

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

GHS classification(s) Serious Eye Damage / Eye Irritation: Category 2A
Skin Corrosion/Irritation: Category 2

2.2 Label elements

Signal word **WARNING**

Pictogram(s)



Hazard statement(s)

H315	Causes skin irritation.
H319	Causes serious eye irritation.

Prevention statement(s)

P264	Wash thoroughly after handling.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Response statement(s)

P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P321	Specific treatment is advised - see first aid instructions.
P332 + P337 + P313	If skin or eye irritation occurs: Get medical advice/ attention.
P362	Take off contaminated clothing and wash before re-use.

Storage statement(s)

None allocated.

Disposal statement(s)
None allocated.

2.3 Other hazards
No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
ALUMINUM HYDROXYCHLORIDE	1324-41-9	-	40 to 60%
WATER	7732-18-5	231-791-2	20 to 60%
PROPRIETARY INGREDIENT(S)	-	-	20 to 40%

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower are recommended.

4.2 Most important symptoms and effects, both acute and delayed
Irritating to the eyes and skin.

4.3 Immediate medical attention and special treatment needed
Treat symptomatically.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media
Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture
Non flammable. May evolve toxic gases if strongly heated.

5.3 Advice for firefighters
Treat as per requirements for surrounding fires. Evacuate area and contact emergency services. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code
None allocated.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS.

6.2 Environmental precautions
Prevent product from entering drains and waterways.

6.3 Methods of cleaning up
Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in a cool, dry, well ventilated area, removed from incompatible substances and foodstuffs. Ensure containers are adequately labelled, protected from physical damage and sealed when not in use. Check regularly for leaks or spills.

7.3 Specific end use(s)

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

No exposure standards have been entered for this product.

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face	Wear splash-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	When using large quantities or where heavy contamination is likely, wear coveralls.
Respiratory	Not required under normal conditions of use.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	CLEAR TO SLIGHTLY HAZY LIQUID
Odour	SLIGHT ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	100°C
Melting point	NOT AVAILABLE
Evaporation rate	NOT RELEVANT
pH	3.5 to 4.0 (neat)
Vapour density	NOT AVAILABLE
Specific gravity	1.33 to 1.35
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE

9.1 Information on basic physical and chemical properties

Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE
Odour threshold	NOT AVAILABLE

9.2 Other information

% Volatiles	50 %

10. STABILITY AND REACTIVITY

10.1 Reactivity

May evolve chlorine gas when in contact with very strong oxidising agents. There is some heat liberated when in contact with strong acids.

10.2 Chemical stability

Stable under recommended conditions of storage.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid heat, sparks, open flames and other ignition sources.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites) and acids (e.g. nitric acid).

10.6 Hazardous decomposition products

Severe overheating may release hydrogen chloride gas and aluminium oxides once water has evaporated.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Health hazard summary	Irritant. This product has the potential to cause adverse health effects with over exposure. Use safe work practices to avoid eye or skin contact and inhalation. Over exposure may result in irritation to the eyes, skin and respiratory system.
Eye	Irritant. Contact may result in irritation, lacrimation, pain and redness. May result in burns with prolonged contact.
Inhalation	Low to moderate irritant. Over exposure may result in irritation of the nose and throat, coughing, dizziness and headache.
Skin	Irritant. Contact may result in irritation, redness, rash and dermatitis. Prolonged or repeated contact may result in burns.
Ingestion	May be harmful. Ingestion may result in gastrointestinal irritation, nausea, vomiting, abdominal pain and diarrhoea.
Toxicity data	No LD50 data available for this product.

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Not a persistent pollutant; can cause coagulation of solids in aqueous suspension, especially when highly diluted by the water in which the solids are suspended. Aluminium compounds are common in most soils and are the principle components of Bauxite and Gibbsite, which are common, naturally occurring minerals. When diluted by copious quantities of water (for example, to the point that the concentration is less than about 100 grams per cubic meter), this product will hydrolyse rapidly to form aluminium hydroxide, which can be expected to become a part of the natural soil profile if not recovered. When not highly diluted with water, this product may be slow to hydrolyse and may form a mixture of partially soluble aluminium species and heavy floc of aluminium hydroxide. Until further diluted, this mixture could affect marine life by clogging sensitive respiratory mechanisms in a similar fashion to muds and clays and possibly by toxic effects that are not yet well understood.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

No information provided.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal For small amounts, absorb with sand, vermiculite or similar and dispose of to an approved landfill site. Contact the manufacturer/supplier for additional information if disposing of large quantities (if required). Prevent contamination of drains and waterways as aquatic life may be threatened and environmental damage may result. This product can be neutralised with alkali to form a mixture of aluminium hydroxide and the chloride salt of the alkali. The resulting mixture is non-hazardous providing the resulting pH is between roughly 5 and 10.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

NOT CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE, IMDG OR IATA

	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	None Allocated	None Allocated	None Allocated
14.2 Proper Shipping Name	None Allocated	None Allocated	None Allocated
14.3 Transport hazard class	None Allocated	None Allocated	None Allocated
14.4 Packing Group	None Allocated	None Allocated	None Allocated

14.5 Environmental hazards No information provided

14.6 Special precautions for user

Hazchem code None Allocated

Other information There is a possibility that this product could be contained in a reagent set or kit composed of various compatible dangerous goods. If the item is part of a set or kit, the classification would change to the following: UN3316 Chemical Kit, Class 9, PG II or III.

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule A poison schedule number has not been allocated to this product using the criteria in the Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Classifications Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals.

The classifications and phrases listed below are based on the Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008(2004)].

Hazard codes Xi Irritant

Risk phrases R36/38 Irritating to eyes and skin.

Safety phrases S24/25 Avoid contact with skin and eyes.
S36/37/39 Wear suitable protective clothing, gloves and eye/face protection.

Inventory listing(s) **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.
UNITED STATES: TSCA (US Toxic Substances Control Act)
All components are listed on the TSCA inventory, or are exempt.

16. OTHER INFORMATION

Additional information

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
GHS	Globally Harmonized System
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Revision history

Revision	Description
1.1	Standard SDS Review.
1.0	Converted to GHS.
0.2	Standard SDS Review

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Prepared by

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Revision: 1.1
SDS date: 19 January 2015

[End of SDS]

SAFETY DATA SHEET

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

1.1 Product identifier

Product name **MAK-SU**

Synonym(s) MAK SULPHURIC ACID 34% • SULFURIC ACID 34 %

1.2 Uses and uses advised against

Use(s) ACID • PH ADJUSTOR

1.3 Details of the supplier of the product

Supplier name **MAK INDUSTRIAL WATER SOLUTIONS PTY LTD**

Address 2/24 Mercantile Way, Malaga, Western Australia, 6090, AUSTRALIA

Telephone +61 8 9249 8007

Fax +61 8 9249 8004

Email service.wa@makwater.com.au

Website http://makwater.com.au

1.4 Emergency telephone number(s)

Emergency +61 8 9249 8007

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

GHS classification(s) Skin Corrosion/Irritation: Category 1A

2.2 Label elements

Signal word **DANGER**

Pictogram(s)



Hazard statement(s)

H314 Causes severe skin burns and eye damage.

Prevention statement(s)

P260 Do not breathe dust/fume/gas/mist/vapours/spray.
P264 Wash thoroughly after handling.
P280 Wear protective gloves/protective clothing/eye protection/face protection.

Response statement(s)

P301 + P330 + P331 IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303 + P361 + P353 IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310 Immediately call a POISON CENTER or doctor/physician.
P321 Specific treatment is advised - see first aid instructions.
P363 Wash contaminated clothing before reuse.

Storage statement(s)

P405 Store locked up.

Disposal statement(s)

P501 Dispose of contents/container in accordance with relevant regulations.

2.3 Other hazards

No information provided.

3. COMPOSITION/ INFORMATION ON INGREDIENTS

3.1 Substances / Mixtures

Ingredient	CAS Number	EC Number	Content
SULPHURIC ACID	7664-93-9	231-639-5	34%
WATER	7732-18-5	231-791-2	Remainder

4. FIRST AID MEASURES

4.1 Description of first aid measures

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. To protect rescuer, use a Full-face Type B (Inorganic and acid gas) respirator or an Air-line respirator (in poorly ventilated areas). Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting.

First aid facilities Eye wash facilities and safety shower should be available.

4.2 Most important symptoms and effects, both acute and delayed

Over exposure may result in severe skin, eye and respiratory burns with permanent lung and tissue damage. Strong inorganic acid mists containing sulphuric acid is classified as carcinogenic to humans (IARC Group 1).

4.3 Immediate medical attention and special treatment needed

CORROSIVE POISONING TREATMENT: Immediate treatment preferably in a hospital is mandatory. In treating corrosive poisoning, DO NOT INDUCE VOMITING; DO NOT ATTEMPT GASTRIC LAVAGE; and DO NOT ATTEMPT TO NEUTRALISE THE CORROSIVE SUBSTANCE. Vomiting will increase the severity of damage to the oesophagus as the corrosive substance will again come in contact with it. Attempting gastric lavage may result in perforating either the oesophagus or stomach. Immediately dilute the corrosive substance by having the patient drink milk or water. If the trachea has been damaged tracheostamy may be required. For oesophageal burns begin broad-spectrum antibiotics and corticosteroid therapy. Intravenous fluids will be required if oesophageal or gastric damage prevents ingestion of liquids. Long-range therapy will be directed toward preventing or treating oesophageal scars and strictures.

5. FIRE FIGHTING MEASURES

5.1 Extinguishing media

Use an extinguishing agent suitable for the surrounding fire.

5.2 Special hazards arising from the substance or mixture

Non flammable. May evolve toxic gases (sulphur oxides) when heated to decomposition. May evolve flammable hydrogen gas in contact with some metals.

5.3 Advice for firefighters

Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

5.4 Hazchem code

2R

2 Water Fog (or fine water spray if fog unavailable)

R Full protective equipment including Self Contained Breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures

Wear Personal Protective Equipment (PPE) as detailed in section 8 of the SDS. Clear area of all unprotected personnel. Ventilate area where possible. Contact emergency services where appropriate.

6.2 Environmental precautions

Prevent product from entering drains and waterways.

6.3 Methods of cleaning up

Contain spillage, then cover / absorb spill with sodium bicarbonate or 50-50 mixture of sodium carbonate and calcium hydroxide. Collect for complete neutralisation and appropriate disposal.

6.4 Reference to other sections

See Sections 8 and 13 for exposure controls and disposal.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

7.2 Conditions for safe storage, including any incompatibilities

Store in a secured, cool, dry, well ventilated area, removed from incompatible substances, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled and protected from physical damage when not in use. Check regularly for leaks or spills. Large storage areas should have appropriate ventilation and fire protection systems.

7.3 Specific end use(s)

No information provided.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8.1 Control parameters

Exposure standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
Sulphuric acid	SWA (AUS)	--	1	--	3

Biological limits

No biological limit values have been entered for this product.

8.2 Exposure controls

Engineering controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face Wear splash-proof goggles.

Hands Wear PVC or rubber gloves.

Body Wear coveralls. When using large quantities or where heavy contamination is likely, wear rubber boots and a PVC apron. In a laboratory situation, wear a laboratory coat.

Respiratory Where an inhalation risk exists, wear a Type B (Inorganic gases and vapours) respirator. If spraying, with prolonged use, or if in confined areas, wear an Air-line respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

Appearance	COLOURLESS LIQUID
Odour	CHARACTERISTIC ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	110°C
Melting point	-55.3°C
Evaporation rate	NOT AVAILABLE
pH	< 1
Vapour density	NOT AVAILABLE
Specific gravity	1.139 to 1.836
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Partition coefficient	NOT AVAILABLE
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Explosive properties	NOT AVAILABLE
Oxidising properties	NOT AVAILABLE

9.2 Other information

% Volatiles	NOT AVAILABLE

10. STABILITY AND REACTIVITY

10.1 Reactivity

Carefully review all information provided in sections 10.2 to 10.6.

10.2 Chemical stability

Potential for exothermic hazard.

10.3 Possibility of hazardous reactions

Polymerization is not expected to occur.

10.4 Conditions to avoid

Avoid contact with incompatible substances.

10.5 Incompatible materials

Incompatible with oxidising agents (e.g. hypochlorites), alkalis (e.g. sodium hydroxide) and some metals.

10.6 Hazardous decomposition products

May evolve toxic gases (sulphur oxides) when heated to decomposition.

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Health hazard summary Causes severe burns. This product has the potential to cause serious adverse health effects. Use safe work practices to avoid eye or skin contact and inhalation. Over exposure may result in severe skin, eye and respiratory burns with permanent lung and tissue damage. Strong inorganic acid mists containing sulphuric acid is classified as carcinogenic to humans (IARC Group 1). Upon dilution, the potential for adverse health effects may be reduced.

Eye Causes severe burns. Contact may result in irritation, lacrimation, pain, redness and corneal burns with possible permanent eye damage.

Inhalation Causes severe burns. Over exposure may result in mucous membrane irritation of the respiratory tract, coughing, bronchitis, ulceration, bloody nose, lung tissue damage, chemical pneumonitis, pulmonary oedema and death.

Skin Causes severe burns. Contact may result in irritation, redness, pain, rash, dermatitis and severe burns.

Ingestion Causes severe burns. Ingestion may result in burns to the mouth and throat, nausea, vomiting, abdominal pain and diarrhoea. Ingestion of large quantities may result in ulceration, unconsciousness, convulsions and death.

Toxicity data

SULPHURIC ACID (7664-93-9)

LC50 (inhalation)	18 mg/m³ (guinea pig)

SULPHURIC ACID (7664-93-9)

LD50 (ingestion)	2140 mg/kg (rat)
TCLo (inhalation)	3 mg/m³/24 weeks (human)

12. ECOLOGICAL INFORMATION

12.1 Toxicity

The manufacturer reports the following aquatic toxicity data: LC50 (Flounder) = 330 mg/L/48 hours; LC50 (Shrimp) = 80 to 90 mg/L/48 hours; LC50 (Prawn) = 42.5 ppm/48 hours. Sulphuric acid is harmful to aquatic life in very low concentrations.

12.2 Persistence and degradability

No information provided.

12.3 Bioaccumulative potential

No information provided.

12.4 Mobility in soil

Sulphuric acid is miscible with water and its dilution will increase the velocity of downward movement in the soil where it may dissolve the soil material.

12.5 Other adverse effects

No information provided.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Waste disposal Wearing the protective equipment detailed above, neutralise to pH 6-8 by SLOW addition to a saturated sodium bicarbonate solution or similar basic solution. Dilute with excess water and flush to drain. Waste disposal should only be undertaken in a well ventilated area.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE



	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
14.1 UN Number	2796	2796	2796
14.2 Proper Shipping Name	SULFURIC ACID with not more than 51% acid or BATTERY FLUID, ACID	SULFURIC ACID with not more than 51% acid or BATTERY FLUID, ACID	SULFURIC ACID with not more than 51% acid or BATTERY FLUID, ACID
14.3 Transport hazard class	8	8	8
14.4 Packing Group	II	II	II

14.5 Environmental hazards No information provided

14.6 Special precautions for user

Hazchem code	2R
GTEPG	8A2
EMS	F-A, S-B

15. REGULATORY INFORMATION

15.1 Safety, health and environmental regulations/legislation specific for the substance or mixture

Poison schedule	Classified as a Schedule 6 (S6) Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).	
Classifications	Safework Australia criteria is based on the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals. The classifications and phrases listed below are based on the Approved Criteria for Classifying Hazardous Substances [NOHSC: 1008(2004)].	
Hazard codes	C	Corrosive
Risk phrases	R35	Causes severe burns.
Safety phrases	S1/2	Keep locked up and out of reach of children.
	S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
	S30	Never add water to this product.
	S45	In case of accident or if you feel unwell seek medical advice immediately (show the label where possible).
Inventory listing(s)	**AUSTRALIA: AICS (Australian Inventory of Chemical Substances)** All components are listed on AICS, or are exempt.	

16. OTHER INFORMATION

Additional information

ACIDS: When mixing acids with water (diluting), caution must be taken as heat will be generated which causes violent spattering. Always add a small volume of acid to a large volume of water, NEVER the reverse.

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
GHS	Globally Harmonized System
IARC	International Agency for Research on Cancer
LC50	Lethal Concentration, 50% / Median Lethal Concentration
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m³	Milligrams per Cubic Metre
OEL	Occupational Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
STEL	Short-Term Exposure Limit
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
SWA	Safe Work Australia
TLV	Threshold Limit Value
TWA	Time Weighted Average

Revision history

Revision	Description
3.0	Converted to GHS.
2.3	Standard SDS Review
2.2	Standard SDS Review.
2.1	Standard SDS Review.
2.0	Standard SDS Review.
1.0	Initial SDS creation

Report status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

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Revision: 3
SDS date: 21 November 2014

[End of SDS]

1. IDENTIFICATION

Product Name	**Sodium bisulphate**
Other Names	Sodium bisulfate; Sodium hydrogen sulfate
Uses	Chemical raw material for industrial purposes Industrial processing with a.o. use in detergents or as a pH regulator
Chemical Family	No Data Available
Chemical Formula	No Data Available
Chemical Name	Sodium bisulphate
Product Description	No Data Available

Contact Details of the Supplier of this Safety Data Sheet

Organisation	Location	Telephone
Redox Pty Ltd	2 Swettenham Road Minto NSW 2566 Australia	+61-2-97333000
Redox Pty Ltd	11 Mayo Road Wiri Auckland 2104 New Zealand	+64-9-2506222
Redox Inc.	2132A E. Dominguez Street Carson CA 90810 USA	+1-424-675-3200
Redox Chemicals Sdn Bhd	Level 2, No. 8, Jalan Sapir 33/7 Seksyen 33, Shah Alam Premier Industrial Park 40400 Shah Alam Sengalor, Malaysia	+60-3-5614-2111

Emergency Contact Details

For emergencies only; DO NOT contact these companies for general product advice.

Organisation	Location	Telephone
Poisons Information Centre	Westmead NSW	1800-251525 131126
Chemcall	Australia	1800-127406 +64-4-9179888
Chemcall	Malaysia	+64-4-9179888
Chemcall	New Zealand	0800-243622 +64-4-9179888
National Poisons Centre	New Zealand	0800-764766
CHEMTREC	USA & Canada	1-800-424-9300 CN723420 +1-703-527-3887

2. HAZARD IDENTIFICATION

Poisons Schedule (Aust) 5

Globally Harmonised System

Hazard Classification		Hazardous according to the criteria of the Globally Harmonised System of Classification and Labelling of Chemicals (GHS)	
Hazard Categories		Serious Eye Damage/Irritation - Category 1	
Pictograms			
Signal Word		Danger	
Hazard Statements		**H318**	Causes serious eye damage.
Precautionary Statements	Prevention	**P280**	Wear eye protection/face protection.
	Response	**P305 + P351 + P338**	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
		P310	Immediately call a POISON CENTER or doctor/physician.

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Environmental Protection Authority (New Zealand)
Hazardous Substances and New Organisms Amendment Act 2015

HSNO Classifications	Health Hazards	**8.3A**	Substances that are corrosive to ocular tissue

3. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients

Chemical Entity	Formula	CAS Number	Proportion
Sodium bisulphate	No Data Available	7681-38-1	93 - 100 %

4. FIRST AID MEASURES

Description of necessary measures according to routes of exposure

Swallowed	If swallowed, Do NOT induce vomiting. Drink plenty of water. Never give anything by mouth to an unconscious person. Consult a physician.
Eye	Rinse immediately and thoroughly with plenty of water for at least 15 minutes and consult a physician. Call a physician immediately.
Skin	Take off all contaminated clothing immediately. Wash off skin and hair with soap and water. If skin irritation persists, call a physician.
Inhaled	Move to fresh air. Call a physician immediately.
Advice to Doctor	Treat symptomatically. Show this safety data sheet to the doctor in attendance.
Medical Conditions Aggravated by Exposure	No information available.

5. FIRE FIGHTING MEASURES

General Measures	Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations.
Flammability Conditions	Non flammable.
Extinguishing Media	Suitable: Use dry chemical, CO2, water spray or alcohol resistant foam. Unsuitable: High volume water jet.
Fire and Explosion Hazard	The pressure in sealed containers can increase under the influence of heat. Vapours may form explosive mixture with air. Vapours are heavier than air and may spread along floors.
Hazardous Products of Combustion	Burning produces noxious and toxic fumes: SOx, NaOx.
Special Fire Fighting Instructions	In the event of fire, cool tanks with water spray.
Personal Protective Equipment	Wear self-contained breathing apparatus.
Flash Point	No Data Available
Lower Explosion Limit	No Data Available
Upper Explosion Limit	No Data Available
Auto Ignition Temperature	No Data Available
Hazchem Code	No Data Available

6. ACCIDENTAL RELEASE MEASURES

General Response Procedure	Ensure adequate ventilation. Do not breathe vapours or spray mist. Avoid contact with skin and eyes.
Clean Up Procedures	Sweep up and shovel into suitable containers for disposal. Dispose of in accordance with local regulations.
Containment	Prevent further leakage or spillage if safe to do so.
Decontamination	No information available.
Environmental Precautionary Measures	Prevent product from entering drains. Local authorities should be advised if significant spillages cannot be contained.
Evacuation Criteria	Evacuate personnel to safe areas. Keep people away from and upwind of spill/leak. Only qualified personnel equipped with suitable protective equipment may intervene.
Personal Precautionary Measures	Wear personal protective equipment. See also section 8.

7. HANDLING AND STORAGE

Handling	Use only in area provided with appropriate exhaust ventilation. Ensure that eye flushing systems and safety showers are located close to the working place. Avoid contact with skin and eyes. Avoid dust formation. Do not breathe dust. Handle in accordance with good industrial hygiene and safety practice.
Storage	Store in dry, cool, well-ventilated area. Keep containers dry and tightly closed to avoid moisture absorption and contamination. Keep away from open flames, hot surfaces and sources of ignition.
Container	Keep in original container as approved by the manufacturer.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

General	No exposure information available for this specific product. Safe Work Australia Exposure Standard for Rogue dust (inspirable dust): TWA = 10 mg/m3
Exposure Limits	No Data Available

Biological Limits	Environmental compartment: PNEC value aqua (freshwater): 11.09 mg/l aqua (marine water): 1.11 mg/l aqua (intermittent, freshwater): 17.66 mg/l sediment (marine water): 4.02 mg/kg dwt soil: 1.54 mg/kg dwt sewage treatment plant: 800 mg/l
Engineering Measures	Ensure adequate ventilation. A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area.
Personal Protection Equipment	The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace. EYE PROTECTION: Tightly fitting safety goggles. HAND PROTECTION: Rubber gloves; PVC. SKIN/BODY PROTECTION: Chemical-resistant overalls. RESPIRATORY PROTECTION: In case of insufficient ventilation wear suitable respiratory equipment. Respirator with a full face mask. Recommended Filter type: ABEK/P2. Wear self-contained breathing apparatus when entering area unless atmosphere is proven to be safe.
Special Hazards Precaustions	Do not flush into surface water or sanitary sewer system. Comply with applicable Community environmental protection legislation.
Work Hygienic Practices	When using, do not eat, drink or smoke. Wash hands before breaks and immediately after handling the product. Keep away from food, drink and animal feeding stuffs. Wash contaminated clothing before re-use. Keep working clothes separately.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State	Solid
Appearance	Crystals / granular
Odour	None
Colour	White, light yellow
pH	1.3
Vapour Pressure	No Data Available
Relative Vapour Density	No Data Available
Boiling Point	No Data Available
Melting Point	315 °C
Freezing Point	No Data Available
Solubility	ca. 1080 g/L 25°C
Specific Gravity	1.4 kg/L - 1.5 kg/L
Flash Point	No Data Available
Auto Ignition Temp	No Data Available
Evaporation Rate	No Data Available
Bulk Density	No Data Available
Corrosion Rate	No Data Available
Decomposition Temperature	460 °C
Density	No Data Available
Specific Heat	No Data Available
Molecular Weight	No Data Available
Net Propellant Weight	No Data Available
Octanol Water Coefficient	-2.2 (KOWWIN)
Particle Size	No Data Available
Partition Coefficient	No Data Available
Saturated Vapour Concentration	No Data Available
Vapour Temperature	No Data Available
Viscosity	No Data Available
Volatile Percent	No Data Available

VOC Volume	No Data Available
Additional Characteristics	Watery solution: same properties as H2SO4. Fine granules, crystals or powder. Fine substance that can cause the irritation of the airways, with coughing and the contraction of the airways. In contact with water the product forms sulphuric acid that can cause burns.
Potential for Dust Explosion	No information available.
Fast or Intensely Burning Characteristics	No information available.
Flame Propagation or Burning Rate of Solid Materials	No information available.
Non-Flammables That Could Contribute Unusual Hazards to a Fire	No information available.
Properties That May Initiate or Contribute to Fire Intensity	No information available.
Reactions That Release Gases or Vapours	Acidic aqueous solution. Gives off hydrogen by reaction with metals.
Release of Invisible Flammable Vapours and Gases	Vapours may form explosive mixture with air.

10. STABILITY AND REACTIVITY

Chemical Stability	Hygroscopic.
Conditions to Avoid	Avoid dust formation. Avoid moisture, heat. Keep away from open flames, hot surfaces and sources of ignition.
Materials to Avoid	Avoid moisture absorption and contamination.
Hazardous Decomposition Products	Gives off hydrogen by reaction with metals (acidic aqueous solution). Vapours may form explosive mixture with air.
Hazardous Polymerisation	No information available.

11. TOXICOLOGICAL INFORMATION

General Information	Inhalation: May cause irritation of respiratory tract. Inhalation may provoke the following symptoms: Shortness of breath, cough, dry/sore throat. Skin contact: May be irritating. Skin contact may provoke the following symptoms: Redness, pain, blisters. Eye contact: Causes serious eye damage. Eye contact may provoke the following symptoms: Redness, pain. Ingestion: Ingestion may cause irritation to mucous membranes. Ingestion may provoke the following symptoms: Abdominal pain, burning sensation.
Acute	
Ingestion	Acute Oral Toxicity - Rat LD50: 2,140 mg/kg sulfuric acid
Inhalation	Acute Inhalation Toxicity - Rat (4 h) LC50 >2,400 mg/m3 Sodium sulphate
SkinIrritant	Not classified (Not classified due to data which are conclusive although insufficient for classification.) pH: 1.3
EyeIrritant	Causes serious eye damage. pH: 1.3
Carcinogen Category	None

12. ECOLOGICAL INFORMATION

Ecotoxicity	Component: Sodium hydrogensulphate (7681-38-1): Toxic to aquatic organisms. LC50/96h/fish: 7960 mg/l EC50/48h/daphnia: 1766 mg/l LC50/72h/algae: 1900 mg/l
Persistence/Degradability	Hydrolysis in water.

Mobility	Highly mobile in soils.
Environmental Fate	Results of PBT and vPvB assessment: Not required (inorganic).
Bioaccumulation Potential	Low potential. Partition coefficient: n-octanol/water: -2,2 (KOWWIN)
Environmental Impact	No Data Available

13. DISPOSAL CONSIDERATIONS

General Information	Dispose of contents/container in accordance with all local, state and federal regulations.
Special Precautions for Land Fill	Collect and dispose of waste product at an authorised disposal facility. Prevent product from entering drains.

14. TRANSPORT INFORMATION

Land Transport (Australia)
ADG Code

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (Fiji)

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (Malaysia)
ADR

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (New Caledonia)

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (New Zealand)
NZS5433

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Land Transport (United States of America)
US DOT

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

Sea Transport
IMDG Code

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available
Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available
EMS	No Data Available
Marine Pollutant	No

Air Transport
IATA

Proper Shipping Name	SODIUM BISULPHATE
Class	No Data Available

Subsidiary Risk(s)	No Data Available
UN Number	No Data Available
Hazchem	No Data Available
Pack Group	No Data Available
Special Provision	No Data Available

National Transport Commission (Australia)
Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

Dangerous Goods Classification	NOT Dangerous Goods according to the criteria of the Australian Code for the Transport of Dangerous Goods by Road & Rail (ADG Code)

15. REGULATORY INFORMATION

General Information	No Data Available
Poisons Schedule (Aust)	5

Environmental Protection Authority (New Zealand)
Hazardous Substances and New Organisms Amendment Act 2015

Approval Code	HSR002503

National/Regional Inventories

Australia (AICS)	Listed
Canada (DSL)	Listed
Canada (NDSL)	Not Listed
China (IECSC)	Listed
Europe (EINECS)	231-665-7
Europe (REACh)	01-2119552465-36
Japan (ENCS/METI)	1-501
Korea (KECI)	KE-31481
Malaysia (EHS Register)	Listed
New Zealand (NZIoC)	Listed
Philippines (PICCS)	Listed
Switzerland (Giftliste 1)	Not Determined
Switzerland (Inventory of Notified Substances)	Not Determined
Taiwan (NCSR)	Listed
USA (TSCA)	Listed

16. OTHER INFORMATION

Related Product Codes	SOBISU1000, SOBISU1001, SOBISU1002, SOBISU1003, SOBISU1004, SOBISU1005, SOBISU1006, SOBISU1600, SOBISU1700, SOBISU1800, SOBISU1801, SOBISU1802, SOBISU1803, SOBISU1804, SOBISU1900, SOBISU1901, SOBISU2000, SOBISU2100, SOBISU2900, SOBISU3000, SOBISU4000, SOBISU5000, SOBISU5001, SOBISU9800, SOBISU0315, SOBISU2515, SOBISU0007, SOBISU1810, SOBISU5025
Revision	3
Revision Date	20 Jul 2015
Key/Legend	**<** Less Than **>** Greater Than **AICS** Australian Inventory of Chemical Substances **atm** Atmosphere **CAS** Chemical Abstracts Service (Registry Number) **cm²** Square Centimetres **CO2** Carbon Dioxide **COD** Chemical Oxygen Demand **deg C (°C)** Degrees Celcius **EPA (New Zealand)** Environmental Protection Authority of New Zealand **deg F (°F)** Degrees Farenheit **g** Grams **g/cm³** Grams per Cubic Centimetre **g/l** Grams per Litre **HSNO** Hazardous Substance and New Organism **IDLH** Immediately Dangerous to Life and Health **immiscible** Liquids are insoluable in each other. **inHg** Inch of Mercury **inH2O** Inch of Water **K** Kelvin **kg** Kilogram **kg/m³** Kilograms per Cubic Metre **lb** Pound **LC50** LC stands for lethal concentration. LC50 is the concentration of a material in air which causes the death of 50% (one half) of a group of test animals. The material is inhaled over a set period of time, usually 1 or 4 hours. **LD50** LD stands for Lethal Dose. LD50 is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals. **ltr** or **L** Litre **m³** Cubic Metre **mbar** Millibar **mg** Milligram **mg/24H** Milligrams per 24 Hours **mg/kg** Milligrams per Kilogram **mg/m³** Milligrams per Cubic Metre **Misc** or **Miscible** Liquids form one homogeneous liquid phase regardless of the amount of either component present. **mm** Millimetre **mmH2O** Millimetres of Water **mPa.s** Millipascals per Second **N/A** Not Applicable **NIOSH** National Institute for Occupational Safety and Health **NOHSC** National Occupational Heath and Safety Commission **OECD** Organisation for Economic Co-operation and Development **Oz** Ounce **PEL** Permissible Exposure Limit **Pa** Pascal **ppb** Parts per Billion **ppm** Parts per Million **ppm/2h** Parts per Million per 2 Hours **ppm/6h** Parts per Million per 6 Hours **psi** Pounds per Square Inch **R** Rankine **RCP** Reciprocal Calculation Procedure **STEL** Short Term Exposure Limit **TLV** Threshold Limit Value **tne** Tonne **TWA** Time Weighted Average **ug/24H** Micrograms per 24 Hours **UN** United Nations **wt** Weight

Sodium Hydroxide Solution

Hazard Alert Code: EXTREME

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME
Sodium Hydroxide Solution

PROPER SHIPPING NAME
SODIUM HYDROXIDE SOLUTION

PRODUCT USE
Used according to manufacturer's directions.
Specialty chemical used in industry for surface finishing as per Technical Data Sheet.

SUPPLIER
Company: Elite Surface Technologies Pty Limited
Address:
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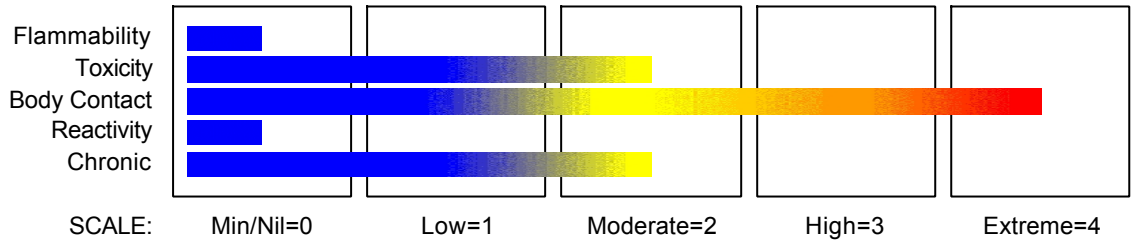
Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS



GHS Classification
Metal Corrosion Category 1
Serious Eye Damage Category 1
Skin Corrosion/Irritation Category 1B

continued...



EMERGENCY OVERVIEW

HAZARD
DANGER

Determined by Chemwatch using GHS criteria

H290	May be corrosive to metals.
H314	Causes severe skin burns and eye damage.

PRECAUTIONARY STATEMENTS

Prevention

Code	Phrase
P234	Keep only in original container.
P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P264	W□□□ □□□d□ □□d □□□□□□d □r□□□ □□□r□ug□□□ □□□r □□□d□□g□
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Response

Code	Phrase
P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304+P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305+P351+P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/physician.
P363	Wash contaminated clothing before reuse.
P390	Absorb spillage to prevent material damage.

Storage

Code	Phrase
P405	Store locked up.
P406	Store in corrosive resistant container or with a resistant inner liner.

Disposal

Code	Phrase
P501	D□□□□□□ □□□□□□□□□□□□□□□□□□□□r □□ □□ □□□r□□□d □□□□ □□□□r□□□□ □□□ □□□□□□□□

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Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
sodium hydroxide	1310-73-2	25-60

Section 4 - FIRST AID MEASURES

SWALLOWED
- For advice, contact a Poisons Information Centre or a doctor at once.
- Urgent hospital treatment is likely to be needed.
- 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 airway and prevent aspiration.

EYE
■ If this product comes in contact with the eyes:
- Immediately hold eyelids apart and flush the eye continuously with running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting

continued...

the upper and lower lids.
• Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes.
• Transport to hospital or doctor without delay.

SKIN
■ If skin or hair contact occurs:
• Immediately flush body and clothes with large amounts of water, using safety shower if available.
• Quickly remove all contaminated clothing, including footwear.
• Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre.
• Transport to hospital, or doctor.

INHALED
• If fumes or combustion products are inhaled remove from contaminated area.
• Lay patient down. Keep warm and rested.
• Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures.
• Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary.
• Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema.
• Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs).
• As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested.
• Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered.

NOTES TO PHYSICIAN
For acute or short-term repeated exposures to highly alkaline materials:
• Respiratory stress is uncommon but present occasionally because of soft tissue edema.
• Unless endotracheal intubation can be accomplished under direct vision, cricothyroidotomy or tracheotomy may be necessary.
• Oxygen is given as indicated.
• The presence of shock suggests perforation and mandates an intravenous line and fluid administration.

Section 5 - FIRE FIGHTING MEASURES

EXTINGUISHING MEDIA
• Water spray or fog.
• Foam.
• Dry chemical powder.
• BCF (where regulations permit).

FIRE FIGHTING
• Alert Fire Brigade and tell them location and nature of hazard.
• Wear full body protective clothing with breathing apparatus.
• Prevent, by any means available, spillage from entering drains or water course.
• Use fire fighting procedures suitable for surrounding area.

FIRE/EXPLOSION HAZARD
• Non combustible.
• Not considered a significant fire risk, however containers may burn.
May emit corrosive fumes.

FIRE INCOMPATIBILITY
■ None known.

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS
• Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.
• Check regularly for spills and leaks.
• Clean up all spills immediately.
• Avoid breathing vapours and contact with skin and eyes.

continued...

• Control personal contact with the substance, by using protective equipment.
• Contain and absorb spill with sand, earth, inert material or vermiculite.

MAJOR SPILLS
• Clear area of personnel and move upwind.
• Alert Fire Brigade and tell them location and nature of hazard.
• Wear full body protective clothing with breathing apparatus.
• Prevent, by any means available, spillage from entering drains or water course.

Personal Protective Equipment advice is contained in Section 8 of the MSDS.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING
• Avoid all personal contact, including inhalation.
• Wear protective clothing when risk of exposure occurs.
• Use in a well-ventilated area.
• WARNING: To avoid violent reaction, ALWAYS add material to water and NEVER water to material.
• DO NOT allow clothing wet with material to stay in contact with skin.

SUITABLE CONTAINER
• DO NOT use aluminium, galvanised or tin-plated containers.
• Lined metal can, lined metal pail/ can.
• Plastic pail.
• Polyliner drum.
• Packing as recommended by manufacturer.
For low viscosity materials
• Drums and jerricans must be of the non-removable head type.
• Where a can is to be used as an inner package, the can must have a screwed enclosure. <</>.

STORAGE INCOMPATIBILITY
Sodium hydroxide/ potassium hydroxide:
• reacts with water evolving heat and corrosive fumes
• reacts violently with acids, trans-acetylene dichloride, aminotetrazole, p-bis(1,3-dibromoethyl), benzene, bromoform, halogenated compounds, nitrogen-containing compounds, organic halogens, chlorine dioxide ((explodes), chloroform, cresols, cyclopentadiene, 4-chloro-2-methylphenol, cis-dichloroethylene, 2,2-dichloro-3,3-dimethylbutane, ethylene chlorohydrin, germanium, iodine pentafluoride, maleic anhydride, p-nitrotoluene,nitrogen trichloride, o-nitrophenol, phosphonium iodide, potassium peroxodisulfate, propylene oxide, 1,2,4,5-tetrachlorobenzene (highly toxic substance is forme), 2,2,3,3-tetrafluoro-1-propanol, tetrahydrofuran, thorium dicarbide, trichloroethanol, 2,4,6-trinitrotoluene, vinyl acetate
• reacts with fluorine, nitroalkanes, (forming explosive compounds)
• incompatible with acetic acid, acetaldehyde, acetic anhydride, acrolein, acrylonitrile, allyl chloride, organic anhydride, acrylates, alcohols, aldehydes, alkylene oxides, substituted allyls, ammonium chloroplatinate, benzanthrone, bromine, benzene-1,4-diol, carbon dioxide, cellulose nitrate, chlorine trifluoride, 4-chlorobutyronitrile, chlorohydrin, chloronitrotoluenes, chlorosulfonic acid, cinnamaldehyde, caprolactam solution, chlorocresols, 1,2-dichloroethylene, epichlorohydrin, ethylene cyanohydrin, formaldehyde (forms formic acid and flammable hydrogen gas), glycols, glyoxal, hexachloroplatinate, hydrogen sulfide, hydroquinone, iron-silicon, isocyanates, ketones, methyl azide, 4-methyl-2-nitrophenol, mineral acids (forming corresponding salt),nitrobenzene, N-nitrosohydroxylamine, nitrates pentol, phenols, phosphorus, phosphorus pentaoxide, beta-propiolactone, sodium, sulfur dioxide, tetrahydroborate, 1,1,1,2-tetrachloroethane, 2,2,2-trichloroethanol, trichloronitromethane, zirconium.
• In presence of moisture, the material is corrosive to aluminium, zinc and tin producing highly flammable hydrogen gas.
• Avoid strong acids, acid chlorides, acid anhydrides and chloroformates.
• Avoid contact with copper, aluminium and their alloys.

STORAGE REQUIREMENTS
• Store in original containers.
• Keep containers securely sealed.
• Store in a cool, dry, well-ventilated area.
• Store away from incompatible materials and foodstuff containers.
• DO NOT store near acids, or oxidising agents.
• No smoking, naked lights, heat or ignition sources.

continued...

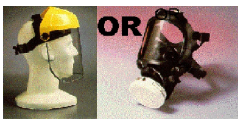
Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS
The following materials had no OELs on our records
• sodium hydroxide: CAS:1310- 73- 2 CAS:12200- 64- 5

MATERIAL DATA
SODIUM HYDROXIDE SOLUTION:
SODIUM HYDROXIDE:
for sodium hydroxide:
The TLV-C is recommended based on concentrations that produce noticeable but not excessive, ocular and upper respiratory tract irritation.

PERSONAL PROTECTION



EYE
• Safety glasses with unperforated side shields may be used where continuous eye protection is desirable, as in laboratories; spectacles are not sufficient where complete eye protection is needed such as when handling bulk-quantities, where there is a danger of splashing, or if the material may be under pressure
• Chemical goggles.whenever there is a danger of the material coming in contact with the eyes; goggles must be properly fitted
• Full face shield (20 cm, 8 in minimum) may be required for supplementary but never for primary protection of eyes; these afford face protection.
• Alternatively a gas mask may replace splash goggles and face shields.

HANDS/FEET
• Elbow length PVC gloves.
• When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.
The selection of the suitable gloves does not only depend on the material, but also on further marks of quality which vary from manufacturer to manufacturer. Where the chemical is a preparation of several substances, the resistance of the glove material can not be calculated in advance and has therefore to be checked prior to the application.
The exact break through time for substances has to be obtained from the manufacturer of the protective gloves and has to be observed when making a final choice.
Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include:

OTHER
• Overalls.
• PVC Apron.
• PVC protective suit may be required if exposure severe.
• Eyewash unit.

ENGINEERING CONTROLS
■ Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
The basic types of engineering controls are:
Process controls which involve changing the way a job activity or process is done to reduce the risk.
Enclosure and/or isolation of emission source which keeps a selected hazard "physically" away from the worker and ventilation that strategically "adds" and "removes" air in the work environment.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE
An off white liquid with an acrid odour.

continued...

PHYSICAL PROPERTIES
Liquid.
Mixes with water.
Corrosive.
Alkaline.

State	Liquid	Molecular Weight	
Melting Range (℃)		Viscosity	Not available
Boiling Range (℃)		Solubility in water (g/L)	Miscible
Flash Point (℃)		pH (1% solution)	
Decomposition Temp (℃)	Not available	pH (as supplied)	2□□ □□□□□□u□□□□□ □13□□
Autoignition Temp (℃)		Vapour Pressure (kPa)	
Upper Explosive Limit (%)		Specific Gravity (water=1)	1□□□
Lower Explosive Limit (%)		Relative Vapour Density (air=1)	
Volatile Component (%vol)		Evaporation Rate	

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY
• Presence of incompatible materials.
• Product is considered stable.
• Hazardous polymerisation will not occur.
For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED
■ Ingestion of alkaline corrosives may produce burns around the mouth, ulcerations and swellings of the mucous membranes, profuse saliva production, with an inability to speak or swallow. Both the oesophagus and stomach may experience burning pain; vomiting and diarrhoea may follow. Epiglottal swelling may result in respiratory distress and asphyxia; shock can occur. Narrowing of the oesophagus, stomach or stomach valve may occur immediately or after a long delay (weeks to years). Severe exposure can perforate the oesophagus or stomach leading to infections of the chest or abdominal cavity, with low chest pain, abdominal stiffness and fever. All of the above can cause death.
■ Ingestion of sodium hydroxide may result in severe pain, burns to the mouth, throat, stomach, nausea and vomiting, swelling of the throat and subsequent perforation of the gastro-intestinal tract and suffocation but a 1% solution (pH 13.4) of sodium hydroxide in water failed to cause any damage of the stomach or gullet in rabbits.
■ The material has NOT been classified by EC Directives or other classification systems as "harmful by ingestion". This is because of the lack of corroborating animal or human evidence. The material may still be damaging to the health of the individual, following ingestion, especially where pre-existing organ (eg. liver, kidney) damage is evident. Present definitions of harmful or toxic substances are generally based on doses producing mortality rather than those producing morbidity (disease, ill-health). Gastrointestinal tract discomfort may produce nausea and vomiting. In an occupational setting however, ingestion of insignificant quantities is not thought to be cause for concern.

EYE
■ If applied to the eyes, this material causes severe eye damage.
■ Direct eye contact with corrosive bases can cause pain and burns. There may be swelling, epithelium destruction, clouding of the cornea and inflammation of the iris. Mild cases often resolve; severe cases can be prolonged with complications such as persistent swelling, scarring, permanent cloudiness, bulging of the eye, cataracts, eyelids glued to the eyeball and blindness.

SKIN
■ The material can produce severe chemical burns following direct contactwith the skin.
■ Skin contact is not thought to have harmful health effects (as classified under EC Directives); the material may still produce health damage following entry through wounds, lesions or abrasions.
■ Sodium hydroxide causes burns which may take time to manifest and cause pain, thus care should be taken to avoid contamination of gloves and boots.
A 5% aqueous solution of it produces tissue death on rabbit skin while 1% solution caused no effect on irrigated rabbit eye.

continued...

■ Skin contact with alkaline corrosives may produce severe pain and burns; brownish stains may develop. The corroded area may be soft, gelatinous and necrotic; tissue destruction may be deep.
■ Open cuts, abraded or irritated skin should not be exposed to this material.
■ Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects. Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.
■ The material may cause severe inflammation of the skin either following direct contact or after a delay of some time. Repeated exposure can cause contact dermatitis which is characterised by redness, swelling and blistering.

INHALED
■ The material can cause respiratory irritation in some persons. The body's response to such irritation can cause further lung damage.
■ Inhaling corrosive bases may irritate the respiratory tract. Symptoms include cough, choking, pain and damage to the mucous membrane. In severe cases, lung swelling may develop, sometimes after a delay of hours to days. There may be low blood pressure, a weak and rapid pulse, and crackling sounds.
■ Sudden inhalation of sodium hydroxide dust may produce fatal outcome such as spasm, inflammation of the throat and airway, burns, severe lung inflammation and fluid accumulated in the lungs These manifest as coughing, wheezing, shortness of breath, headache, nausea and vomiting.
■ The material has NOT been classified by EC Directives or other classification systems as "harmful by inhalation". This is because of the lack of corroborating animal or human evidence. In the absence of such evidence, care should be taken nevertheless to ensure exposure is kept to a minimum and that suitable control measures be used, in an occupational setting to control vapours, fumes and aerosols.

CHRONIC HEALTH EFFECTS
Repeated or prolonged exposure to corrosives may result in the erosion of teeth, inflammatory and ulcerative changes in the mouth and necrosis (rarely) of the jaw. Bronchial irritation, with cough, and frequent attacks of bronchial pneumonia may ensue. Gastrointestinal disturbances may also occur. Chronic exposures may result in dermatitis and/or conjunctivitis.
Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.
Substance accumulation, in the human body, may occur and may cause some concern following repeated or long-term occupational exposure.

TOXICITY AND IRRITATION
~OTHER
■ Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound.
The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.
The material may cause severe skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin. Repeated exposures may produce severe ulceration.

SKIN

sodium hydroxide	GESAMP/EHS Composite List - GESAMP Hazard Profiles	D1: skin irritation/corrosion	(3)
sodium hydroxide	GESAMP/EHS Composite List - GESAMP Hazard Profiles	D1: skin irritation/corrosion	3C

Section 12 - ECOLOGICAL INFORMATION

This material and its container must be disposed of as hazardous waste.

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
sodium hydroxide	LOW	No Data Available	LOW	HIGH

continued...

Section 13 - DISPOSAL CONSIDERATIONS

■ Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area.
A Hierarchy of Controls seems to be common - the user should investigate:
• Reduction.
• DO NOT allow wash water from cleaning or process equipment to enter drains.
• It may be necessary to collect all wash water for treatment before disposal.
• In all cases disposal to sewer may be subject to local laws and regulations and these should be considered first.
• Where in doubt contact the responsible authority.
• Recycle wherever possible.
• Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.
• Treat and neutralise at an approved treatment plant.
• Treatment should involve: Neutralisation with suitable dilute acid followed by: burial in a land-fill specifically licenced to accept chemical and / or pharmaceutical wastes or Incineration in a licenced apparatus (after admixture with suitable combustible material).

Section 14 - TRANSPORTATION INFORMATION



Labels Required: CORROSIVE

HAZCHEM:
2R

Land Transport UNDG:

Class or division:	8	Subsidiary risk:	None
UN No.:	1824	UN packing group:	II

Shipping Name:SODIUM HYDROXIDE SOLUTION

Air Transport IATA:

ICAO/IATA Class:	8	ICAO/IATA Subrisk:	None
UN/ID Number:	1824	Packing Group:	II
Special provisions:	A3A803		
Cargo Only			
Packing Instructions:	855	Maximum Qty/Pack:	30 L
Passenger and Cargo		Passenger and Cargo	
Packing Instructions:	851	Maximum Qty/Pack:	1 L
Passenger and Cargo Limited Quantity		Passenger and Cargo Limited Quantity	
Packing Instructions:	Y840	Maximum Qty/Pack:	0.5 L

Shipping name:SODIUM HYDROXIDE SOLUTION

Maritime Transport IMDG:

IMDG Class:	8	IMDG Subrisk:	None
UN Number:	1824	Packing Group:	II
EMS Number:	F-A,S-B	Special provisions:	None
Limited Quantities:	1 L		

Shipping name:SODIUM HYDROXIDE SOLUTION

Section 15 - REGULATORY INFORMATION

REGULATIONS

continued...

Regulations for ingredients

sodium hydroxide (CAS: 1310-73-2, 12200-64-5) is found on the following regulatory lists;
"CODEX General Standard for Food Additives (GSFA) - Additives Permitted for Use in Food in General, Unless Otherwise Specified, in Accordance with GMP", "GESAMP/EHS Composite List - GESAMP Hazard Profiles", "IMO IBC Code Chapter 17: Summary of minimum requirements", "International Council of Chemical Associations (ICCA) - High Production Volume List", "International Fragrance Association (IFRA) Survey: Transparency List", "OECD List of High Production Volume (HPV) Chemicals", "United Nations Consolidated List of Products Whose Consumption and/or Sale Have Been Banned, Withdrawn, Severely Restricted or Not Approved by Governments"

No data for Sodium Hydroxide Solution (CW: 9-40141)

Section 16 - OTHER INFORMATION

INGREDIENTS WITH MULTIPLE CAS NUMBERS

Ingredient Name	CAS
sodium hydroxide	1310-73-2, 12200-64-5

■ Classification of the preparation and its individual components has drawn on official and authoritative sources using available literature references.

■ The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

Issue Date: 30-Aug-2016
Print Date: 30-Aug-2016

CoogeeChemicals

Elite Chemicals

SAFETY DATA SHEET

Product Name **SODIUM HYPOCHLORITE 13%**

1. IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Supplier Name	**COOGEE CHEMICALS**
Address	Cnr of Patterson and Kwinana Beach Roads, Kwinana, WA, AUSTRALIA, 6167
Telephone	(08) 9439 8200
Fax	(08) 9439 8300
Emergency	1800 800 655
Email	businessrelations@coogee.com.au
Web Site	www.coogee.com.au
Synonym(s)	SODIUM HYPOCHLORITE SOLUTION
Use(s)	DISINFECTANT · PROCESS CHEMICAL
SDS Date	23 November 2012

2. HAZARDS IDENTIFICATION

CLASSIFIED AS HAZARDOUS ACCORDING TO SAFE WORK AUSTRALIA CRITERIA

RISK PHRASES

R31	Contact with acids liberates toxic gas.
R34	Causes burns.

SAFETY PHRASES

S1/2	Keep locked up and out of reach of children.
S26	In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
S28	After contact with skin, wash immediately with plenty of water.
S37/39	Wear suitable gloves and eye/face protection.
S45	In case of accident or if you feel unwell seek medical advice immediately (show the label where possible).
S50	Do not mix with incompatible materials.

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE

UN Number	1791	**DG Class**	8
Packing Group	III	**Subsidiary Risk(s)**	None Allocated
Hazchem Code	2X		

3. COMPOSITION/ INFORMATION ON INGREDIENTS

Ingredient	Identification	Classification	Content
SODIUM HYPOCHLORITE	CAS: 7681-52-9 EC: 231-668-3	T;R31 C;R34 N;R50	10 - 30%
SODIUM HYDROXIDE	CAS: 1310-73-2 EC: 215-185-5	C;R35	<1%
NON HAZARDOUS INGREDIENTS	Not Available	Not Available	Remainder

4. FIRST AID MEASURES

Eye If in eyes, hold eyelids apart and flush continuously with running water. Continue flushing until advised to stop by a Poisons Information Centre, a doctor, or for at least 15 minutes.

Inhalation If inhaled, remove from contaminated area. Apply artificial respiration if not breathing.

Skin If skin or hair contact occurs, remove contaminated clothing and flush skin and hair with running water. Continue flushing with water until advised to stop by a Poisons Information Centre or a doctor.

Ingestion For advice, contact a Poison Information Centre on 13 11 26 (Australia Wide) or a doctor (at once). If swallowed, do not induce vomiting. Rinse mouth out with water and give plenty of water to drink.

Advice to Doctor Treat symptomatically.

First Aid Facilities Eye wash facilities and safety shower should be available.

5. FIRE FIGHTING MEASURES

Flammability Non flammable. May evolve toxic gases (chlorine) when heated to decomposition.

Fire and Explosion Evacuate area and contact emergency services. Toxic gases may be evolved in a fire situation. Remain upwind and notify those downwind of hazard. Wear full protective equipment including Self Contained Breathing Apparatus (SCBA) when combating fire. Use waterfog to cool intact containers and nearby storage areas.

Extinguishing Use an extinguishing agent suitable for the surrounding fire.

Hazchem Code 2X

2 Water Fog (or fine water spray if fog unavailable)

X Full protective clothing including Self Contained Breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

Spillage Contact emergency services where appropriate. Use personal protective equipment. Clear area of all unprotected personnel. Ventilate area where possible. Contain spillage, then cover / absorb spill with non-combustible absorbent material (vermiculite, sand, or similar), collect and place in suitable containers for disposal.

7. STORAGE AND HANDLING

Storage Store in a cool, dry, well ventilated area, removed from acids, reducing agents, organic materials, active metals, heat or ignition sources and foodstuffs. Ensure containers are adequately labelled, protected from physical damage, sealed when not in use, vented and stored upright. Check regularly for leaks or spills. Large storage areas should have appropriate ventilation systems.

Handling Before use carefully read the product label. Use of safe work practices are recommended to avoid eye or skin contact and inhalation. Observe good personal hygiene, including washing hands before eating. Prohibit eating, drinking and smoking in contaminated areas.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards

Ingredient	Reference	TWA		STEL	
		ppm	mg/m³	ppm	mg/m³
SODIUM HYPOCHLORITE	SWA (AUS)	1	3	--	--
Sodium hydroxide (peak limitation)	SWA (AUS)	--	2	--	--

Biological Limits No biological limit allocated.

Engineering Controls Avoid inhalation. Use in well ventilated areas. Where an inhalation risk exists, mechanical extraction ventilation is recommended. Maintain vapour levels below the recommended exposure standard.

PPE

Eye / Face	Wear splash-proof goggles.
Hands	Wear PVC or rubber gloves.
Body	Wear coveralls. When using large quantities or where heavy contamination is likely, wear rubber boots and a PVC apron.
Respiratory	Where an inhalation risk exists, wear a Type B (Inorganic gases and vapours) respirator.



9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	CLEAR PALE YELLOW LIQUID
Odour	CHARACTERISTIC ODOUR
Flammability	NON FLAMMABLE
Flash point	NOT RELEVANT
Boiling point	100°C (Approximately)
Melting point	NOT AVAILABLE
Evaporation rate	NOT AVAILABLE
pH	12.5 to 13.5
Vapour density	NOT AVAILABLE
Specific gravity	1.17 to 1.20
Solubility (water)	SOLUBLE
Vapour pressure	NOT AVAILABLE
Upper explosion limit	NOT RELEVANT
Lower explosion limit	NOT RELEVANT
Autoignition temperature	NOT AVAILABLE
Decomposition temperature	NOT AVAILABLE
Viscosity	NOT AVAILABLE
Partition coefficient	NOT AVAILABLE

10. STABILITY AND REACTIVITY

Chemical Stability	Stable under recommended conditions of storage.
Conditions to Avoid	Avoid heat, sparks, open flames and other ignition sources.
Material to Avoid	Incompatible with reducing agents (eg. amines), organic materials, some metals. Do not mix with any other chemicals.
Hazardous Decomposition Products	May evolve chlorine gas when heated to decomposition.
Hazardous Reactions	Polymerization is not expected to occur.

11. TOXICOLOGICAL INFORMATION

Health Hazard Summary	Corrosive. This product has the potential to cause adverse health effects. Use safe work practices to avoid eye or skin contact and inhalation. Over exposure to chlorine vapour may result in lung tissue damage. Do not mix with other chemicals unless advised and specific instructions provided, as toxic and irritating gases may be evolved. Use safe work practices to avoid over exposure. Upon dilution, the potential for corrosive effects may be reduced.
Eye	Corrosive - irritant. Contact may result in irritation, lacrimation, pain, redness, corneal burns and possible permanent damage.
Inhalation	Slightly corrosive - irritant. Over exposure may result in irritation of the nose and throat, coughing, nausea and headache.
Skin	Corrosive - severe irritant. Contact may result in irritation, redness, pain, rash, dermatitis and possible burns.
Ingestion	Corrosive. Ingestion may result in ulceration and burns to the mouth and throat, nausea, vomiting,

abdominal pain and diarrhoea.

Toxicity Data

SODIUM HYPOCHLORITE (7681-52-9)

LD50 (ingestion)	5800 mg/kg (mouse)
TDLo (ingestion)	1 gm/kg (woman)
TDLo (intravenous)	45 mg/kg (man)

SODIUM HYDROXIDE (1310-73-2)

LD50 (intraperitoneal)	40 mg/kg (mouse)
LDLo (ingestion)	500 mg/kg (rabbit)

12. ECOLOGICAL INFORMATION

Environment Limited ecotoxicity data was available for this product at the time this report was prepared. Ensure appropriate measures are taken to prevent this product from entering the environment.

Ecotoxicity Hypochlorites are extremely toxic to fish; Exposure to 0.5 % over 96 hours resulted in death of trout.

Persistence/Degradability Hypochlorites are non-persistent in the environment and there is no accumulation potential as they gradually decompose into a salt and oxygen.

Mobility May leach to groundwater with resultant toxicity to aquatic organisms.

13. DISPOSAL CONSIDERATIONS

Waste Disposal For small amounts absorb with sand, vermiculite or similar and dispose of to an approved landfill site. Contact the manufacturer for additional information if larger amounts are involved. Prevent contamination of drains and waterways as aquatic life may be threatened and environmental damage may result.

Legislation Dispose of in accordance with relevant local legislation.

14. TRANSPORT INFORMATION

CLASSIFIED AS A DANGEROUS GOOD BY THE CRITERIA OF THE ADG CODE



	LAND TRANSPORT (ADG)	SEA TRANSPORT (IMDG / IMO)	AIR TRANSPORT (IATA / ICAO)
UN Number	1791	1791	1791
Proper Shipping Name		HYPOCHLORITE SOLUTION	
DG Class/ Division	8	8	8
Subsidiary Risk(s)	None Allocated	None Allocated	None Allocated
Packing Group	III	III	III
GTEPG	8A1		
Specific EPG	8.0.004		
Hazchem Code	2X		
EMS		F-A, S-B	

15. REGULATORY INFORMATION

Poison Schedule Classified as a Schedule 6 (S6) Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP).

Inventory Listing(s) **AUSTRALIA: AICS (Australian Inventory of Chemical Substances)**
All components are listed on AICS, or are exempt.

16. OTHER INFORMATION

Additional Information

RESPIRATORS: In general the use of respirators should be limited and engineering controls employed to avoid exposure. If respiratory equipment must be worn ensure correct respirator selection and training is undertaken. Remember that some respirators may be extremely uncomfortable when used for long periods. The use of air powered or air supplied respirators should be considered where prolonged or repeated use is necessary.

EXPOSURE STANDARDS - TIME WEIGHTED AVERAGE (TWA) or WES (WORKPLACE EXPOSURE STANDARD) (NZ): Exposure standards are established on the premise of an 8 hour work period of normal intensity, under normal climatic conditions and where a 16 hour break between shifts exists to enable the body to eliminate absorbed contaminants. In the following circumstances, exposure standards must be reduced: strenuous work conditions; hot, humid climates; high altitude conditions; extended shifts (which increase the exposure period and shorten the period of recuperation).

PERSONAL PROTECTIVE EQUIPMENT GUIDELINES:
The recommendation for protective equipment contained within this ChemAlert report is provided as a guide only. Factors such as method of application, working environment, quantity used, product concentration and the availability of engineering controls should be considered before final selection of personal protective equipment is made.

HEALTH EFFECTS FROM EXPOSURE:
It should be noted that the effects from exposure to this product will depend on several factors including: frequency and duration of use; quantity used; effectiveness of control measures; protective equipment used and method of application. Given that it is impractical to prepare a ChemAlert report which would encompass all possible scenarios, it is anticipated that users will assess the risks and apply control methods where appropriate.

Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
CAS #	Chemical Abstract Service number - used to uniquely identify chemical compounds
CNS	Central Nervous System
EC No.	EC No - European Community Number
GHS	Globally Harmonized System
IARC	International Agency for Research on Cancer
LD50	Lethal Dose, 50% / Median Lethal Dose
mg/m^3	Milligrams per Cubic Metre
PEL	Permissible Exposure Limit
pH	relates to hydrogen ion concentration using a scale of 0 (high acidic) to 14 (highly alkaline).
ppm	Parts Per Million
REACH	Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
STOT-RE	Specific target organ toxicity (repeated exposure)
STOT-SE	Specific target organ toxicity (single exposure)
SUSMP	Standard for the Uniform Scheduling of Medicines and Poisons
TLV	Threshold Limit Value
TWA/OEL	Time Weighted Average or Occupational Exposure Limit

Revision History

Revision	Description
1.0	Initial SDS Creation

Report Status

This document has been compiled by RMT on behalf of the manufacturer, importer or supplier of the product and serves as their Safety Data Sheet ('SDS').

It is based on information concerning the product which has been provided to RMT by the manufacturer, importer or supplier or obtained from third party sources and is believed to represent the current state of knowledge as to the appropriate safety and handling precautions for the product at the time of issue. Further clarification regarding any aspect of the product should be obtained directly from the manufacturer, importer or supplier.

While RMT has taken all due care to include accurate and up-to-date information in this SDS, it does not provide any warranty as to accuracy or completeness. As far as lawfully possible, RMT accepts no liability for any loss, injury or damage (including consequential loss) which may be suffered or incurred by any person as a consequence of their reliance on the information contained in this SDS.

Product Name **SODIUM HYPOCHLORITE 13%**

Prepared By

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Revision: 1
SDS Date: 23 November 2012

End of SDS

Coogee Chemicals Sulphuric Acid

Coogee Chemicals

Chemwatch: **48-4494**
Version No: **2.1.1.1**
Safety Data Sheet according to WHS and ADG requirements

Chemwatch Hazard Alert Code: 4

Issue Date: **02/04/2015**
Print Date: **30/07/2015**
Initial Date: **Not Available**
S.GHS.AUS.EN

SECTION 1 IDENTIFICATION OF THE SUBSTANCE / MIXTURE AND OF THE COMPANY / UNDERTAKING

Product Identifier

Product name	Coogee Chemicals Sulphuric Acid
Proper shipping name	SULPHURIC ACID with more than 51% acid
Other means of identification	Not Available

Relevant identified uses of the substance or mixture and uses advised against

Relevant identified uses	Battery Acid, Explosive Manufacture, Fertilizer.

Details of the manufacturer/importer

Registered company name	Coogee Chemicals
Address	Cnr of Patterson and Kwinana Beach Roads Kwinana WA Australia
Telephone	+61 8 9439 8200
Fax	+61 8 9439 8300
Website	www.coogee.com.au
Email	businessrelations@coogee.com.au

Emergency telephone number

Association / Organisation	Coogee Chemicals
Emergency telephone numbers	1800 800 655
Other emergency telephone numbers	Not Available

SECTION 2 HAZARDS IDENTIFICATION

Classification of the substance or mixture

HAZARDOUS CHEMICAL. DANGEROUS GOODS. According to the Model WHS Regulations and the ADG Code.

CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability	0	
Toxicity	0	
Body Contact	4	
Reactivity	2	
Chronic	0	

0 = Minimum
1 = Low
2 = Moderate
3 = High
4 = Extreme

Poisons Schedule	S6
GHS Classification [1]	Metal Corrosion Category 1, Skin Corrosion/Irritation Category 1A, Serious Eye Damage Category 1
Legend:	*1. Classified by Chemwatch; 2. Classification drawn from HSIS ; 3. Classification drawn from EC Directive 1272/2008 - Annex VI*

Label elements

GHS label elements



SIGNAL WORD **DANGER**

Hazard statement(s)

H290	May be corrosive to metals
H314	Causes severe skin burns and eye damage
H318	Causes serious eye damage

Supplementary statement(s)

Continued...

Not Applicable

Precautionary statement(s) Prevention

P260	Do not breathe dust/fume/gas/mist/vapours/spray.
P280	Wear protective gloves/protective clothing/eye protection/face protection.

Precautionary statement(s) Response

P301+P330+P331	IF SWALLOWED: Rinse mouth. Do NOT induce vomiting.
P303+P361+P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.

Precautionary statement(s) Storage

P405	Store locked up.

Precautionary statement(s) Disposal

P501	Dispose of contents/container to authorised chemical landfill or if organic to high temperature incineration

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Substances

See section below for composition of Mixtures

Mixtures

CAS No	%[weight]	Name
7664-93-9	98	sulfuric acid
7732-18-5	2	water

SECTION 4 FIRST AID MEASURES

Description of first aid measures

Eye Contact	If this product comes in contact with the eyes: ▸ Immediately hold eyelids apart and flush the eye continuously with running water. ▸ Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids. ▸ Continue flushing until advised to stop by the Poisons Information Centre or a doctor, or for at least 15 minutes. ▸ Transport to hospital or doctor without delay. ▸ Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact	If skin or hair contact occurs: ▸ Immediately flush body and clothes with large amounts of water, using safety shower if available. ▸ Quickly remove all contaminated clothing, including footwear. ▸ Wash skin and hair with running water. Continue flushing with water until advised to stop by the Poisons Information Centre. ▸ Transport to hospital, or doctor.
Inhalation	▸ If fumes or combustion products are inhaled remove from contaminated area. ▸ Lay patient down. Keep warm and rested. ▸ Prostheses such as false teeth, which may block airway, should be removed, where possible, prior to initiating first aid procedures. ▸ Apply artificial respiration if not breathing, preferably with a demand valve resuscitator, bag-valve mask device, or pocket mask as trained. Perform CPR if necessary. ▸ Transport to hospital, or doctor. ▸ Inhalation of vapours or aerosols (mists, fumes) may cause lung oedema. ▸ Corrosive substances may cause lung damage (e.g. lung oedema, fluid in the lungs). ▸ As this reaction may be delayed up to 24 hours after exposure, affected individuals need complete rest (preferably in semi-recumbent posture) and must be kept under medical observation even if no symptoms are (yet) manifested. ▸ Before any such manifestation, the administration of a spray containing a dexamethasone derivative or beclomethasone derivative may be considered. **This must definitely be left to a doctor or person authorised by him/her.** (ICSC13719)
Ingestion	▸ For advice, contact a Poisons Information Centre or a doctor at once. ▸ Urgent hospital treatment is likely to be needed. ▸ 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 airway and prevent aspiration. ▸ Observe the patient carefully. ▸ Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious. ▸ Give water to rinse out mouth, then provide liquid slowly and as much as casualty can comfortably drink. ▸ Transport to hospital or doctor without delay.

Indication of any immediate medical attention and special treatment needed

For acute or short term repeated exposures to strong acids:
- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling
- Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.
- Strong acids produce a coagulation necrosis characterised by formation of a coagulum (eschar) as a result of the dessicating action of the acid on proteins in specific tissues.

INGESTION:
- Immediate dilution (milk or water) within 30 minutes post ingestion is recommended.
- **DO NOT** attempt to neutralise the acid since exothermic reaction may extend the corrosive injury.
- Be careful to avoid further vomit since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.
- Charcoal has no place in acid management.

Continued...

- Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:

- Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.
- Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:

- Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjuctival cul-de-sacs. Irrigation should last at least 20-30 minutes. **DO NOT** use neutralising agents or any other additives. Several litres of saline are required.
- Cycloplegic drops, (1% cyclopentolate for short-term use or 5% homatropine for longer term use) antibiotic drops, vasoconstrictive agents or artificial tears may be indicated dependent on the severity of the injury.
- Steroid eye drops should only be administered with the approval of a consulting ophthalmologist).

[Ellenhorn and Barceloux: Medical Toxicology]

SECTION 5 FIREFIGHTING MEASURES

Extinguishing media

	▸ Water spray or fog. ▸ Foam.

Special hazards arising from the substrate or mixture

Fire Incompatibility	None known.

Advice for firefighters

Fire Fighting	▸ Alert Fire Brigade and tell them location and nature of hazard. ▸ May be violently or explosively reactive.
Fire/Explosion Hazard	▸ Non combustible. ▸ Not considered to be a significant fire risk.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Minor Spills	▸ Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material. ▸ Check regularly for spills and leaks.
Major Spills	▸ Clear area of personnel and move upwind. ▸ Alert Fire Brigade and tell them location and nature of hazard.
	Personal Protective Equipment advice is contained in Section 8 of the MSDS.

SECTION 7 HANDLING AND STORAGE

Precautions for safe handling

Safe handling	▸ Avoid all personal contact, including inhalation. ▸ Wear protective clothing when risk of exposure occurs.
Other information	▸ Store in original containers. ▸ Keep containers securely sealed.

Conditions for safe storage, including any incompatibilities

Suitable container	▸ **DO NOT** use aluminium or galvanised containers ▸ Lined metal can, lined metal pail/ can. ▸ Plastic pail.
Storage incompatibility	▸ Reacts with mild steel, galvanised steel / zinc producing hydrogen gas which may form an explosive mixture with air. ▸ Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous



\+ X + X O +

X — Must not be stored together
0 — May be stored together with specific preventions
+ — May be stored together

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Control parameters

OCCUPATIONAL EXPOSURE LIMITS (OEL)

INGREDIENT DATA

Source	Ingredient	Material name	TWA	STEL	Peak	Notes
Australia Exposure Standards	sulfuric acid	Sulphuric acid	1 mg/m3	3 mg/m3	Not Available	Not Available

EMERGENCY LIMITS

Continued...

Ingredient	Material name	TEEL-1	TEEL-2	TEEL-3
sulfuric acid	Sulfuric acid	Not Available	Not Available	Not Available

Ingredient	Original IDLH	Revised IDLH
sulfuric acid	80 mg/m3	15 mg/m3
water	Not Available	Not Available

Exposure controls

Appropriate engineering controls	Engineering controls are used to remove a hazard or place a barrier between the worker and the hazard. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection.
Personal protection	
Eye and face protection	▸ Safety glasses with unperforated side shields may be used where continuous eye protection is desirable, as in laboratories; spectacles are not sufficient where complete eye protection is needed such as when handling bulk-quantities, where there is a danger of splashing, or if the material may be under pressure. ▸ Chemical goggles.whenever there is a danger of the material coming in contact with the eyes; goggles must be properly fitted.
Skin protection	See Hand protection below
Hands/feet protection	▸ Elbow length PVC gloves ▸ When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.
Body protection	See Other protection below
Other protection	▸ Overalls. ▸ PVC Apron.
Thermal hazards	Not Available

Recommended material(s)

GLOVE SELECTION INDEX

Glove selection is based on a modified presentation of the:
"Forsberg Clothing Performance Index".
The effect(s) of the following substance(s) are taken into account in the ***computer-generated*** selection:
Coogee Chemicals Sulphuric Acid

Material	CPI
NEOPRENE	A
BUTYL	C
NATURAL RUBBER	C
NATURAL+NEOPRENE	C
NEOPRENE/NATURAL	C
NITRILE	C
PE	C
PVA	C
PVC	C
SARANEX-23	C
VITON	C

* CPI - Chemwatch Performance Index
A: Best Selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to Dangerous Choice for other than short term immersion
NOTE: As a series of factors will influence the actual performance of the glove, a final selection must be based on detailed observation. -
* Where the glove is to be used on a short term, casual or infrequent basis, factors such as "feel" or convenience (e.g. disposability), may dictate a choice of gloves which might otherwise be unsuitable following long-term or frequent use. A qualified practitioner should be consulted.

Respiratory protection

Type E-P Filter of sufficient capacity. (AS/NZS 1716 & 1715, EN 143:2000 & 149:2001, ANSI Z88 or national equivalent)

Where the concentration of gas/particulates in the breathing zone, approaches or exceeds the "Exposure Standard" (or ES), respiratory protection is required.
Degree of protection varies with both face-piece and Class of filter; the nature of protection varies with Type of filter.

Required Minimum Protection Factor	Half-Face Respirator	Full-Face Respirator	Powered Air Respirator
up to 10 x ES	E-AUS P2	-	E-PAPR-AUS / Class 1 P2
up to 50 x ES	-	E-AUS / Class 1 P2	-
up to 100 x ES	-	E-2 P2	E-PAPR-2 P2 ^

^ - Full-face
A(All classes) = Organic vapours, B AUS or B1 = Acid gasses, B2 = Acid gas or hydrogen cyanide(HCN), B3 = Acid gas or hydrogen cyanide(HCN), E = Sulfur dioxide(SO2), G = Agricultural chemicals, K = Ammonia(NH3), Hg = Mercury, NO = Oxides of nitrogen, MB = Methyl bromide, AX = Low boiling point organic compounds(below 65 degC)

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance	Clear brown colour acidic liquid with strong odour; miscible with water.

Physical state	Liquid	**Relative density (Water = 1)**	1.8
Odour	Not Available	**Partition coefficient n-octanol / water**	Not Available
Odour threshold	Not Available	**Auto-ignition temperature (°C)**	Not Available

Continued...

pH (as supplied)	Not Available	**Decomposition temperature**	Not Available
Melting point / freezing point (°C)	10	**Viscosity (cSt)**	Not Available
Initial boiling point and boiling range (°C)	335	**Molecular weight (g/mol)**	Not Applicable
Flash point (°C)	Not Applicable	**Taste**	Not Available
Evaporation rate	Not Available	**Explosive properties**	Not Available
Flammability	Not Applicable	**Oxidising properties**	Not Available
Upper Explosive Limit (%)	Not Applicable	**Surface Tension (dyn/cm or mN/m)**	Not Available
Lower Explosive Limit (%)	Not Applicable	**Volatile Component (%vol)**	Not Available
Vapour pressure (kPa)	<0.001	**Gas group**	Not Available
Solubility in water (g/L)	Miscible	**pH as a solution (1%)**	Not Available
Vapour density (Air = 1)	Not Available	**VOC g/L**	Not Available

SECTION 10 STABILITY AND REACTIVITY

Reactivity	See section 7
Chemical stability	▸ Contact with alkaline material liberates heat
Possibility of hazardous reactions	See section 7
Conditions to avoid	See section 7
Incompatible materials	See section 7
Hazardous decomposition products	See section 5

SECTION 11 TOXICOLOGICAL INFORMATION

Information on toxicological effects

Inhaled	Corrosive acids can cause irritation of the respiratory tract, with coughing, choking and mucous membrane damage. There may be dizziness, headache, nausea and weakness.
Ingestion	Ingestion of acidic corrosives may produce burns around and in the mouth, the throat and oesophagus. Immediate pain and difficulties in swallowing and speaking may also be evident.
Skin Contact	Skin contact with acidic corrosives may result in pain and burns; these may be deep with distinct edges and may heal slowly with the formation of scar tissue. Open cuts, abraded or irritated skin should not be exposed to this material Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects.
Eye	If applied to the eyes, this material causes severe eye damage. Direct eye contact with acid corrosives may produce pain, tears, sensitivity to light and burns.
Chronic	Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and/or ulceration of mouth lining. Irritation of airways to lung, with cough, and inflammation of lung tissue often occurs.

Coogee Chemicals Sulphuric Acid	TOXICITY	IRRITATION
	Not Available	Not Available
sulfuric acid	TOXICITY	IRRITATION
	Inhalation (guinea pig) LC50: 0.018 mg/L/8H[2]	Eye (rabbit): 1.38 mg SEVERE
	Inhalation (mouse) LC50: 0.32 mg/L/2H[2]	Eye (rabbit): 5 mg/30sec SEVERE
	Inhalation (rat) LC50: 0.51 mg/L/2hE[2]	
	Oral (rat) LD50: 2140 mg/kgE[2]	
water	TOXICITY	IRRITATION
	Oral (rat) LD50: >90000 mg/kg[2]	Not Available
Legend:	*1. Value obtained from Europe ECHA Registered Substances - Acute toxicity 2.* Value obtained from manufacturer's msds. Unless otherwise specified data extracted from RTECS - Register of Toxic Effect of chemical Substances*	

SULFURIC ACID	Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS) which can occur following exposure to high levels of highly irritating compound. Occupational exposures to strong inorganic acid mists of sulfuric acid:
WATER	No significant acute toxicological data identified in literature search.

Acute Toxicity	⊘	**Carcinogenicity**	⊘
Skin Irritation/Corrosion	✔	**Reproductivity**	⊘

Continued...

Serious Eye Damage/Irritation	✔	**STOT - Single Exposure**	⊘
Respiratory or Skin sensitisation	⊘	**STOT - Repeated Exposure**	⊘
Mutagenicity	⊘	**Aspiration Hazard**	⊘

Legend: ✔ – *Data required to make classification available*
✘ – *Data available but does not fill the criteria for classification*
⊘ – *Data Not Available to make classification*

SECTION 12 ECOLOGICAL INFORMATION

Toxicity

Prevent, by any means available, spillage from entering drains or water courses.
DO NOT discharge into sewer or waterways.

Persistence and degradability

Ingredient	Persistence: Water/Soil	Persistence: Air
water	LOW	LOW

Bioaccumulative potential

Ingredient	Bioaccumulation
water	LOW (LogKOW = -1.38)

Mobility in soil

Ingredient	Mobility
water	LOW (KOC = 14.3)

SECTION 13 DISPOSAL CONSIDERATIONS

Waste treatment methods

Product / Packaging disposal	▸ Recycle wherever possible. ▸ Consult manufacturer for recycling options or consult local or regional waste management authority for disposal if no suitable treatment or disposal facility can be identified.

SECTION 14 TRANSPORT INFORMATION

Labels Required



Marine Pollutant	NO
HAZCHEM	2P

Land transport (ADG)

UN number	1830
Packing group	II
UN proper shipping name	SULPHURIC ACID with more than 51% acid
Environmental hazard	No relevant data
Transport hazard class(es)	Class: 8 Subrisk: Not Applicable
Special precautions for user	Special provisions: Not Applicable Limited quantity: 1 L

Air transport (ICAO-IATA / DGR)

UN number	1830
Packing group	II
UN proper shipping name	Sulphuric acid with more than 51% acid
Environmental hazard	No relevant data
Transport hazard class(es)	ICAO/IATA Class: 8 ICAO / IATA Subrisk: Not Applicable ERG Code: 8L

Continued...

Special precautions for user	Special provisions	Not Applicable
	Cargo Only Packing Instructions	855
	Cargo Only Maximum Qty / Pack	30 L
	Passenger and Cargo Packing Instructions	851
	Passenger and Cargo Maximum Qty / Pack	1 L
	Passenger and Cargo Limited Quantity Packing Instructions	Y840
	Passenger and Cargo Limited Maximum Qty / Pack	0.5 L

Sea transport (IMDG-Code / GGVSee)

UN number	1830	
Packing group	II	
UN proper shipping name	SULPHURIC ACID with more than 51% acid	
Environmental hazard	Not Applicable	
Transport hazard class(es)	IMDG Class	8
	IMDG Subrisk	Not Applicable
Special precautions for user	EMS Number	F-A , S-B
	Special provisions	Not Applicable
	Limited Quantities	1 L

Transport in bulk according to Annex II of MARPOL 73 / 78 and the IBC code

Source	Ingredient	Pollution Category
IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk	sulfuric acid	Y

SECTION 15 REGULATORY INFORMATION

Safety, health and environmental regulations / legislation specific for the substance or mixture

SULFURIC ACID(7664-93-9) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Exposure Standards
Australia Hazardous Substances Information System - Consolidated Lists
Australia Inventory of Chemical Substances (AICS)
International Agency for Research on Cancer (IARC) - Agents Classified by the IARC Monographs
International Air Transport Association (IATA) Dangerous Goods Regulations - Prohibited List Passenger and Cargo Aircraft

WATER(7732-18-5) IS FOUND ON THE FOLLOWING REGULATORY LISTS

Australia Inventory of Chemical Substances (AICS)

National Inventory	Status
Australia - AICS	Y
Canada - DSL	Y
Canada - NDSL	N (water; sulfuric acid)
China - IECSC	Y
Europe - EINEC / ELINCS / NLP	Y
Japan - ENCS	N (water)
Korea - KECI	Y
New Zealand - NZIoC	Y
Philippines - PICCS	Y
USA - TSCA	Y
Legend:	*Y = All ingredients are on the inventory N = Not determined or one or more ingredients are not on the inventory and are not exempt from listing(see specific ingredients in brackets)*

SECTION 16 OTHER INFORMATION

Other information

Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.
A list of reference resources used to assist the committee may be found at:
www.chemwatch.net

The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings.

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end of SDS

APPENDIX C VENDOR WMF CHEMICALS AND EPC

Commercial in Confidence

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	%	Proper Shipping Name	Supplier	Area	Transport		Onsite Storage		Operation		Annual Usage (ROP volumes based on peak rate of 10ML/d)	Purpose / Function
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration		
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite Sodium Hydroxide	7681-52-9 1310-73-2	10-30% <10%	Hypochlorite Solution	Coogee Chemicals	Reverse Osmosis Plant	10000L	12.50%	15000L	12.50%	18-35L/hour (25 AVG)	12.50%	220000L	oxidizing agent / disinfectant
Hydrex 4129 (antiscalant)	Phosphonic Acid Diethylene triamine penta (methylene phosphonic acid) pentasodiun salt 1-Hydroxyethylene (1,1 diphosphonic acid) Water	13598-36-2 22042-96-2 2809-21-4 7732-18-5	1-5% 13% 15% remainder	Hydrex 4129	Veolia Water Solutions	Reverse Osmosis Plant	1000L IBC		2 x 1000L (IBC)		6 mg/L (AVG)		21900L	antiscalant / scale inhibitor
Sodium Bisulphite	Sodium Bisulphite Water	7631-90-5 7732-18-5	30-50% 50-70%	Sodium Bisulphite	REDOX	Reverse Osmosis Plant	1000L IBC	40%	4 x 1000L (IBC)	40%	7mg/L (AVG)	40%	25550L	dechlorination
Ammonium Hydroxide 10-35%	Ammonia Water	7664-41-7 7732-18-5	10-35% 65-90%	Ammonia Aqueous Solution	REDOX	Reverse Osmosis Plant	1000L IBC	20%	2 x 1000L (IBC)	20%	2 mg/L (AVG)	20%	7300L	used to form monochloramine / disinfectant
MAK MFC1 (multi floc coagulant)	Cationic Polymer Aluminium Hydroxychloride Water	n/a 1327-41-9 7732-18-5	20-40% 40-60% 20-60%	MAK MFC1	MAK Water Industrial	Oily Water Treatment Plant	1000L IBC		2 x 1000L (IBC)		0.8mg/L (AVG)			polymer / coagulant
MAK-SU Sulphuric Acid	Sulphuric Acid	7664-93-9	34%	Sulphuric Acid	MAK Water Industrial	Oily Water Treatment Plant	1000L IBC	98%	2 x 1000L (IBC)	98%	NIL	98%	NIL	pH adjustment

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	%	Proper Shipping Name	Supplier	Area	Transport		Onsite Storage		Operation		Annual Usage (ROP volumes based on peak rate of 10ML/d)	Purpose / Function
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration		
	Water	7732-18-5	remainder											
Sodium Hydroxide 50% (Caustic Soda)	Sodium Hydroxide Water	1310-73-2 7732-18-5	25-60% remainder	Sodium Hydroxide Solution	Elite Surface Technologies Pty Ltd	Oily Water Treatment Plant	1000L IBC	50%	2 x 1000L (IBC)	50%	1.5mg/L (AVG)	50%		pH adjustment
Hydrex 4703 (citric)	Sodium Citrate Dihydrate Water	6132-04-3 7732-18-5	10% remainder	Hydrex 4703	Veolia Water Solutions	Reverse Osmosis Plant	1000L IBC		2 x 1000L (IBC)		100L per CIP		2400L (2 CIP per month)	membrane cleaning
Hydrex 4705 (alkaline CIP)	Ethylenediaminetetraacetic Acid, tetrasodium salt Potassium Hydroxide Sodium Carbonate Water	64-02-8 1310-58-3 497-19-8 7732-18-5	10-20% 1-5% 20% 65%	Hydrex 4705	Veolia Water Solutions	Reverse Osmosis Plant	1000L IBC		2 x 1000L (IBC)		100L per CIP		2400L (2 CIP per month)	membrane cleaning
Hydrex 4714 (CIP)	Hydrogen Peroxide Acetic Acid Peroxyacetic Acid Water	7722-84-1 64-19-7 79-21-0 7732-18-5	20-30% 10-20% 5-10% n/a	Hydrex 4714	Veolia Water Solutions	Reverse Osmosis Plant	1000L IBC		2 x 1000L (IBC)		NIL		NIL	membrane cleaning
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate Water	12042-91-0 7732-18-5	48-50% 50-52%	Aluminium Chlorohydrate	REDOX	Reverse Osmosis	10000L	50%	20000L	50%	13-17L/hour	50%	150000L	coagulant
Hydrex 3502 (Actiflo Polymer)	Polyacrylamide (anionic)	9003-05-8	100%	Hydrex 3502	Veolia Water Solutions	Reverse Osmosis Plant	25kg bags	100%	1000kg	100%	0.6mg/L	100%		actiflo polymer
Hydrex 6926 (Sludge Polymer)	Adipic Acid Cationic acrylamide copolymer	124-04-9 69418-26-4	1-5% 80-90%	Hydrex 6926	Veolia Water Solutions	Reverse Osmosis Plant	25kg bags	100%	1000kg	100%	2mg/L (AVG)	100%	7300L	sludge polymer

L = litres
mg/l = milligrams per litre
L/hr = litre per hour
AVG = average
mg/kg = milograms per kilogram
NA = not applicable

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	Fate	Assumed Chemical % For Transportation Release Scenario	Assumed Release Volume for Transportation Release Scenario	Transport Release Surface Water Concentration (mg/l)			Transport Release Soil Concentration (mg/kg)	Permeate Concentration
				%	L	100%	25%	5%	100%	(mg/l)
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite	7681-52-9	Converted to monochloramine and SMBS dosing prior to RO membranes	30%	10000	3000000	750000	150000	3571	NA
	Sodium Hydroxide	1310-73-2		10%	10000	1000000	250000	50000	1190	NA
Hydrex 4129 (antiscalant)	Phosphonic Acid	13598-36-2	Brine Dams >99% membrane rejection	5%	1000	50000	12500	2500	6.0	0.003
	Diethylene triamine penta (methylene phosphonic acid) pentasodiun salt	22042-96-2		13%	1000	130000	32500	6500	15	0.0078
	1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4		15%	1000	150000	37500	7500	18	0.009
	Water	7732-18-5		67%	NA	670000	NA	NA	NA	NA
Sodium Bisulphite	Sodium Bisulphite	7631-90-5	No residual	50%	1000	500000	125000	25000	60	NA
	Water	7732-18-5		50%	NA	500000	NA	NA	NA	NA
Ammonium Hydroxide 10-35%	Ammonia	7664-41-7	Unreacted / residual ammonia to Desalinated Water Balance Pond	35%	1000	350000	87500	17500	42	0.0175
	Water	7732-18-5		65%	NA	650000	NA	NA	NA	NA
MAK MFC1 (multi floc coagulant)	Cationic Polymer	n/a	Removed with oily water sludge (solid waste)	30%	1000	300000	75000	15000	36	NA
	Aluminium Hydroxychloride	1327-41-9		50%	1000	500000	125000	25000	60	NA
	Water	7732-18-5		20%	NA	200000	NA	NA	NA	NA
MAK-SU Sulphuric Acid	Sulphuric Acid	7664-93-9	Treated oily water is directed to Brine Dams	34%	1000	340000	85000	17000	40	NA

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	Fate	Assumed Chemical % For Transportation Release Scenario	Assumed Release Volume for Transportation Release Scenario	Transport Release Surface Water Concentration (mg/l)			Transport Release Soil Concentration (mg/kg)	Permeate Concentration
				%	L	100%	25%	5%	100%	(mg/l)
	Water	7732-18-5		66%	NA	660000	NA	NA	NA	NA
Sodium Hydroxide 50% (Caustic Soda)	Sodium Hydroxide	1310-73-2	Treated oily water is directed to Brine Dams	60%	1000	600000	150000	30000	71	NA
	Water	7732-18-5		40%	NA	400000	NA	NA	NA	NA
Hydrex 4703 (citric)	Sodium Citrate Dihydrate	6132-04-3	Membrane cleaning waste is directed to the Brine Dams	10%	1000	100000	25000	5000	12	NA
	Water	7732-18-5		90%	NA	900000	NA	NA	NA	NA
Hydrex 4705 (alkaline CIP)	Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	Membrane cleaning waste is directed to the Brine Dams	13%	1000	125000	31250	6250	15	NA
	Potassium Hydroxide	1310-58-3		3%	1000	25000	6250	1250	3	NA
	Sodium Carbonate	497-19-8		20%	1000	200000	50000	10000	24	NA
	Water	7732-18-5		65%	NA	650000	NA	NA	NA	NA
Hydrex 4714 (CIP)	Hydrogen Peroxide	7722-84-1	Membrane cleaning waste is directed to the Brine Dams	30%	1000	300000	75000	15000	36	NA
	Acetic Acid	64-19-7		20%	1000	200000	50000	10000	24	NA
	Peroxyacetic Acid	79-21-0		10%	1000	100000	25000	5000	12	NA
	Water	7732-18-5		40%	NA	400000	NA	NA	NA	NA
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate	12042-91-0	Removed with Actiflo sludge (solid waste)	50%	10000	5000000	1250000	250000	5952	NA
	Water	7732-18-5		50%	NA	5000000	NA	NA	NA	NA
Hydrex 3502 (Actiflo Polymer)	Polyacrylamide (anionic)	9003-05-8	Removed with Actiflo sludge (solid waste)	100%	NA	25000	6250	1250	NA	NA
Hydrex 6926 (Sludge Polymer)	Adipic Acid	124-04-9	Removed with Actiflo sludge (solid waste)	5%	NA	1250	312.5	62.5	NA	NA
	Cationic acrylamide copolymer	69418-26-4		90%	NA	22500	5625	1125	NA	NA

L = litres
mg/l = milligrams per litre
L/hr = litre per hour
AVG = average
mg/kg = milograms per kilogram
NA = not applicable

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	Permeate notes	COPC concentration in soil from release of permeate (mg/kg)	COPC concentration in soil from 20 years of irrigation mg/kg	Brine Concentration (mg/l)	Brine Notes
Sodium Hypochlorite Solution 12.5%	Sodium Hypochlorite	7681-52-9	Fully dissociates to sodium (Na) and chloride (Cl) removed by the RO system (95%) goes to brine, 5% stays within permeate. Na concentrations are diminimis (< 10 mg/l), residual Na would be less than 4 mg/l. Na and Cl residual concentrations are consistent with or less than geogenic background.	NA	NA	NA	Fully dissociates with Na removed by the RO system (95%) will go to brine. Residual Na would be less than 80 mg/l in brine, which is consistent or less than geogenic background.
	Sodium Hydroxide	1310-73-2	Fully dissociates to Na and hydroxyl ion (OH^-), with Na and OH^- removed by the RO system at 95% to the brine and 5% stays within permeate. Na concentrations are diminimis (< 10mg/l) and consistent with or less than geogenic background.	NA	NA	NA	Fully dissociates to Na and hydroxyl ion (OH-), with Na and OH- removed by the RO system at 95% to the brine dams. However, concentrations of Na consitient or less than geogenic background.
Hydrex 4129 (antiscalant)	Phosphonic Acid	13598-36-2	Membrane has 99% rejection efficiency, therefore, 0.06 mg/l of product in permeate. Dissociates to phosphonate; therefore, 0.06 mg/l of phosphonate in permeate. Only 5% of product is phosphonic acid originally; therefore, 0.06 mg/l x 0.05 = 0.003 mg/l of phosphonic acid in permeate.	0.19	0.23	0.297	Approximately 99% of product sent to brine dams through membrane rejection. Therefore, 5.94 mg/l of product in brine. Only 5% of product is phosponic acid; therefore, 5.94 mg/l x 0.05 = 0.297 mg/l of phosphonic in brine.
	Diethylene triamine penta (methylene phosphonic acid) pentasodiun salt	22042-96-2	Membrane has 99% rejection efficiency, therefore, 0.06 mg/l of product in permeate. Does not biodegrade. Comprises 13% of total product; therefore, 0.06 mg/l x 0.13 = 0.0078 mg/l in permeate.	0.50	0.59	0.7722	Approximately 99% of product sent to brine dams through membrane rejection. Therefore, 5.94 mg/l of product in brine. Chemical comprises 13% of product; therefore, 5.94 mg/l x 0.13 = 0.7722 mg/l of chemical in brine.
	1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	Membrane has 99% rejection efficiency, therefore, 0.06 mg/l of product in permeate. Does not biodegrade. Comprises 15% of total product;, therefore, 0.06 mg/l x 0.15 = 0.009 mg/l in permeate.	0.58	0.69	0.891	Approximately 99% of product sent to brine dams through membrane rejection. Therefore, 5.94 mg/l of product in brine. Chemical comprises 15% of product; therefore, 5.94 mg/l x 0.15 = 0.891 mg/l of chemical in brine.
	Water	7732-18-5		NA	NA	NA	
Sodium Bisulphite	Sodium Bisulphite	7631-90-5	Will fully to dissociate to sulphate (SO4) and Na. Rejection efficiency on Na and SO4 will be 95%. Potentially 0.1 mg/l for Na and 0.25 mg/l for SO4. Concentrations are consistent or less than geogenic background.	NA	NA	NA	Will fully to dissociate to sulphate (SO4) and Na. Rejection efficiency on Na and SO4 will be at least 95%; therefore, 7 mg/l x 50% = 3.5 mg/l total; 2:5 Na:SO4 3.5/(2 /7) mg/l Na, 5/(5/7) mg/l sulfite, 95% - potentially 0.1 mg/l for Na and 0.25 mg/l for SO4. Concentrations are consistent or less than geogenic background.
	Water	7732-18-5		NA	NA	NA	
Ammonium Hydroxide 10-35%	Ammonia	7664-41-7	Will stay as ammonia or ammonium (NH4+) and approximately 50:50. Therefore, residual ammonia = 2 mg/l * 35%*0.5 = 0.35 mg/L. At a rejection efficiency of 95%, the estimated concentration of ammonia in the permeate is 0.0175 mg/l.	1.13	1.33	NA	Not directed to brine pond
	Water	7732-18-5		NA	NA	NA	
MAK MFC1 (multi floc coagulant)	Cationic Polymer	n/a	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA	The oily water is clarified to seperate solids and oils; then run through the RO system. Estimate 5% residual in brine, the balance is sludge.
	Aluminium Hydroxychloride	1327-41-9	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA	The oily water is clarified to seperate solids and oils; then run through the RO system. Estimate 5% residual in brine, the balance is sludge. Estimate that chemical will dissociate to aluminium (Al) and Cl- at 40% Al and 55% Cl-.
	Water	7732-18-5		NA	NA	NA	
MAK-SU Sulphuric Acid	Sulphuric Acid	7664-93-9	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Additionally, this chemical dissociates completely to hydrogen and sulfate. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA	No more than 80mg/l in Brine

Table C-1
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)
Santos GLNG Gas Field Development Project

Product Name	Chemical Name	CAS Number	Permeate notes	COPC concentration in soil from release of permeate (mg/kg)	COPC concentration in soil from 20 years of irrigation mg/kg	Brine Concentration (mg/l)	Brine Notes
	Water	7732-18-5		NA	NA	NA	
Sodium Hydroxide 50% (Caustic Soda)	Sodium Hydroxide	1310-73-2	Oily water is clarified to remove solids and oils then run through the RO system. The amount relative to flux of RO system is <1%. Therefore, the net on permeate quality is deminimis. Additionally this chemical fully dissociates to Na and OH-. Therefore, no concentration of chemical in this product in the permeate.	NA	NA	NA	Fully dissociates to Na and hydroxyl ion (OH-), with Na and OH- removed by the RO system at 95% to the brine dams. However, concentrations of Na consitient or less than geogenic background.
	Water	7732-18-5		NA	NA	NA	
Hydrex 4703 (citric)	Sodium Citrate Dihydrate	6132-04-3	This product is not directed to the permeate stream.	NA	NA		assume 2xmonth 20 ML/day; 20 ML/day x 60days x 7% (vol of water o brine pond); 50 ML of brine - 100 L citric goes to brine, will break down quickly
	Water	7732-18-5		NA	NA	NA	
Hydrex 4705 (alkaline CIP)	Ethylenediaminetetraacetic Acid, tetrasodium salt	64-02-8	This product is not directed to the permeate stream.	NA	NA	NA	Assume dose 2 x month at 20 ML/day; 20 ML/day x 60days x 7% (vol of water to brine pond); 50 ML of brine - EDTA will break down, left with sodium
	Potassium Hydroxide	1310-58-3	This product is not directed to the permeate stream.	NA	NA	NA	Assume 2xmonth 20 ML/day; 20 ML/day x 60days x 7% (vol of water o brine pond); 50 ML of brine - 2 parts K, diluted into
	Sodium Carbonate	497-19-8	This product is not directed to the permeate stream.	NA	NA		
	Water	7732-18-5	This product is not directed to the permeate stream.	NA	NA	NA	
Hydrex 4714 (CIP)	Hydrogen Peroxide	7722-84-1	This product is not directed to the permeate stream.	NA	NA	NA	all compounds break down, end up with water and carbon dioxide
	Acetic Acid	64-19-7	This product is not directed to the permeate stream.	NA	NA	NA	will biodgrade with in pond
	Peroxyacetic Acid	79-21-0	This product is not directed to the permeate stream.	NA	NA		
	Water	7732-18-5	This product is not directed to the permeate stream.	NA	NA	NA	
Aluminium Chlorohydrate 50%	Aluminium chlorohydrate	12042-91-0	This product is not directed to the permeate stream.	NA	NA	NA	This product not directed to brine dams.
	Water	7732-18-5	This product is not directed to the permeate stream.	NA	NA	NA	This product not directed to brine dams.
Hydrex 3502 (Actiflo Polymer)	Polyacrylamide (anionic)	9003-05-8	This product is not directed to the permeate stream.	NA	NA	NA	This product not directed to brine dams.
Hydrex 6926 (Sludge Polymer)	Adipic Acid	124-04-9	This product is not directed to the permeate stream.	NA	NA	NA	This product not directed to brine dams.
	Cationic acrylamide copolymer	69418-26-4	This product is not directed to the permeate stream.	NA	NA	NA	This product not directed to brine dams.

L = litres
mg/l = milligrams per litre
L/hr = litre per hour
AVG = average
mg/kg = milograms per kilogram
NA = not applicable

APPENDIX D RISK ASSESSMENT DOSSIERS

Commercial in Confidence

Table D-1
Summary of Risk Assessment Dossiers

Chemical name	CAS Number	Summary
Acrylamide, (2-acryloyloxyethyltrimethylammonium chloride)	79-06-1	Acrylamide, (2-acryloyloxyethyltrimethylammonium chloride), also known as polyquaternium-33 is a copolymer of trimethylaminoethylacetate salt and acrylamide. Polyquaternium-33 is a highly charged cationic polymer with high molecular weights. It is expected to be poorly biodegraded and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility. As a cationic polymer polyquaternium-33 will rapidly react with many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays. Due to its physical properties (*i.e.* , molecular size), polyquaternium-33 is not expected to bioaccumulate. The acute toxicity of polyquaternium-33 is very low by the oral route. It is non-irritating to the skin and is not a skin sensitizer. No other data are available regarding the human health hazard of polyquaternium-33. Polyquaternium-33 has a moderate acute toxicity concern to aquatic organisms.
Adipic acid	124-04-9	Adipic acid is readily biodegradable. It is not expected to bioaccumulate, and it has low potential to adsorb to sediment and soil. The acute toxicity of adipic acid is low by the oral, dermal, and inhalation routes. It is slightly irritating to the skin, but severely irritating to the eyes. Adipic acid is not a skin sensitizer. Rats fed adipic acid in their diet for two years showed no target organ or carcinogenic effects. It is not genotoxic. There was no developmental toxicity seen in pregnant animals from oral exposure to adipic acid. Adipic acid is moderately toxicity to aquatic organisms on an acute and chronic basis.
Ammonia	7664-41-7	In water, ammonia is in equilibrium with the ammonium ion (NH_4^+), depending on the pH. Under environmental conditions (pH 5-8), the predominant form will be the ammonium ion (NH_4^+). Ammonia or ammonium ion is rapidly converted to nitrate by nitrification under aerobic conditions in the aquatic environment. Ammonia is part of the nitrogen cycle. Biodegradation is not applicable to ammonia or the ammonium ion. Ammonia (or the ammonium ion) is easily mineralized to the nitrite ion (NO_2^-) by numerous species of bacteria. Ammonia is not expected to bioaccumulate in the environment because of its dissociation to the ammonium ion and because it is part of the nitrogen cycles in air, soil, and water. Ammonia and the ammonium ion have a low potential to adsorb to soil and sediment. The acute toxicity of ammonia is moderate by the inhalation route. Depending on the concentration, solutions of ammonia are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapours from aqueous solutions of ammonia can cause respiratory irritation. No target organ effects were seen in rats given ammonia by oral gavage or in feed for up to two years. Ammonia is not genotoxic. There were no increases in tumors when rats were fed ammonia in their diet for two years. A reproductive and developmental screening toxicity (OECD 422) study showed no reproductive or developmental effects in rats when given oral gavage doses of an aqueous solution of ammonia. Ammonia is acutely toxic to aquatic life. The ANZECC water quality guideline (2000) is freshwaters is a trigger value of 900 mg/L TOTAL ammonia-N at pH 8.0.
Anionic Polyacrylamide	9003-05-8	Anionic polyacrylamide is the copolymer of acrylamide and acrylic acid. No studies on the environmental fate of polyacrylamide are available. As a high-molecular weight polymer, it is not expected to biodegrade or bioaccumulate. Anionic polyacrylamide is not bioavailable when ingested. It is essentially non-toxic by the oral route, and it is not irritating to the skin or eyes. Lifetime dietary studies in rats showed no toxicity or carcinogenic effects. There were no indications of reproductive or developmental toxicity in rats given polyacrylamide in their feed over several generations. Anionic polyacrylamide has a low acute toxicity concern to aquatic organisms.
Calcium chloride anhydrous	10043-52-4	Calcium chloride dissociates completely in aqueous solutions to calcium (Ca^{2+}) and chloride (Cl^-) ions. Calcium chloride and its dissociated ions are ubiquitous in the environment. Because of its dissociation properties and high water solubility, calcium chloride is not expected to be adsorbed to soil. Calcium (Ca^{2+}) and chloride (Cl^-) ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Neither calcium chloride or its dissociated ions are expected to bioaccumulate. Calcium chloride exhibits low acute toxicity by the oral and dermal routes. It is irritating to the eyes, but not to the skin. There was no toxicity or carcinogenic effects in rats given calcium chloride in the diet for 12 months. Calcium chloride is not genotoxic. No developmental toxicity was reported in pregnant female rats, mice, or rabbits given oral doses of calcium chloride. Calcium chloride is of low toxicity concern to aquatic organisms.
Cationic polymer	NA	The identity of the cationic polymer is unknown. Information on the cationic polymer has been read-across from polydiallyldimethylammonium chloride (CAS No. 26062-79-3).
Dialuminium chloride pentahydroxide	12042-91-0	Dialuminium chloride pentahydroxide is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to dialuminium chloride pentahydroxide. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Dialuminium chloride pentahydroxide is not expected to bioaccumulate in aquatic organisms. Dialuminium chloride pentahydroxide has low acute toxicity by the oral and dermal routes. It is non-irritating to the skin and slightly irritating to the eyes. It is not a skin sensitizer. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day aluminium hydroxychloride (a structurally similar compound) in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Dialuminium chloride pentahydroxide is not genotoxic. The Australian drinking water guideline values for aluminium (acid-soluble) is 0.2 mg/L based on aesthetics. ADWG has concluded that there is insufficient data to set a guidance value based on health considerations. The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of trigger values for Aluminium, which are 55 µg/L at pH >6.5 and 0.8 µg/L at pH of <6.5.

Table D-1
Summary of Risk Assessment Dossiers

Chemical name	CAS Number	Summary
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	Diethylene triamine penta(methylene phosphonic acid), sodium salt (DTPMP sodium salt) is an UVCB substance. DTPMP sodium salt is not biodegradable and it adsorbs significantly to sediment and soil. DTPMP sodium salt has a low potential for bioaccumulation. The acute toxicity of DTPMP sodium salt is low by the oral and dermal routes. DTPMP sodium salt is slightly irritating to the skin and non-irritating to the eyes. DTPMP (and presumably its sodium salt) is not a skin sensitizer. Rats given repeated oral doses of DTPMP sodium salt in the diet showed alterations in iron and calcium homeostasis as evidenced by certain hematological changes and bone density, respectively. The changes in calcium homeostasis was not sufficient to alter serum calcium levels. While one in vitro genotoxicity study showed a positive response, other genotoxicity studies conducted both in vitro and in vivo showed no mutagenic or genotoxic response. Rat studies given high oral DTPMP by oral gavage showed a low potential for reproductive and developmental toxicity. DTPMP and its sodium salts are of low toxicity concern to aquatic organisms.
Ethylene diaminetetraacetic acid tetrasodium salt	13235-36-4	Ethylene diaminetetraacetic acid tetrasodium salt (Na_4EDTA) is not readily biodegradable, but it can under certain conditions (*i.e.* , alkaline pH) be degraded. It is not expected to adsorb to soil or sediment. EDTA has a low potential for bioaccumulation. Na_4EDTA exhibits low acute toxicity by the oral route. It is irritating to the eyes. Data on other sodium salts of EDTA show that these substances are not skin sensitizers. Exposures of sodium EDTA salts to rats in their diet for up to two years showed no systemic or carcinogenic effects. No systemic effects were seen in rats exposed by inhalation to a sodium EDTA salt for 13 weeks, although there were some localized (site-of-contact) effects seen in the respiratory tract. Sodium EDTA salts are not considered to be genotoxic. No reproductive toxicity was seen in a multi-generation rat study with a sodium EDTA salt. There was no developmental toxicity when Na_4EDTA, as well as other sodium EDTA salts, were given by oral gavage to pregnant female rats. However, other studies have shown specific fetotoxic and teratogenic effects when high doses of sodium EDTA salts were given to pregnant females; these effects appear to be caused by zinc deficiency. The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism. In general, complexed and non-complexed EDTA has a low toxicity concern for fish and invertebrates. EDTA is highly toxic to algae in tests using standard media; the effect is probably caused by nutritional deficiency. If nutrient metal concentrations are increased, then EDTA has a low toxicity concern for algae; this is more likely scenario in the environment.
Hydrochloric acid	7647-01-0	Hydrochloric acid (HCl) can exist in a gaseous phase at room temperature and pressure. Due to its high water solubility and low vapour pressure, hydrochloric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H^+) and chloride (Cl^-) ions. Both ions are ubiquitous in the environment. H^+ and Cl^- ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Hydrochloric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of hydrochloric acid (HCl) are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapours from aqueous solutions of HCl can cause respiratory irritation. HCl is not a skin sensitiser. Subchronic inhalation studies show localized irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some *in vitro* genotoxicity studies, which are considered to be the result of the pH change in the test system. A lifetime inhalation study showed no carcinogenic in rats exposed to HCl. No adequate reproductive or developmental studies have been conducted on HCl. The hazard of hydrochloric acid for aquatic organisms is caused by the hydrogen ion (H^+). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.
(1-Hydroxyethylidene)-1,1-diphosphonic acid	2809-21-4	(1-Hydroxyethylidene)-1,1-diphosphonic acid (HEDP) has the consistency of a syrup at room temperature. HEDP is a strong complexing agent, and is high hydrophilic. DEHP has low to moderate acute toxicity by the oral and dermal routes. DEHP is a severely irritating to the eyes. It is not a skin sensitizer. Repeated exposure of DEHP in rats by the oral route showed effects primarily related to its ability to chelate metal ions and affect calcium and iron homeostatis. Lifetime studies in rats showed no carcinogenic effects when DEHP was given in the diet. In a rat study, high oral doses of HEDP was toxic to the developing fetus at levels that did not cause maternal toxicity; no teratogenic effects were noted. No developmental effects were seen in a rabbit study. HEDP are of low acute toxicity to fish and invertebrates; it does exhibit moderate toxicity concern to algae, which may be due to the complexation of DEHP with essential trace metals.
Hydrogen peroxide	7722-84-1	Hydrogen peroxide is a strong oxidising liquid. Hydrogen peroxide is normally a short-lived substance in the environment. It is biologically degraded by an enzyme-mediated process, which is rapid and can be considered equivalent to readily biodegradation. Abiotic degradation of hydrogen peroxide is also an important process, involving transition metals, reaction with itself, organic compounds that can react with hydrogen peroxide, and other factors such as heat and sunlight. Hydrogen peroxide has moderate acute toxicity by the oral and inhalation routes and low acute toxicity by the dermal route. Depending on the concentration, solutions of hydrogen peroxide are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapors from aqueous solutions of hydrogen peroxide can cause respiratory irritation. Hydrogen peroxide is not a skin sensitizer. Repeated oral doses of a hydrogen peroxide solution in drinking water resulted in mucosal hyperplasia of the duodenum (small intestine) in male and female rats; no other effects were seen in the gastrointestinal tract or in other organs. Repeated inhalation exposures to hydrogen peroxide resulted in an inflammatory response in the larynx of male and female rats but not in any other locations of the respiratory tract, including the lung. In vitro genotoxicity tests have shown positive responses with hydrogen peroxide; however, in vivo studies are negative for genotoxicity. There are no adequate carcinogenicity, reproductive, or developmental toxicity studies on hydrogen peroxide. Hydrogen peroxide is moderately toxic to aquatic organisms on an acute and chronic basis.

Table D-1
Summary of Risk Assessment Dossiers

Chemical name	CAS Number	Summary
Peroxyacetic acid	79-21-0	Peroxyacetic acid is an organic peroxide. It is not flammable under conditions where the liquid is open to the atmosphere. However, a sustained flame is possible in a close system. Decomposition of peroxyacetic acid produces oxygen. A closed system prevents the release of oxygen, which in the presence of the acetic acid can sustain a flame. Thus, all the gases produced remain in the system and can burn. Peroxyacetic acid will rapidly hydrolyze in water at high pH values (e.g., pH 9). It is readily biodegradable and is not expected to bioaccumulate. It has low potential to adsorb to sediment and soil. Peroxyacetic acid has high acute toxicity by the oral and inhalation routes and moderate toxicity by the dermal routes. Depending on the concentration, aqueous solutions of peroxyacetic acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of peroxyacetic acid can cause respiratory irritation. It is not a skin sensitizer. Repeated oral doses of peroxyacetic acid to rats showed no systemic toxicity. Peroxyacetic acid is not genotoxic. Developmental effects (but no teratogenicity) were seen in laboratory animals at oral doses that also were toxicity to the pregnant females. Peroxyacetic acid is highly toxic to aquatic organisms on both an acute and chronic basis.
Phosphonic acid	13598-36-2	Phosphonic acid will rapidly dissociate in water at environmental pH levels to form H^+ ions and mainly the phosphonate ion (HPO_3^{2-}). The phosphonate ion can be converted to phosphate primarily by soil-borne bacteria, although these bacteria do not use the phosphonate ion until most of the phosphate is depleted. Phosphonic acid is not expected to bioaccumulate in the environment because of its dissociation to ionic species. As an inorganic acid it is expected to have a low potential to adsorb to soil and sediment. A dilute solution (10%) of phosphonic acid has moderate acute toxicity by the oral route. It is expected that more concentrated solutions of phosphonic acid will exhibit higher acute oral toxicity. Phosphonic acid is corrosive to the skin, eyes, and gastrointestinal tract. No information is available on its skin sensitizing potential. Repeated oral doses to rats showed no target organ effects associated with systemic exposure; however, there were severe localized effects to the forestomach and stomach, a likely result of the corrosive nature of phosphonic acid. Phosphonic acid is not genotoxic. No reproductive or developmental toxicity to was seen in rats dosed orally to phosphonic acid. Phosphonic acid is of low acute toxicity concern to aquatic organisms.
Polydiallyldimethylammonium chloride	26062-79-3	Polydiallyldimethylammonium chloride (polyDADMAC) are highly charged cationic polymers with high molecular weights. They are expected to be poorly biodegraded, and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility. As a cationic polymer, polyDADMAC will rapidly react with many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays. Due to its physical properties (*i.e.* , molecular size), polyDADMAC is not expected to bioaccumulate. PolyDADMAC is not acute toxic by the oral route; nor does it exhibit any systemic toxicity from repeated exposures through ingestion. PolyDADMAC exhibits a moderate toxicity concern to aquatic organisms.
Potassium hydroxide	1310-58-3	Potassium hydroxide (KOH) is a strong alkaline substance that dissociates completely in water to potassium (K^+) and hydroxyl (OH^-) ions. Both ions are ubiquitous in the environment. K^+ and OH^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues. Potassium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function. Depending on the concentration, aqueous solutions of KOH are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of KOH can cause respiratory irritation. KOH is not a skin sensitiser. There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide. These studies would have questionable usefulness because of the corrosive/irritating nature of KOH, which would limit the amount absorbed. The hazard of KOH for aquatic organisms is caused by the hydroxyl ion (OH^-) which has the potential to increase the pH of the aquatic environment, depending of the buffering capacity.
Sodium bisulfite	7631-90-5	At environmental pHs, sodium bisulfite dissociates in water to form sodium (Na^+) ions, bisulfite ions (HSO_3^-), sulfite (SO_2^{3-}) ions, and sulfur dioxide (SO_2) which is a gas. Sodium bisulfite is not expected to bioaccumulate in the environment because of its dissociation to ionic species and a gas. Furthermore, sulfite will oxidize to sulfate, which is ubiquitous in the environment. Sodium bisulfite and its dissociated species are expected to have a low potential to adsorb to soil and sediment. Limited toxicity data are available on sodium bisulfite; therefore, structural analogues have been used to read-across to sodium bisulfite. Sodium sulfite has low acute toxicity by the oral, inhalation, and dermal routes. Sodium sulfite is minimally irritating to the skin and slightly irritating to the eyes. Sodium sulfite is not a skin sensitizer. No systemic toxicity was seen in rats when given sodium metabisulfite in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localized irritation from the ingestion of sodium metabisulfite. Sodium bisulfite is not expected to be genotoxic. No reproductive or developmental toxicity was observed in any of the animal studies on sodium bisulfite or its structural analogues. No aquatic toxicity studies have been conducted on sodium bisulfite. Other inorganic sulfite compounds show low to moderate toxicity concern to aquatic organisms.
Sodium carbonate	497-19-8	Due to its high water solubility and low vapour pressure, sodium carbonate will be found predominantly in the aquatic environment where it dissociates completely to sodium (Na^+) and carbonate (CO_3^{2-}) ions. Both ions are ubiquitous in the environment. Na^+ and CO_3^{2-} ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues There are limited toxicity data on sodium carbonate. It has a low order of acute toxicity by the oral, dermal, and inhalation routes. It is not a skin irritant, but it is an eye irritant. Sodium carbonate is not expected to be systemically available in the body from oral exposure due to its dissociation in bodily fluids and the neutralisation of the carbonate ion in the stomach. No developmental toxicity was seen in studies with rats, mice, or rabbits. Sodium carbonate is of low toxicity concern to aquatic and terrestrial organisms.

Table D-1
Summary of Risk Assessment Dossiers

Chemical name	CAS Number	Summary
Sodium citrate	6132-04-3	Sodium citrate is readily biodegradable. It is not expected to bioaccumulate. Due to its high water solubility, citric acid is unlikely to adsorb to soil or sediment. Sodium citrate exhibits low toxicity by the oral and dermal routes. It is non-irritating to the skin and eyes; and is not a skin sensitizer. Minimal toxicity and no carcinogenic effects were observed in rats given oral doses of citric acid for up to two years. Citric acid and sodium dihydrogen citrate were not mutagenic to bacteria, but *in vitro* studies on citric acid using human lymphocytes showed genotoxic effects. *In vivo* genotoxicity studies on citric acid were negative. There were no reproductive or developmental effects in rats given oral doses of citric acid. Sodium citrate is of low toxicity concern to aquatic organisms.
Sodium hypochlorite	7681-52-9	Sodium hypochlorite is a yellow, limpid liquid with a chlorinated odor. In water, sodium hypochlorite (NaOCl) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion. The hypochlorite ion (ClO^-) is in equilibrium with hydrochlorous acd (HOCl) in water and chlorine gas (Cl_2) , with the relative amounts determined by pH, temperature and ionic strength of the water. Between pH 2 and 7, hydrochlorous acid (HOCl) is the dominant form; at pH 7.4 and 20^oC, there is equimolar contribution of HOCl and ClO^-. Sodium hypochlorite (NaOCl) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride. Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative. Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes, and gastrointestinal tract, depending on the concentration. Inhalation of vapors for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitizer. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some *in vitro* genotoxicity studies, the *in vivo* studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant. Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.
Sodium hydroxide	1310-73-2	Sodium hydroxide (NaOH) is a strong alkaline substance that dissociates completely in water to sodium (Na^+) and hydroxyl (OH^-) ions. Both ions are ubiquitous in the environment. Na^+ and OH^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues. Sodium hydroxide dissociates completely in aqueous solutions to sodium (Na^+) and hydroxyl (OH^-) ions. Sodium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function. Depending on the concentration, aqueous solutions of NaOH are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of NaOH can cause respiratory irritation. NaOH is not a skin sensitiser. There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide. These studies would have questionable usefulness because of the corrosive/irritating nature of NaOH, which would limit the amount absorbed. The hazard of NaOH for aquatic organisms is caused by the hydroxyl ion (OH^-) which has the potential to increase the pH of the aquatic environment, depending of the buffering capacity.
Sulfuric acid	7664-93-9	Due to its high water solubility and low vapour pressure, sulfuric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H^+) and sulfate (SO_4^{2-}) ions. Both ions are ubiquitous in the environment. Addition of sulfuric acid to an aquatic ecosystem may decrease the pH depending on the buffer capacity of the receiving water. H^+ and SO_4^{2-} ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues. Sulfuric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of sulfuric acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of sulfuric acid can cause respiratory irritation. Sulfuric acid is not acutely toxic by the oral route when administered as dilute solution. Subchronic inhalation studies show localized irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some *in vitro* genotoxicity studies, which are considered to be the result of the pH change in the test system. No adequate reproductive or developmental studies have been conducted on sulfuric acid. The hazard of sulfuric acid for aquatic organisms is caused by the hydrogen ion (H^+). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.

ANZECC	Australian and New Zealand Environment Conservation Council
ADWG	Australian Drinking Water Guideline
DEHP	di-(2-ethylhexyl)phthalate
UVCB	Unknown or Variable Composition, Complex Reaction Products and Biological Materials

(1-HYDROXYETHYLIDENE)-1,1-DIPHOSPHONIC ACID [ETIDRONIC ACID]

This dossier on (1-hydroxyethylidene)-1,1-diphosphonic acid (HEDP) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of HEDP in its use in water treatment systems. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA), and from the OECD-SIDS documents on the Phosphonic Acid Compounds Group 2 category, which includes HEDP (OECD, 2004a,b). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): (1-Hydroxy-1,1-diyl)bis(phosphonic acid)

CAS RN: 2809-21-4

Molecular formula: $C_2H_8O_7P_2$

Molecular weight: 206.03

Synonyms: Etidronic acid; etidronate; HEDP; (1-hydroxyethylidene)-1,1-diphosphonic acid; (1-hydroxyethylidene)-1,1-bisphosphonic acid; (1-hydroxyethylidene)diphosphonic acid; 1-hydroxy-ethylidene-1,1-diphosphonic acid; 1-hydroxy-1,1-ethanediyl ester; 1-hydroxyethylidene-1,1-diphosphonic acid; ethane-1-hydroxy-1,1-diphosphonic acid; hydroxyethanediphosphonic acid; hydroxyethylidene diphosphonic acid

SMILES: CC(O)(P(=O)(O)O)P(=O)(O)O

II. PHYSICO-CHEMICAL PROPERTIES

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

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Syrup	2	ECHA
Melting Point	198-199°C; 228°C (decomposition)	2	ECHA
Boiling Point	Decomposes before boiling	2	ECHA
Density	1.45 @ 20°C	4	ECHA
Vapor Pressure	~0 Pa	2	ECHA
Partition Coefficient (log K_{ow})	-3.5	2	ECHA
Water Solubility	Very soluble	2	ECHA
Dissociation constants	Four pKa values (at 0.1 M ionic strength potassium nitrate: 1.6, 2.7, 6.9, 11	4	OECD, 2004a,b

HEDP is a diphosphonic acid. The properties of HEDP and its salts are profoundly directed by its ionisation behavior. HEDP can ionise by the loss of a hydrogen ion up to five times to give the corresponding anion. The fifth ionisation (of the hydroxyl group) cannot be attained under normal

aqueous conditions. As a consequence of ionisation, HEDP is a strong complexing agent and is high hydrophilic (OECD, 2004a,b).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

HEDP is not readily biodegradable. There is evidence for partial degradation over short time periods, and with evidence of mineralisation, particularly in light, over long periods. It strongly absorbs to inorganic surfaces, sediment and soils. HEDP has a low potential for bioaccumulation.

B. Biodegradation

In a closed bottle test, there was 0% degradation after 30 days (OECD, 2004). In an OECD ready biodegradation test, 10% of HEDP was degraded after 28 days (ECHA) [Kl. score = 2]. In another OECD ready biodegradation test, 1-3% of HEDP was degraded after 28 days (HERA, 2004).

In a Zahn-Wellens inherent biodegradability test, the percentage of DOC removal after 28 days was 33% (HERA, 2004; ECHA) [Kl. score = 4]. Biodegradation of radiolabelled HEDP was 1.9 to 6.7% over a 210-day period in an SCAS test (HERA, 2004).

In non-sterile natural water, the ultimate biodegradation ($^{14}CO_2$ evolution) of HEDP was 2% in the dark and 2.7% in the sunlight after 60 days (HERA, 2004) [Kl. score = 4]. In the presence of sediment, the biodegradation was faster, with 7.1% degradation in 50 days (HERA, 2004) [Kl. score = 4].

In soils, there was 3 to 47% degradation of HEDP after 119 to 148 days (HERA, 2004) [Kl. score = 4].

C. Environmental Distribution

<u>Adsorption/desorption</u>

A log K_{oc} of 4.22 was determined experimentally (ECHA; OECD, 2004a,b). [Kl. score = 2]

D. Bioaccumulation

The BCF values of HEDP in a carp (*Cyprinus carpio*) were determined to be <7 for the whole body and 71 for the non-edible portions (0.06 mg/L). At 0.6 mg/L, the BCF values were <2 for the whole body and 31 for the non-edible portions of the fish (ECHA). [Kl score = 2]

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

HEDP has low to moderate acute toxicity by the oral and dermal routes. HEDP is severely irritating to the eyes. It is not a skin sensitizer. Repeated exposure of HEDP in rats by the oral route showed effects primarily related to its ability to chelate metal ions and affect calcium and iron homeostasis. Lifetime studies in rats showed no carcinogenic effects when HEDP was given in the diet. In a rat study, high oral doses of HEDP was toxic to the developing fetus at levels that did not cause maternal toxicity; no teratogenic effects were noted. No developmental effects were seen in a rabbit study.

B. Acute Toxicity

The oral LD_{50} for HEDP is 3,500 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} of an aqueous solution of 60% HEDP is 3,130 mg/kg [equivalent to 1,878 mg HEDP/kg] (ECHA) [Kl. score = 2].

The dermal LD_{50} for an aqueous solution of 60% HEDP is >10,000 mg/kg [equivalent to 6,000 mg HEDP/kg] (ECHA). [Kl. score = 2]

C. Irritation

There are no reliable dermal irritation studies; however, the data suggests that HEDP is not irritating to the skin (OECD, 2004).

Two studies have shown that instillation of 0.1 mL of an aqueous solution of 60% HEDP and 0.02% HCl into the eyes of rabbits were severely irritating to the eyes (HERA, 2004). [Kl. scores = 2]

D. Sensitization

Disodium HEDP was not a skin sensitizer in a guinea pig maximisation test (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

Oral

Male and female CD rats were fed in their diet HEDP for 90 days. The average daily intakes were: 0, 154, 524, or 1,583 mg/kg-day for males; and 0, 166, 545, and 1724 mg/kg-day for females. The effect was seen only in the high-dose animals. Body weight gain was decreased in both males and females, with feed intake slightly decreased in the males only. Changes in haematological parameters were: increased erythrocyte counts (males), decreased haemoglobin concentration (both sexes), and decreased leukocyte counts (females after 84 days only). These changes were thought to be due to reduced availability of iron and consequent alterations in iron homoeostasis. Liver weights were decreased in the high-dose group. Histopathological effects included bilateral mineralized microconcentrations in kidney tubules in some males and extramedullary hematopoiesis in the spleen of some females. These effects were thought to be due to altered calcium homoeostasis and were not considered to be toxicologically significant. The NOAEL for this study was considered to be 1,583 mg/kg-day for males and 1,724 mg/kg-day for females (ECHA). [Kl. score = 2]

Male and female SD rats were fed in their diet 0, 500, 2,000, or 10,000 ppm disodium etidronate (sodium salt of HEDP) for 104 weeks. The estimated daily intakes were: 0, 19, 78, or 384 mg/kg-day for males; and 0, 24, 96, or 493 mg/kg-day for females. There were no treatment-related effects on survival, clinical signs, feed and water consumption, ophthalmoscopy, gross or histopathological effects. The NOAEL for this study is 384 mg/kg-day in males and 493 mg/kg-day in females (ECHA). [Kl. score = 2]

Inhalation

No studies were located.

Dermal

No studies were located.

F. Genotoxicity

In Vitro Studies

Disodium HEDP was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537, or TA1538 in the absence or presence of metabolic activation (ECHA) [Kl. score = 2]. Disodium HEDP was not mutagenic in a mouse lymphoma assay in the absence or presence of metabolic activation (ECHA) [Kl. score = 1].

In Vivo Studies

Male and female CF-1 mice were given an intraperitoneal injection of 0, 18.75, or 150 mg/kg disodium HEDP on two consecutive days. There were no significant increases in micronuclei of bone marrow cells at either dose (ECHA). [Kl. score = 2]

Disodium HEDP was tested in a mouse dominant lethal assay at doses of 0, 20, 200, and 1,000 mg/kg. There was no evidence of mutagenicity (ECHA). [Kl. score = 2]

G. G. Carcinogenicity

Oral

Male and female SD rats were fed in their diet 0, 500, 2,000, or 10,000 ppm disodium etidronate (sodium salt of HEDP) for 104 weeks. The estimated daily intakes were: 0, 19, 78, or 384 mg/kg-day for males; and 0, 24, 96, or 493 mg/kg-day for females. Survival was similar across all groups. There were no significant differences in tumour incidences between treated and control animals (ECHA). [Kl. score = 2]

No inhalation or dermal studies were located.

H. Reproductive Toxicity

Disodium HEDP was fed either continuously to male and female rats or pregnant female rats on GD 5-15. The doses were 0, 0.1, or 0.5% in feed, which was estimated to be 0, 112, or 447 mg/kg-day. The F_0 females were allowed to deliver two litres (F_{1a}, F_{1b}) while a third was used for a teratology evaluation (see next section). The F_{1a} litters were discarded after weaning, and the F_{1b} litters were used for breeding the F_2 generation. The F_{2a} litters were discarded after weaning, and the F_{2b} litters were used for the teratology evaluation (see next section). The pregnancy rate was unaffected by treatment. The NOAEL for reproductive toxicity is 447 mg/kg-day (ECHA). [Kl. score = 4]

I. Developmental Toxicity

Pregnant female rats were fed in their diet 0, 112, or 447 mg/kg disodium HEDP during GD 5 to 15. There was no maternal toxicity. Litter size was decreased in the dams given 0.5% in the diet on GD 5-15, indicating fetotoxicity. No teratogenic effects were noted. The NOAELs for maternal and developmental toxicity are 447 and 112 mg/kg-day, respectively (ECHA). [Kl. score = 4]

Pregnant female New Zealand rabbits were fed in their diet 0, 25, 50, or 100 mg/kg disodium HEDP during GD 2 to 19. There was no maternal or developmental toxicity. The NOAELs for maternal and developmental toxicity is 100 mg/kg-day (ECHA). [Kl. score = 4]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for HEDP 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, 2011).

A. Non-Cancer

Oral

A two-year chronic dietary study has been conducted on disodium HEDP. There were no treatment-related effects at dietary levels up to 10,000 ppm. The NOAELs were 384 and 493 mg/kg-day for males and females, respectively. The lowest NOAEL of 384 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 384/(10 x 10 x 1 x 1 x 1) = 384/100 = 4 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (4 x 70 x 0.1)/2 = 14 mg/L

B. Cancer

No carcinogenic effects were seen in rats in a chronic dietary study; thus, no cancer reference value was derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

HEDP does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

HEDP is of low acute toxicity to fish and invertebrates; it does exhibit moderate toxicity concern to algae, which may be due to the complexation of DEHP with essential trace metals.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies conducted on HEDP.

Table 2: Acute Aquatic Toxicity Studies on HEDP

Test Species	Endpoint	Results* (mg/L)	Klimisch score	Reference
Onychorhynchus mykiss	96-hr LC_{50}	195	1	ECHA
Lepomis. macrochirus	96-hr LC_{50}	2,180	2	ECHA
Ictalurus punctatus	96-hr LC_{50}	695	2	ECHA
Lepomis. macrochirus	96-hr LC_{50}	868	2	ECHA
Onychorhynchus mykiss	96-hr LC_{50}	368	2	ECHA
Daphnia magna	48-hr EC_{50}	527	2	ECHA
Pseudokirchnerella subcapitata	96-hr EC_{50}	7.23 (biomass)	2	ECHA
Pseudokirchnerella subcapitata	96-hr EC_{50} NOEC	3 (biomass) 14 (growth rate)	2	ECHA

*Active acid or active ingredient.

The toxicity of DEHP to algae may be the consequence of nutrient limitation caused by the complexation of DEHP with essential trace metals and not true toxicity (OECD, 2004).

Chronic Studies

The 28-day NOEC from a 28-day *Daphnia magna* reproduction toxicity study is 6.75 mg HEDP/L (ECHA). [Kl. score = 2]

The 14-d NOEC to *Pseudokirchnerella subcapitata* was 14 mg HEDP/L (growth rate) (ECHA). [Kl. score = 2]

C. Terrestrial Toxicity

The 14-day LC_{50} value to the earthworm *Eisenia foetida* was >1,000 mg HEDP/kg dw soil (ECHA). [Kl. score = 2]

The 14-day EC_{50} and NOEC of HEDP to the growth of *Avena sativa* were >960 mg HEDP/kg dw soil (HERA 2004). [Kl. score = 4]

The 96-hr LC_{50} values for the mallard duck (*Anas platyhynchos*) and the bobwhite quail (*Colinus virginianus*) are >284 mg HEDP/kg (ECHA). [Kl. scores = 2]

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (195 mg/L), *Daphnia* (527 mg/L), and algae (14 mg/L). Chronic toxicity data are available for two trophic levels, with the lowest NOEC being 6.75 mg/L for algae. On the basis that the data consists of short-term results from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest NOEC of 6.75 mg/L. The $PNEC_{water}$ is 0.14 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 35 mg/kg wet weight.

The calculations are as follows:

$$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$$
$$= (320/1280) \times 1000 \times 0.14$$
$$= 35$$

Where:

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

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

$$K_{sed\text{-}water} = 0.8 + [0.2 \times KP_{sed}/1000 \times BD_{soilid}]$$
$$= 0.8 + [0.2 \times 664/1000 \times 2400]$$
$$= 320$$

Where:

Kp = solid-water partition coefficient (L/kg).

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

$$Kp = K_{oc} \times f_{oc}$$
$$= 16,596 \times 0.04$$
$$= 664$$

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for HEDP is 16,596.

F_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC soil

Experimental results are available for two trophic levels. An acute LC_{50} value is available for earthworms (>1,000 mg/kg dw soil). Results are available for one tropic, with the NOEC of 960 mg/kg dw soil for plants (*Avena sativa*). On the basis that the data consists of a short-term result from one trophic level and a long-term result from one trophic level, an assessment factor of 100 has been applied to the lowest NOEC of 960 mg/ kg dw soil. The $PNEC_{water}$ is 9.6 mg/kg dw soil.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

HEDP is not readily biodegradable; thus it meets the screening criteria for persistence.

The BCF values in fish for HEDP are <2 to 71. Thus, HEDP does not meet the criteria for bioaccumulation.

The lowest chronic aquatic NOEC is >0.1 mg/L. Thus, HEDP does not meet the criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Metal Corrosion Category 1
Acute Toxicity Category 4 [Oral]
Eye Damage Category 1
Aquatic Acute Toxicity Category 3

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: phosphorus oxides, phosphine, carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Pick up with absorbent material. Use a neutralising agent: sodium carbonate or lime. Dispose of contaminated material as prescribed.

D. STORAGE AND HANDLING

General Handling

Provide adequate ventilation. Do not breathe vapours.

Other Handling Precautions

Avoid eye and skin contact.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for HEDP.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Australian Dangerous Goods
UN 3265, CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (ETIDRONIC ACID)
Class 8
Packing Group III

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration

ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
µm	micrometre

ACETIC ACID

This dossier on acetic acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of acetic acid in its use in drilling muds and hydraulic fracturing fluids. 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Acetic acid

CAS RN: 64-19-7

Molecular formula: $C_2H_4O_2$

Molecular weight: 60.1

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

SMILES: CC(=O)O

II. PHYSICO-CHEMICAL PROPERTIES

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	Colorless liquid with a pungent odor.	2	ECHA
Melting Point	16.64°C	2	ECHA
Boiling Point	117.9°C	2	ECHA
Density	1.04 g/cm^3	2	ECHA
Vapor Pressure	20.79 hPa @ 25°C	2	ECHA
Partition Coefficient (log K_{ow})	-0.17	2	ECHA

Water Solubility	602.9 g/L	2	ECHA
Flash Point	39ºC @ 101.3 kPa	2	ECHA
Auto flammability	463ºC	2	ECHA
Viscosity	1.056 mPa s @ 25ºC	2	ECHA
Dissociation constant	4.756 @ 25ºC	2	ECHA

Acetic acid readily dissociates in aqueous media to the acetate ($H_3C2O_2^-$) and hydrogen (H^+) ions.

III. ENVIRONMENTAL FATE PROPERTIES

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. Biodegradation

Acetic acid was readily biodegradable 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].

C. Environmental Distribution

Adsorption/desorption

No experimental data are available for acetic acid. Using KOCWIN in EPISUITE™ (EPA, 2017), the estimated K_{oc} values from log K_{ow} and the molecular connectivity index (MCI) are 1.153 and 1.0 L/kg ,respectively.

D. 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.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Acetic acid is a corrosive liquid. Depending on the concentration, aqueous solutions of acetic acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapours from aqueous solutions of acetic acid can cause respiratory irritation. There are no adequate repeated dose toxicity studies on acetic acid. Acetic acid is not genotoxic. Positive findings have been reported in some *in vitro* genotoxicity studies, and are considered to be the result of the pH change in the test system. Animals studies have shown no developmental toxicity from ingestion of acetic acid.

B. Acute Toxicity

The oral LD_{50} of the sodium salt of acetic acid in rats is 3,310 mg/kg (Woodard et al., 1941; ECHA) [Kl. score =2]. The oral LD_{50} of the acetic acid in unfasted rats is 3,530 mg/kg (ECHA) [Kl. score =4]. The oral LD_{50} of the sodium salt of acetic acid in mice is 4,960 mg/kg (Smyth et al., 1951; ECHA) [Kl. score =2].

The 4-hour inhalation LC_{50} in rats for acetic acid vapor is 11.4 mg/L. There were clinical signs that were indicative of corrosion (ECHA) [Kl. score = 2].

C. Irritation

Application of a 3.3% or a 10% aqueous solution of acetic acid to the skin of rabbits for 4 hours was slightly irritating. The Primary Dermal Irritation Index scores were 0.5 and 1.1, respectively (Nixon et al., 1990; ECHA) [Kl. score = 2]. Application of a 10% solution of acetic acid to the skin of rabbits for 4 hours under semi-occlusive conditions was slightly irritating (ECHA) [Kl. score = 2].

Instillation of 0.1 mL of a 10% solution of acetic acid to the eyes of rabbits was considered irritating. The mean of the 24, 48, and 72 hours scores were: 2.67 for erythema; 1.67 for chemosis; 1.72 for corneal opacity; and a mean of 87% corneal swelling (Jacobs and Martens, 1989; ECHA) [Kl. score = 2]

D. Sensitization

No studies are available.

E. Repeated Dose Toxicity

<u>Oral</u>

No adequate studies for human health risk assessment are available.

Inhalation

No studies are available.

Dermal

No adequate studies for human health risk assessment are available.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on acetic acid are presented below in Table 2.

Table 2: *In vitro* Genotoxicity Studies on Acetic Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	NC	-	2	Ishidate et al. (1984); ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	-	-	2	Zeiger et al. (1992); ECHA
Chromosomal aberrations (CHO cells)	-**	-**	2	Morita et al. (1990); ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-***	-***	2	Seifried et al. (2006); ECHA

*+, positive; -, negative; NC, not conducted.
**A dose-dependent increase in chromosomal aberrations was observed with 10 mM acetic acid (-S9) and 8 mM acetic acid (+S9). These concentrations were close to the cytotoxic limit at which the cells could no longer be evaluated. These effects were abolished by neutralizing the test medium or increasing the buffer capacity. These results suggest that the positive findings are due to the acidic pH of the incubation medium rather than a consequence of an intrinsic clastogenic potential of acetic acid.
***Acetic anhydride (hydrolyzes to acetic acid in aqueous media).

In vivo Studies

No studies are available on acetic acid.

A bone marrow micronucleus study has been conducted on acetic anhydride (which hydrolyses to acetic acid). Male and female SD rats were exposed by inhalation to 0, 1, 5, or 20 ppm acetic anhydride, 6 hours/day, 5 days/week for 13 weeks. The incidence of micronucleated immature erythrocytes was not increased at any exposure concentration (ECHA) [Kl. score = 1]

G. Carcinogenicity

No oral or inhalation studies are available.

No deaths and no skin tumors were seen when acetic acid was applied dermally once a week to CD-1 mice for 32 weeks (Slaga et al., 1975; ECHA) [Kl. score = 4].

H. Reproductive Toxicity

No studies are available.

I. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage with 0 or various concentrations up to 1,600 mg/kg apple cider vinegar (5% acetic acid) on gestational days 6 to 15. There were no maternal or developmental toxicity at any dose level. The NOAEL for maternal and developmental toxicity is 1,600 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 16, 74.3, 345, or 1,600 mg/kg apple cider vinegar (5% acetic acid) on gestational days 6 to 15. There were no treatment-related effects on maternal or fetal survival, or on soft or skeletal tissues. There was no effect on the fetal development in the presence of slight maternal toxicity (reduced body weight gain) at 345 mg/kg. At 1,600 mg/kg, there was an increase in the number of litters containing a dead fetus and some reductions in ossification. The NOAELs for maternal and developmental toxicity are 74.3 and 345 mg/kg-day, respectively (ECHA). [Kl. score = 2]

Pregnant female Dutch-belted rabbits were dosed by oral gavage with 0, 16, 74.3, 345, or 1,600 mg/kg apple cider vinegar (5% acetic acid) on gestational days 6 to 18. There were no treatment-related effects on maternal or fetal survival, or on soft or skeletal tissues. There was a reduction in the pregnancy rate in the high-dose group; and a dose-dependent decrease in maternal body weights at $\geq$74.3 mg/kg. Some deaths or abortions occurred in all treated groups and some litter losses were reported at $\geq$345 mg/kg. Maternal effects were much more noticeable than the effects on fetal development. These findings have been considered a consequence of the bactericidal properties of orally administered acetic

acid within the gastrointestinal tract of female rabbits, and not a direct effect on embryonic implantation and development of acetic acid (EU, 2008). It is likely that this accounts for the apparent increased sensitivity of this species to oral administration of acetic acid. The NOAEL for developmental toxicity is 1,600 mg/kg-day; a NOAEL for maternal toxicity was not identified (ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for acetic acid 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, 2011).

A. Non-Cancer

Oral

There are no repeated dose toxicity studies that were considered adequate for human health risk assessment.

The Joint FAO/WHO Expert Committee on Food Additives (JECFA) has maintained a group ADI of "not limited" for acetic acid and its potassium and sodium salts (JECFA).

The Australian drinking water guidance value for pH may apply to acetic acid.

B. Cancer

There are no carcinogenicity studies by the oral or inhalation route. A dermal carcinogenicity study in mice showed no carcinogenic activity when acetic acid was applied to the skin for 32 weeks. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Acetic acid is a flammable liquid.

Acetic acid does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

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	*Oncorhynchus mykiss*	96-h LC_{50}	>300.82*	2	ECHA
Potassium acetate	*Danio rerio*	96-h LC_{50}	>300.82*	2	ECHA
Acetic acid	*Oncorhynchus mykiss*	96-h LC_{50}	64.8 (measured)	4	ECHA
Acetic acid	*Oncorhynchus mykiss*	96-h LC_{50}	31.3 – 67.6	4	ECHA
Potassium acetate	*Daphnia magna*	48-h EC_{50}	>300.82*	2	ECHA
Acetic acid	*Daphnia magna*	48-h EC_{50}	79.5 (measured)	4	ECHA
Acetic acid	*Daphnia magna*	48-h EC_{50}	18.9 (measured)	4	ECHA
Acetic acid	*Desmodesmus subspicatus*	72-h 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.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. For the acute toxicity studies, data are available on both acetic acid and potassium acetate; both substances dissociate completely in aqueous media to the acetate anion and the corresponding cations (H^+ and K^+). The toxicity of these substances is expected to be driven by the acetate ion, with the cations having a minor role. The toxicity data on potassium acetate are preferred because of the absence of a potential pH change from the dissociated H^+ ion of acetic acid. For the chronic toxicity studies, only acetic acid has been tested for two trophic levels: fish and invertebrates. These studies will not be used to derive the PNEC value; however, an assessment factor of 100 will be applied to the lowest acute $E(L)C_{50}$ values.

From the potassium acetate studies, acute $E(L)C_{50}$ values (adjusted for acetic acid) are available for fish (300.82 mg/L) and *Daphnia* (300.82 mg/L). By applying an assessment factor of 100 to the $E(L)C_{50}$ value of 300.82 mg/L from either fish or *Daphnia*, the $PNEC_{aquatic}$ for acetic acid is 3.0 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 1.9 mg/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.82/1280) \times 1000 \times 3.0$
$= 1.9$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [(0.2 \times Kp_{sed})/1000 \times BD_{solid}]$
$= 0.8 + [(0.2 \times 0.04/1000 \times 2400]$
$= 0.82$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 1.0 \times 0.04$
$= 0.04$

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for acetic acid calculated from EPISUITE™ using the MCI is 1.0 L/kg .
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.04 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.02/1500) \times 1000 \times 3.0$
$= 0.04$

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$

= 1.0 x 0.02
= 0.02

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for aceti acid calculated from EPISUITE™ using the MCI is 1.0 L/kg .
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

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.

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

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

IX. CLASSIFICATION AND LABELING

A. Classification

Flammable Liquid Category 3
Skin Corrosion Category 1A

EU:
≥90%: Skin Corrosion 1A
≥25% to <90%: Skin Corrosion 1B
≥10% to <25%: Skin irritant Category 2; Eye irritant Category 2

In addition to the hazard statements corresponding the GHS classifications (if Skin Corrosion 1A or 1B is included), the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician
Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use water spray or fog, foam, dry chemical or carbon dioxide. Do not use straight streams of water.

Specific Exposure Hazards
Flammable liquid and vapor. Vapors are flammable and heavier than air. Vapors may travel across the ground and reach remote ignition sources causing a flashback fire danger. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon dioxide, carbon monoxide.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Isolate area. Keep unnecessary and unprotected personnel from entering the area. Use personal protective clothing. Ensure adequate ventilation. Wear respiratory protection if ventilation is inadequate. Do not breath mist, vapors, or spray Avoid contact with skin, eye, and clothing. Eliminate all sources of ignition.

Environmental Precautions
Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled
Eliminate all sources of ignition. All equipment used when handling the material must be grounded. A vapor suppressing foam may be used to reduce vapors. Use clean non-sparking tools to collect absorbed material. Pick up with suitable absorbent material and transfer to a container for chemical waste. For large amounts: dike spillage and pump off product into container for chemical waste. Dispose of contaminated material as prescribed.

D. STORAGE AND HANDLING

General Handling

Prevent exposure to ignition sources (i.e., use non-sparking tools and explosion-proof equipment). Avoid contact with eyes, skin, and clothing. Avoid breathing vapor. Wash thoroughly after handling. Keep container closed. Use with adequate ventilation. Use proper bonding and/or ground procedures. However, bonding and grounds may not eliminate the hazard from static accumulation. Peroxides may form upon prolonged storage. Exposure to light, heat or air significantly increases peroxide formation. If evaporated to a residue, the mixture of peroxides residue and material vapor may explode when exposed to heat or shock.

Storage

Keep container tightly closed. Store in a cool, well-ventilated area away from heat and light. Storage containers should be grounded and bonded. Fixed storage containers, transfer containers and associated equipment should be grounded and bonded to prevent accumulation of static charge.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

The workplace exposure standard for acetic acid in Australia is 10 ppm (25 mg/m^3) as a 8-hr TWA and 15 ppm (37 mg/m^3) as a 15-min STEL.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection:

If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. If there are no applicable exposure limit requirements or guidelines, use an approved respirator. Selection of air-purifying or positive pressure supplied-air will depend on the specific operation and the potential airborne concentration of the product. For emergency conditions, use an approved positive-pressure self-contained breathing apparatus.

Hand Protection:

Use gloves chemically resistant to this material. Consult the SDS for appropriate glove barrier materials.

Skin Protection:

Use protective clothing chemically resistant to the this material. Selection of specific items such as face shield, boots, apron, or full body suit will depend on the task.

Eye protection*:*
Use chemical goggles.

Other Precautions:
Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

For glacial acetic acid or >80% acetic acid solutions:

UN 2789 (ACETIC ACID, GLACIAL or ACETIC ACID SOLUTION)
Class: 8
Packing Group: II

For ≥50% to 80% acetic acid solutions:

UN 2790 (ACETIC ACID SOLUTION)
Class: 8
Packing Group: II

For >10% to <50% acetic acid solutions:

UN 2790 (ACETIC ACID SOLUTION)
Class: 8
Packing Group: III

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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ADIPIC ACID

This dossier on adipic acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of adipic acid in its use in water treatment systems. 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) and from the OECD-SIDS document on adipic acid (OECD, 2004). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Hexanedioic acid

CAS RN: 124-04-9

Molecular formula: $C_6H_{10}O_4$

Molecular weight: 146.1 g/mol

Synonyms: Adipic acid; hexanedioic acid

SMILES: C(CCC(=O)O)CC(=O)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Adipic Acid

Property	**Value**	**Klimisch score**	**Reference**
Physical state at 20°C and 101.3 kPa	White, crystalline solid	2	ECHA
Melting Point	150.85°C	1	ECHA
Boiling Point	337.5°C	1	ECHA
Density	1.36 g/cm^3 @ 25°C	2	ECHA
Vapor Pressure	0.097 hPa @ 18.5°C	2	ECHA
Partition Coefficient (log K_{ow})	0.093 [experimental]	2	ECHA

Water Solubility	23 g/L @ 25°C	2	ECHA
Flash Point	196°C	2	ECHA
Auto flammability	>400°C	1	ECHA
Dissociation constants	pK_1 = 4.43 pK_2 = 5.42	2	ECHA
Henry's Law Constant	0.0616 Pa*m^3/mol	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Adipic acid is readily biodegradable. It is not expected to bioaccumulate, and it has low potential to adsorb to sediment and soil.

B. Biodegradation

Adipic acid was readily biodegradable in an OECD 301 D test. Degradation was 93% after 30 days (ECHA) [Kl. score = 2]. In a Zahn-Wellens test, adipic acid showed 90% degradation after 5 days (ECHA) [Kl. score = 2].

C. Environmental Distribution

Adsorption/desorption

No experimental data are available for adipic acid. Using KOCWIN in EPISUITE™ (EPA, 2018), the estimated K_{oc} value from log K_{ow} is 1.585 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 24.34 L/kg.

D. Bioaccumulation

No bioconcentration studies have been conducted on adipic acid. Adipic acid is not expected to bioaccumulate based on the experimental log K_{ow} of 0.093 (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of adipic acid is low by the oral, dermal, and inhalation routes. It is slightly irritating to the skin, but severely irritating to the eyes. Adipic acid is not a skin sensitizer. Rats fed adipic acid in their diet for two years showed no target organ or carcinogenic effects. It is not genotoxic. There was no developmental toxicity seen in pregnant animals from oral exposure to adipic acid.

B. Acute Toxicity

The oral LD_{50} values in rats are: 5,560, >5,000, and 5,050 mg/kg (ECHA). [Kl. scores = 2]

The 4-hour inhalation LC_{50} in rats is >7,700 mg/m^3 (nose-only). The mass median aerodynamic diameter (MMAD) of the dust was <3.5 μm (ECHA). [Kl. score = 2]

The dermal LD_{50} of a 40% solution of adipic acid in rats was >7,940 mg/kg (ECHA). [Kl. score = 2]

C. Irritation

Application of 0.5 g of a 50% aqueous suspension of adipic acid to the intact skin of rabbits for 24 hours under semi-occlusive conditions was slightly irritating. Reversible reddening was observed (scored 2-3 on a scale of up to a maximum of 4), which disappeared after three days. There was no edema at any time point during the observation period (ECHA) [Kl. score = 2].

Instillation of 0.1 mL of adipic acid into the eyes of rabbits was severely irritating. The mean of the 24, 48, and 72 hour scores were: 2.3 for corneal opacity; 1.8 for iridial lesions; 1.0 for conjunctival redness; and 1.0 for chemosis. The observed effects were fully reversible within 16 days (ECHA) [Kl. score = 1].

D. Sensitization

Adipic acid was not a skin sensitizer in a guinea pig maximization test (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

<u>Oral</u>

Rats were fed adipic acid in their diet for two years. Males were fed 0, 0.1, 1, 3, and 5% adipic acid (0 and approximately 75, 750, 2,250, and 3,750 mg/kg-day) and female rats were fed 0 or 1% adipic acid (0 and approximately 750 mg/kg-day). The percent survival for each test group was higher than for the control group. Body weight gains were significantly lower in the 3% and 5% male rats; the remaining treated groups were similar

to the controls. Histopathologic examination showed no treatment-related effects. The NOAEL is 1% in the diet, which corresponds to 750 mg/kg-day for both sexes (ECHA). [Kl. score = 2

Inhalation

No adequate studies are available.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on adipic acid are presented in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Adipic Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA
Mammalian cell gene mutation (Chinese hamster lung fibroblasts, V79)	-	-	1	ECHA
Chromosomal aberration (human embryonic lung cells [WI-38])	-	-	2	ECHA

*+, positive; -, negative

In Vivo Studies

Male rats were given a single oral gavage dose of 0, 3.75, 37.5, or 375 mg/kg adipic acid. In another test, male rats were given a single oral gavage dose of 0 or 5,000 mg/kg adipic acid. There were no increases in chromosomal aberrations of bone marrow cells of treated rats in either test compared to the controls (ECHA; OECD, 2004). [Kl. score = 2]

Male rats were given a daily oral gavage doses of 0, 3.75, 37.5, or 375 mg/kg adipic acid for five consecutive days. In another test, the male rats were given 5 daily doses of 0 or 2,500 mg/kg adipic acid. There were no increases in chromosomal aberrations of bone

marrow cells of treated rats in either test compared to the controls (ECHA; OECD, 2004). [Kl. score = 2]

Adipic acid was tested in two rat dominant lethal assays, with similar doses to the in vivo bone marrow chromosomal aberration studies reported above. Neither studies showed a treatment-related mutagenic effect (OECD, 2004; ECHA). [Kl. score = 2]

G. Carcinogenicity

Oral

Rats were fed adipic acid in their diet for two years. Males were fed 0, 0.1, 1, 3, and 5% adipic acid (0 and approximately 75, 750, 2,250, and 3,750 mg/kg-day) and female rats were fed 0 or 1% adipic acid (0 and approximately 750 mg/kg-day). The incidences of tumors were similar between the treated and control animals (Horn et al., 1957). [Kl. score = 2]

H. Reproductive Toxicity

No adequate reproductive toxicity studies are available.

I. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage with 0, 2.9, 13, 62, or 288 mg/kg adipic acid on GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 288 mg/kg-day (OECD, 2004; ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 2.6, 12, 56, or 263 mg/kg adipic acid on GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 263 mg/kg-day (OECD, 2004; ECHA). [Kl. score = 2]

Pregnant female Dutch-belted rabbits were dosed by oral gavage with 0, 2.5, 12, 54, or 250 mg/kg adipic acid on GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 250 mg/kg-day (OECD, 2004; ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for adipic acid 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, 2011).

A. Non-Cancer

Oral

Adipic acid has been tested in a two-year rat dietary study. The only effect seen was reduced body weight gain in the male rats given 3% and 5% adipic acid (2,250 and 3,750 mg/kg-day, respectively) in their diet (OECD, 2004; ECHA). The NOAEL for male and female rats was 1% in the diet, which corresponds to 750 mg/kg-day. The NOAEL of 250 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 250/(10 x 10 x 1 x 1 x 1) = 250/100 = 2.5 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (2.5 x 70 x 0.1)/2 = 8.8 mg/L

B. Cancer

Adipic acid was not carcinogenic to rats in a two-year dietary study. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Adipic acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Adipic acid is moderately toxicity to aquatic organisms on an acute and chronic basis.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of the acute aquatic toxicity studies on adipic acid.

Table 3: Acute Aquatic Toxicity Studies on Adipic Acid

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio	96-h LC_{50}	>1,000	2	ECHA
Leuciscus idus	96-h LC_{50}	230	2	ECHA
Daphnia magna	48-h EC_{50}	46	2	ECHA
Daphnia magna	48-h EC_{50}	85.7	2	ECHA
Pseudokidrchnerella subcapitata	72-h EC_{50} 72-h NOEC	59 41	2	ECHA

Chronic Studies

The NOEC from a 21-day *Daphnia* reproduction study is 6.3 mg/L (ECHA). [Kl. score = 2]

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (230 mg/L), invertebrates (46 mg/L), and algae (59 mg/L). The NOEC values from long-term studies are available for invertebrates (6.3 mg/L) and algae (41 mg/L). On the basis that the data consist of short-term from three trophic levels and long-term results from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 6.3 mg/L for invertebrates. The $PNEC_{water}$ is 0.13 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.08 mg/kg sediment wet weight.

The calculations are as follows:

$$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$$
$$= (0.83/1280) \times 1000 \times 0.126$$
$$= 0.08$$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$$K_{sed\text{-}water} = 0.8 + [0.2 \times (Kp_{sed}/1000) \times BD_{solid}]$$
$$= 0.8 + [0.2 \times (0.063/1000) \times 2400]$$

= 0.83

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
= 1.585 x 0.04
= 0.063

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for adipic acid calculated from EPISUITE™ using the log K_{ow} is 1.585 L/kg.
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 0.003 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
= (0.032/1500) x 1000 x 0.126
= 0.003

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
= 1.585 x 0.02
= 0.032

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for adipic acid calculated from EPISUITE™ using the log K_{ow} is 1.585 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

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

The experimental log K_{ow} for adipic acid is 0.093. Thus, adipic acid does not meet the criteria for bioaccumulation.

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

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

IX. CLASSIFICATION AND LABELING

A. Classification

Eye damage Category 1
Aquatic Acute Category 3

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately.

Skin Contact
Wash thoroughly with soap and water.

Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion
Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

Notes to Physician
All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards
May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide.

Special Protective Equipment for Firefighters
Wear self-contained breathing apparatus and chemical-protective clothing.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing. Eliminate all sources of ignition.

Environmental Precautions
Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled
Scoop up and remove.

D. STORAGE AND HANDLING

General Handling

No special measures necessary provided product is used correctly.

Other Handling Precautions
Avoid eye and skin contact. Avoid creating or inhaling dust. Take precautionary measures against static discharges by bonding and grounding equipment.

Storage
Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for adipic acid.

Engineering Controls
None

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Chemical resistant protective gloves.

Skin *Protection*:
Body protection must be chosen depending on activity and possible exposure.

Eye protection*:*
Safety glasses with side-shields.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Adipic acid is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. 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.

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ALUMINUM HYDROXYCHLORIDE

This dossier on aluminum hydroxychloride does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of aluminum hydroxychloride in water treatment systems. 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Aluminium(3+) ion dichloride hydroxide

CAS RN: 1327-41-9

Molecular formula: General formula" $Al(OH)_x(Cl)_{(3-x)}$, with x ranging from >0 to 2.3 and typically being >0.5.

Molecular weight: variable

Synonyms: Aluminium hydroxychloride; polyaluminium chloride; aluminium chloride, basic; aluminium(3+) ion dichloride hydroxide

Aluminium hydroxychloride is an UVCB substance.

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Aluminium Hydroxychloride (as Aqueous Solution)

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Clear yellow liquid.	1	ECHA
Melting Point	<-90°C	1	ECHA
Boiling Point	70 – 170°C*	1	ECHA
Density	1.36 g/cm^3	1	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-

Water Solubility	>1,000 g/L @ 20ºC (pH of sample was 2.4)	1	ECHA
Flash Point	No flash point was observed.	1	ECHA
Auto flammability	Not auto-ignitable	1	ECHA

*Assigned to boiling of water in the test sample.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Aluminium hydroxychloride is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to aluminium hydroxychloride. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Aluminium hydroxychloride is not expected to bioaccumulate in aquatic organisms.

B. Bioaccumulation

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions (Spry and Wiener, 1991). The initial uptake of aluminium by fish occurs mainly on the gill mucous layer (Wilkinson and Campbell, 1993); both mucus and bound aluminium may be rapidly eliminated following exposure. Roy (1999) calculated the BCFs in fish to range from 400 to 1,365.

The BCF for *Daphnia magna* varied from 10,000 at pH 6.5 to 0 at pH 4.5, based on the results of Havas (1985). Most of the metal appears to be adsorbed to external surfaces and is not internalised (Havas, 1985; Frick and Hermann, 1990).

The accumulation of aluminium by the algae *Chlorella pyrenoidosa* increased with the concentration of inorganic monomeric aluminium (Parent and Campbell, 1994). A comparison of assays performed at different pH values but the same concentration of aluminium showed suppression of that aluminium accumulation at low pH.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Aluminium hydroxychloride has low acute toxicity by the oral, dermal, and inhalation routes. It is non-irritating to the skin, but severely irritating to the eyes. It is not a skin

sensitizer. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day aluminium hydroxychloride in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Aluminium hydroxychloride is not genotoxic.

B. Acute Toxicity

The oral LD_{50} of aluminium hydroxychloride in rats is >2,000 mg/kg (ECHA). [Kl. score = 2]

The 4-hour LC_{50} in rats is >5 mg/L as aerosol (ECHA). [Kl. score = 2]

The dermal LD_{50} of aluminium hydroxychloride in rats is >2,000 mg/kg (ECHA). [Kl. score = 2]

C. Irritation

Application of 0.5 mL of aluminum hydroxychloride to the skin of rabbits for 4 hours under semi-occlusive conditions was not irritating. The mean of the 24, 48 and 72 hour scores were zero for both erythema and edema (ECHA). [Kl. score = 1]

Instillation of 0.1 mL of aluminium hydroxychloride (low basicity) to the eyes of rabbits was severely irritating/corrosive. The mean of the 24, 48, and 72 hour scores were: 1.45 for corneal opacity; 0.89 for iridial lesions; 2.67 for conjunctival redness; and 2.55 for chemosis. The effects were not completely reversible within 21 days. One animal was killed due to the severity of the eye effects (ECHA). [Kl. score = 2]

D. Sensitization

Aluminium hydrochloride was not a skin sensitizer in a guinea pig maximization test using the Magnusson and Kligman method (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

Oral

Aluminium hydroxychloride was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg aluminium hydroxychloride; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There were no effects in the females at any dose level. In males, there were effects indicative of stomach irritation at the high-dose; no other effects were noted. The NOAEL for systemic

effects in this study is 1,000 mg/kg-day, the highest dose tested. The NOAEL for localized effects (site-of-contact) is 200 mg/kg-day (ECHA). [Kl. score = 2]

Inhalation

No adequate studies are available.

Dermal

No studies are available.

F. Genotoxicity

The *in vitro* genotoxicity studies on aluminium hydroxychloride are presented in Table 2.

In Vitro Studies

Table 2: *In Vitro* Genotoxicity Studies on Aluminium Hydroxychloride

Test System	**Results***		**Klimisch Score**	**Reference**
	-S9	**+S9**		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Micronucleus (peripheral human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

No studies are available on aluminium hydroxychloride.

Male and female NMRI mice were given an oral gavage dose of 0 or 2,000 mg/kg dialuminium chloride pentahydroxide on two consecutive days. There were no increases in the frequency of micronucleated polychromatic erythrocytes in the bone marrow of the treated mice compared to the controls (ECHA). [Kl. score = 1]

G. Carcinogenicity

No studies are available.

H. Reproductive/Developmental Toxicity

Aluminium hydroxychloride was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg aluminium hydroxychloride; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There was no reproductive or developmental toxicity at any dose level. The NOAELs for reproductive and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Toxicological reference values were not derived for aluminium hydroxychloride.

The Australian drinking water guideline values for aluminium (acid-soluble) is 0.2 mg/L based on aesthetics. ADWG has concluded that there is insufficient data to set a guidance value based on health considerations (ADWG, 2011).

The Australian drinking water guidance value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Aluminium hydroxychloride does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

<u>Acute Studies on Aluminium Polychlorohydrate</u>

The 96-hr LC_{50} for aluminium polychlorohydrate in *Danio rerio* was determined to be 142 mg/L nominal. For dissolved aluminium, the 96-hr LC_{50} was 0.58 mg/L. A very steep concentration-effect relationship was observed for the test substance; this was due

to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance (ECHA). [Kl. score = 2]

The 96-hr LC_{50} for aluminium polychlorohydrate in *Danio rerio* was determined to be 186 mg/L nominal. For dissolved aluminium, the 96-hr LC_{50} was 1.39 mg/L, corresponding to 16.9 mg/L Total Al (measured values). A very steep concentration-effect relationship was observed for the test substance; this was due to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance. Theoretically, 186 mg/L of aluminium polychlorohydrate reduced the pH of reconstituted water to a level which enabled 1.4 mg Al/L to be dissolved. (ECHA). [Kl. score = 2]

The 96-hr EC_{50} and NOEC for aluminium polychlorohydrate in *Danio rerio* were determined to be >0.357 mg/L measured as dissolved Al (equivalent to 91.5 Total Al). The NOEC was >1,000 mg/L nominal, which is equivalent to 91.5 mL Total Al. In this study, the pH of the test media was maintained at 7.5 (ECHA). [Kl. score = 1]

The 48-hr EC_{50} for aluminium polychlorohydrate in *Daphnia magna* is 98 mg/L nominal and 7.8 mg/L measured (ECHA) [Kl. score = 2]. Another study reported 48-hr EC_{50} values for aluminium chlorohydrate of 38 mg/L nominal and 3.45 mg/L measured (ECHA) [Kl. score = 2].

The 72-hr EC_{50} for growth rate in *Pseudokidrchneriella subcapitata* was 14 mg/L nominal, which was equivalent to 0.644 mg/L as Total Al. The average measured concentrations of dissolved Al were 0.24 mg/L at a pH between 7.1 and 8.4. The EC_{10} for growth rate was 0.14 mg/L as Total Al and 0.051 mg/L based on measured Al. The NOEC for growth inhibition was nominally 1.0 mg/L (0.046 mg/l based on Total Al and <0.02 mg/L when based on measured Al (ECHA). [Kl. score = 1]

Data used by ANZECC for Aluminium water quality guideline

In developing a water quality guideline for aluminium (ANZECC 2000), ANZECC separated the screened freshwater toxicity data into those conducted at pH >6.5 and those at pH <6.5. These data are summarised below (it should be noted that only the acute toxicity data was used to derive a water quality guideline):

Freshwater pH >6.5:

Fish

The 48-96 hour LC_{50} values for 5 species were 600 to 106,000 µg/L (the lowest value was for *Salmo salar*). The chronic 8- to 28-day NOEC equivalents[1] from seven species were 34-7,100 µg/L. The lowest measured chronic value was an 8-day LC_{50} for *Micropterus* species of 170 µg/L.

Amphibian

The 96-hour LC_{50} values for *Bufo americanus* were 860-1,660 µg/L. The chronic 8-day LC_{50} for *Bufo americanus* was 2,280 µg/L.

Crustacean

The 48-hour LC_{50} values for one species were 2,300-36,900 µg/L. The chronic 7- to 28-day NOECs were 136-1,720 µg/L.

Algae

The 96-hour EC_{50} values were 460-570 µg/L based on population growth. The NOECs for two species were 800-2,000 µg/L.

Freshwater pH<6.5 (all between pH 4.5 and 6.0):

Fish

The 24-96-hour LC_{50} values for two species were 15-4,200 µg/L (the lowest value was for *Salmo trutta*). The 21- to 42-day LC_{50} values were 15-105 µg/L,

Amphibian

The 96- to 120-day LC_{50} values were 540-2,670 µg/L; the absolute range was 400-5,200 µg/L.

Algae

The NOEC from one species was 2,000 µg/L based on growth.

[1]Chronic toxicity values were a mixture of LC/EC_{50} LOEC, MATC, and NOEC values; where stated, these were converted to NOEC equivalents.

C. Terrestrial Toxicity

A study equivalent to the earthworm acute toxicity (OECD TG 207) test was conducted on sulfuric acid, aluminium salt (3:2), octadecahydrate (CAS No. 7784-31-8). The 14-day LC_{50} to earthworm *Eisenia andre*i is 316 mg/kg soil dry weight (van Gestel and Hoogerwerf, 2001; ECHA). [Kl. score = 2]

D. Calculation of PNEC

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of trigger values for aluminium. The guideline for freshwater is: *"A freshwater moderate reliability trigger value of 55 µg/L for aluminium at pH >6.5*

using the statistical distribution method (Burr distribution as modified by SCIRO, Section 8.3.3.3) with 95% protection and an ACR of 8.2.

"A freshwater low-reliability trigger value of 0.8 µg/L was derived for aluminium at pH of <6.5 using an AF of 20 (essential element) on the low pH trout figure."

"The low-reliability figures should only be used as indicative interim working levels."

PNEC sediment

No experimental toxicity data on sediment organisms are available. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as aluminium hydroxychloride. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of aluminium hydroxychloride to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of aluminium hydroxychloride is dominated by its water solubility. Sorption of aluminium hydroxychloride should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as aluminium hydroxychloride. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, aluminium hydroxychloride is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Aluminium hydroxychloride is an inorganic compound that dissociates in water to form chloride ions and various species of aluminium hydroxide hydrolysis. Biodegradation is not applicable to aluminium hydroxychloride. Both chloride ions and aluminium hydroxide ionic species can be found naturally in the environment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic compound.

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions. Chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, aluminium hydroxychloride and its dissociated ions are not expected to meet the criteria for bioaccumulation.

The lowest chronic NOEC value in fish for aluminium is <0.1 mg/L; thus, the dissolved aluminium from aluminium hydroxychloride meets the screening criteria for toxicity.

The overall conclusion is that aluminium hydroxychloride is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

Eye Irritant Category 2

B. Labelling

Warning

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on the conditions, decomposition products may include the following: hydrogen chloride.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

D. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidising agents.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has established an occupational exposure standard of 2 mg/m^3 as an 8-hour TWA for aluminium, soluble salts (as Al).

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Aluminium hydroxychloride is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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AMMONIA

This dossier on ammonia does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of ammonia in its use in water treatment systems. 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) and the OECD-SIDS category for ammonia (OECD, 2007). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Ammonia

CAS RN: 7664-41-7

Molecular formula: NH_3

Molecular weight: 17

Synonyms: Ammonia, ammonia gas, ammonia anhydrous, liquid ammonia

SMILES: N

II. PHYSICO-CHEMICAL PROPERTIES

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

Property	**Value**	**Klimisch score**	**Reference**
Physical state at 20°C and 101.3 kPa	Colorless gas	2	ECHA
Melting Point	-77.7°C	2	ECHA
Boiling Point	-33.3°C	2	ECHA
Vapor Pressure	8,611 hPa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	482 g/L @ 20°C;510 – 531 g/L @ 20°C	2	ECHA

Flash Point	No flash point	2	ECHA
Auto flammability	651°C	2	ECHA
Henry's Law Constant	1.6 x 10^{-5} atm-m^3mol @ 25°C	2	ECHA

The dissociation constant (pK_a) of aqueous ammonia is 9.25 at 25°C (ECHA) [Kl. score = 2].

III. ENVIRONMENTAL FATE PROPERTIES

In water, ammonia is in equilibrium with the ammonium ion (NH_4^+), depending on the pH. The following equilibria occurs at ambient environmental conditions:

$NH^+ + H_2O \leftrightarrow NH_3 + H^+$

$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$

Under environmental conditions (pH 5-8), the predominant form will be the ammonium ion (NH_4^+). As pH decreases, the concentration of the ammonium ion will increase, while the un-ionized ammonia concentration will decrease.

Ammonia or ammonium ion is rapidly converted to nitrate by nitrification under aerobic conditions in the aquatic environment (OECD, 2007). Ammonia is part of the nitrogen cycle. Biodegradation is not applicable to ammonia or the ammonium ion. Ammonia (or the ammonium ion) is easily mineralized to the nitrite ion (NO_2^-) by numerous species of bacteria (OECD, 2007).

Ammonia is not expected to bioaccumulate in the environment because of its dissociation to the ammonium ion and because it is part of the nitrogen cycles in air, soil, and water. Ammonia and the ammonium ion have a low potential to adsorb to soil and sediment.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of ammonia is moderate by the inhalation route. Depending on the concentration, solutions of ammonia are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapors from aqueous solutions of ammonia can cause respiratory irritation. No target organ effects were seen in rats given ammonia by oral gavage or in feed for up to two years. Ammonia is not genotoxic. There were no increases in tumors when rats were fed ammonia in their diet for two years. A reproductive and developmental screening

toxicity (OECD 422) study showed no reproductive or developmental effects in rats when given oral gavage doses of an aqueous solution of ammonia.

B. Acute Toxicity

The oral LD_{50} of aqueous ammonia (as ammonium hydroxide) in rats is 350 mg/kg (Smyth et al., 1941). [Kl. score = 2]

The 1-hour LC_{50} values of ammonia in rats are 9,850 mg/m^3 for males and 13,770 mg/m^3 for females (Appelman et al., 1982). [Kl. score = 2]

C. Irritation

Application of a 12% aqueous solution of ammonia (as ammonium hydroxide) to the skin of rabbits for four hours under occlusive conditions was corrosive. A 10% aqueous solution was not corrosive under similar conditions (ECHA). [Kl. score = 2]

No eye irritation studies are available.

D. Sensitization

No studies are available.

E. Repeated Dose Toxicity

Oral

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422), male and female Crj: CD(SD) male and female rats were dosed by oral gavage with 0, 250, 750, or 1,500 mg/kg diammonium phosphate. The exposure period for the toxicity subgroup was 35 days. There was no treatment-related deaths and no clinical signs of toxicity. The 1,500 mg/kg males had reduced (22% of controls) body weight gain and feed consumption. Activated partial thromboplastin time was reduced in the 750 and 1,500 mg/kg males. In males: elevated alkaline phosphatase (750 and 1,500 mg/kg; 132% and 131% of controls); reduced glucose and phosphorus levels (1,500 mg/kg; 79% and 82% of controls); reduced total protein (750 and 1,500 mg/kg); 93% and 91% of controls; slightly elevated albumin/globulin ratio 1,500 mg/kg; 117% of controls). In females: decreased phosphorus levels (1,500 mg/kg; 81% of controls). No details were given as to whether these values were within normal range. The functional observation battery (FOB) and motor activity results showed no treatment-related effects. Relative kidney and liver weights were increased in the 1,500 mg/kg females compared to controls. Reddening of the extremities were seen in all dose

groups during the first week of the study but were reduced at the study progressed. Histopathologic examination showed submucosal inflammation of the stomach at all dose levels, which was not statistically significant at 250 mg/kg-day. Given the lack of histopathological findings (excluding the irritation effect seen in stomach), the serum chemistry changes do not seem indicative of an adverse effect. The NOAEL for this study is 750 mg/kg-day (ECHA). [Kl. score = 1]

Male and female F344 rats were fed in their diet 0, 0.1, 0.6, or 3% ammonium sulfate for 52 weeks. The estimated daily intakes were: 0, 42, 256, and 1,527 mg/kg-day for the males; and 0, 48, 284, and 1,490 mg/kg-day for the females. There was a significant increase in kidney and/or liver weights in the 3% dietary group. No effects were noted, however, on survival, body weights, hematology, serum chemistry, or histopathology. The kidney and liver weight changes do not appear to be an adverse effect because of no corresponding serum chemistry and/or histopathological changes in these organs. The NOAEL for this study is 3% in the diet, corresponding to 1,527 and 1,490 mg/kg-day for males and females, respectively (Ota et al., 2006). [Kl. score = 2]

Male and female F344 rats were fed in their diet 0, 1.5, or 3% ammonium sulfate for 104 weeks. The estimated daily intakes were: 0, 564, and 1,288 mg/kg-day for the males; and 0, 650, and 1,371 mg/kg-day for the females. Body weights and feed consumptions were similar across all groups. There was an increased incidence of chronic nephropathy in the male rats, which was statistically significant only in the 1.5% dietary group (Ota et al., 2006). [Kl. score = 2]

Inhalation

See U.S EPA's Toxicological Review of Ammonia – Noncancer Inhalation for its Integrated Risk Information System (IRIS). Available at: https://www.epa.gov/iris

Dermal

No studies are available.

F. Genotoxicity

Table 2 lists the *in vitro* genotoxicity studies on ammonia and ammonium sulfate.

In Vitro Studies

Table 2: *In Vitro* Genotoxicity Studies on Ammonia and Ammonium Sulfate

Test System	Test Substance	Results*		Klimisch Score	Reference
		-S9	+S9		
Bacterial reverse	Anhydrous	-	-	2	ECHA

mutation (*S. typhimurium* and *E. coli* strains)	ammonia				
Bacterial reverse mutation (*S. typhimurium* strains)	Ammonium sulfate	-	-	1	ECHA

*+, positive

In Vivo Studies

Male ddY mice were given a single intraperitoneal injection of 0, 62.5, 125, 250, or 500 mg/kg ammonium chloride. There were no increases in the frequency of micronucleated erythrocytes at any dose level (Hayashi et al., 1988).

Male ddY mice were given intraperitoneal injections of 0, 31.3, 62.6, 125, or 250 mg/kg ammonium chloride on four consecutive days. There were no treatment-related increases in the frequency of micronucleated erythrocytes at any dose level (Hayashi et al., 1988).

G. Carcinogenicity

Male and female F344 rats were fed in their diet 0, 1.5, or 3% ammonium sulfate for 104 weeks. The estimated daily intakes were: 0, 564, and 1,288 mg/kg-day for the males; and 0, 650, and 1,371 mg/kg-day for the females. Body weights and feed consumptions were similar across all groups. The tumor incidences were similar between the treated and control groups (Ota et al., 2006). [Kl. score = 2]

H. Reproductive/Developmental Toxicity

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422), male and female Crj: CD(SD) male and female rats were dosed by oral gavage with 0, 250, 750, or 1,500 mg/kg diammonium phosphate. The males and females were treated for 28 and 53 days, respectively. There were no reproductive or developmental toxicity at any dose level. The NOAEL for reproductive and developmental toxicity is 1,500 mg/kg-day (ECHA). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

An oral reference dose was not derived for ammonia.

The Australian drinking water guideline value for ammonia (0.5 mg/L, aesthestics) may be applicable (ADWG, 2011).

B. Cancer

A two-year rat dietary study on ammonium sulfate showed no carcinogenic effects. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Ammonia is a flammable gas.

It does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

ANZECC developed a water quality guideline for ammonia (ANZECC 2000). The term 'ammonia' refers to both the un-ionized ammonia (NH_3) and the ionized ammonium ion (NH_4^+). The proportion of the chemical forms in water varies with the physico-chemical properties of the water, particularly pH and temperature. The concentrations of ammonia are usually expressed as either total ammonia (the sum of NH_3 and NH_4^+) which takes into account the total amount as NH_3 or N, or as concentration of the un-ionized NH_3. The concentrations can be given as component of N (e.g., NH_3-N) or total ammonia-N.

The values given below from ANZECC (2000) are geometric means of species data taken from all screened data that concurrently measured pH and temperature. Figures were adjusted to a standard pH of 8.0 and calculated in terms of <u>total ammonia-N</u>.

<u>Freshwater fish</u>
The 24 – 96 hour LC_{50} values for 15 species were 3,944 to 169,873 μg/L (an anomalous figure of 72 μg/L was extracted from AQUIRE [1994]). The 6- to 28-d chronic NOEC and EC_{20} (growth and survival) for 9 species were 1,350 to 19,720 μg/L.

<u>Freshwater crustacean</u>
The 24 - 96 hour LC_{50} values for 10 species are 7,754 to 108,500 μg/L. The cladoceran *Simocephalus vetulus* was the most sensitive (24-hour EC and LC_{50} values were ~1,580 μg/L), and the amphipod *Crangonyx pseudogracilis* was the least sensitive. The 7-day to

10-week chronic NOEC and EC_{20} values (reproduction) for 4 species are 1,450 to 19,770 μg/L.

Freshwater insects
The 24 - 96 hour LC_{50} values for 8 species are 15,091 to 282,400 μg/L. The 29-d chronic NOEC (reproduction) for 2 species are 1,790 to 4,400 μg/L.

Freshwater molluscs
The acute toxicity for 7 species were 12,588 to 74,623 μg/L. The chronic 42- to 60-d NOEC and EC_{20} (reproduction and survival) for two species are 540 to 2,620 μg/L. The most sensitive species under chronic exposure was the New Zealand species *Sphaerium novaezelandiae* with NOEC (60-day mortality and reproduction) of 540 μg/L total ammonia-N.

Freshwater annelid
The 24 - 96 hour LC_{50} values for two species are 20,071 to 79,788 μg/L.

Freshwater rotifer
The 24-hour LC_{50} for *Brachionus rubens* is 1,300 μg/L.

Freshwater Platyhelminthes
The 24 – 96 LC_{50} value for *Polycelus tenuis* is 37,634 μg/L.

B. Terrestrial Toxicity

At 2.1 to 28 mg/m^3, ammonia gas may damage foliage of plants within four hours; damage may occur within 4 to 8 minutes at air concentrations of 175 to 700 mg/m^3 (WHO, 1986; OECD, 2007). Application of ammonium sulfate to soil inhibited onion growth at 399 mg N/kg soil (OECD, 2007).

Frog species *Pseudacris regilla* and *Rana aurora* exposed to ammonium sulfate in the water for 10 days showed no adverse effects at 17.4 to 82.7 mg NH_3-N/L (OECD, 2007). Larvae of the salamander *Ambystoma gracile* showed no effects after 10 days of exposure to 81.5 mg NH_3-N/L (OECD, 2007).

D. Calculation of PNEC

PNEC water

The ANZECC water quality guideline (2000) for ammonia in freshwaters is: "A freshwater high reliability trigger value of 900 μg/L TOTAL ammonia-N was calculated at pH 8.0 [emphasis added] using the statistical distribution method with 95% protection. This translates to about 900 μg/L un-ionized ammonia-N at 20°C." See Appendix on how the guideline figure changes at different pH value.

PNEC sediment

No experimental toxicity data on sediment organisms are available. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as ammonia and the ammonium ion. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of ammonia or the ammonium ion to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of ammonia is dominated by its water solubility. Sorption of ammonia and the ammonium ion should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as ammonia or the ammonium ion. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, ammonia and the ammonium ion are not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

In water, ammonia is in equilibrium with the ammonium ion (NH_4^+), depending on the pH. Under environmental conditions (pH 5-8), the predominant form will be the ammonium ion (NH_4^+). Ammonia or ammonium ion is rapidly converted to nitrate by nitrification under aerobic conditions in the aquatic environment. Ammonia is part of the nitrogen cycle. Biodegradation is not applicable to ammonia or the ammonium ion. Ammonia (or the ammonium ion) is easily mineralized to the nitrite ion (NO_2^-) by numerous species of bacteria.

Ammonia is not expected to bioaccumulate in the environment because of its dissociation to the ammonium ion and because it is part of the nitrogen cycles in air, soil, and water.

The chronic NOECs reported in ANZECC (2000) for ammonia for aquatic species are >1 mg/L, except for a mollusk found in New Zealand. It is unknown whether a similar sensitive species is found in Australia. For the purposes of this risk assessment, the chronic NOECs for ammonia will be considered to be >1 mg/L. Thus, ammonia does not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification [for solutions only]

Skin Corrosion Category 1A
STOT SE Category 3 [Respiratory irritation]
Aquatic Acute Category 1

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING [for 20% ammonia solution]

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician
Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use dry chemical, carbon dioxide, water spray or fog, or foam.

Specific Exposure Hazards
Containers may explode when heated. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: oxides of nitrogen.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Ventilate enclosed areas. Do not walk through spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapors, or spray. Do not get in eyes, on skin, or on clothing.

Environmental Precautions
Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilled
As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

D. STORAGE AND HANDLING

Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis. Do not store above 49°C/120°F.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

The workplace exposure standard for ammonia in Australia is 25 ppm (17 mg/m^3) as an 8-hour TWA and 35 ppm (24 mg/m^3) as a 15-minute STEL.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection:

If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much be based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection:

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection:
Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Eye protection*:*
Wear chemical splash goggles and face shield.

Other Precautions:
Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

UN 2672 (AMMONIA SOLUTION, relative density between 0.880 and 0.957 at 15ºC in water, with more than 10% but not more than 35% ammonia)
Class: 8
Packing group: III

UN 2073 (AMMONIA SOLUTION, relative density less than 0.880 at 15ºC in water, with more than 35% but not more than 50% ammonia)
Class: 2.2

UN 3318 (AMMONIA SOLUTION, relative density less than 0.880 at 15ºC in water, with more than 50% ammonia)
Class: 2.3

Environmentally Hazardous Substance

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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Appendix

Freshwater trigger values as total ammonia-N in μg/L at different pH (Temperature is not taken into consideration). Taken from Table 8.3.7 (ANZCC 2000).

pH	Freshwater Trigger value (μg/L as total ammonia-N)	pH	Freshwater Trigger value (μg/L as total ammonia-N)
6.0	2570	7.6	1470
6.1	2555	7.7	1320
6.2	2540	7.8	1180
6.3	2520	7.9	1030
6.4	2490	8.0	900
6.5	2460	8.1	780
6.6	2430	8.2	660
6.7	2380	8.2	560
6.8	2330	8.4	480
6.9	2260	8.4	400
7.0	2180	8.6	340
7.1	2090	8.7	290
7.2	1990	8.8	240
7.3	1880	8.9	210
7.4	1750	9.0	180
7.5	1610	-	-

ANIONIC POLYACRYLAMIDE

This dossier on anionic polyacrylamide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of anionic polyacrylamide in its use in water treatment systems. The information presented in this dossier was obtained primarily from the Cosmetic Ingredient Review on polyacrylamide (CIR, 2005) and from the book titled *Ecological Assessment of Polymers. Strategies for Product Stewardship and Regulatory Programs* (Lyons and Vasconellos, 1997). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBTANCE IDENTIFICATION

Description: Copolymer of polyacrylamide (poly(2-propenamide)] and polyacrylate [poly(2-propenoic acid)]

CAS RN: 9003-05-8

Molecular formula: $(C_3H_5NO)_x$- and $(C_3H_3O_2)_x$-

Molecular weight: 1,000,000 to >50,000,000 for polyacrylamide co-polymers used as flocculents (Lyons and Vasconcellos, 1997)

Synonyms: Anionic polyacrylamide

II. PHYSICO-CHEMICAL PROPERTIES

Polyacrylamide polymers can exist in cationic, anionic, or non-ionic forms, depending on their ionic charge. The non-ionic form of polyacrylamide is generated from the basic polymerization of acrylamide. Anionic polyacrylamide polymer can then be formed from the hydrolysis of the acrylamide homopolymer either simultaneously during the polymerization process or as a subsequent step (Zheng et al., 2013). Anionic polyacrylamide polymer can also be formed from the copolymerization of acrylamide and acrylic acid (Lyons and Vasconellos, 1997; Zheng et al., 2013).

III. ENVIRONMENTAL FATE PROPERTIES

No studies on the environmental fate of anionic polyacrylamide are available. As a high-molecular-weight polymer, it is not expected to biodegrade or bioaccumulate (Lyons and Vasconcellos, 1997). The environmental fate of anionic polyacrylamide will be determined primarily by adsorption (Lyons and Vasconcellos, 1997).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Anionic polyacrylamide is not bioavailable when ingested. It is essentially non-toxic by the oral route, and it is not irritating to the skin or eyes. Lifetime dietary studies in rats showed no toxicity or carcinogenic effects. There were no indications of reproductive or developmental toxicity in rats given polyacrylamide in their feed over several generations.

B. Toxicokinetics and Metabolism

Female rats were dosed by oral gavage with 140 mg/kg [^{14}C]-anionic polyacrylamide (molecular weight of 3,000,000). No radioactivity was observed in any of the animals. After 25 hours, the sum of

the radioactivity recovered in the feces was 95.13% of the administered dose, and the gastrointestinal tract and contents accounted for 1.64% of the dose. The urine contained activity representing 0.82% of the dose and carbon dioxide in the expired air was 0.07%. Liver and kidney tissue contained about 0.05%. (McCollister et al., 1965).

A male rat were dosed by oral gavage with 175 mg/kg [^{14}C]-anionic polyacrylamide (molecular weight of 3,000,000). After 5 days, 99% of the recovered activity was in the feces and the gastrointestinal tract and its contents (McCollister et al., 1965).

C. Acute Toxicity

No deaths were observed in rats given either nonionic or anionic polyacrylamide at oral doses up to 4,000 mg/kg. The oral LD_{50} is >4,000 mg/kg (McCollister et al., 1965).

D. Irritation

Application of a 5% solution of polyacrylamide to the skin of rabbits was "well tolerated" (CIR, 2005). Polyacrylamide is non-irritating to slightly irritating to the eyes (CIR, 2005).

E. Sensitization

No studies are available.

F. Repeated Dose Toxicity

Oral

Male and female rats were given in their diet 0, 5, or 10% anionic polyacrylamide (molecular weight of 3,000,000) for two years. The animals in the 10% dose group showed significant retardation of growth. At the end of the study, there was a slight statistically significant increase in kidney weights in the 10% males and in the ≥5% females. Gross and microscopic examination of the tissues from the ≥5% groups at 12 months showed some slight diffuse cloudy swelling, areas of focal necrosis and mild replacement fibrosis in the liver. At 18 and 24 months, all the animals showed tissue changes indicate of old age. These changes involved the small arterioles of the heart, kidney, spleen, pancreas, and to a lesser degree, the liver. All groups of animals were affected including the controls, but the degree of severity was somewhat increased in the ≥5% animals. The authors of the study suggested that the effects seen in the ≥5% dietary groups are attributed indirectly to the large, hydrophilic, non-nutritive bulkiness of the polymer in the gastrointestinal tract. For instance, reduced caloric intake may be partially responsible for the growth retardation; there may also have been interference of the absorption of dietary nutrients. Moreover, the [C^{14}]polymer bioavailability studies no gastrointestinal absorption. The NOAEL for this study is 10% in the diet (McCollister et al., 1965).

Inhalation

No studies are available.

Dermal

No studies are available.

G. Genotoxicity

No studies are available.

H. Carcinogenicity

Male and female rats were fed 0, 5, or 10% anionic polyacrylamide (molecular weight of 3,000,000) in their diet for two years. The tumor incidences were similar between the treated and control animals (McCollister et al., 1965).

I. Reproductive/Developmental Toxicity

In an abstract, it was reported that rats fed up to 2,000 ppm polyacrylamide in a three-generation reproductive toxicity study showed no reproductive, developmental, or parental toxicity (CIR, 2005).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for polyacrylamide 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, 2011).

A. Non-Cancer

Oral

No adverse effects were reported in rats fed anionic polyacrylamide in their diet at doses up to 10% for two years (McCollister et al., 1965). Using 0.05 as the fraction of body weight that is consumed per day as food for the rat, the NOAEL for this study is 5,000 mg/kg-day. The NOAEL of 5,000 mg/kg-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:

- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 5,000/(10 x 10 x 1 x 1 x 1) = 5,000/100 = 50 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (50 x 70 x 0.1)/2 = 175 mg/L

B. Cancer

Polyacrylamide was not carcinogenic to rats when given in a two-year dietary study; thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Anionic polyacrylamide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Anionic polyacrylamide has a low acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Table 1 lists the results of acute aquatic toxicity studies on the powder form of anionic polyacrylamides, respectively. The data were reported in a table as LC_{50} values with no details on the individual studies.

Table 1: Acute Aquatic Toxicity Studies on Anionic Polyacrylamide* in Powder Form

Test Species	Ionic Charge	LC_{50} (mg/L)	Reference
Fathead minnow	-31	810	Betz Laboratories, Inc. (1995)
Rainbow trout	-31	>100	Betz Laboratories, Inc. (1995)
Bluegill sunfish	-31	>300	Betz Laboratories, Inc. (1995)
Rainbow trout	-22	>100	Betz Laboratories, Inc. (1995)
Bluegill sunfish	-22	>300	Betz Laboratories, Inc. (1995)
Rainbow trout	-12	>100	Betz Laboratories, Inc. (1995)
Bluegill sunfish	-12	>300	Betz Laboratories, Inc. (1995)
Daphnia magna	-39	470	Betz Laboratories, Inc. (1995)

*Acrylic acid-acrylamide copolymers with molecular weights of >1,000,000.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for two trophic levels. Acute LC_{50} values are available for fish (>100 mg/L) and invertebrates (470 mg/L). On the basis that the data consist of short-term results from three trophic levels, an assessment factor of 1,000 has been applied to the lowest LC_{50} value of 100 mg/L for fish. The $PNEC_{water}$ is 0.1 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for anionic polyacrylamide; these values cannot be estimated using QSAR models because of the high molecular weight of anionic polyacrylamide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$.

PNEC soil

There are no toxicity data for soil-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for anionic polyacrylamide; these values cannot be estimated using QSAR models because of the high molecular weight of anionic polyacrylamide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Anionic polyacrylamide is a large molecular weight, water-soluble polymer. It is not expected to be readily biodegradable; thus, it meets the screening criteria for persistence.

Pharmacokinetic studies showed that anionic polyacrylamide was not bioavailable to rats when ingested; this is most likely due to its large size (high molecular weight) and presumed resistance to breakdown in the gastrointestinal tract. Anionic polyacrylamide is thus not expected to be bioavailable to aquatic or terrestrial organisms. It is not expected to meet the criteria for bioaccumulation.

No chronic aquatic toxicity data are available on polyacrylamide. The acute LC_{50} values in fish and invertebrates are >1 mg/L. Thus, it does not meet the criteria for toxicity.

The overall conclusion is that anionic polyacrylamide is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

No classification.

B. Labelling

No signal word.

C. Pictogram

None.

X. SAFETY AND HANDLING

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

A. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, nitrogen oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

B. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

C. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid creating or inhaling dust.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

D. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for polyacrylamide.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.

E. TRANSPORT INFORMATION

Polyacrylamide is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. 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.

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts

EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

DIALUMINIUM CHLORIDE PENTAHYDROXIDE

This dossier on dialuminium chloride pentahydroxide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of dialuminium chloride pentahydroxide in water treatment systems. 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).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Dialuminium chloride pentahydroxide

CAS RN: 12042-91-0

Molecular formula: $Al_2ClH_5O_5$; general formula $Al(OH)_x(Cl)_{(3-x)}$ with x between 2.3 and 2.6

Molecular weight: 174.45

Synonyms: Dialuminium chloride pentahydroxide; dialuminium chloride pentahydroxide; aluminium chlorohydroxide; aluminium hydroxychloride dehydrate; aluminium chloride hydroxide, dihydrate

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Dialuminium Chloride Pentahydroxide

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid; fine flakes	1	ECHA
Melting Point	No melting point below 400°C could be determined.	1	ECHA
Boiling Point	No boiling point below 400°C could be determined.	1	ECHA
Density	1.95 g/cm^3 @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	-	-	-
Water Solubility	>1,000 g/L @ 20°C (sample pH was 3.3)	1	ECHA
Auto flammability	Not auto flammable.	1	ECHA

Polyaluminium coagulants, which have been developed for water treatment applications, have the general formula $(Al_n(OH)_mCl_{(3n-m)})_x$. The length of the polymerised chain, molecular weight, and the number of ionic charges is determined by the degree of polymerization. The polyaluminium coagulants include polyaluminium chloride (n=2; m=3), dialuminium chloride pentahydroxide (n=2; n=5), and polydialuminium chloride pentahydroxide (similar to dialuminium chloride pentahydroxide) (Gebbie, 2001).

On hydrolysis, various mono- and polymeric species are formed, with an important cation being $Al_{13}O_4(OH)_{24}^{7+}$. A less predominant species is $Al_8(OH)_{20}^{4+}$.

Depending on the pH, the following reaction takes place (Gebbie, 2006):

$Al_2(OH)_5Cl \rightarrow Al_2(OH)_5^+ + Cl^- + H_2O \rightarrow 2Al(OH)_3 + H^+ + Cl^-$

This reaction will typically take place at a water pH of 5.8 to 7.5. Within this pH, colour and the colloidal matter are removed by adsorption onto/within the metal hydroxide hydrolysis products that are formed (Gebbie, 2006).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Dialuminium chloride pentahydroxide is very soluble in water and will dissociate to form aluminium hydroxide species and chloride ions. Biodegradation is not applicable to dialuminium chloride pentahydroxide. The aluminium hydroxide hydrolysis products will adsorb to colloidal matter. Dialuminium chloride pentahydroxide is not expected to bioaccumulate in aquatic organisms.

B. Bioaccumulation

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions (Spry and Wiener, 1991). The initial uptake of aluminium by fish occurs mainly on the gill mucous layer (Wilkinson and Campbell, 1993); both mucus and bound aluminium may be rapidly eliminated following exposure. Roy (1999) calculated the BCFs in fish to range from 400 to 1,365.

The BCF for *Daphnia magna* varied from 10,000 at pH 6.5 to 0 at pH 4.5, based on the results of Havas (1985). Most of the metal appears to be adsorbed to external surfaces and is not internalised (Havas, 1985; Frick and Hermann, 1990).

The accumulation of aluminium by the algae *Chlorella pyrenoidosa* increased with the concentration of inorganic monomeric aluminium (Parent and Campbell, 1994). A comparison of assays performed at different pH values but the same concentration of aluminium showed suppression of that aluminium accumulation at low pH.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Dialuminium chloride pentahydroxide has low acute toxicity by the oral and dermal routes. It is non-irritating to the skin and slightly irritating to the eyes. It is not a skin sensitizer. No systemic, reproductive, or developmental toxicity was seen in rats at oral doses up to 1,000 mg/kg-day aluminium hydroxychloride (a structurally similar compound) in a combined repeated dose toxicity and reproductive/developmental toxicity screening (OECD 422) study. Dialuminium chloride pentahydroxide is not genotoxic.

B. Acute Toxicity

No oral acute toxicity studies are available for dialuminium chloride pentahydroxide. The oral LD_{50} of aluminium hydroxychloride in rats is >2,000 mg/kg (ECHA) [Kl. score = 2].

The dermal LD_{50} of dialuminium chloride pentahydroxide in rats is >2,000 mg/kg (ECHA) [Kl. score = 2].

C. Irritation

No skin irritation studies area available for dialuminium chloride pentahydroxide. Application of 0.5 mL of aluminum hydroxychloride to the skin of rabbits for 4 hours under semi-occlusive conditions was not irritating. The mean of the 24, 48 and 72 hour scores were zero for both erythema and edema (ECHA). [Kl. score = 1]

Dialuminium chloride pentahydroxide was slightly irritating to the eyes of rabbits. The mean of the 24, 48, and 72-hour conjunctival redness scores was 1.00; all other parameters were zero (ECHA). [Kl. score = 1]

D. Sensitization

Dialuminium chloride pentahydroxide was not a skin sensitizer in a guinea pig maximisation test (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

Oral

No studies are available on dialuminium chloride pentahydroxide.

Aluminium chloride, basic (aluminium hydroxychloride) was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg aluminium chloride, basic; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There were no effects in the females at any dose level. In males, there were effects indicative of stomach irritation at the high-dose; no other effects were noted. The NOAEL for systemic effects in this study is 1,000 mg/kg-day, the highest dose tested. The NOAEL for localized effects (site-of-contact) is 200 mg/kg-day (ECHA). [Kl. score = 2]

Inhalation

No adequate studies were located.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

Dialuminium chloride pentahydroxide was not mutagenic to *S. typhimurium* strains TA98, TA100, TA1535, TA1537 and *E. coli* strain WP2*uvr*A in the absence or presence of metabolic activation (ECHA). [Kl. score = 1]

The *in vitro* genotoxicity studies on the structurally similar compound aluminium hydroxychloride is shown below in table 2.

Table 2: *In Vitro* Genotoxicity Studies on Aluminium Hydroxychloride

Test System	Results*	Klimisch	Reference

	-S9	+S9	Score	
Bacterial reverse mutation (S. typhimurium and E. coli strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Micronucleus (peripheral human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

Male and female NMRI mice were given an oral gavage dose of 0 or 2,000 mg/kg dialuminium chloride pentahydroxide on two consecutive days. There were no increases in the frequency of micronucleated polychromatic erythrocytes in the bone marrow of the treated mice compared to the controls (ECHA). [Kl. score = 1]

G. Carcinogenicity

No studies are available.

H. Reproductive/Developmental Toxicity

No studies are available for dialuminium chloride pentahydroxide.

Aluminium chloride, basic (aluminium hydroxychloride) was tested in a combined repeated dose toxicity and reproductive/developmental screening toxicity (OECD 422) study. Male and female Wistar rats were dosed by oral gavage with 0, 40, 200, or 1,000 mg/kg aluminium chloride, basic; these doses correspond to 0, 3.6, 18, or 90 mg/kg-day aluminium. There was no reproductive or developmental toxicity at any dose level. The NOAELs for reproductive and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Oral

Toxicological reference values were not derived for dialuminium chloride pentahydroxide.

The Australian drinking water guideline values for aluminium (acid-soluble) is 0.2 mg/L based on aesthetics. ADWG has concluded that there is insufficient data to set a guidance value based on health considerations (ADWG, 2011).

The Australian drinking water guidance value for chloride is 250 mg/L based on aesthetics (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Dialuminium chloride pentahydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability

- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

Acute Studies on Aluminium Polychlorohydrate

The 96-hr LC_{50} for aluminium polychlorohydrate in *Danio rerio* was determined to be 142 mg/L nominal. For dissolved aluminium, the 96-hr LC_{50} was 0.58 mg/L. A very steep concentration-effect relationship was observed for the test substance; this was due to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance (ECHA). [Kl. score = 2]

The 96-hr LC_{50} for aluminium polychlorohydrate in *Danio rerio* was determined to be 186 mg/L nominal. For dissolved aluminium, the 96-hr LC_{50} was 1.39 mg/L, corresponding to 16.9 mg/L Total Al (measured values). A very steep concentration-effect relationship was observed for the test substance; this was due to the increase in solubility of aluminium as a result of the drop in pH from the increasing concentration of the test substance. Theoretically, 186 mg/L of aluminium polychlorohydrate reduced the pH of reconstituted water to a level which enabled 1.4 mg Al/L to be dissolved. (ECHA). [Kl. score = 2]

The 96-hr EC_{50} and NOEC for aluminium polychlorohydrate in *Danio rerio* were determined to be >0.357 mg/L measured as dissolved Al (equivalent to 91.5 Total Al). The NOEC was >1,000 mg/L nominal, which is equivalent to 91.5 mL Total Al. In this study, the pH of the test media was maintained at 7.5 (ECHA). [Kl. score = 1]

The 48-hr EC_{50} for aluminium polychlorohydrate in *Daphnia magna* is 98 mg/L nominal and 7.8 mg/L measured (ECHA) [Kl. score = 2]. Another study reported 48-hr EC_{50} values for dialuminium chloride pentahydroxide of 38 mg/L nominal and 3.45 mg/L measured (ECHA) [Kl. score = 2].

The 72-hr EC_{50} for growth rate in *Pseudokidrchneriella subcapitata* was 14 mg/L nominal, which was equivalent to 0.644 mg/L as Total Al. The average measured concentrations of dissolved Al were 0.24 mg/L at a pH between 7.1 and 8.4. The EC_{10} for growth rate was 0.14 mg/L as Total Al and 0.051 mg/L based on measured Al. The NOEC for growth inhibition was nominally 1.0 mg/L (0.046 mg/l based on Total Al and <0.02 mg/L when based on measured Al (ECHA). [Kl. score = 1]

Data used by ANZECC for Aluminium water quality guideline

In developing a water quality guideline for aluminium (ANZECC 2000), ANZECC separated the screened freshwater toxicity data into those conducted at pH >6.5 and those at pH <6.5. These data are summarised below (it should be noted that only the acute toxicity data was used to derive a water quality guideline):

Freshwater pH >6.5:

Fish

The 48-96 hour LC_{50} values for 5 species were 600 to 106,000 µg/L (the lowest value was for *Salmo salar*). The chronic 8- to 28-day NOEC equivalents[1] from seven species were 34-7,100 µg/L. The lowest measured chronic value was an 8-day LC_{50} for *Micropterus* species of 170 µg/L.

Amphibian

The 96-hour LC_{50} values for *Bufo americanus* were 860-1,660 µg/L. The chronic 8-day LC_{50} for *Bufo americanus* was 2,280 µg/L.

Crustacean

The 48-hour LC_{50} values for one species were 2,300-36,900 µg/L. The chronic 7- to 28-day NOECs were 136-1,720 µg/L.

Algae

The 96-hour EC_{50} values were 460-570 µg/L based on population growth. The NOECs for two species were 800-2,000 µg/L.

Freshwater pH<6.5 (all between pH 4.5 and 6.0):

Fish

The 24-96-hour LC_{50} values for two species were 15-4,200 µg/L (the lowest value was for *Salmo trutta*). The 21- to 42-day LC_{50} values were 15-105 µg/L,

Amphibian

The 96- to 120-day LC_{50} values were 540-2,670 µg/L; the absolute range was 400-5,200 µg/L.

Algae

The NOEC from one species was 2,000 µg/L based on growth.

[1]Chronic toxicity values were a mixture of LC/EC_{50} LOEC, MATC, and NOEC values; where stated, these were converted to NOEC equivalents.

B. Terrestrial Toxicity

A study equivalent to the earthworm acute toxicity (OECD TG 207) test was conducted on sulfuric acid, aluminium salt (3:2), octadecahydrate (CAS No. 7784-31-8). The 14-day LC_{50} to earthworm *Eisenia andre*i is 316 mg/kg soil dry weight (van Gestel and Hoogerwerf, 2001; ECHA). [Kl. score = 2]

C. Calculation of PNEC

PNEC water

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of trigger values for aluminium. The guideline for freshwater is: *"A freshwater moderate reliability trigger value of 55 µg/L for aluminium at pH >6.5 using the statistical distribution method (Burr distribution as modified by SCIRO, Section 8.3.3.3) with 95% protection and an ACR of 8.2.*

"A freshwater low-reliability trigger value of 0.8 µg/L was derived for aluminium at pH of <6.5 using an AF of 20 (essential element) on the low pH trout figure."

"The low-reliability figures should only be used as indicative interim working levels."

PNEC sediment

No experimental toxicity data on sediment organisms are available. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as dialuminium chloride pentahydroxide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of dialuminium chloride pentahydroxide to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of dialuminium chloride pentahydroxide is dominated by its water solubility. Sorption of dialuminium chloride pentahydroxide should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as dialuminium chloride pentahydroxide. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, dialuminium chloride pentahydroxide is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Dialuminium chloride pentahydroxide is an inorganic compound that dissociates in water to form chloride ions and various species of aluminium hydroxide hydrolysis. Biodegradation is not applicable to dialuminium chloride pentahydroxide. Both chloride ions and aluminium hydroxide ionic species can be found naturally in the environment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic compound.

Fish accumulate aluminium in and on the gill, and it has been suggested that the rate of transfer of aluminium into the body is either slow or negligible under natural environmental conditions. Chloride ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, dialuminium chloride pentahydroxide and its dissociated ions are not expected to meet the criteria for bioaccumulation.

The lowest chronic NOEC value in fish for aluminium is <0.1 mg/L; thus, the dissolved aluminium from dialuminium chloride pentahydroxide meets the screening criteria for toxicity.

The overall conclusion is that dialuminium chloride pentahydroxide is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

No classification.

B. Labelling

No signal word.

C. Pictogram

None.

X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on the conditions, decomposition products may include the following: hydrogen chloride.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

D. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Keep away from acids and oxidising agents.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has established an occupational exposure standard of 2 mg/m^3 as an 8-hour TWA for aluminium, soluble salts (as Al).

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Dialuminium chloride pentahydroxide is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WHO	World Health Organisation
µm	micrometre

DIETHYLENE TRIAMINE PENTA(METHYLENE PHOSPONIC ACID), SODIUM SALT

This dossier on diethylene triamine penta(methylene phosphonic acid), sodium salt (DTPMP sodium salt) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of DTPMP in its use in water treatment systems. The information presented in this dossier was obtained primarily from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA), and from the OECD-SIDS documents on the Phosphonic Acid Compounds Group 3 category, which includes DTPMP and its sodium salts (OECD, 2004a,b). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): [bis[2-[bis(phosphonomethyl)amino]ethyl]amino]methylphosphonic acid; sodium salt

CAS RN: 22042-96-2

Molecular formula: $C_9H_{28}N_3O_{15}P_5.xNa$

Molecular weight: Not applicable. This substance is a UVCB substance.

Synonyms: Diethylene triamine penta(methylene phosphonic acid), sodium salt; [[(phosphonomethyl)imino]bis[(ethylenenitrilo)bis(methylene)]]tetrakisphosphonic acid, sodium salt; [bis[2-[bis(phosphonomethyl)amino]ethyl]amino]methylphosphonic acid; sodium salt

SMILES (for DTPMP):
O=P(O)(O)CN(CCN(CP(=O)(O)O)CP(=O)(O)O)CCN(CP(=O)(O)O)CP(=O)(O)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of DTPMP sodium salt

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Brown liquid	2	ECHA
Melting Point	>450°C (DTPMP)	1	ECHA
Boiling Point	>480°C (DTPMP)	1	ECHA
Density	1.3 to 1.4 g/cm^3 (DTPMP)	2	ECHA
Vapor Pressure	Negligible	2	ECHA
Partition Coefficient (log	-3.4 (DTPMP)	2	ECHA

K_{ow})			
Water Solubility	>520 g/L @ 25°C (DTPMP)	2	ECHA

DTPMP can ionize by loss of a hydrogen ion up to six times. Thus, it is a strong complexing agent and is highly hydrophilic. The sodium salts of DTPMP will dissolve readily in water to give a speciation state that is dictated by the pH of the aqueous medium. DTPMP has ten possible ionization states. Eight pK_a values were reported by Martell and Sillen (1968): 2.8, 4.45, 5.5, 6.38, 7.17, 8.15, 10.1, and 12.04, which were measured in 0.1 M potassium chloride. In a source giving no experimental details, DTPMP is described as having ten pK_a values: 1.03, 2.08, 3.11, 4.15, 5.19, 6.23, 7.23, 8.30, 11.18, and 12.58 (Tomson et al., 1994).

At pH7, DTPMP in water will be almost fully ionized five times, with a majority of the molecules ionized six times, and some seven or eight times.

Diethylene triamine penta(methylene phosphonic acid), sodium salt (CAS No. 22042-96-2) is a UVCB substance that can potentially have 1-10 sodium salts.

This dossier contains information on DTPMP as well as the sodium salts of DTPMP. The read-across of the acid to the sodium salts is justified because sodium is not significant with respect to the properties under consideration in this dossier. In dilute aqueous conditions of defined pH, a salt will be completely dissociated and will behave no differently to the parent acid, at identical concentration of the particular speciated form present. Thus, some properties (measured or expressed in aqueous media) for a salt can be directly read-across (with suitable mass correction) to the parent acid and vice versa; the effect of the sodium ion, in this case, will not be significant. In biological systems and the environment, polyvalent metal ions will be present, and the phosphonate ions show very strong affinity to them (OECD 2004b).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

DTPMP sodium salt is not biodegradable and it adsorbs significantly to sediment and soil.
DTPMP sodium salt has a low potential for bioaccumulation.

C. Biodegradation

In a Zahn-Wellens/EMPA (OECD 302B) test, there was no biodegradation after 28 days (ECHA) [Kl. score = 2]. There was also no biodegradation after 28 days in an OECD 301E test (ECHA) [Kl. score = 1].

Using [^{14}C]-DTPMP, there was 64% and 62.6% biodegradation in river bank soil and silt loam soil, respectively, after 148 days (ECHA) [Kl. score = 2].

D. Environmental Distribution

<u>Adsorption/desorption</u>

DTPMP adsorbs strongly to inorganic surfaces, soils, and sediments. The nature of the adsorption is believed to be primarily due to interaction with inorganic substrates and not to organic carbon (OECD 2004b).

A K_{oc} value of 9,748 was obtained for DTPMP by evaluating $K_{p(sediment\text{-}water}$ data from a study by Michael (1979).

E. Bioaccumulation

DTPMP exhibits a low potential for bioaccumulation. After 28 days, the BCF values in carp were <10 and <94 for concentrations of 18.8 and 2.03 mg/L, respectively (ECHA). [Kl. score = 1

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of DTPMP sodium salt is low by the oral and dermal routes. DTPMP sodium salt is slightly irritating to the skin and non-irritating to the eyes. DTPMP (and presumably its sodium salt) is not a skin sensitizer. Rats given repeated oral doses of DTPMP sodium salt in the diet showed alterations in iron and calcium homeostasis as evidenced by certain hematological changes and bone density, respectively. The changes in calcium homeostasis was not sufficient to alter serum calcium levels. While one in vitro genotoxicity study showed a positive response, other genotoxicity studies conducted both in vitro and in vivo showed no mutagenic or genotoxic response. Rat studies given high oral DTPMP by oral gavage showed a low potential for reproductive and developmental toxicity.

B. Acute Toxicity

The oral LD_{50} of the heptasodium salt of DTPMP (CAS No. 68155-78-2) in rats was >10 mL/kg, which was calculated to be equivalent to >5,838 mg active salt/kg (ECHA) [Kl. score = 1]. The oral LD_{50} of a heptasodium salt of DTPMP was <15 mL/kg or <6,881 mg active salt/kg (ECHA) [Kl. score = 1]. The oral LD_{50} of a heptasodium salt of DTPMP was >5,000 mg/kg or >1,650 mg active salt/kg (ECHA) [Kl. score = 2]. The oral LD_{50} of a heptasodium salt of DTPMP was >9,000 mg/kg or >3,870 mg active salt/kg (ECHA) [Kl. score = 2].

No inhalation studies are available.

The dermal LD_{50} of a sodium salt of DTPMP was >10 mL/kg, which was calculated to be >5,838 mg active salt/kg or >4,602 mg parent acid/kg (ECHA) [Kl. score = 1]. The dermal LD_{50} of a sodium salt of DTPMP was >2,000 mg/kg, which was calculated to be >860 mg active salt/kg (ECHA) [Kl. score = 2]. The dermal LD_{50} of a heptasodium salt of DTPMP was >5 mL/kg, which was calculated to be >2,145 mg active salt/kg (ECHA) [Kl. score = 2].

C. Irritation

Application of 0.5 mL DTPMP sodium salt to the skin of rabbits for four hours under semi-occlusive conditions was very slightly irritating. The primary dermal irritation index was 0.75 (ECHA). [Kl. score = 1]

Instillation of 0.1 mL DTPMP sodium salt into the eyes of rabbits was not irritating (ECHA). [Kl. score = 1]

D. Sensitization

DTPMP was not a skin sensitizer in a guinea pig maximization test (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

Oral

Male and female Wistar rats were given in their diet 0, 100, 1,000, or 10,000 ppm DTPMP sodium salt for 90 days. The calculated daily intakes were: 0, 8.2, 82.3, and 841.9 mg/kg-day for males; and 0, 9.2, 92.3, and 902.6 mg/kg-day for females. There were no deaths during the study. At 10,000 ppm, minor changes were seen in hematological parameters (red blood cell count was significantly increased; mean cell volume and mean cell hemoglobin concentration were significantly decreased). Total serum iron was decreased in the 10,000 ppm females only, while total serum iron binding capacity was increased in the 10,000 ppm males only. A reduction in iron complexes and reduced pigmentation for age was noted in the spleens of the 10,000 ppm animals. The changes in hematological parameters and serum iron and binding capacity were considered by the study authors to be perturbations of iron homeostasis as a result of the iron binding capacity of DTPMP, which is a chelating agent. Bone density was significantly increased in both sexes in the 10,000 ppm dose group, and the incidence of microlithiasis (formation of minute calculi) in the kidney was reduced in all dose groups; these changes were considered indicative of the effect of the test material on calcium homeostasis due to its chelating ability. There was, however, no change in calcium plasma levels. The NOAEL for this study is 1,000 ppm based on the changes in hematology and bond density; this corresponds to 82.5 and 92.3 mg/kg-day for males and females, respectively (ECHA, HERA). [Kl. score = 1]

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

The results of the *in vitro* genotoxicity studies on DTPMP sodium salts is presented in Table 2.

In Vitro Studies

Table 2: *In vitro* Genotoxicity Studies on DTPMP sodium salts

Test System	Results*		Klimisch Score	References
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA, OECD (2004a,b)
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	2	ECHA, OECD (2004a,b)
Chromosomal aberration (Chinese hamster lung cells)	**	**	1	ECHA

*+, positive; -, negative

**For the 6-hour pulse treatment and the 24-hour continuous treatment, the results were negative with and without metabolic activation. For the 48-hour continuous treatment, the results were positive, but no information is provided on whether this occurred with and/or without metabolic activation.

In Vivo Studies

Male and female SD rats were given a single oral dose of an aqueous solution containing 19.7% DTPMP (neutralized to pH 7) at doses of 0, 200, 660, and 1,970 mg active acid/kg. At the high dose, 25% of the animals died; there was mild clinical signs of toxicity; and reduced body weights in both sexes. There was no evidence of chromosomal aberrations in the bone marrow cells in either sex at any dose level (ECHA; OECD, 2004a,b). [Kl. score = 2]

G. Carcinogenicity

No studies are available.

H. Reproductive Toxicity

A reproductive toxicity study was conducted on DTPMP in rats via the diet. The females were treated over two generations and males over one generation. concentrations were 0, 300, 1,000, and 3,000 ppm; the daily intakes were calculated to be 0, 28, 97, and 294 mg/kg-day for males and 0, 32, 108, and 312 mg/kg-day for females. The 3,000 ppm F_0 females delivered fewer live pups with lower body weights (both effects were not statistically significant). Pregnancy rate (not statistically significant) and a reduced pup weight (statistically significant) was seen in the F_{2a} litters from the 3,000 ppm dams. These changes were not seen in the F_1 litters or replicated in the F_{2b} litters. The NOAEL for reproductive toxicity was determined to be 3,000 ppm, which corresponds to 294 and 312 mg/kg-day for males and females, respectively (ECHA; OECD 2004a,b). [Kl. score = 2]

A three-generation reproductive toxicity study was conducted on DTPMP in rats via the diet. The concentrations were 0, 300, 1,000, and 3,000 ppm. There was no systemic, reproductive or developmental toxicity at any dose level. The NOAEL for this study is 3,000 ppm, which was calculated to be 275 mg/kg-day for males and 310 mg/kg-day for females (ECHA). [Kl. score = 2]

I. Developmental Toxicity

Pregnant female SD rats were dosed by oral gavage with 0, 500, 1,000, or 2,000 mg/kg DTPMP during GD 6-15. Toxicity was observed in the 2,000 mg/kg dams as evidenced by an approximate 30% decrease in body weight gain and by the appearance of soft stools. There was no developmental toxicity. The NOAELs for maternal and developmental toxicity were 1,000 and 2,000 mg/kg-day, respectively (ECHA; OECD 2004a,b). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with 0, 100, 500, or 1,000 mg/kg DTPMP during GD 6-15. There were no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity is 1,000 mg/kg-day, the highest dose tested (ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for DTPMP sodium salt 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, 2011).

A. Non-Cancer

Oral

A 90-day dietary study was conducted on a sodium salt of DTPMP using rats. The rats of both sexes showed changes in hematology and bone density that were indicative of alterations in iron and calcium homeostasis, due to the chelating ability of DTPMP. The NOAEL for this study was 10,000 ppm, which corresponds to 82.5 and 92.3 mg/kg-day for males and females, respectively. The NOAEL of 92.3 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 82.5/(10 x 10 x 1 x 3 x 1) = 82.5/300 = 0.3 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (0.3 x 70 x 0.1)/2 = 1.0 mg/L

B. Cancer

There are no carcinogenicity studies on DTPMP and its sodium salts. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

DTPMP sodium salt does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

DTPMP and its sodium salts are of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No acute toxicity studies are available for the sodium salts of DTPMP. Table 3 lists the results of acute aquatic toxicity studies on DTPMP.

Table 3: Acute Aquatic Toxicity Studies on DTPMP

Test Species	Endpoint	Results (mg active acid/L)	Klimisch score	Reference
Oncorhynchus mykiss	96-h LC_{50}	180 - 252 (mean: 216)	2	ECHA

Chironomus tentans	48-h EC_{50}	7,589	2	ECHA

Algal studies have also been conducted on DTPMP and its sodium salts, but the results have not been provided because of the following confounding factors:

a). Algal growth may be stimulated by the presence of supplementary phosphorus released by the photolytic degradation of phosphonic acids.

b.) Algal growth may be inhibited by the complexation of micronutrients (trace metals) by phosphonic acids. This inhibition is an algistatic rather than algicidal effect. Under the standard test conditions used for most studies, the trace metals will be fully and strongly bound to the DTPMP, with the strong possibility that their bioavailability will have been reduced considerably.

Chronic Studies

The 60-d NOEC of DTPMP in *Oncorhynchus mykiss* was determined to be 25.6 mg active acid/L (ECHA). [Kl. score = 1]

The value of 25.6 mg equivalent active acid/L can be converted to units of mg DTPMP-xNa salt/L at relevant conditions of pH by considering the ionization state of DTPMP (CAS No. 15827-60-8) at the 25.6 mg/L concentration. At pH 6 (the expected value of the test medium), DTPMP is ionized six times (pK_a6 = pH 6.23). Also for the calculation, the number of hydrogen atoms substituted by the sodium salt is removed, which is seven. The calculation is as follows:

mwt of DTPMP-7Na / mwt of DTPMP = 573.2 + ((21.982 – 1.008) x 6) / 573.2 = 1.22

25.6 mg DTPMP/L x 1.22 = 31 mg DTPMP-xNa/L

C. Terrestrial Toxicity

The 14-day dietary LC_{50} values to the Mallard duck (*Anas platyrhynchos*) and Bobwhite Quail (*Colunus virginianus*) are >454 mg/kg; there was no mortality at the highest dose tested (OECD 2004a,b).

D. Calculation of PNEC

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

PNEC water

Experimental results are available for two trophic levels for DTPMP, but not for the sodium salts of DTPMP. Acute $E(L)C_{50}$ values are available for fish (216 mg/L) and invertebrates (7,589 mg/L). Results are available for a fish chronic study (31 mg DTPMP sodium salt/L). On the basis that the data consists of short-term and long-term results from two trophic levels, an assessment factor of 100 has been applied to the chronic NOEC of 31 mg/L for fish. The $PNEC_{water}$ is 0.31 mg DTPMP sodium salt/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 46 mg DTPMP sodium salt/kg sediment wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (188/1280) \times 1000 \times 0.31$
$= 46$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times (Kp_{sed}/1000) \times BD_{solid}]$
$= 0.8 + [0.2 \times (390/1000) \times 2400]$
$= 188$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 9{,}748 \times 0.04$
$= 390$

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for DTPMP was estimated to be 9,748 (ECHA).
F_{oc} = fraction of organic carbon in sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ is 40 mg DTPMP sodium salt/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (195/1500) \times 1000 \times 0.31$
$= 40$

Where:
Kp_{soil} = soil-water partition coefficient (m^3/m^3)
BD_{soil} = bulk density of soil (kg/m^3) = 1,500 [default]

$Kp_{soil} = K_{oc} \times f_{oc}$
$= 9{,}748 \times 0.02$
$= 195$

Where:
K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for DTPMP was estimated to be 9,748 (OECD 2004a,b).
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

DTPMP and its sodium salts are not readily biodegradable; thus, it meets the screening criteria for persistence.

The BCF values from a fish study are <10 and <94 for concentrations of 18.8 and 2.03 mg/L, respectively. Thus, DTPMP does not meet the screening criteria for bioaccumulation.

The NOEC from a chronic fish study on DTPMP is >0.1 mg/L. Thus, DTPMP and its sodium salts do not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Metal Corrosive Category 1

B. Labelling

Warning

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately.

Skin Contact
Wash thoroughly with soap and water.

Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion
Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. Do not induce vomiting. If symptoms develop, seek medical advice.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards
May emit toxic fumes under fire conditions. Decomposition products may include the following materials: carbon monoxide carbon dioxide nitrogen oxides phosphorus oxides, phosphine

Special Protective Equipment for Firefighters
Wear self-contained breathing apparatus and chemical-protective clothing.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Use appropriate protective equipment. Handle in accordance with good industrial hygiene and safety practice.

Environmental Precautions
Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled
For large amounts: dike spillage and pump off product. For residues: pick up with suitable absorbent material. Dispose of contaminated material as prescribed.

D. STORAGE AND HANDLING

General Handling
Avoid prolonged or repeated contact with skin. Wash hands thoroughly after handling or contact.

Storage
Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

Suitable materials: glass lining, PVC, polypropylene, glass reinforced plastic, polyethylene. Unsuitable materials: mild steel, carbon steel, aluminum, other metals.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for DTPMP and its sodium salts.

Engineering Controls
None

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Chemical resistant protective gloves.

Skin *Protection*:
Body protection must be chosen depending on activity and possible exposure.

Eye protection*:*
Safety glasses with side-shields.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Australian Dangerous Goods
UN 3265 CORROSIVE LIQUID, ACIDIC, ORGANIC N.O.S. (diethylene triamine penta(methylene phosphonic acid) sodium salt)
Class: 8
Packing Group: III

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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HYDROGEN PEROXIDE

This dossier on hydrogen peroxide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of hydrogen peroxide in its use in water treatment systems. 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Hydrogen peroxide

CAS RN: 7722-84-1

Molecular formula: H_2O_2

Molecular weight: 34.0

Synonyms: Hydrogen peroxide; hydrogen dioxide; dihydrogen dioxide

SMILES: OO

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Hydrogen Peroxide

Property	**Value**	**Klimisch score**	**Reference**
Physical state at 20°C and 101.3 kPa	Colorless, clear liquid without odor	1	ECHA
Melting Point	-0.43°C (pure H_2O_2)	2	ECHA
Boiling Point	150°C (pure H_2O_2)	2	ECHA
Density	1.71 g/cm^3 @ -20°C (pure H_2O_2) 1.29 g/cm^3 @ 20°C (70% soln) 1.2 g/cm^3 @ 20°C (50% soln)	2	ECHA
Vapor Pressure	1.95 mmHg @ 25°C (pure H_2O_2) 200 Pa @ 30°C (70% soln)	2	ECHA

	99 Pa @ 30°C (50% soln)		
Partition Coefficient (log K_{ow})	-1.57 (QSAR)	2	ECHA
Water Solubility	"Miscible in all proportions"	2	ECHA
pK_a	11.62 @ 25°C	2	EU, 2003
Viscosity	1.249 mPa/s (pure H_2O_2)	2	ECHA
Henry's Law Constant	0.0075 Pa*m^3 /mol	2	EU, 2003

Hydrogen peroxide is normally handled as an aqueous solution. Commercial solutions must be stabilized with additives to prevent possible violent decomposition due to catalytic impurities or elevated temperatures and pressure. (EU, 2003).

Hydrogen peroxide can decompose explosively. At atmospheric pressures, vapors containing ≥26 mol% can be exploded by a spark, by contact with catalytically active materials initially at room temperature, or by "non-catalytic" materials at elevated temperatures. Because of the high relative volatility of water to hydrogen peroxide, the danger of vapor phase explosion on storage of liquid hydrogen peroxide will be encountered only at >74% solutions at elevated temperatures. At >86 wt%, the liquid can be made to explode (EU, 2003)

Hydrogen peroxide is used widely as an oxidizing and a reducing agent.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Hydrogen peroxide is normally a short-lived substance in the environment. It is biologically degraded by an enzyme-mediated process, which is rapid and can be considered equivalent to readily biodegradation. Abiotic degradation of hydrogen peroxide is also an important process, involving transition metals, reaction with itself, organic compounds that can react with hydrogen peroxide, and other factors such as heat and sunlight.

B. Abiotic Degradation

Hydrogen peroxide decomposes into water and oxygen at rates which depend on contact with catalytic materials, such as metals (transition and heavy), activated carbon, and enzymes; and other factors, such as heat and sunlight (EU, 2003).

Pure aqueous solutions of hydrogen peroxide are relatively stable. Stability increases with increasing concentration. Stability of pure hydrogen peroxide in pure water is pH-dependent. Decomposition is acid and alkali induced. Stability is at a maximum at pH 3.5 to 4.5 and decomposition rates are highest in alkaline solution (EU, 2003)

Hydrogen peroxide may react as an oxidant, as a reductant, or form additional compounds. Hydrogen peroxide does react easily with various functional groups. Most aromatic and aliphatic amines as well as most aldehydes do react with hydrogen peroxide. Hydrogen peroxide reacts with many organic acids to form peracids. Peracid formation in the aquatic environment is an equilibrium reaction (EU, 2003).

C. Biodegradation

Hydrogen peroxide is biologically degradable. The catalase enzyme that metabolizes hydrogen peroxide to water and oxygen is found in most aerobic bacteria. Degradation is initiated when hydrogen peroxide comes in contact with microbial material (EU, 2003).

Hydrogen peroxide was tested in a respiration inhibition test (OECD 209) using activated sludge from a primarily domestic wastewater treatment plant. This test was used for hydrogen peroxide since the standard biodegradation tests cannot be used for inorganic substances. Rapid, biologically mediated decomposition of hydrogen peroxide was found in municipal sewage sludge, with a half-life of $\leq$2 minutes. These results would suggest that hydrogen peroxide should be classified as readily biodegradable, fulfilling the 10-day window (ECHA). [Kl. score = 2]

The biodegradation rates of hydrogen peroxide have been studied in natural waters. The summer time degradation rate of hydrogen peroxide was studied in lake water from Ontario, Canada. The half-life of hydrogen peroxide was 7.8 hours for unfiltered lake water. It was determined using different filter sizes that the fraction containing picoplankton was responsible for the major proportion of the biological agent responsible for the degradation of hydrogen peroxide (Eu, 2003. Half-lives of between 14.7 and 21.6 hours was measured for hydrogen peroxide in Lake Ontario water. It was determined that bacteria and/or algae were the major agents for the decline in hydrogen peroxide concentrations (EU, 2003).

Hydrogen peroxide is a short-lived substance in soil. Rapid degradation will occur due to high concentration of catalytic material, such as metals, enzymes, easily oxidized/reduced organic substances and living microbes (EU, 2003). The decomposition rate of hydrogen peroxide was found to be first-order with a half-life of four hours in a test using soil from a contaminated site (ECHA).

D. Environmental Distribution

<u>Adsorption/desorption</u>

No experimental data are available for hydrogen peroxide. It is expected to have a low potential for adsorption to soil and sediment because it is highly polar substance with high water solubility.

E. Bioaccumulation

Hydrogen peroxide is not expected to bioaccumulate because it is a reactive polar substance. Moreover, the estimated log K_{ow} is -1.57 (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Hydrogen peroxide has moderate acute toxicity by the oral and inhalation routes and low acute toxicity by the dermal route. Depending on the concentration, solutions of hydrogen peroxide are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapours from aqueous solutions of hydrogen peroxide can cause respiratory irritation. Hydrogen peroxide is not a skin sensitizer. Repeated oral doses of a hydrogen peroxide solution in drinking water resulted in mucosal hyperplasia of the duodenum (small intestine) in male and female rats; no other effects were seen in the gastrointestinal tract or in other organs. Repeated inhalation exposures to hydrogen peroxide resulted in an inflammatory response in the larynx of male and female rats but not in any other locations of the respiratory tract, including the lung. In vitro genotoxicity tests have shown positive responses with hydrogen peroxide; however, in vivo studies are negative for genotoxicity. There are no adequate carcinogenicity, reproductive, or developmental toxictiy studies on hydrogen peroxide.

B. Acute Toxicity

The oral LD_{50} values of hydrogen peroxide (as 70% w/w aqueous solution) in rats are 1,026 mg/kg for males and 694 mg/kg for females (ECHA) [Kl. score = 1]. The oral LD_{50} values of hydrogen peroxide (as 35% w/w aqueous solution) in rats are 1,193 mg/kg for males and 1,270 mg/kg for females (ECHA) [Kl. score = 1].

The 4-hour LC_{50} value of an aerosol of a 50% aqueous solution of hydrogen peroxide in rats is >170 mg/m^3 (ECHA). [Kl. score = 1]

The acute dermal LD_{50} value of a 35% solution of hydrogen peroxide in rabbits is >2,000 mg/kg (ECHA). [Kl. score = 1]

C. Irritation

Application of a 0.5 mL of a 10% aqueous solution of hydrogen peroxide to the skin of rabbits for 4 hours under semi-occlusive conditions was essentially non-irritating. The mean of the 24, 48, and 72 hour scores were: 0.08 for erythema and 0.00 for edema (ECHA) [Kl. score = 1]. Application of a 0.5 mL of a 35% aqueous solution of hydrogen peroxide to the skin of rabbits for 4 hours under semi-occlusive conditions was irritating. The mean of the 24, 48, and 72 hour scores were: 1.6 for erythema and 0.4 for edema (ECHA) [Kl. score = 1].

Instillation of 0.1 mL of a 3% aqueous solution of hydrogen peroxide into the eyes of rabbits was not irritating (ECHA) [Kl. score = 2]. Instillation of 0.1 mL of a 5% aqueous solution of hydrogen peroxide into the eyes of rabbits was slightly irritating. The mean of the 24, 48, and 72 hour scores were: 0.0 for corneal opacity; 0.00 for iridial lesions; 1.25 for conjunctival redness; and 0.00 for chemosis (ECHA) [Kl. score = 1]. Instillation of 0.1 mL of a 6% aqueous solution of hydrogen peroxide into the eyes of rabbits was irritating. There was slight to severe irritation in the unwashed or washed eyes of the tested animals, which were reversible in most animals within 72 hours following treatment. The treated eye in one animal was normal after 7 days. Moderate to severe corneal damage was seen in one rabbit (ECHA) [Kl. score = 2]. Instillation of 0.1 mL of a 10% aqueous solution of hydrogen peroxide into the eyes of rabbits was extremely irritating (ECHA) [Kl. score = 1].

D. Sensitization

Hydrogen peroxide (as a 3% aqueous solution) was not a skin sensitizer to guinea pigs in a Magnusson-Kligman test (EU, 2003; ECHA). [Kl. score = 4]

E. Repeated Dose Toxicity

Oral

Male and female C57BL/6NCRIBR mice were given 35% aqueous solution of hydrogen peroxide in their drinking water for 90 days. Additional groups of animals were exposed for 90 days followed by a 6-week recovery period. The concentrations of hydrogen peroxide in the drinking water were 0, 100, 300, 1,000, or 3,000 ppm. The daily intakes were: 0, 26, 76, 239, and 547 mg/kg-day for males; and 0, 37, 103, 328, and 785 mg/kg-day for females. The strain of mouse was chosen because of their particular sensitivity to hydrogen peroxide due to a deficiency in the detoxification pathway of hydrogen peroxide. There were no deaths or clinical signs related to treatment. The 3,000 ppm males had significantly reduced body weights and body weight gain from Day 42 to the end of the exposure period. Feed and water consumption was significantly reduced in the 3,000 ppm animals, and in the 1,000 ppm females. At 300 ppm, there was a significantly reduction of feed and water consumption on Day 35 of the study, but not at Day 63 or at

the end of the exposure period. Total serum protein and serum globulin were significantly reduced in the 3,000 ppm males. Histopathological examination showed mild mucosal hyperplasia of the duodenum of the small intestine in 8/9 of the 3,000 ppm males and in 7/10 of the 1,000 ppm males. Minimal mucosal hyperplasia was also noted in 1/10 of the 300 ppm males. Minimal to mild mucosal hyperplasia was seen in 10/10 of the 3,000 ppm females and in 8/10 of the 1,000 ppm females. There were no other histopathologic effects in the gastrointestinal tract or in other organs. All effects were reversed following the 6-week recovery period. The NOAEL for systemic toxicity is 1,000 ppm in male mice (corresponding to 239 mg/kg-day). While feed and water consumption were significantly reduced in the 1,000 ppm females, there was no corresponding reduction in body weight or body weight gain (ECHA). [Kl. score = 1]

Inhalation

Male and female Alpk:APfSD (Wistar-derived) rats were exposed by inhalation to 0, 2.03, 10.3, or 23.3 ppm 6 hours/day, 5 days/week for 28 days. Initially, the highest exposure group was 58.1 ppm; the exposure was reduced to 27.3 ppm and finally terminated because of the severity of toxicity of the exposure animals. Clinical signs were indicative of a respiratory tract irritant, and consisted of reddened noses, stains around the nose, and abnormal respiratory noise. In general, the time of onset, the incidence, and the severity of these clinical signs increased with exposure concentration and repeated exposure. The 23.3 ppm males had lower body weight gain and feed consumption. Serum albumin and total protein were significantly reduced in the 23.3 animals. Histopathological changes were seen in the anterior-most regions of the nasal cavity lined with squamous epithelium of the $\geq$10.3 ppm animals; these changes were minimal to slight necrosis (with associated inflammation) and rhinitis. Inflammation and epithelial erosion in the larynx and increased perivascular neutrophil infiltration in the lungs were considered unlikely to be treatment-related because of an absence of a clear dose-response relationship. The NOEC for this study is 2.03 ppm or 2.9 mg/m^3 (ECHA). [Kl. score = 1]

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

A 3% aqueous solution of hydrogen peroxide was not mutagenic to *S. typhimurium* strains TA 1535, TA 1538, TA 1537, and TA 98 or *E. coli* strain WP2 with or without metabolic activation. It was mutagenic to *S. typhimurium* strain TA 100 with and without metabolic activation (Prival et al., 1991).

The *in vitro* cytogenetic studies of hydrogen peroxide were evaluated in the EU Risk Assessment Report (EU, 2003). Ten different studies were assessed which used different

mammalian cell lines (CHO, CHL, CHC, V79, mouse skin cells and splenocytes, human embryonic fibroblasts, D98/AH2 (variant of HeLa) cells) and different endpoints (chromosomal aberration, micronucleus test, chromatid translocations). The studies without metabolic activation in total covered a concentration range from 0.83 μM to 7.35 mM. Only one study is available that evaluated the effect after metabolic activation with S9; the concentration range was 330 mM to 3.3 M. Eight of the 10 studies that tested without metabolic activation gave positive results. These data indicate that hydrogen peroxide has the potential to induce chromosomal aberrations in mammalian cells without metabolic activation.

The *in vitro* gene mutation studies in mammalian cells of hydrogen peroxide were evaluated in the EU Risk Assessment Report (EU, 2003). Eleven different studies were assessed which used different mammalian cell lines (CHO, V79, VC-1, and L5178Y) and different endpoints (HGPRT, thymidine kinase, 6-thioguanine resistance, 6-azaguanidine resistance, ouabain resistance, mutation of the supF locus of the pZ189 plasmid). In total, the studies covered a concentration range from 0.2 μM to 10 mM. Positive results were seen in 7 studies, negative results were seen in 3 studies, and 1 study gave ambiguous results (all without metabolic activation). In the only one study with metabolic activation, there was a negative result. These data indicate that hydrogen peroxide has the potential to induce mutations in mammalian cells without metabolic activation (EU, 2003; ECHA).

In Vivo Studies

Male and female Swiss OF1 mice were given a single intraperitoneal injection of 0, 250, 500, or 1,000 mg/kg hydrogen peroxide. The polychromatic to normochromatic erythrocyte ratio (PCE/NCE) in bone marrow cells was significantly decreased, indicating cytotoxicity. There were no increases in the frequency of micronucleated erythrocytes in the bone marrow of treated animals at any dose level compared to the controls (ECHA) [Kl. score = 1].

Male and female C57BL/6NCr1Br mice were given in their drinking water 0, 200, 1,000, 3,000, or 6,000 ppm hydrogen peroxide for 14 days. The daily intakes were: 0, 42.4, 164, 415, and 536 mg/kg-day for males; and 0, 48.5, 198, 485, and 774 mg/kg-day for females. There were no increases in the frequency of micronucleated erythrocytes in the bone marrow of treated animals at any dose level compared to the controls (ECHA) [Kl. score = 1].

Male Wistar rats were administered intravenously 0, 25 ,or 50 mg/kg hydrogen peroxide. Animals were sacrificed either after 2-4 hours or 12-14 hours. The livers were removed; hepatocytes were prepared in culture; and then treated with [^{3}H]-thymidine. There was no induction of unscheduled DNA synthesis (UDS) in the hepatocytes from treated rats compared to the controls (ECHA) [Kl. score = 2].

G. Carcinogenicity

No adequate studies are available.

H. Reproductive Toxicity

No adequate studies are available.

I. Developmental Toxicity

No adequate studies are available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for hydrogen peroxide 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, 2011).

A. Non-Cancer

Oral

A 90-day drinking water was conducted on hydrogen peroxide using a strain of mouse that is sensitive to hydrogen peroxide because of a deficiency in the detoxication pathway (ECHA). The NOAEL for systemic toxicity is 1,000 ppm in male mice (which corresponds to 239 mg/kg-day). At 3,000 ppm the male rats showed reduced body weights and body weight gain; reduced feed and water consumption; and serum chemistry changes. While reduced water and/or feed consumption were seen in the female mice at 1,000 and 3,000 ppm, there were no corresponding changes in the body weights or body weight gain. Mucosal hyperplasia of the duodenum (small intestine) was seen in the $\geq$1,000 ppm males and females. There were no other histopathologic effects in the gastrointestinal tract or in other organs. The NOAEL of 239 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10

UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 239/(10 x 10 x 1 x 3 x 1) = 239/300 = 1 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (1 x 70 x 0.1)/2 = 3.5 mg/L

B. Cancer

There are no adequate carcinogenicity studies on hydrogen peroxide. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Hydrogen peroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Hydrogen peroxide is moderately toxic to aquatic organisms on an acute and chronic

basis.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies on hydrogen peroxide.

Table 2: Acute Aquatic Toxicity Studies on Hydrogen Peroxide

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Pimephales promelas	96-h LC_{50}	16.4	2	ECHA
Daphnia pulex	48-h LC_{50}	2.4	2	ECHA
Daphnia carinata	48-h EC_{50}	5.6	2	ECHA
Skeletonema costatum	72-EC_{50} NOEC	1.38 0.63	2	ECHA

Chronic Studies

The NOEC from a 21-day *Daphnia* reproduction study on hydrogen peroxide was 0.63 mg/L (ECHA). [Kl. score = 1]

C. Terrestrial Toxicity

No adequate studies are available.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. Acute E(L)C_{50} values are available for fish (16.4 mg/L), invertebrates (2.4 mg/L), and algae (1.38 mg/L). Chronic toxicity studies are available for invertebrates (0.63 mg/L) and algae (0.63 mg/L). On the basis that the data consist of short-term results from three trophic levels and long-term

results from two trophic levels, an assessment factor of 50 has been applied to the NOEC values of 0.63 mg/L for invertebrates and algae. The $PNEC_{water}$ is 0.013 mg/L.

PNEC sediment

No reliable experimental toxicity data on sediment organisms are available. The environmental distribution of hydrogen peroxide is dominated by its water solubility. The K_{oc} parameter does not readily apply to inorganics, such as hydrogen peroxide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sediment}$. Based on its properties, no adsorption of hydrogen peroxide to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No reliable experimental toxicity data on terrestrial organisms are available. The environmental distribution of hydrogen peroxide is dominated by its water solubility. Sorption of hydrogen peroxide should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. The K_{oc} parameter does not readily apply to inorganics, such as hydrogen peroxide. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, hydrogen peroxide is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Hydrogen peroxide is normally a short-lived substance in the environment. It is biologically degraded by an enzyme-mediated process, which is rapid and can be considered equivalent to readily biodegradation. Abiotic degradation of hydrogen peroxide is also an important process. Thus, hydrogen peroxide does meet the criteria for persistence.

Hydrogen peroxide is not expected to bioaccumulate because it is a reactive polar substance. Moreover, the estimated log K_{ow} is -1.57. Thus, it does not meet the screening criteria for bioaccumulation.

The NOEC values from chronic aquatic toxicity studies on hydrogen peroxide are >0.1 mg/L. Thus, it does not meet the criteria for toxicity.

The overall conclusion is that hydrogen peroxide is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

Oxidizing Liquid Category 1
Acute Toxicity Category 4 [Oral]
Acute Toxicity Category 4 [Inhalation]
Skin Corrosion Category 1
Eye Damage Category 1
STOT SE Category 3 [Respiratory irritation]
Aquatic Acute Category 2
Aquatic Chronic Category 3

EU Concentration Limits:

≥63%
Aquatic Chronic 3

≥70%
Skin Corrosion Category 1A

≥50% to <70%
Skin Corrosion Category 1B

≥35% to <50%
Skin Irritant Category 2

≥8% to <50%
Eye Damage Category 1

≥5% to <8%
Eye Irritant 2

≥35%
STOT SE Category 3 [Respiratory irritation]

≥70%
Oxidizing Liquid Category 1

≥50% to <70%
Oxidizing Liquid Category 2

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician
Hydrogen peroxide is a strong oxidant. Treat as a corrosive substance. All treatments should be based on observed signs and symptoms of distress in the patient. In case of

accidental ingestion, rapid release of oxygen may cause stomach swelling and hemorrhaging, which may produce major, or even fatal, injury to organs if a large amount has been ingested.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use water spray only.

Specific Exposure Hazards
Containers may rupture in closed unventilated containers due to the increased pressure form decomposition. Contact with combustible material may cause fire.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Ventilate enclosed areas. Do not walk through spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapors, or spray. Do not get in eyes, on skin, or on clothing. Eliminate all sources of ignition and remove combustible materials.

Combustible materials exposed to hydrogen peroxide should be immediately submerged in or rinsed with large amounts of water to ensure that all hydrogen peroxide is removed. Residual hydrogen peroxide that is allowed to dry (upon evaporation hydrogen peroxide can concentrate) on organic materials such as paper, fabrics, cotton, leather, wood or other combustibles can cause the material to ignite and result in fire.

Environmental Precautions
Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilled
As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Dilute with large quantities or water. Hydrogen peroxide may be decomposed by adding sodium metasulfite or sodium sulfite after diluting to about 5%.

D. STORAGE AND HANDLING

General Handling

Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest.

Never return unused hydrogen peroxide to original container. Contamination may cause decomposition and generation of oxygen gas which could result in high pressures and possible container rupture. Empty drums should be triple rinsed with water before discarding. Utensils used for handling hydrogen peroxide should only be made of glass, stainless steel, aluminum or plastic. Pipes and equipment should be passivated before first use.

Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from combustible materials. Incompatible materials: combustible materials; copper alloys; galvanized iron; strong reducing agents; heavy metals; iron; copper alloys. Contact with metal ions, alkalis, reducing agents and organic matter (such as alcohols and terpenes) may produce self-accelerated thermal decomposition.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

The workplace exposure standard for hydrogen peroxide in Australia is 1 ppm (1.4 mg/m^3) as an 8-hour TWA.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection:

If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much be based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection:

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection:
Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Eye protection*:*
Wear chemical splash goggles and face shield.

Other Precautions:
Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

UN 2014 (HYDROGEN PEROXIDE, AQUEOUS SOLUTION with not less than 20% but no more than 60% hydrogen peroxide (stabilised as necessary))
Class: 5.1
Packing Group: II

UN 2015 (HYDROGEN PEROXIDE, STABILISED or HYDROGEN PEROXIDE, AQUEOUS SOLUTION, STABILISED with more than 60% hydrogen peroxide
Class: 5.1
Packing Group: I

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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ETHYLENEDIAMINETETRAACETIC ACID TETRASODIUM SALT [NA4EDTA]

This dossier on Na_4EDTA does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of Na_4EDTA in its use in drilling muds and water treatment systems. The information presented in this dossier was obtained primarily from the EU Risk Assessment Report on Na_4EDTA, and 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Tetrasodium{[2-bis-carboxymethyl-amino)-ethyl]-carboxymethyl-amino}-acetate

CAS RN: 64-02-8

Molecular formula: $C_{10}H_{12}N_2O_8Na_4$

Molecular weight: 380.2

Synonyms: Tetrasodium ethylenediaminetetraacetate; ethylenediaminetetraacetic acid tetrasodium salt; ethylene dinitrilotetraacetic tetrasodium salt; Edetic acid tetrasodium salt; Na_4EDTA or EDTA tetrasodium; Edetate sodium or Sodium ededate; N,N'-1,2-Ethanediylbis[N-(carboxymethyl)glycine]tetrasodium salt; tetrasodium 2,2',2'',2'''-(ethane-1,2-diyldinitrilo)tetraacetate

SMILES: C(CN(CC(=O)[O-])CC(=O)[O-])N(CC(=O)[O-])CC(=O)[O-].[Na+].[Na+].[Na+].[Na+]

The tetrahydrate salt of EDTA ($C_{10}H_{12}N_2O_8Na_4 \bullet 4H_2O$) has the CAS No. 13235-36-4.

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Na_4EDTA

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White powder	2	ECHA
Melting Point	>150°C; >300°C; decomposition may occur at >150°C	2	ECHA
Boiling Point	-	-	-
Density	1.67 g/cm^3	2	ECHA
Vapor Pressure	-	-	-
Partition Coefficient (log K_{ow})	-	-	-
Water Solubility	Very soluble	2	ECHA
Flash Point	-	-	-
Auto flammability	>200°C @ 1,013 hPa	2	ECHA

The most important property of EDTA is that it forms complexes (usually 1:1-complexes) with multivalent metal ions (EU, 2004).

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

EDTA is not readily biodegradable, but it can under certain conditions (*i.e.*, alkaline pH) be degraded. It is not expected to adsorb to soil or sediment. EDTA has a low potential for bioaccumulation.

B. Abiotic Degradation

Hydrolysis

EDTA is resistant to hydrolysis (EU, 2004).

EDTA degradation rates measured in aerobically incubated sediments after 4 weeks and total degradation after 10 weeks are as follows: Wintergreen Lake, 3.6% and 11.3%; Clear Lake, 5.6% and 15.2%; and Mill Pond, 3.2% and 9.1%. The results were similar in soil (Tiedje, 1975; EU, 2004).

C. Biodegradation

There have been many degradation tests conducted on EDTA; in most cases, the acid or the sodium salt was tested, but not EDTA in its complexed form. EDTA is not readily biodegradable. (EU, 2004). In a 28-day Sturm test, there was only 10% degradation (measured as CO_2) after 28 days (EU, 2004). In a Closed Bottle test, degradation was 3% and 0% of TOD after 28 days in two separate tests (EU, 2004). Inherent biodegradability tests have shown variable results, ranging from 0 to 37% biodegradation rates (EU, 2004).

EDTA can be degraded under alkaline conditions. A Closed Bottle test was conducted to investigate the potential of samples from a river, a ditch and a lake to degrade $CaNa_2EDTA$ (8 mg/L) at pH values 6.5 – 8.0. There was little to no biodegradation (2-12%) at pH 6.5 within the first 28 days and 60-83% after 49 days. At pH 8, rates of 53, 62, and 72% were seen after 28 days and 75-89% after 35 days (van Ginkel, 1999). The pH values of lakes and river water range from 7.7 to 8.5; however, EDTA is preferably complexed with heavy metal ions (EU, 2004).

EDTA can be biodegraded in soil under aerobic conditions. After four weeks, biodegradation of EDTA was between 4.8 and 7.9% at 30°C was determined in agriculture soil of mid-Michigan (EU, 2004). Another study showed primary degradation of 53 to 60% after 173 days at 22°C. Additional 39% of the substance was assumed to be eliminated by sorption and abiotic degradation (EU, 2004).

D. Environmental Distribution

Adsorption/desorption

No adsorption to the organic fraction of soils or sediments is expected under environmental relevant pH conditions due to the ionic structure of Na_4EDTA.

The mobility of EDTA in soil was investigated by eluting solutions of H_4EDTA and ZnEDTA through cores of two various surface soils. H_4EDTA was slightly adsorbed and moved quite readily through both soils. The EDTA from ZnEDTA also moved readily through the soils (EU, 2004).

E. Bioaccumulation

BCF values of 1.8 (0.08 mg/L EDTA) and 1.1 (0.76 mg/L EDTA) were determined in a 28-day bioaccumulation test on *Lepomis macrochirus* (EU, 2004).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. A. Summary

Na_4EDTA exhibits low acute toxicity by the oral route. It is irritating to the eyes. Data on other sodium salts of EDTA show that these substances are not skin sensitizers. Exposures of sodium EDTA salts to rats in their diet for up to two years showed no systemic or carcinogenic effects. No systemic effects were seen in rats exposed by inhalation to a sodium EDTA salt for 13 weeks, although there were some localised (site-of-contact) effects seen in the respiratory tract. Sodium EDTA salts are not considered to be genotoxic. No reproductive toxicity was seen in a multi-generation rat study with a sodium EDTA salt. There was no developmental toxicity when Na_4EDTA, as well as other sodium EDTA salts, were given by oral gavage to pregnant female rats. However, other studies had shown specific fetotoxic and teratogenic effects when high doses of sodium EDTA salts were given to pregnant females; these effects appear to be caused by zinc deficiency. The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism. In general, complexed and non-complexed EDTA have a low toxicity concern for fish and invertebrates. EDTA is highly toxic to algae in tests using standard media; the effect is probably caused by nutritional deficiency. If nutrient metal concentrations are increased, then EDTA has a low toxicity concern for algae; this is more likely scenario in the environment.

B. Acute Toxicity

For Na_4EDTA, the oral LD_{50} values in rats from three different studies range from 1,700 to 1,913 mg/kg; two additional limit studies reported the oral LD_{50} values to be >2,000 mg/kg (EU, 2004).

No acute inhalation studies have been conducted on Na_4EDTA. In a study on Na_2EDTA (CAS No. 139-33-3), male Wistar rats were exposed nose-only to an aerosol of 0, 30, 300, or 1,000 mg/m^3 for 6 hours on five consecutive days. Exposure to 1,000 mg/m^3 for one day (6 hours) resulted in deaths of 6 out of 20 animals (ECHA). [Kl. score = 1]

No dermal toxicity studies on Na_4EDTA are available.

C. Irritation

Application of 0.5 g (in 80% water) of Na_2EDTA to the skin of rabbits for 4 hours under occlusive conditions was not irritating. The mean of the 24, 48, and 72 hours erythema scores was 0.4. The mean of the 24, 48, and 72-hour edema scores was 0 (ECHA) [Kl. score = 1]. Application of a 40% solution of Na_4EDTA in water (CAS No. 67401-50-7) with a pH 11 to the skin of rabbits for up to 20 hours under occlusive conditions was not irritating (ECHA) [Kl. score = 2].

Instillation of 50 mg of Na_4EDTA into the eyes of rabbits was irritating. The mean 24 and 72-hour scores were: 1.25 for corneal lesions; 1.75 for conjunctival redness; 1.25 for chemosis; and 0 for iridial lesions (ECHA) [Kl. score = 2].

D. Sensitization

No sensitization studies have been conducted on Na_4EDTA. Na_3EDTA was not a dermal sensitizer in a guinea pig sensitization study (ECHA) [Kl. score = 2].

Na_2EDTA was not a dermal sensitizer in a guinea pig maximisation test. The intradermal injection was 0.5% in corn oil; the topical applications were 30% in corn oil, and the challenge dose was 30% in corn oil (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

Oral

Male Holtzman rats were fed in their diet 0, 1, 5, or 10% (0, 500, 2,500, or 5,000 mg/kg-day) Na_2EDTA for 90 days. There was mortality in the mid- and high-dose groups: 20% and 60%, respectively. Body weights and food consumption were significantly lower in the mid- and high-dose groups compared to controls. The animals in these two groups also had diarrhea and were emaciated, and water consumption was increased. The 10% group showed intermittent decreases in hematocrit and haemoglobin levels, and the livers appeared pale when examined at necropsy. Histopathologic evaluation showed no treatment-related effects. The NOAEL is 500 mg/kg-day (Wynn, 1970; ECHA). [Kl. score = 2]

Male and female F344 rats were fed in their diet 0, 3,750 or 7,500 ppm (0, 248, or 495 mg/kg-day) Na_3EDTA. There were no clinical signs; survival and body weights were similar between treated and control groups throughout the study. There was no evidence of adverse effects in the gross necropsy and histopathologic examinations. The NOAEL is 495 mg/kg-day (EU, 2004). [Kl. score = 2]

Male and female $B6C3F_1$ mice were fed in their diet 0, 3,750 or 7,500 ppm (0, 469, or 938 mg/kg-day) Na_3EDTA. There was no clinical signs and survival was similar across all groups. Body weights in the high-dose males showed a significant decrease in body weights throughout the study. There was no evidence of adverse effects in the gross necropsy and histopathologic examinations. The NOAEL is 938 mg/kg-day (NCI, 1977). [Kl. score = 2]

Inhalation

Male and female Wistar rats were exposed nose-only to 0, 0.5, 3, or 15 mg/m^3 Na_2EDTA (as an aerosol dust) 6 hours/day, 5 days/week for 13 weeks. The MMAD of the particles for the respective groups were: 2.3 - 2.8 µm, 2.0 – 2.4 µm, and 2.3 – 2.5 µm, respectively. There were no clinical signs of toxicity or any effects on the haematology and clinical chemistry parameters. Histopathological examination showed some effects on the larynx in the 15 mg/m^3 females, but no evidence of systemic toxicity. The NOAEC for systemic toxicity in this study is 15 mg/m^3. The NOAEC for localized (site-of-contact) effects is 3 mg/m^3 (ECHA). [Kl. score = 1]

Dermal

No dermal studies are available.

F. Genotoxicity

In Vitro Studies

There are no *in vitro* genotoxicity studies on Na_4EDTA; however, studies have been conducted on Na_2EDTA and Na_3EDTA (Table 2).

Table 2: In Vitro Genotoxicity Studies on Na_2EDTA and Na_3EDTA

Test System	Test Substance	Results*		Klimisch Score	Reference
		-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	Na_3EDTA	-	-	2	ECHA

Test System	Test	Results*		Klimisch	Reference
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Na_2EDTA	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Na_3EDTA	-	-	2	ECHA
Chromosomal aberration (CHO cells)	Na_3EDTA	-	-	2	ECHA
Cell transformation assay (Syrian hamster embryos)	Na_2EDTA	N/A	-	1	ECHA
Cell transformation assay (Syrian hamster embryos)	Na_3EDTA	N/A	-	2	ECHA

*+, positive; -, negative; N/A, not applicable.

In Vivo Studies

There are no *in vivo* genotoxicity studies on Na_4EDTA. Studies conducted on other sodium salts of EDTA are summarised below.

Male NMRI mice were dosed by oral gavage with 0, 500, 1,000, or 2,000 mg/kg Na_2EDTA once daily for two consecutive days. There were no increased frequencies of micronuclei in the normochromatic erythrocytes of the bone marrow in the treated animals compared to controls (ECHA). [Kl. score = 1]

Male Balb/c mice were given a single intraperitoneal injection of 0, 93 or 186 mg/kg Na_2EDTA and the spermatocytes were examined 6 hours and 5 days later for aneuploidy. There were no significant increases in aneuploidy in the primary and secondary spermatocytes at both time points (Zordan et al., 1990; ECHA). [Kl. score = 2]

Male Balb/c mice were given a single intraperitoneal injection of 0 or 186 mg/kg Na_2EDTA, and the frequency of micronuclei was analysed in the Golgi and Cap phase, which represents the two earliest phases of spermatid development. The sampling time points were 24 and 48 hours post-dosing. Micronuclei were induced in the Golgi phase spermatids at both time points; there was no increase in micronuclei in the Cap phase (Russo and Lewis, 1992; ECHA). [Kl. score = 2]

No chromosomal aberrations were noted in male Balb/c mouse spermatogonia following a single intraperitoneal dose of 186 mg/kg Na_2EDTA (Russo and Lewis, 1992; ECHA). [Kl. score = 2]

In summary, Na_2EDTA did not induce genotoxicity in bone marrow cells in mice. In germ cells of mice, Na_2EDTA did not induce chromosomal aberrations in spermatogonia, aneuploidy in primary and secondary spermatocytes, but micronuclei were induced at a specific phase of spermatogenesis. The dose of Na_2EDTA used to induce micronuclei in these spermatids is an extremely high dose; given that the induction of aneuploidy is based on a threshold mode-of-action, it is unlikely that this effect will occur in humans exposed to sodium salts of EDTA. Overall, the sodium salts of EDTA are not genotoxic (EU, 2004).

G. Carcinogenicity

Oral

No studies are available on Na_4EDTA.

Male and female F344 rats were fed in their diet 0, 3,750 or 7,500 ppm (0, 248, or 495 mg/kg-day) Na_3EDTA. There were no clinical signs; survival and body weights were similar between treated and

control groups throughout the study. Tumour incidences were similar across all groups, indicating no evidence of carcinogenicity from chronic exposure to Na_3EDTA (NCI, 1977). [Kl. score = 2]

Male and female $B6C3F_1$ mice were fed in their diet 0, 3,750 or 7,500 ppm (0, 469, or 938 mg/kg-day) Na_3EDTA. There was no clinical signs and survival was similar across all groups. Body weights in the high-dose males showed a significant decrease in body weights throughout the study. Tumour incidences were similar across all groups, indicating no evidence of carcinogenicity from chronic exposure to Na_3EDTA (NCI, 1977). [Kl. score = 2]

No inhalation or dermal carcinogenicity studies were located.

H. Reproductive Toxicity

No studies are available on Na_4EDTA.

Male and female Wistar rats were given in their feed 0, 50, 125, or 250 mg/kg-day $CaNa_2EDTA$ (CAS No. 62-33-9) for two years. The study included reproductive and lactation components in four successive generations. There were no significant differences between treated and controls groups in behaviour, clinical signs, survival, body weight gain in any generation. The high-dose group showed no treatment-related organ weight changes or histopathologic effects in any of the organs examined, including the testes. There were no consistent treatment-related effects on reproductive performance or developmental effects in any of the four generations examined. The NOAEL for reproductive toxicity is 250 mg/kg-day, the highest dose tested (Oser et al., 1963; ECHA). [Kl. score = 2]

I. Developmental Toxicity

Pregnant female rats were dosed by oral gavage with 0 or 1,000 mg EDTA/kg during GD 7-14. The salts of EDTA (Na_2EDTA, Na_3EDTA, $CaNa_2EDTA$, and Na_4EDTA were also included in this study and were tested on an equimolar basis. For Na_4EDTA, the dose is 1,374 mg/kg-day which was given as equally divided doses twice daily. There was diarrhea in 90% of the dams after each daily dosing and which disappeared after the last day of dosing. There was also reduced feed intake and reduced weight gain during the treatment period; both recovered during the post-treatment period. There was no developmental toxicity in any of the treatment groups compared to controls. The NOAEL for maternal and developmental toxicity for Na_4EDTA is 1,374 mg/kg-day (Schardein et al. 1981; ECHA)

The toxicity and teratogenicity of Na_2EDTA were studied in pregnant female CD rats following different routes of administration during GD 7-14. When Na_2EDTA was administered in the diet at 3% (average dose of 954 EDTA/kg-day), the dams had reduced feed intake, severe diarrhea, and severe weight loss. There was a significant proportion of fetal deaths (~33% resorptions/litter), significantly lower average fetal weight and gross external, internal, and skeletal malformations in about 71% of the surviving fetuses. When Na_2EDTA was administered by oral gavage at doses of 1,250 or 1,500 mg EDTA/kg-day, there was severe toxicity to the dams: 3/8 and 7/8 deaths in the 1,250 and 1,500 mg/kg-day groups, respectively; significantly reduced weight gain, and diarrhea in the 1,250 mg/kg-day group. There was a significantly higher proportion of malformed surviving fetuses. When administered subcutaneously with 375 mg EDTA, the dams showed signs of severe pain (vocalisations and shock) and 24% of them died; there was also a significant reduction in body weight and feed intake. Fetal toxicity included about 32% resorptions/litter and significant reduction of fetal body weight, and about a 4% malformed survivors/litter (Kimmel 1977; ECHA)

Pregnant female CD rats were given in their diet 0, 2, or 3% Na_2EDTA; in addition, a group was fed 3% Na_2EDTA supplemented with 1,000 ppm zinc (Zn). Exposures were as follows: 2% (GD 0-21), 3% (GD 0-21, GD 6-14, or GD 6 to 21); 3% + Zn (GD 6-21). The dietary doses of 2% and 3% Na_2EDTA correspond to approximately 1,000 and 1,500 mg/kg-day, respectively. All of the dams had

moderate to severe diarrhea. In the 2% Na_2EDTA group, all rats had living young at term; the litter size was normal; the young were slightly small than controls, and 7% of the fetuses were malformed. In the 3% Na_2EDTA (GD 0-21), reproduction was severely disturbed, and none of the females had grossly visible implantation sites. In the 3% Na_2EDTA (GD 6-14 and 6-21), almost all females had implantation sites; half of the sites had dead or resorbed fetuses; 100% of the fetuses were malformed in the GD 6-21 group. In the 3% Na_2EDTA + Zn group, there was a normal reproduction, and none of the young was malformed. It was suggested by the study authors that the congenital abnormalities caused by EDTA were due specifically to zinc deficiency (Swenerton et al., 1977).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Toxicological reference values were not derived for Na_4EDTA.

The Australian drinking water guidance value for EDTA is 0.25 mg/L (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Na_4EDTA does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Details on the aquatic toxicity studies on EDTA and its sodium salts can be found in the EU Risk Assessment Report (RAR) on Na_4EDTA (EU, 2004). The mode-of-action of EDTA in aquatic systems involves disturbances of metal metabolism; hence the complex formation properties of EDTA need to be taken into account.

Uncomplexed EDTA will only be present in the test media of aquatic toxicity studies when present in an excess amount relative to the calcium and magnesium ions, as well some level of heavy metal ions, which are present mainly as trace nutrients. Complexes with the heavy metals predominant because the formation constants are several orders of magnitude higher than those of the calcium and magnesium ions. After addition of EDTA (as an acid or sodium salt), the concentration of uncomplexed trace metals will decrease considerably, and if there is a surplus of EDTA, there will also be complexing with the calcium and magnesium ions.

EDTA and its sodium salts appear to be more toxic in an uncomplexed form in the acute toxicity studies. Most of the acute fish studies have LC_{50} values that are much greater than 100 mg/L, with the exception of two studies tested with H_4EDTA in soft and very soft water: the LC_{50} values were 41 and 59.8 mg/L, respectively. It is thought that there was an excess of uncomplexed EDTA in the test media of these two studies due to the low levels of magnesium and calcium ions in soft water; this, however, is an unlikely scenario in the environment.

The EU Risk Assessment Report (EU, 2004) considered the most relevant chronic fish toxicity study to be an early-life stage test on zebrafish; the NOEC was >26.8 mg/L H_4EDTA ($CaNa_2EDTA$ was the test substance) (EU, 2004).

The acute toxicity tests on *Daphna magna* reported 24-hr EC_{50} values of 480 to 790 mg/L (EU, 2004). The 21-day NOEC from a *Daphnia* reproduction test was 22 mg/L (EU, 2004).

Essential trace metal bioavailability seems to be the critical factor in algal toxicity from EDTA exposure. The ratio of the EDTA concentration to the metal cations is a critical element to algal growth and not the absolute EDTA concentration. H_4EDTA concentrations up to 310 mg/L will not cause any effect on algal growth if there is sufficient trace metals present. Since there is a considerable amount of metal ions present in the environment, EDTA is not expected to have an intrinsic toxic effect on plants. In a study with *Scenedesmus subspicatus*, an EC_{10} value of 0.37 mg/L was obtained (EU, 2004). The EU RAR considered that the effect was probably due to nutrient deficiency because essential metals (Cu, Zn, Co) are largely complexed to the EDTA, resulting in considerably reduced concentrations. In another study with *Pseudokirchnerella subcapitata* conducted according to OECD TG 201, the ECb_{50} and ECr_{50} of Fe(III)EDTA were >100 mg/L; the NOEC values were 79.4 and 48.4 mg/L, respectively, when based on mean measured concentrations.

B. Terrestrial Toxicity

No relevant studies are available. The only test results that are available are those that have investigated the decrease of heavy metal toxicity caused by EDTA.

C. Calculation of PNEC

The PNEC calculations for Na_4EDTA follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for three trophic levels. Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 22 mg/L for algae (EU, 2004). On the basis that the data consist of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported long-term NOEC of 22 mg/L for invertebrates. The $PNEC_{water}$ is 2.2 mg/L.

PNEC sediment

No experimental toxicity data on sediment organisms are available. The equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$ because EDTA is not expected to adsorb to sediment. The assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$ because EDTA is not expected to adsorb to soil. The assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Na_4EDTA is not readily biodegradable. Thus, it does not meet the screening criteria for persistence.

The experimental BCF of EDTA in fish is 1.1 – 1.8. Thus, Na_4EDTA does not meet the criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies is >0.1 mg/L. Thus, Na_4EDTA does not meet the screening criteria for toxicity.

The overall conclusion is that Na_4EDTA is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

Acute Toxicity Category 4 [oral]
Acute Toxicity Category 4 [inhalation]
Eye Damage Category 1

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

Notes to Physician

All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

May emit toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following: carbon monoxide, carbon dioxide, nitrogen oxides.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus and chemical protective clothing.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use personal protective clothing. Avoid dust formation. Ensure adequate ventilation. Do not breathe dust. Wear respiratory protection if ventilation is inadequate. Avoid contact with skin, eye, and clothing. Eliminate all sources of ignition.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Scoop up and remove.

D. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid eye and skin contact. Avoid creating or inhaling dust. Take precautionary measures against static discharges by bonding and grounding equipment.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for Na_4EDTA.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Na_4EDTA is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume

IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

PEROXYACETIC ACID

This dossier on peroxyacetic acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of peroxyacetic acid in its use in water treatment systems. 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Ethaneperoxoic acid

CAS RN: 79-21-0

Molecular formula: $C_2H_4O_3$

Molecular weight: 76.1

Synonyms: Peroxyacetic acid; peracetic acid; ethaneperoxoic acid; acetic peroxide;peroxoacetic acid; monoperacetic acid; acetyl hydroperoxide

SMILES: CC(=O)OO

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Peroxyacetic Acid

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Colorless liquid	1	ECHA
Melting Point	-73°C (15.37% peroxyacetic acid; 25.56% hydrogen peroxide; 14.27% acetic acid)	1	ECHA
Boiling Point	105°C (15.37% peroxyacetic acid; 25.56% hydrogen peroxide; 14.27% acetic acid)	1	ECHA
Density	1.1284 g/cm^3	1	ECHA

Vapor Pressure	17 hPa @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	-0.59 @ 25°C (pH 5-9) [Experimental]	1	ECHA
Water Solubility	Very soluble	2	ECHA
Flash Point	>68 to <83°C	2	ECHA
Auto flammability	See below*	1	ECHA
pK_a	8.24	1	ECHA

*Most of the peroxyacetic acid equilibrium grades ranging from 5% to 15% exhibit closed-cup flash points but no measurable open-cup flash points. Thus, these grades are not flammable under conditions where the liquid is open to the atmosphere. However, a sustained flame is possible in a closed system. Decomposition of peroxyacetic acid produces oxygen. A closed system prevents the release of the oxygen, which in the presence of the acetic acid can sustain a flame. Thus, all the gases produced remain in the system and they can burn. Equilibrium grades of ≥30% peroxyacetic acid exhibit both open and closed-cup flash points and are flammable.

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Peroxyacetic acid will rapidly hydrolyze in water at high pH values (e.g., pH 9). It is readily biodegradable and is not expected to bioaccumulate. It has low potential to adsorb to sediment and soil.

B. Abiotic Degradation

Hydrolysis

In a hydrolysis test (EU Method C.7), the degradation half-lives of peroxyacetic acid at 25°C were 48, 48, and 3.6 hours at pH values of 4, 7, and 9. These results indicate that peroxyacetic acid is rapidly degraded in the environment and that decomposition is faster at high pH values (ECHA). [Kl. score = 2]

C. Biodegradation

Peroxyacetic acid was readily biodegradable in an OECD 301E test. The test material was applied gradually over a two-week period because addition of the full amount on

Day 0 caused inhibition of the micro-organisms. After 14 days, DOC and TOC removal were 78% and 58%, respectively. After 28 days, DOC and TOC removal were 98% and 75%, respectively (ECHA). [Kl. score = 1]

Peroxyacetic acid tested in an OECD 209 test. Degradation was rapid, and the half-life was <3 minutes (ECHA). [Kl. score = 2]

D. Environmental Distribution

Adsorption/desorption

No experimental data are available for peroxyacetic acid. Using KOCWIN in EPISUITE™ (EPA, 2018), the estimated K_{oc} value from log K_{ow} is 1.27 L/kg. The estimated K_{oc} value from the molecular connectivity index (MCI) is 1.508 L/kg.

E. Bioaccumulation

There are no bioaccumulation studies on peroxyacetic acid. Peroxyacetic acid is not expected to bioaccumulate based on a log K_{ow} of -0.59 (ECHA).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Peroxyacetic acid has high acute toxicity by the oral and inhalation routes and moderate toxicity by the dermal routes. Depending on the concentration, aqueous solutions of peroxyacetic acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of peroxyacetic acid can cause respiratory irritation. It is not a skin sensitizer. Repeated oral doses of peroxyacetic acid to rats showed no systemic toxicity. Peroxyacetic acid is not genotoxic. Developmental effects (but no teratogenicity) were seen in laboratory animals at oral doses that also were toxicity to the pregnant females.

B. Toxicokinetics

Following dermal application of radiolabelled peroxyacetic acid, absorption was rapid after an initial lag time of approximately one hour. Only a small portion of the administered dose (1%) was recovered as unchanged peroxyacetic acid, with 58% (as the mean) of the dose recovered as CO_2. The excretion via the feces accounted for 3-4% of the administered radioactivity, tissue-bound radioactivity was 20% (as the mean) of the radioactivity, and urinary excretion was 11% (as the mean) of the radioactivity. The tissue bound fraction likely represents the incorporation of formed acetic acid into the C2 pool involved in the metabolic pathways of the body (ECHA) [Kl. score = 2].

The half-life of peroxyacetic acid in rat blood is <5 minutes (ECHA). [Kl. score = 2]

B. Acute Toxicity

The acute oral LD_{50} values for peroxyacetic acid in the rat are shown in Table 2.

Table 2: Acute Oral LD_{50} Values of Peroxyacetic Acid in Rats

Test material (peroxyacetic acid concentration)	LD_{50} as test material (mg/kg)	LD_{50} as Peroxyacetic acid (mg/kg)	Klimisch score	Reference
0.15% solution	>5,000	>17.8	1	ECHA
0.89% solution	>2,000	>7.5	1	ECHA
2.6% solution	1,656	43	1	ECHA
5% solution	1,700-1,900 (m) 1,400 (f)	77-86 (m) 63 (f)	1	ECHA
4.89% solution	-	185	1	ECHA
5% solution	1,992	96.1	1	ECHA
5.6% solution	3,622	202.8	1	ECHA
6.1% solution	1,270	77.6	1	ECHA
10% solution	2,540 (m) 2,390 (f)	254 (m) 239 (f)	2	ECHA
11.7% solution	652	76.2	1	ECHA
15% solution	1,026 (m) 1,015 (f)	153.9 (m) 152.3 (f)	2	ECHA
10% solution	1,780	271	1	ECHA

The 4-hour LC_{50} value of an aerosol of a 5% solution of peroxyacetic acid in rats is 204 mg/m^3 (ECHA) [Kl. score = 2].

The dermal LD_{50} of a 0.89% solution of peroxyacetic acid in rats is >2,000 mg/kg (>17.8 mg a.i./kg) (ECHA) [Kl. score = 1]. The dermal LD_{50} of a 4.89% solution of peroxyacetic acid in rats is 1,040 mg/kg (56.1 mg a.i./kg) (ECHA) [Kl. score = 1]. The dermal LD_{50} of a 11.7% solution of peroxyacetic acid in rats is 1,957 mg/kg (228.8 mg a.i./kg) (ECHA) [Kl. score = 1].

C. Irritation

Application of 0.5 mL of formulations containing 5%, 15%, or 40% peroxyacetic acid to the skin of rabbits for 4 hours under occlusive conditions was corrosive (ECHA) [Kl. score = 1]. Application of 0.5 mL of formulations containing 0.034%, 0.34%, or 3.4% peroxyacetic acid to the skin of rabbits for 24 hours under occlusive conditions were non-irritating, slightly irritating, and corrosive, respectively (ECHA) [Kl. score = 1]. Application of 0.5 mL of a formulation containing 5% peroxyacetic acid under occlusive conditions was moderately irritating after 3 minutes and corrosive after 45 minutes (ECHA) [Kl. score = 1]. Application of 0.5 mL of a formulation containing 15% peroxyacetic acid to the skin of rabbits for 4 hours under occlusive conditions was corrosive (ECHA) [Kl. score = 1].

Instillation of 0.1 mL of a formulation containing 0.15% peroxyacetic acid to the eyes of rabbits was corrosive (ECHA) [Kl. score = 1]. Instillation of 0.1 mL of a formulation containing 17% peroxyacetic acid to the eyes of rabbits was slightly irritating (ECHA) [Kl. score = 1].

D. Sensitization

Peroxyacetic acid was not a skin sensitizer when tested on guinea pigs using the Magnusson-Kligman or Buehler methods (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

Oral

Male and female SD rats were dosed by oral gavage with 0, 15, 50, or 150 mg/kg of a 5% peroxyacetic acid formulation from day 1 to 10 of the study; 0, 15, 50, or 100 mg/kg on days 11 to 22 of the study; and then 0, 5, 15, or 50 mg/kg on days 23 to 92 of the study. The doses on a time-weighted average were 0, 7.4, 23.4, and 67.4 mg/kg-day. No systemic effects were observed. In the high-dose group, 3/10 males and 9/10 females died or were killed prematurely between study days 8 and 71. In most of these animals symptoms of loud breathing, dyspnea, abdominal swelling or ptyalism were observed. Some of the surviving high-dose animals also showed ptyalism, loud breathing and/or piloerection. One mid-dose female died showing reddened lungs with foamy content, lung congestion and alveolar edema [this may indicate a death due to gavage error].

Body weights and body weight gain in the high-dose animals were reduced compared to the controls. There were no treatment-related effects on hematology parameters, clinical chemistry, or histopathology in the surviving animals in the high-dose or at the lower doses. In the high-dose animals that died or were killed prematurely, the stomach and several parts of the gastrointestinal tract were distended with gas and were reddish in color; and the lungs were dilated. Treatment-related effects were also seen in the trachea (narcotizing inflammation) and lung (acute bronchitis at the tracheobronchial bifurcation) of these animals. Although the trachea and lungs were not directly in contact with the test material when administered by gavage, it is possible that rapid degradation of hydrogen peroxide and peroxyacetic acid occurred in the stomach and intestinal tract, resulting in release of oxygen gas that refluxed with the acidic stomach fluid into the trachea and lungs; this led to local irritation and an inflammatory response. The NOAEL for this study is 23.4 mg/kg-day (ECHA). [Kl. score = 2]

Inhalation

No adequate studies are available.

Dermal

No adequate studies are available.

F. Genotoxicity

The results of the *in vitro* genotoxicity studies on solutions of peroxyacetic acid are shown in Table 3.

In Vitro Studies

Table 3: *In Vitro* Genotoxicity Studies on Peroxyacetic Acid Solutions

Test System	**Results***		**Klimisch Score**	**Reference**
	-S9	**+S9**		
Bacterial reverse mutation (*S. typhimurium* strains)[1]	-	-	1	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)[2]	-	-	2	ECHA
Chromosomal aberration (Chinese hamster lung fibroblasts [V79])[3]	-	-	1	ECHA

Chromosomal aberration (human lymphocytes)[4]	+	+	2	ECHA
Unscheduled DNA synthesis (human lung fibroblasts [WI-38 CCL75])[5]	-	NA	2	ECHA

*+, positive; -, negative; NA, not applicable.
[1]4.6%peroxyacetic acid, 29.4% hydrogen peroxide, 7.4% acetic acid.
[2]40% peroxyacetic acid.
[3]10.7% peroxyacetic acid
[4]5.17% peroxyacetic acid, 20% hydrogen peroxide, 10% acetic acid.
[5]No composition information given.

In Vivo Studies

Male and female CF1/W 68 mice were given two oral gavage doses (24 hours apart) with 0, 200, 400, or 800 mg/kg of a formulation containing peroxyacetic acid. The concentrations of peroxyacetic acid were 0, 18, 36, and 72 mg/kg. There were no increases in the frequency of micronucleated erythrocytes in the bone marrow of treated mice compared to the controls (ECHA). [Kl. score = 2]

Male and female CD-1 mice were given a single oral gavage dose of 0, 8, 35, or 150 mg/kg of a formulation containing peroxyacetic acid. The concentrations of peroxyacetic acid were 0, 0.41, 1.8, and 7.8 mg/kg. There were no increases in the frequency of micronucleated erythrocytes in the bone marrow of treated mice compared to the controls (ECHA). [Kl. score = 1]

In an unscheduled DNA synthesis test, male F344 rats were given a single oral dose of 0, 1,000 or 2,000 mg/kg of a formulation containing peroxyacetic acid. The concentrations of peroxyacetic acid were 0, 52, and 104 mg/kg. There was no indication of a proliferative effect in the liver cells of the treated rats compared to the controls (ECHA). [Kl. score = 1]

In an unscheduled DNA synthesis test, male F344/DuCrj rats were given a single oral dose of 0, 330 or 1,000 mg/kg of a formulation containing peroxyacetic acid. The concentrations of peroxyacetic acid were 0, 17, and 52 mg/kg. There was no indication of a proliferative effect in the liver cells of the treated rats compared to the controls (ECHA). [Kl. score = 1]

G. Carcinogenicity

No studies are available.

H. Reproductive Toxicity

No adequate studies are available.

I. Developmental Toxicity

Pregnant female Wistar rats were given in their drinking water a test material containing 32-38% w/w peroxyacetic acid and 10-14% w/w hydrogen peroxide on GD 5-20. The doses were 0, 12.5, 30.4, and 48.1 mg peroxyacetic acid/kg-day and 0, 4.2, 10.1, and 16 mg hydrogen peroxide/kg-day. There were no maternal treatment-related clinical signs of toxicity or deaths. Food and water consumption was significantly reduced in the high-dose dams throughout the treatment period. The high-dose dams also had significantly reduced terminal body weights, corrected body weight and body weight gain from GD 5-20. Body weight gain in the lower dose females were transient and not significantly different from the controls by the end of the study. There was significantly reduced fetal body weights in the high-dose group and increased incidence of poor and/or hypertrophic ossification. The latter effect was thought to be a secondary effect to maternal toxicity. The effect on fetal weight in this dose group is also questionably treatment-related because the litter size was about 13% higher than in the controls which might have contributed to slightly smaller fetuses in this dose group. The most prominent finding in the study was a dose-dependent discoloration (greyish brown, yellowish or yellow) of the fetal livers, with the severity ranging from 5 to 100% when the size of discoloration or the affected area was taken into account. The incidence and severity of fetal liver discoloration was reported to increase with dose. Furthermore, a dose-related increase in the severity of fetal liver damage was observed and characterized by loosening or unrecognizable structure of liver parenchyma, degeneration to necrosis of the nuclei, atypical mitosis, lysis of hepatic cells, partly large blood islands with cell detritus and pyknotic nuclei. The fetal liver preparations were re-examined by an independent experienced veterinary pathologist and the laboratory pathologist responsible for this study. It was determined that the discoloration was a typical alteration of improperly chemically-fixed organs. Such discoloration is known to progress with time (wet tissue storage). The exact cause of the discoloration is unknown but may have been a consequence of the fixation method used. Thus, it was concluded that there was no treatment-related liver discoloration in the fetal liver and no fetal liver damage. The NOAEL for maternal and developmental toxicity was considered to be 30.4 mg a.i./kg-day (ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for peroxyacetic acid 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, 2011).

A. Non-Cancer

Oral

A 90-day oral gavage study was conducted on a 5% peroxyacetic acid formulation using rats. There was significant mortality, clinical signs, reduction in body weight and body weight gain. In the animals that died or were killed prematurely, histopathologic effects indicative of localized irritation and inflammation were seen in the gastrointestinal and respiratory tract. The NOAEL for this study is 23.4 mg a.i./kg-day. This NOAEL will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 23.4/(10 x 10 x 1 x 3 x 1) = 23.4/300 = 0.08 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (0.08 x 70 x 0.1)/2 = 0.3 mg/L

B. Cancer

There are no carcinogenicity studies on peroxyacetic acid. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Peroxyacetic acid is classified as a Category 3 Flammable Liquid.

Peroxyacetic acid does not exhibit the following physico-chemical properties:

- Explosivity
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Peroxyacetic acid is highly toxic to aquatic organisms on both an acute and chronic basis.

B. Aquatic Toxicity

Acute Studies

Table 4 lists the results of the acute aquatic toxicity studies on peroxyacetic acid.

Table 4: Acute Aquatic Toxicity Studies on Peroxyacetic Acid

Test Species	Endpoint	Results (mg a.i./L)	Klimisch score	Reference
Oncorhynchus mykiss	96-h LC_{50}	0.53	2	ECHA
Lepomis macrochirus	96-h LC_{50}	1.1	2	ECHA
Oncorhynchus mykiss	96-h LC_{50}	1.0	2	ECHA
Lepomis macrochirus	96-h LC_{50}	1.2	2	ECHA
Oncorhynchus	96-h LC_{50}	2.0	2	ECHA

mykiss				
Danio rerio	96-h LC_{50}	1.1	2	ECHA
Oncorhynchus mykiss	96-h LC_{50}	0.08 (measured)	1	ECHA
Danio rerio	96-h LC_{50}	1.0	2	ECHA
Daphnia magna	48-h EC_{50}	0.73	2	ECHA
Daphnia	48-h LC_{50}	1.1	2	ECHA
Daphnia magna	48-h EC_{50}	1.94	2	ECHA
Daphnia magna	48-h EC_{50}	0.5	2	ECHA
Daphnia	48-h EC_{50}	0.48	2	ECHA
Pseudokirchneriella subcapitata	72-h EC_{50} NOEC	0.16 0.061	1	ECHA
Pseudokirchneriella subcapitata	72-h EC_{50} NOEC	0.86 0.084	1	ECHA
Desmodesmus subspicatus	72-h EC_{50} NOEC	1.6 0.27	2	ECHA

Chronic Studies

The NOEC from a 33-day fish (*Danio rerio*) early-life stage toxicity test was 0.002 mg a.i./L (ECHA). [Kl. score = 2]

The NOEC from a *Daphnia* reproduction test was 0.012 mg a.i./L (ECHA). [Kl. score = 2]

C. Terrestrial Toxicity

Earthworms

In an OECD TG 207 test, the 14-day LC_{50} value for peroxyacetic acid in the earthworm *Eisenia fetida* was >1,000 mg a.i./kg soil dry weight (ECHA). [Kl. score = 1]

Terrestrial Plants

Peroxyacetic acid has also been evaluated in a seedling emergence and seedling growth (OECD TG 208) test (ECHA) [Kl. score = 1]. The results (expressed as active ingredient) are presented in Table 5.

Table: 5 Terrestrial Plant Toxicity Test (OECD 208) Results* on Peroxyacetic Acid

Plant	21-day EC_{25}	21-day EC_{50}	21-day NOEC
Brassica napus	278	>320	180
Glycine max (*G. soja*)	307	328	180
Avena sativa	363	413	180

*mg/kg soil dry weight based on seedling emergence.

Soil Organisms

In the soil microorganisms: nitrogen transformation (OECD TG 216) test, the EC_{25} and the EC_{50} values for peroxyacetic acid were 813 and >933.3 mg a.i./kg soil dry weight, respectively. The 28-day NOEC was 295.2 mg a.i./kg soil dry weight (ECHA). [Kl. score = 1]

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (0.08 mg/L), invertebrates (0.48 mg/L), and plants (0.16 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC being 0.002 mg/L for fish. On the basis that the data consist of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 0.002 mg/L for fish. The $PNEC_{water}$ is 0.0002 mg/L or 2×10^{-4} µg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ is 0.00013 mg/kg wet weight or 1.3×10^{-4} µg/kg wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.824/1280) \times 1000 \times 0.0002$
$= 0.00013$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times (Kp_{sed}/1000) \times BD_{soilid}]$
$= 0.8 + [0.2 \times (0.05/1000) \times 2400]$
$= 0.824$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).
BD_{solid} = bulk density of the solid phase (kg/m^3) = 2,400 [default]

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 1.27 \times 0.04$
$= 0.05$

Where:
K_{oc} = organic carbon normalized distribution coefficient (L/kg). The K_{oc} for peroxyacetic acid based on log K_{ow} is 1.27 L/kg.
F_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC soil

Experimental results are available for three trophic levels. An acute LC_{50} value is available for earthworms (>1,000 mg/kg soil dry weight). Results from long-term studies are available for two trophic levels, with the lowest NOEC being 180 mg/kg soil dry weight for all three plant species. On the basis that the data consist of short-term and long-term tests from two trophic levels, an assessment factor of 50 has been applied to the lowest reported long-term NOEC of 180 mg/kg soil dry weight. The $PNEC_{soil}$ is 3.6 mg/kg soil dry weight.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Peroxyacetic acid is readily biodegradable. Thus, it does not meet the screening criteria for persistence.

The experimental log K_{ow} for peroxyacetic acid is -0.59. Thus, it does not meet the screening criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies on peroxyacetic acid is <0.1 mg/L. Thus, it meets the criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Flammable Liquid Category 3
Organic Peroxide Type F
Acute Toxicity Category 3 [Oral]
Acute Toxicity Category 4 [Dermal]
Acute Toxicity Category 3 [Inhalation]
Skin Corrosion Category 1A
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Acute Category 1
Aquatic Chronic Category 1

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

EU Concentration Limits:

≥25%
Acute Toxicity Category 3 [Oral/Inhalation]
Skin Corrosion Category 1A
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Acute Category 1
Aquatic Chronic Category 1

>20 to ≤25%
Acute Toxicity Category 3 [Oral/Inhalation]
Skin Corrosion Category 1A
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 1

≥10 to ≤20%
Acute Toxicity Category 4 [All routes]
Skin Corrosion Category 1A
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 1

≥5% to <10%
Acute Toxicity Category 4 [All routes]
Skin Corrosion Category 1B
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 1

≥3% to <5%
Acute Toxicity Category 4 [All routes]
Skin Corrosion Category 1C
Eye Damage Category 1
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 1

≥2.5% to <3%
Acute Toxicity Category 4 [All routes]
Skin Irritant Category 2
Eye Irritant Category 2
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 1

≥1% to <2.5%
Acute Toxicity Category 4 [All routes]
Skin Irritant Category 2
Eye Irritant Category 2
STOT Category 3 [Respiratory irritation]
Aquatic Chronic Category 2

≥0.25% to <1%
Aquatic Chronic Category 2

≥0.025% to <0.25%

Aquatic Chronic Category 3

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician

Peroxyacetic acid is a strong oxidant. Treat as a corrosive substance. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use water or water spray only. Chemical type extinguishers are not effective with peroxyacetic acid.

Specific Exposure Hazards
Contact with combustible material may cause fire. Explosive when mixed with combustible material. Heating above 110°C may cause an explosion. Containers may rupture in closed unventilated containers due to the increased pressure form decomposition.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Ventilate enclosed areas. Do not walk through spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapors, or spray. Do not get in eyes, on skin, or on clothing. Eliminate all sources of ignition and remove combustible materials. Never return spills in original containers for re-use.

Environmental Precautions
Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilled
As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Dilute with large quantities or water. Never return spill in original containers for re-use.

D. STORAGE AND HANDLING

General Handling

Never return unused peroxyacetic acid to original container. Open container carefully as content may be under pressure. Keep away from sources of ignition. Keep away from combustible material. Do not exposed to temperatures above 30ºC. Use only with adequate ventilation. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest.

Storage

Store in a cool, dry, well-ventilated place. Keep away from heat and sources of ignition. Store in original container. Store in a container with a safety valve. Materials to avoid: rust, dirt, combustible material, flammable materials, reducting agents, organic materials, metal chlorides, bases

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard specifically for peroxyacetic acid.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection:

If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much be based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection:

Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection:

Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Eye protection*:*
Wear chemical splash goggles and face shield.

Other Precautions:
Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

Australian Dangerous Goods
UN 3109 (ORGANIC PEROXIDE TYPE F, LIQUID (PEROXYACETIC ACID, TYPE F, STABILIZED))
Class: 5.2

Environmentally Hazardous Substance

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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PHOSPHONIC ACID

This dossier on phosphonic acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of phosphonic acid in its use in water treatment systems. 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Dihydroxy(oxo)phosphanium

CAS RN: 13598-36-2

Molecular formula: H_3O_3P

Molecular weight: 81.99

Synonyms: Phosphonic acid; dihydroxyphosphine oxide; oxidanylphosphinate; orthophosphorous acid; dihydroxy(oxo)phosphonium

SMILES: O[P](=O)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Phosphonic Acid

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, odorless solid	1	ECHA
Melting Point	63 – 74°C	1	ECHA
Boiling Point	259°C	1	ECHA
Density	1.837 g/cm^3 @ 20°C	1	ECHA
Vapor Pressure	Negligible	1	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-

Water Solubility	>1,067 g/L @ 20ºC	1	ECHA
Auto flammability	No self-ignition up to 85ºC	1	ECHA

Phosphonic acid will rapidly dissociate in water to form H^+ and two anionic species, depending on the pH. The pK_a values are 1.8, forming the hydrogen phosponate ion $HP(O_2)(OH)^-$; and 6.2, forming the phosphonate ion HPO_3^{2-}. The hydrogen that is bonded directly to the phosphorus atom does not readily ionize. At environmental pH values of between 6 and 8, phosphonic acid will be present mainly as the phosphonate ion (HPO_3^{2-}), a moderately strong acid.

III. ENVIRONMENTAL FATE PROPERTIES

Phosphonic acid will rapidly dissociate in water at environmental pH levels to form H^+ ions and mainly the phosphonate ion (HPO_3^{2-}). The phosphonate ion can be converted to phosphate primarily by soil-borne bacteria, although these bacteria do not use the phosphonate ion until most of the phosphate is depleted (Adams and Conrad, 1953). Phosphonic acid is not expected to bioaccumulate in the environment because of its dissociation to ionic species. As an inorganic acid it is expected to have a low potential to adsorb to soil and sediment.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

A dilute solution (10%) of phosphonic acid has moderate acute toxicity by the oral route. It is expected that more concentrated solutions of phosphonic acid will exhibit higher acute oral toxicity. Phosphonic acid is corrosive to the skin, eyes, and gastrointestinal tract. No information is available on its skin sensitizing potential. Repeated oral doses to rats showed no target organ effects associated with systemic exposure; however, there were severe localized effects to the forestomach and stomach, a likely result of the corrosive nature of phosphonic acid. Phosphonic acid is not genotoxic. No reproductive or developmental toxicity to was seen in rats dosed orally to phosphonic acid.

B. Acute Toxicity

The oral LD_{50} of a 10% phosphonic acid solution in rats was 1,580 mg/kg for males and 1,560 mg/kg for females (ECHA). [Kl. score = 2]

There are no reliable acute inhalation or dermal studies on phosphonic acid.

C. Irritation

Application of an 80% solution of phosphonic acid to the skin of rabbits for one hour or more under occlusive conditions was corrosive (ECHA). [Kl. score = 2]

No eye irritation studies are available for phosphonic acid.

D. Sensitization

There are no skin sensitization studies on phosphonic acid.

E. Repeated Dose Toxicity

Oral

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422), male and female Wistar rats dosed by oral gavage with 0, 80, 250, or 750 mg/kg phosphonic acid. At 750 mg/kg, there were three males and one female that died after 2-4 days of treatment. These animals were replaced by spare rats. After the dose was lowered to 500 mg/kg on Day 5 of the study, there were an additional four females that died or were euthanized after 29-36 days, and one male that was killed in extremis after nine treatments. For the high-dose animals that survived, clinical signs were rales, salivation, hunched posture, labored respiration, piloerection, lean appearance, lethargy, spasms, and flat posture. Sporadic clinical signs were noted in the 250 mg/kg animals and were not considered to be adverse. Body weights and body weight gain were lower for the high-dose males from Day 8 to the end of the treatment period. Body weights and body weight gain were lower for the high-dose females from gestational days (GD) 14-20, although the values for absolute body weights were statistically significant on GD 14. The difference for females was mostly attributed to weight loss and reduced body weight gains for two of the high-dose females. Absolute and relative food consumption was significantly lower for the high females during gestational days 4 to 17. Hematological changes were noted in the high-dose animals but were not considered to be toxicologically relevant. The only biologically significant changes in serum chemistry were lower values for total protein in the high-dose males, lower albumin in the high-dose females, and a higher concentration of bile acids in the high-dose males. The high-dose females had lower absolute and relative uterine weights and lower absolute spleen weights. The mid-dose females also had lower absolute spleen weights. The lower spleen weights in the high-dose females parallel the decrease in hematopoietic foci (primarily erythropoiesis) seen in histopathologic examination of these females. The neurobehavioral examination (functional observation battery, motor activity) showed no treatment-related effects. Histopathologic examination showed effects in the forestomach and stomach of the high-dose rats; these effects were indicative of chronic irritation. The NOAEL for localized and systemic toxicity is 250 mg/kg-day (ECHA). [Kl. score = 1]

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on phosphonic acid are presented in Table 2.

Table 2: *In Vitro* Genotoxicity Studies on Phosphonic Acid

Test System	Results*		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	-	-	1	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	-	-	1	ECHA
Chromosomal aberration (human lymphocytes)	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

No studies are available.

G. Carcinogenicity

No studies are available.

H. Reproductive/Developmental Toxicity

In a combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422), male and female Wistar rats dosed by oral gavage with 0, 80,

250, or 750 mg/kg phosphonic acid. At 750 mg/kg, there were three males and one female that died after 2-4 days of treatment. These animals were replaced by spare rats. After the dose was lowered to 500 mg/kg on Day 5 of the study, there were an additional four females that died or were euthanized after 29-36 days, and one male that was killed in extremis after nine treatments. There was no reproductive tor developmental toxicity seen at any dose level. The NOAEL for reproductive toxicity is 500 mg/kg-day, the highest dose tested. Because there were insufficient litters available for evaluation at the high-dose level, the NOAEL for developmental toxicity could only be reliably set at the mid-dose level of 250 mg/kg-day (ECHA). [Kl. score = 1]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for phosphonic acid 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, 2011).

A. Non-Cancer

Oral

A combined repeated dose toxicity study with the reproduction/developmental toxicity screening test (OECD 422) was conducted on phosphonic acid. Male and female rats were dosed by oral gavage with 0, 80, 250, or 750 mg/kg phosphonic acid (ECHA). Because of mortality at 750 mg/kg after 2-4 days of treatment, the dose was lowered to 500 mg/kg on Day 5 of the study. There was no reproductive or developmental toxicity seen at any dose level. Systemic toxicity and localized effects (chronic irritation in the forestomach and stomach) were observed in both sexes at the high-dose. The NOAEL for both localized and systemic toxicity is 250 mg/kg-day. The NOAEL of 250 mg/kg-day will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 3
UF_D (database uncertainty) = 1

Oral RfD = 250/(10 x 10 x 1 x 3 x 1) = 250/300 = 0.8 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (0.8 x 70 x 0.1)/2 = 3 mg/L

B. Cancer

There are no carcinogenicity studies on phosphonic acid. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Phosphonic acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Phosphonic acid is of low acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of the acute aquatic toxicity studies on phosphonic acid.

Table 3: Acute Aquatic Toxicity Studies on Phosphonic Acid

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Cyprinus carpio	96-h LC_{50}	>100	1	ECHA
Daphnia magna	48-h EC_{50}	>1,000	1	ECHA
Pseudokircheriella subcapitata	72-h EC_{50}	153 (growth rate) 13.5 (yield)	1	ECHA

Chronic Studies

No studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (>100 mg/L), invertebrates (>1,000 mg/L), and algae (153 mg/L). On the basis that the data consist of short-term results from three trophic levels, an assessment factor of 100 has been applied to the lowest reported acute $E(L)C_{50}$ value of 153 mg/L from algae. The $PNEC_{water}$ is 1.5 mg/L.

PNEC sediment

No experimental toxicity data on sediment organisms are available. Phosphonic acid dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as phosphonic acid. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of phosphonic acid to sediment is to

be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. Phosphonic acid dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as phosphonic acid. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, no adsorption of phosphonic acid to soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Phosphonic acid is an inorganic acid that dissociates at environmental pH levels to form H^+ ions and mainly he phosphonate ion (HPO_3^{2-}). Biodegradation is not applicable to these inorganic ions. For the purposes of this PBT assessment, the persistent criterion is not considered applicable to this inorganic salt.

Phosphonic acid is not expected to bioaccumulate because of the ionic nature of its dissociated species.

The acute $E(L)C_{50}$ values for phosphonic acid are >1 mg/L in fish, invertebrates and algae. Thus, phosphonic acid does not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Metal Corrosive Category 1
Acute Toxicity Category 4 [Oral]
Skin Corrosion Category 1
Eye Damage Category 1
STOT SE Category 3 [Respiratory irritation]

In addition to the hazard statements corresponding the GHS classifications, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician
Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use dry chemical, carbon dioxide, water spray or fog, or foam.

Specific Exposure Hazards
Containers may explode when heated. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: oxides of phosphorus.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Ventilate enclosed areas. Do not walk through spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapors, or spray. Do not get in eyes, on skin, or on clothing.

Environmental Precautions
Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilled
As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

D. STORAGE AND HANDLING

Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

Storage
Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis. Do not store above 49°C/120°F.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards
Workplace Australia has not established an occupational exposure standard for phosphonic acid.

Engineering Controls
Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection:
If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much be based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection:
Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection:
Personal protective equipment for the body should be selected based on the task being performed and the risks involved.

Eye protection*:*
Wear chemical splash goggles and face shield.

Other Precautions:

Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

UN 2834 (PHOSPHOROUS ACID)
Class: 8
Packing Group: III

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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POLYDADMAC
[POLYDIALLYLDIMETHYLAMMONIUM CHLORIDE]

This dossier on polyDADMAC does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyDADMAC in its use in water treatment systems. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

I. SUBSTANCE IDENTIFICATION

Chemical Name: Polydiallyldimethylammonium chloride

CAS RN: 26062-79-3

Molecular formula: $(C_8H_{16}N.Cl)_x$-

Molecular weight: Variable

Synonyms: PolyDADMAC; 2-Propen-1-aminium, N,N-dimethyl-N-2-propenyl-, chloride, homopolymer; Poly-2-propen-1-aminium, N,N-dimethyl-N-2-propenyl-, chloride; N-N-dimethyl-N-2-propenyl-2-propen-1-aminium chloride, homopolymer; poly-N,N-dimethyl-N-N-diallyammonium chloride; polyquaternium-6;

II. PHYSICO-CHEMICAL PROPERTIES

PolyDADMAC are highly charged cationic homopolymers with high molecular weights; those used in water treatment may have molecular weights less than 500,000 (Lyons and Vasconcellos, 1997).

III. ENVIRONMENTAL FATE PROPERTIES

PolyDADMAC are highly charged cationic polymers with high molecular weights. They are expected to be poorly biodegraded, and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility (Lyons and Vasconcellos, 1997). As a cationic polymer, polyDADMAC will rapidly react with many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays (Lyons and Vasconcellos, 1997).

Due to its physical properties (*i.e.*, molecular size), polyDADMAC is not expected to bioaccumulate.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

PolyDADMAC is not acute toxic by the oral route; nor does it exhibit any systemic toxicity from repeated exposures through ingestion.

B. Acute Toxicity

There were no deaths in rats given a single oral dose of 5,000 mg/kg polyDADMAC. The oral LD_{50} in rats is >5,000 mg/kg (EPA, 2016a).

C. Irritation

No studies were located.

D. Sensitisation

No studies were located.

E. Repeated Dose Toxicity

Oral

Male and female SD rats were fed in their diet 0, 1,000, or 2,000 mg/kg polyDADMAC for six months. There were no clinical signs of toxicity. Two low-dose males were sacrificed in a moribund condition, while one low-dose male and one high-dose male died during the exposure period. Feed consumption was significantly increased in the treated groups compared to controls. Body weight gain was significantly lower in the treated animals compared to the controls. Final body weights were significantly lower in all dose groups compared to controls (10.4% and 19.5% in males; 6.6% and 10% in females for the low- and high-dose groups, respectively). Hematology and clinical chemistry parameters and urinalysis showed no biologically significant differences between treated and control groups. Relative liver weights were decreased in the ≥1,000 mg/kg males and 2,000 mg/kg females. Relative heart weights were decreased in the 2,000 mg/kg (both sexes), and relative kidney weights were decreased in the 2,000 mg/kg males. The histopathologic examination showed no treatment-related changes in these organs. No other compound-related pathology was observed, although histopathologic effects were seen in the lungs and urinary tract in animals of all groups. The LOAEL for this study is 1,000 mg/kg-day based on reduced body weights and body weight gain; a NOAEL was not established (EPA, 2016b).

Inhalation

No studies were located.

Dermal

No studies were located.

F. Genotoxicity

No studies were located.

G. Carcinogenicity

No studies were located.

H. Reproductive Developmental Toxicity

No studies were located.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for polyDADMAC 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, 2011).

A. Non-Cancer

Oral

PolyDADMAC has been tested in a six-month rat feeding study. No target organs were identified. However an NOAEL was not established. The LOAEL is 1,000 mg/kg-day based on reduced body weights and body weight gain. It is unclear from the limited data whether these changes in the treated animals are due to a direct or indirect effect of polyDADMAC. PolyDADMAC has a high molecular weight and would not be expected to be absorbed from the gastrointestinal tract. Feed consumption was significantly increased in the treated rats (both dose groups) even though body weights and body weight gain were reduced. A likely explanation for these findings is that the weight changes and feed consumption reflect the nutritional status of the treated animals due to the bulk presence of high levels of polymer in the feed and not to systemic toxicity. Given the absence of any other effects, it is proposed that the NOAEL for systemic toxicity in this study is 2,000 mg/kg-day, the highest dose tested.

The NOAEL of 2,000 mg/kg-day will be used for determining the oral Reference Dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 3
- UF_D (database uncertainty) = 1

Oral RfD = 2,000/(10 x 10 x 1 x 3 x 1) = 2,000/300 = 7 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (6.7 x 70 x 0.1)/2 = 23 mg/L

B. Cancer

No carcinogenicity studies were located; thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

PolyDADMAC does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

PolyDADMAC exhibits a moderate toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

Table 1 lists the results of acute aquatic toxicity studies conducted on polyDADMAC.

Table 1: Acute Aquatic Toxicity Studies on polyDADMAC

Test Species	Endpoint	Results (mg/L)	Reference
Bluegill	96-hr LC_{50}	0.9	EPA, 2016c
Bluegill	96-hr LC_{50}	0.32	EPA, 2016d
Rainbow trout	96-hr LC_{50}	0.32	EPA, 2016d
Rainbow trout	96-hr LC_{50}	0.42	EPA, 2016e
Rainbow trout	96-hr LC_{50}	0.77	EPA, 2016f
Fathead minnow	96-hr LC_{50}	0.3	EPA, 2016g
Fathead minnow	96-hr LC_{50}	6.51*	EPA, 2016g
Fathead minnow	96-hr LC_{50}	0.46	Cary et al., (1987)
Fathead minnow	96-hr LC_{50}	6.5***	Cary et al., (1987)
Daphnia magna	48-hr EC_{50}	0.23	EPA, 2016g
Daphnia magna	48-hr EC_{50}	11.8**	EPA, 2016g
Daphnia magna	48-hr EC_{50}	0.33	EPA, 2016h
Daphnia magna	48-hr EC_{50}	0.2	Cary et al., (1987)
Daphnia magna	48-hr EC_{50}	7.4***	Cary et al., (1987)

*10 mg/L humic acid in standard laboratory water.
**10 mg/L TOC in standard laboratory water.
***50 mg/L humic acid in standard laboratory water.

In standard acute aquatic toxicity tests, PolyDADMAC, as a highly charged cationic polymer, is very toxic to fish and *Daphnia*. The toxicity of cationic polymers to fish is from the binding of the polymer to gill tissue, disrupting gill structure and function. Physical damage to fish gill by cationic polymers has been shown by Beisinger and Stokes (1986).

Table 1 also shows the change in acute toxicity when suspended solids or Total Organic Carbon (TOC) is added to the standard laboratory water used in the toxicity tests. In the presence of humic acid or TOC, the $E(L)C_{50}$ values for fathead minnow and *Daphnia magna* increase by 21.7-fold and

51.3-fold, respectively. A similar effect of humic acid on the acute toxicity of polyDADMAC on fish and *Daphnia magna* was reported by Cary et al. (1987). The studies by Cary et al. (1987) also showed increases in varying amounts in the E(L)C_{50} values for fathead minnow and *Daphnia magna* with bentonite, illite, kaolin, silica, tannic acid, lignin, lignosite, and fulvic acid. The concentrations of suspended solids and DOC in the studies by Cary et al. (1987) were considered to be low estimates of levels found in the natural environments. These findings demonstrate that toxicity tests conducted on cationic polymers, such as polyDADMAC, using water with no organic carbon will likely overestimate the toxicity of these polymers in the environment.

Chronic Studies

No studies were located for polyDADMAC. The ratio of the acute toxicity to chronic toxicity for polyDADMAC is expected to be low. In 21-day *Daphnia magna* reproduction studies, three cationic polymers had 21-day threshold levels for survival that were higher by order of magnitude than the 48-hr TL_{50} values. The test solutions in these studies were renewed several times along with food, which served as new organic matter. The cationic polymer bioavailability was likely reduced from the adsorption to the food (Biesinger et al., 1976). In another study, low acute to chronic ratios was observed for a cationic polymer for *Ceriodaphnia dubia* and fathead minnows (Godwin-Saad et al., 1994).

It cannot be determined from the standard chronic tests if the adsorbed polymer is ingested or simply becomes unavailable by flocculating and/or settling. In any case, the low acute to chronic ratios of these cationic polymers appears to be best correlated with acute effects (Lyons and Vasconcellos, 1997).

C. Terrestrial Toxicity

No studies were located.

D. Calculation of PNEC

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

PNEC water

Experimental results are available for two trophic levels. Acute E(L)C_{50} values are available for fish (0.2 mg/L) and *Daphnia* (0.3 mg/L) in standard laboratory water; and for fish (6.5 mg/L) and *Daphnia* (11.8 mg/L) in standard laboratory water with the addition of humic acid or TOC. The PNEC water will be based on the E(L)C_{50} values from the acute toxicity tests conducted with humic acid in the dilution water because this most likely represents the environmental conditions for which this assessment is being conducted for. Furthermore, an assessment factor of 50 is proposed because chronic toxicity is expected to be similar to the acute toxicity of polyDADMAC (when tested in the presence of humic acid) because of the adsorption of the polymer to organic matter (food source) that would occur in standard test methods; hence, an assessment factor will be used for chronic testing for two trophic levels. An assessment factor of 50 has been applied to the E(L)C_{50} value of 6.5 mg/L for fish. The $PNEC_{water}$ is 0.13 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for polyDADMAC; these values cannot estimate using QSAR models because of the high molecular weight of polyDADMAC. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$.

PNEC soil

There are no toxicity data for soil-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for polyDADMAC; these values cannot estimate using QSAR models because of the high molecular weight of polyDADMAC. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

PolyDADMAC is a high molecular weight polymer; it is expected to be poorly biodegraded. Thus, it meets the screening criteria for persistence.

PolyDADMAC is a high molecular weight polymer that is not expected to be bioavailable to aquatic or terrestrial organisms. Thus, it is not expected to bioaccumulate.

No chronic aquatic toxicity studies have been conducted on polyDADMAC. The $E(L)C_{50}$ values of fish and *Daphnia* for acute toxicity tests conducted with humic acid or TOC in dilution water were >1 mg/L. thus, polyDADMAC does not meet the screening criteria for toxicity.

The overall conclusions are that polyDADMAC is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Aquatic Acute Toxicity Category 2
Aquatic Chronic Toxicity Category 2

B. Labelling

Warning

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Carbon oxides, nitrogen oxides

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment. Slippery when wet.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Pump off product for large amounts. For residues, pick up with suitable absorbent material. Dispose of absorbed material in accordance with regulations.

D. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for polyDDMAC.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.

F. TRANSPORT INFORMATION

Australian Dangerous Goods

Environmentally Hazardous Substance

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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U.S. EPA [EPA] (2016g). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920000053; accessed October 2016.

U.S. EPA [EPA] (2016h). U.S. Environmental Protection Agency (EPA) Toxic Substance Control Act Test Submissions (TSCATS) database. DCN 88920002752; accessed October 2016.

XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute

DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

ACRYLAMIDE, (2-ACRYLOYLOXYETHYLTRIMETHYLAMMONIUM CHLORIDE

This dossier on acrylamide-acroloyloxyethyltrimethyl ammonium chloride (also known as polyquaternium-33) does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of polyquaternium-33 in its use in water treatment systems. Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (NICNAS): Acrylamide, (2-acryloyloxyethyl)trimethylammonium chloride polymer

CAS RN: 69418-26-4

Molecular formula: $(C_8H_{16}ClNO_2)x.(C_3H_5NO)_x$

Molecular weight: No information is available. It is expected to be a high molecular-weight polymer

Synonyms: Acrylamide, (2-acryloyloxyethyl)trimethylammonium chloride polymer; ethanaminium, N,N,N,trimethyl-2-[1-oxo-2-propenyl)oxy]-, chloride, polymer with 2-propenamide; polyquaternium-33

This polymer is a copolymer of trimethylaminoethylacetate salt and acrylamide. It is used as flocculent, retention and drainage aid in the manufacture of food contact paper and paper board (FDA, 2013).

Polyquaternium-33 is a cationic polymer.

II. PHYSICO-CHEMICAL PROPERTIES

The commercial polymer is a white to off-white powder. It is soluble in water, forming a viscous solution (BASF, 2010; WaterSolve, 2013).

While specific information is not available, typical flocculants that are cationic polyacrylamide-based copolymers have molecular weights that can range from 1 million to >50 million (Lyons and Vasconcellos, 1997).

III. ENVIRONMENTAL FATE PROPERTIES

Polyquaternium-33 is a highly charged cationic polymer with high molecular weights. It is expected to be poorly biodegraded and adsorption would be expected to be the primary process that determines its ecological concentrations and mobility (Lyons and Vasconcellos, 1997). As a cationic polymer polyquaternium-33 will rapidly react with

many kinds of naturally occurring substances, such as humic acids, lignins, silts, and clays (Lyons and Vasconcellos 1997).

Due to its physical properties (*i.e.*, molecular size), polyquaternium-33 is not expected to bioaccumulate.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of polyquaternium-33 is very low by the oral route. It is non-irritating to the skin and is not a skin sensitizer. No other data are available regarding the human health hazard of polyquaternium-33.

B. Acute Toxicity

The oral LD_{50} in rats is >5,000 mg/kg (BASF, 2010; WaterSolve, 2013). [Kl. score = 4]

C. Irritation

Polyquaternium-33 is non-irritating to the skin of rabbits (BASF, 2010; WaterSolve, 2013). [Kl. score = 4]

No eye irritation studies are available. Polyquaternium-33 is expected to be a non-irritant to the eyes of rabbits (BASF, 2010; WaterSolve, 2013).

D. Sensitization

Polyquaternium-33 is not a skin sensitizer to guinea pigs (WaterSolve, 2013).

E. Repeated Dose Toxicity

No studies are available.

F. Genotoxicity

No studies are available.

G. Carcinogenicity

No studies are available.

H. Reproductive Toxicity

No studies are available.

I. Developmental Toxicity

No studies are available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

No data are available to derive toxicological reference and drinking water guidance values for polyquaternium-33.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Polyquaternium-33 does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Polyquaternium-33 has a moderate acute toxicity concern to aquatic organisms.

B. Aquatic Toxicity

The 96-h LC_{50} to fish was reported to be 1 – 10 mg/L (BASF, 2010; WaterSolve, 2013). [Kl. score = 4]

The 48-h EC_{50} to *Daphnia magna* was approximately 35 mg/L (WaterSolve, 2013). [Kl. score = 4]

Chronic Studies

No studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

The PNEC calculations for polyquaternium-33 follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for two trophic levels. Acute $E(L)C_{50}$ values are available for fish (1-10 mg/L) and invertebrates (35 mg/L). On the basis that the data consist of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest $E(L)C_{50}$ value of 1-10 mg/L for fish. The $PNEC_{water}$ is 0.001-0.01 mg/L.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for polyquaternium-33; these values cannot be estimated using QSAR models because of the high molecular weight of polyquaternium-33. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$.

PNEC soil

There are no toxicity data for soil-dwelling organisms. The K_{ow} and K_{oc} have not been experimentally derived for polyquaternium-33; these values cannot be estimated using QSAR models because of the high molecular weight of polyquaternium-33. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Polyquaternium-33 is a large molecular weight, water-soluble polymer. It is not expected to be readily biodegradable; thus, it meets the screening criteria for persistence.

Polyquaternium-33 is not expected to be bioavailable to aquatic or terrestrial organisms because of its large molecular weight and size. Thus, it is not expected to meet the criteria for bioaccumulation.

There are no chronic aquatic toxicity studies on polyquaternium-33. The E(L)C_{50} values from the acute aquatic toxicity studies on polyquaternium-33 are >1 mg/L. Thus, it is does not meet the screening criteria for toxicity.

The overall conclusion is that polyquaternium-33 is not a PBT substance.

IX. CLASSIFICATION AND LABELING

A. Classification

Aquatic Acute Category 2

B. Labelling

No signal word.

C. Pictogram

None

X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes.

Skin Contact
Wash thoroughly with soap and water.

Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion
Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards
Carbon oxides, nitrogen oxides

Special Protective Equipment for Firefighters
Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Use appropriate protective equipment. Slippery when wet.

Environmental Precautions
Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled
Pump off product for large amounts. For residues, pick up with suitable absorbent material. Dispose of absorbed material in accordance with regulations.

D. STORAGE AND HANDLING

General Handling
No special measures necessary provided product is used correctly.

Other Handling Precautions

Storage
Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards
Workplace Australia has not established an occupational exposure standard for polyquaternium-33.

Engineering Controls
None

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Chemical resistant protective gloves.

Skin *Protection*:
Body protection must be chosen depending on activity and possible exposure.

Eye protection*:*
Safety glasses with side-shields.

Other Precautions:
Handle in accordance with good industrial hygiene and safety practice. Wearing of closed work clothing is recommended.

F. TRANSPORT INFORMATION

Polyquaternium-33 is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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POTASSIUM HYDROXIDE

This dossier on potassium hydroxide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of potassium hydroxide in its use in drilling muds, hydraulic fracturing fluids, and water treatment systems. The information presented in this dossier was obtained from the OECD-SIDS documents on potassium hydroxide (OECD, 2002) and 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).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Potassium hydroxide

CAS RN: 1310-58-3

Molecular formula: KOH

Molecular weight: 56.1

Synonyms: Potassium hydroxide; caustic potash; potash lye; potassium hydrate

SMILES: O[K]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Physico-Chemical Properties of Potassium Hydroxide

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline solid	2	ECHA
Melting Point	406°C 250°C	2	ECHA
Boiling Point	1,327°C @ 1013 hPa	2	ECHA
Density	2.04 g/cm^2, 20°C	2	ECHA
Vapour Pressure	1 Pa @ 520°C	2	ECHA
Partition Coefficient (log Kow)	Not applicable	-	-
Water Solubility	Very soluble	2	ECHA
pH of 5% NaOH solution	ca. 13.5 @ 25ºC [5.611 g/L]	2	ECHA

Potassium hydroxide (KOH) is a strong alkaline substance that dissociates completely in water to potassium (K^+) and hydroxyl (OH^-) ions.

III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, potassium hydroxide will be found predominantly in the aquatic environment where it dissociates completely to potassium (K^+) and hydroxyl (OH^-) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of potassium hydroxide to an aquatic ecosystem may increase the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ ($pKa_1 = 6.35$)
$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ ($pKa_2 = 10.33$)

A release of potassium hydroxide into the aquatic environment from the use of KOH could potentially increase the potassium concentration and the pH in the aquatic environment. Table 2 shows the concentration of potassium hydroxide needed to increase the pH to values of 9.0, 10.0, 11.0, and 12.0.

Table 2: Potassium Hydroxide Concentration (mg/L) Needed to Increase pH to a Value of 9 (OECD, 2002)

Buffer capacity	Concentration of KOH (mg/L)
0 mg/L HCO_3 (distilled water)	0.56
20 mg/L HCO_3 (10th percentile of 77 rivers)	0.86
106 mg/L HCO_3^- (mean value of 77 rivers)	4.51
195 mg/L HCO_3^- (90th percentile of 77 rivers)	8.30

K^+ and OH^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Limited toxicity data exist for potassium hydroxide (KOH). Depending on the concentration, solutions of KOH are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapors from aqueous solutions of KOH can cause respiratory irritation. KOH is not a skin sensitiser. There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide.

B. Toxicokinetics/Metabolism

Potassium hydroxide dissociates completely in aqueous solutions to potassium (K^+) and hydroxyl (OH^-) ions. Potassium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function (Ganong, 1995). The acute toxicity of potassium hydroxide is moderate to high by the oral route

C. Acute Toxicity

The oral LD_{50} values in rats for potassium hydroxide have been reported to be 365 mg/kg (Johnson *et al.*, 1975; ECHA) and 273 mg/kg (Bruce, 1987; ECHA). [Kl. scores = 2]

No acute dermal or inhalation studies are available.

D. Irritation

Application of 0.5 mL of a 5% solution of potassium hydroxide to the skin of rabbits for 4 hours under semi-occlusive conditions was moderately irritation, with a PII score of 4.8. A 10% solution was severely irritating (Nixon *et al.*, 1990; OECD, 2002) [Kl. score = 2]. Application of 0.1 mL of a 5% solution of potassium hydroxide to the skin of rabbits for 24 hours under semi-occlusive conditions was mildly irritating to intact skin (Johnson *et al.*, 1975; OECD, 2002) [Kl. score = 2].

Instillation of 0.1 mL of a 5% potassium hydroxide solution into the eyes of rabbits for 5 minutes was extremely irritating to corrosive; a 1% KOH solution for 5 minutes or 24 hours was considered

irritating; 0.5% potassium hydroxide solution for 24 hours was marginally irritating; and 0.1% potassium hydroxide solution for 24 hours was negative (Johnson *et al.*, 1975; OECD, 2002) [Kl. score = 2].

E. Sensitisation

Potassium hydroxide was not a skin sensitizer in a guinea pig sensitization test (Johnson et al., 1975; OECD, 2002) [Kl. score = 2]

F. Repeated Dose Toxicity

No studies are available.

G. Genotoxicity

In Vitro Studies

Potassium hydroxide was not mutagenic to *S. typhimurium* strains TA 97 and TA 102 in the absence or presence of metabolic activation (ECHA). [Kl. score = 2]

In Vivo Studies

No studies are available.

H. Carcinogenicity

No studies are available.

I. Reproductive Toxicity

No studies are available.

J. Developmental Toxicity

No studies are available.

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide. These studies would have questionable usefulness because of the corrosive/irritating nature of potassium hydroxide, which would limit the amount absorbed. Potassium hydroxide dissociates to potassium and hydroxyl ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, a toxicological reference value was not derived for potassium hydroxide.

The Australian drinking water guideline value for pH is 6.5 to 8.5 (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Potassium hydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

The OECD-SIDS SIAR on potassium hydroxide states the following regarding the aquatic toxicity studies on potassium hydroxide (OECD, 2002):

> "At concentrations reported in publications and study reports, the toxicity has been assumed to be due to hydroxide only, because at these effect concentrations the concentration of potassium is too low to explain the effects. However, it should be realised that the results of toxicity tests with KOH depend on the buffer capacity of the test medium. In a highly buffered test medium, the hydroxyl ion will be neutralised, and the observed toxicity will be low, while in a poorly buffered test medium the pH will increase rapidly and therefore the observed toxicity will be relatively high. Besides the direct effects (pH change) KOH could also have indirect effects. The pH change could influence the speciation of other chemicals and therefore increase and/or decrease the toxicity, e.g.; NH_3 is more toxic than NH_4^+."

There are no guideline studies on potassium hydroxide; the studies summarised below have Klimisch scores of 3 or 4. Studies on sodium hydroxide (NaOH) have also been included, given its similarity to KOH.

Acute Fish

KOH: The 96-hour LC_{50} to *Gambusia affinis* (mosquito fish) is 80 mg/L. At 56 mg/L, no mortality was observed.

NaOH: The 24-hour LC_{50} to *Carassius auratus* (goldfish) is 160 mg/L. At 100 mg/L, which was equivalent to a pH of 9.8, no mortality was observed. The 48-hour LC_{50} to *Leuciscus idus melanotus*, is 189 mg/L. The 96-hour LC_{50} of *Gambusia affinis* (mosquitofish) is 125 mg/L. At 84 mg/L, no effects on the fish were observed. The pH was 9 at 100 mg/L.

Acute Invertebrate

KOH: No studies are available.

NaOH: The 48-hour LC_{50} is 40 mg/L for *Ceriodaphnia cf. dubia*. The toxicity threshold concentration of NaOH for *Daphnia magna* was reported to range from 40 to 240 mg/L.

Acute Algae

No studies are available.

B. Terrestrial Toxicity

No studies are available.

C. Calculation of PNEC

The OECD-SIDS SIAR on potassium hydroxide (KOH) states the following regarding the aquatic toxicity studies on KOH (OECD, 2002):

> "With few exceptions, the available toxicity studies with KOH or NaOH were not conducted according to current standard guidelines. In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with KOH. The observed variation on LC50 values can be explained by the buffer capacity of the testing water, which was used."
>
> "Based on the natural alkalinity of waters, organisms will have different optimum pH conditions, ranging from poorly buffered waters with a pH of 6 or less to very hard waters with pH values up to 9. A lot of information is available about the relationship between pH and ecosystem structure and also natural variations in pH of aquatic ecosystems have been quantified and reported extensively in ecological publications and handbooks."
>
> "Based on the available data it is not considered useful to derive a PNEC or a PNEC added for KOH because:
> - The natural pH of aquatic ecosystems can vary significantly between aquatic ecosystems,
> - Also, the sensitivity of the aquatic ecosystems to a change of the pH can vary significantly between aquatic ecosystems and
> - The change in pH due to an anthropogenic NaOH addition is influenced significantly by the buffer capacity of the receiving water."
>
> "Although a PNEC or a PNEC added was not calculated for KOH, there is a need to assess the environmental effect of a KOH (alkaline) discharge. Based on the pH and buffer capacity of effluent and receiving water and the dilution factor of the effluent, the pH of the receiving water after the discharge can be calculated. Of course, the pH change can also be measured very easily via a laboratory experiment or by conducting field measurements. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison it should be assessed if the pH change is acceptable."

Based on the information above, PNEC values for freshwater, sediment, and soil were not derived for potassium hydroxide.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Potassium hydroxide is an inorganic salt that dissociates completely to potassium and hydroxide ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both potassium and hydroxide ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Potassium and hydroxide ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, potassium hydroxide is not expected to bioaccumulate.

No chronic toxicity data exist on potassium hydroxide; however, the acute $E(L)C_{50}$ values are >1 mg/L in fish, invertebrates and algae. Thus, potassium hydroxide does not meet the screening criteria for toxicity.

The overall conclusion is that potassium hydroxide is not a PBT substance.

IX. CLASSIFICATION AND LABELLING

A. Classification

Metal Corrosive Category 1
Acute Toxicity Category 4 [Oral]
Skin Corrosive Category 1A
Eye Damage Category 1

EU Concentration Limits:
≥5%:
Skin Corrosive Category 1A
Eye Damage Category 1

>2% and <5%
Skin corrosion, Category 1B
Eye Damage Category 1

≥0.5% to <2%
Skin Irritant Category 2
Eye Irritant Category 2

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictograms



X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Flush with plenty of fresh water for 15 minutes holding eyelids open, lifting eyelids occasionally to ensure complete removal of the product. Remove contacts, if present and easy to do. DO NOT allow rubbing of eyes or keeping eyes closed. Seek medical attention.

Skin Contact

Rinse with soap and plenty of water for several minutes. Remove contaminated clothing. Seek medical attention immediately.

Inhalation

Remove person to fresh air. Apply artificial respiration if not breathing. Seek medical attention.

Ingestion

Rinse mouth with water (only if the person is conscious), but do not administer fluids. Do NOT induce vomiting. Seek medical attention immediately.

B. Fire Fighting Information

Extinguishing Media

Carbon dioxide, water spray, foam, dry chemical.

Specific Exposure Hazards

Containers may explode when heated. May form explosive mixtures with strong acids. Hazardous combustion products may include the following materials: halogenated compounds, metal oxides/oxides, potassium monoxide.

Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment and avoid direct contact. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Ventilate the area before entry.

Environmental Precautions

Prevent spills from entering storm drains or sewers and contact with soil.

Steps to be Taken if Material is Released or Spilt

Use an absorbent material to recover as much product as possible, then, rinse the affected area with water to dilute the residue. Disposal of leftover product and used containers should be carried out in accordance with all local, state and federal regulations.

D. Storage and Handling

General Handling

Wear appropriate personal protective equipment. Avoid contact with eyes, skin or clothing. Avoid breathing mist, vapours or spray. Use only with adequate ventilation. Wash hands after use. Launder contaminated clothing.

Storage

Store away from acids. Keep container closed when not in use. Store in a cool well-ventilated area.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for potassium hydroxide in Australia is 2 mg/m^3 as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

Engineering Controls

Good general ventilation should be used. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection: Use a mask or approved air-purifying respirator with appropriate cartridge or canister in spray applications or in confined spaces.

Hand Protection: Wear impervious gloves to prevent skin contact and absorption of this material. Rubber or Neoprene gloves may afford adequate skin protection.

Skin Protection: Wear appropriate clothes (i.e., coveralls). Use non-slip footwear.

Eye protection: Wear eye protection in situations where splash or thick mists are possible.

Other Precautions: Avoid contact with skin, eyes and clothing. When using, do not eat or drink. Wash hands thoroughly with soap and water before eating or drinking. Remove contaminated clothing and launder before reuse.

F. Transport Information

UN 1814 (POTASSIUM HYDROXIDE SOLUTION)
Class: 8
Packing Group: II or III

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
CNS	central nervous system
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment

IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

SODIUM BISULFITE

This dossier on sodium bisulfite does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium bisulfite in water treatment systems. The information presented in this dossier was obtained mainly 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium hydrogen sulfite

CAS RN: 7631-90-5

Molecular formula: $NaHSO_3$

Molecular weight: 104.1

Synonyms: Sodium bisulfite; sodium hydrogen sulfite; sodium hydrogensulfite; monosodium sulfite; sodium sulfhydrate; hydrogen sodium sulfite; sulfurous acid, monosodium salt

SMILES: OS(=O)[O].[Na]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Physico-chemical Properties of Sodium Bisulfite

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	White, crystalline, solid	-	HSDB
Melting Point	Decomposes	-	HSDB
Density	1.348 g/cm^3	1	ECHA
Vapor Pressure	Not applicable	-	-
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Very soluble	2	ECHA

Sodium bisulfite is a weak acid with a pK_a of 6.97. Its conjugate base is the sulfite ion (SO_3^{2-}).

$NaHSO_3 \leftrightarrow Na^+ + HSO_3^-$

$HSO_3^- \leftrightarrow H^+ + SO_3^{2-}$

At neutral pH, a mixture of 50% sulfite (SO_3^{2-}) and 50% bisulfite (HSO_3^{2-}) is present.

In surface waters, sulfite is oxidized to sulfate either catalytically by air oxygen or by microbial action (OECD, 2008). The presence of cations like iron, copper or manganese in the environment accelerates the oxidation rate significantly.

Dissociation of sodium bisulfite in aqueous solutions can also liberate sulfur dioxide (SO_2), which is a gas.

III. ENVIRONMENTAL FATE PROPERTIES

At environmental pHs, sodium bisulfite dissociates in water to form sodium (Na^+) ions, bisulfite ions (HSO_3^-), sulfite (SO_2^{3-}) ions, and sulfur dioxide (SO_2) which is a gas.

Sodium bisulfite is not expected to bioaccumulate in the environment because of its dissociation to ionic species and a gas. Furthermore, sulfite will oxidize to sulfate, which is ubiquitous in the environment.

Sodium bisulfite and its dissociated species are expected to have a low potential to adsorb to soil and sediment.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Limited toxicity data are available on sodium bisulfite; therefore, structural analogues have been used to read-across to sodium bisulfite. Sodium sulfite has low acute toxicity by the oral, inhalation, and dermal routes. Sodium sulfite is minimally irritating to the skin and slightly irritating to the eyes. Sodium sulfite is not a skin sensitizer. No systemic toxicity was seen in rats when given sodium metabisulfite in their diet over a lifetime. There were, however, indications of stomach lesions as a result of localized irritation from the ingestion of sodium metabisulfite. Sodium bisulfite is not expected to be genotoxic. No reproductive or developmental toxicity was observed in any of the animal studies on sodium bisulfite or its structural analogues.

B. Acute Toxicity

No acute toxicity studies are available for sodium bisulfite.

The oral LD_{50} value in rats for sodium sulfite is 2,610 mg/kg (ECHA) [Kl. score = 2]. The oral LD_{50} values in rats for sodium metabisulfite are 1,420 mg/kg (males), 1,630 mg/kg (females), and 1,540 mg/kg (combined sexes) (ECHA) [Kl. score = 2].

The 4-hour inhalation LC_{50} in rats for sodium sulfite is >5.5 mg/L (ECHA). [Kl. score = 2]

The dermal LD_{50} in rats for sodium sulfite is >2,000 mg/kg (ECHA). [Kl. score = 2]

C. Irritation

No studies are available on sodium bisulfite.

Application of 0.5 mL of sodium sulfite to the skin of rabbits for 4 hours under occlusive conditions was minimally irritating. The mean of the 24, 48, and 72 scores were: 0.5 for erythema and 0.0 for edema (ECHA). [Kl. score = 2]

Instillation of 0.1 mL of sodium sulfite (with 0.5% cobalt sulfate) into the eyes of rabbits produced slight irritation. The mean of the 24, 48, and 72 hour scores are as follows: 0.5 for conjunctival redness; 0.5 for conjunctival chemosis; 0.0 for corneal lesions; and 0.0 for iridial lesions (ECHA). [Kl. score = 2]

D. Sensitization

No studies are available on sodium bisulfite.

Sodium bisulfite was not considered a skin sensitizer in a mouse local lymph node assay (ECHA). [K. score = 1]

E. Repeated Dose Toxicity

Oral

No studies are available on sodium bisulfite.

A study is available on sodium metabisulfite. Sodium metabisulfite dissociates in water to form sodium (Na^+) ions, disulfite ($S_2O_5^{2-}$) ions, and sulfur dioxide (SO_2). The disulfite ions can form bisulfite (HSO_3^-) and sulfite ions (SO_2^{3-}); at neutral pH, a mixture of 50% sulfite (SO_3^{2-}) and 50% bisulfite (HSO_3^{2-}) is present.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The general condition of the rats was good during the first 72 weeks in the F_0 generation, as well as the other two generations. After 72 weeks, there was a rapid increase in mortality in all groups. Survival in the treated groups were generally higher than the controls, except for the 2% F_1 males; no deaths occurred in the 2% F_2 females. A marginal reduction in body weight gain was observed in the 2% dose group (both sexes) in the F_1 and F_2 generations. Feed consumption was similar between treated and control groups. There were no changes in hematology and clinical chemistry parameters and urinalysis that were considered toxicologically significant. The $\geq$1% dietary groups had occult blood in their feces. Relative kidney weights were increased in the 2% F_2 females, but there were no pathological changes noted in the kidneys from this group. Hyperplastic changes in the fore- and glandular stomachs were noted in the $\geq$1% groups in all three generations. Some slight alterations were also noted in stomachs of the 0.5% F_2 rats. The NOAEL for systemic toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg-day based on a rat body weight of 400 g and a daily feed intake of 20 g. The histopathologic effects on the stomach and the occult blood in feces are considered to be the result of localized irritation (a site-of-contact effect) from the ingestion of sodium metabisulfite (Til et al., 1972; ECHA). [Kl. score = 2]

Inhalation

No studies on sodium bisulfite were located.

Dermal

No studies on sodium bisulfite were located.

G. Genotoxicity

In Vitro Studies

No *in vitro* genotoxicity studies were located for sodium bisulfite. Table 2 presents the findings from *in vitro* genotoxicity studies conducted on structural analogues of sodium bisulfite.

Table 2: *In Vitro* Genotoxicity Studies on Structural Analogues to Sodium Bisulfite

Test System	Test Substance	Results*		Klimisch Score	Reference
		-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* strains)	Sodium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	Potassium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* strains)	Potassium metabisulfite	-	-	2	ECHA
Bacterial reverse mutation (*S. typhimurium* and *E. coli* strains)	Sodium metabisulfite	-	-	2	ECHA
Mammalian cell gene mutation (mouse lymphoma L5178Y cells)	Sodium metabisulfite	-	-	2	ECHA
Chromosomal aberration (human lymphocytes)	Sodium metabisulfite	-	-	1	ECHA

*+, positive; -, negative

In Vivo Studies

Sodium bisulfite did not show a mutagenic response in a rat dominant lethal assay when given in feed at doses of 0, 4.5, 15, or 45 mg/kg-day (ECHA). [Kl. score = 2]

Sodium sulfite was not genotoxic in a bone marrow micronucleus test in rats. Male NMRI rats were given a single subcutaneous injection of 0, 250, 500, or 1,000 mg/kg sodium sulfite (ECHA). [Kl. score = 1]

H. Carcinogenicity

No studies are available on sodium bisulfite.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. There was no

increased incidence of tumors in the treated groups compared to the controls (Til et al., 1972). [Kl. score = 2]

Male and female ICR/JCL mice were given in their drinking water 0, 1, or 2% potassium metabisulfite for two years. There was no increased incidence of tumors in the treated groups compared to the controls (Tanaka et al., 1979). [Kl. score = 2]

No inhalation or dermal carcinogenicity studies were located.

I. Reproductive Toxicity

No studies are available on sodium bisulfite.

Male and female Wistar rats were fed in their diet 0, 0.125, 0.25, 0.5, 1.0, or 2.0% sodium metabisulfite for up to two years and over three generations. The diet was enriched with thiamine to prevent thiamine deficiency as a result of sulfite-induced destruction of this vitamin. During storage up to the time of consumption, the losses of sulfite from the feed containing sodium metabisulfite at levels of 0.125, 0.25, 0.5, 1.0, and 2.0% averaged 22, 14,12, 8, and 4.5%, respectively, while the decrease in thiamine was 2.7, 1.7, 8.3, 14.5, and 15.4%, respectively. Addition of thiamine to the diet prevented thiamine deficiency in rats at all dose levels based on measurements of thiamine levels in the urine and liver. The effects other than reproductive and developmental toxicity are discussed above in the Repeated Dose Toxicity section. There were no treatment-related effects on female fertility, the number of young per litter, or birth weight or mortality of the offspring. The number of F_{2a} pups was significantly reduced in the $\geq$0.5% groups during the first breeding cycle, but there was no dose-response and the reduction did not occur during the second breeding cycle. Slight growth retardation was observed in the F_1 and F_2 generation rats both before and after weaning. The NOAEL for reproductive toxicity is 1.91% in the diet. This was estimated to be 955 mg/kg-day based on a rat body weight of 400 g and a daily feed intake of 20 g (Til et al., 1972; ECHA). [Kl. score = 2]

Male and female rats were given sodum metabisulfite in their drinking water for up to 2.5 years and in three successive generations. The doses were 375 and 750 ppm as sulfur dioxide (SO_2). There was no evidence of systemic toxicity in either dose group. The number of offspring of either the F_1 and F_2 generation and the proportion surviving to the end of lactation were similar between treated and control groups. The NOAEL for reproductive toxicity is 750 ppm (as SO_2) in drinking water. Assuming an average rat body weight of 400 g and a daily water intake of 28 mL, 750 ppm (as SO_2) corresponds to 53 mg/kg-day sodium metabisulfite (Lockett and Natoff, 1960; ECHA). [Kl. score = 2]

J. Developmental Toxicity

Pregnant female Wistar rats were dosed by oral gavage with up to 110 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 110 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female CD-1 mice were dosed by oral gavage with up to 150 mg/kg-day sodium bisulfite during GD 6-15. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 150 mg/kg-day (ECHA). [Kl. score = 2]

Pregnant female Dutch-belted were dosed by oral gavage with up to 100 mg/kg-day sodium bisulfite during GD 6-18. There was no maternal or developmental toxicity. The NOAEL for maternal and developmental toxicity for this study is 100 mg/kg-day (ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium metabisulfite 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, 2011).

A. Non-Cancer

Oral

No repeated dose toxicity studies have been conducted on sodium bisulfite. In a study conducted on sodium metabisulfite, there was no evidence of systemic toxicity in rats fed up to 2% for two years (Til et al., 1972). The NOAEL for this study is 2% or 955 mg/kg-day.

Using the molecular weights of sodium metabisulfite (190.1 g/mol) and sodium bisulfite (104.1 g/mol), the NOAEL of 955 mg/kg-day for sodium metabisulfite is converted to 523 mg/kg-day for sodium bisulfite. The NOAEL of 523 mg/kg-day will be used for determining the oral reference dose (RfD) and the drinking water guidance value for sodium bisulfite.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10

UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 523/(10 x 10 x 1 x 1 x 1) = 523/100 = 5 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (5 x 70 x 0.1)/2 = 18 mg/L

The Australian drinking water guidance value for sodium is 180 mg/L based on aesthetics (ADWG, 2011).

B. Cancer

There are no carcinogenicity studies on sodium bisulfite. No carcinogenic effects were reported for sodium metabisulfite in rat and mouse chronic studies. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium bisulfite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

No aquatic toxicity studies have been conducted on sodium bisulfite. Other inorganic sulfite compounds show low to moderate toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No acute aquatic studies are available on sodium bisulfite; however, studies are available on other inorganic sulfite compounds. The studies on these inorganic sulfite compounds can used to read-across to sodium bisulfite since sulfite ions are formed in water upon dissociation of sodium bisulfite. Table 3 lists the results of acute aquatic toxicity studies on the structural analogues of sodium bisulfite.

Table 2: Acute Aquatic Toxicity Studies on the Structural Analogues of Sodium Bisulfite

Test Species	Test Substance	Endpoint	Results (mg/L)	Klimisch score	Reference
Leuciscus idus	Potassium sulfite	96-hr LC_{50}	316	2	ECHA
Salmo gairdneri	Sodium pyrosulfite	96-hr LC_{50}	147-215 (177.8*)	2	ECHA
Brachydanio rerio	Potassium metabisulfite	96-hr LC_{50}	464-1,000 (681.2*)	1	ECHA
Daphnia magna	Sodium disulfite	48-hr EC_{50}	88.8	2	ECHA
S. subspicatus	Sodium disulfite	96-hr EC_{50} 72-hr EC_{10}	43.9 33.3	2	ECHA

*Geometric mean.

Chronic Studies

No chronic studies are available on sodium bisulfite; however, studies are available on sodium sulfite. Table 4 lists the results of chronic aquatic toxicity studies conducted on sodium sulfite.

Table 4: Chronic Aquatic Toxicity Studies on Sodium Sulfite (CAS No. 7757-83-7)

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Danio rerio	34-d NOEC	>316	1	ECHA
Daphnia magna	21-d NOEC	>10	2	ECHA

B. Terrestrial Toxicity

No studies were located.

C. Calculation of PNEC

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

PNEC water

No studies have been conducted on sodium bisulfite; however, the results from studies conducted on other inorganic sulphite compounds can be used to read-across to sodium bisulfite. Hence, experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for fish (177.8 mg/L for sodium pyrosulfite), invertebrates (88.8 mg/L for sodium sulfite), and algae (43.9 mg/L for sodium disulfite).

Results from chronic studies on sodium sulfite are also available for all three trophic levels, with the lowest NOEC being 10 mg/L for invertebrates. Using the molecular weights of sodium sulfite (126 g/mol) and sodium bisulfite (104.1 g/mol, the NOEC of 10 mg/L for sodium sulfite is converted to 8.3 mg/L. On the basis that the data consist of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 8.3 mg/L for invertebrates. The $PNEC_{water}$ is 0.8 mg/L.

PNEC sediment

No experimental toxicity data on sediment organisms are available. Sodium bisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium bisulfite. Thus, the equilibrium partitioning method cannot be used to calculate

the $PNEC_{sed}$. Based on its properties, no adsorption of sodium bisulfite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. Sodium bisulfite dissociates completely in water with its environmental distribution is dominated by its high water solubility. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium bisulfite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{soil}$. Based on its properties, no adsorption of sodium bisulfite to soil is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sodium bisulfite is an inorganic compound that dissociates completely to ionic species and sulfur dioxide gas. Biodegradation is not applicable to these compounds. For the purposes of this PBT assessment, the persistent criterion is not considered applicable to sodium bisulfite or its dissociated compounds.

Sodium bisulfite is not expected to bioaccumulate because its dissociated species are inorganic ions and a gas.

There are no aquatic toxicity data on sodium bisulfite. The lowest NOEC from chronic aquatic toxicity studies on sodium sulfite, a structural analogue of sodium bisulfite, is >0.1 mg/L. Thus, sodium bisulfite is not expected to meet the criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Aquatic Acute Category 3

B. Labelling

No signal word.

C. Pictogram

None

X. SAFETY AND HANDLING [for a solution of sodium bisulfite]

A. FIRST AID

Eye Contact
In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact
Wash thoroughly with soap and water.

Inhalation
If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion
Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards
When contacted by water, sodium bisulfite releases sulfur dioxide (SO_2), a poisonous gas. In the case of fire, the following may be liberated: Sulfur oxides and sulfur dioxide.

Special Protective Equipment for Firefighters
Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Use appropriate protective equipment.

Environmental Precautions
Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled
Pick up with absorbent material. Dispose of contaminated material as prescribed.

D. STORAGE AND HANDLING

General Handling
No special measures necessary provided product is used correctly.

Other Handling Precautions
Avoid eye and skin contact.

Storage
Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

The workplace exposure standard for sodium bisulfite in Australia is 5 mg/m^3 as an 8-hr TWA.

Engineering Controls
None

Personal Protection Equipment

Respiratory Protection:
Respiratory protection is not required.

Hand Protection:
Chemical resistant protective gloves.

Skin *Protection*:
Body protection must be chosen depending on activity and possible exposure.

Eye protection*:*
Safety glasses with side-shields.

Other Precautions:

Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Sodium bisulfite is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. 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.

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SODIUM CARBONATE

This dossier on sodium carbonate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium carbonate in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on sodium carbonate (OECD, 2002a, b) and 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).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): disodium carbonate

CAS RN: 497-19-8

Molecular formula: $CH_2O_3.2Na$

Molecular weight: 106

Synonyms: sodium carbonate; disodium carbonate; carbonic acid, disodium salt; bisodium carbonate; soda ash, calcined soda

SMILES: C(=O)([O-])[O-].[Na+].[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-Chemical Properties of Sodium Carbonate

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid; white powder	1	ECHA
Melting Point	851°C	2	ECHA
Boiling Point	No data	-	-
Density	>2.52 and <2.53 (20°C)	1	ECHA
Vapour Pressure	No data	-	-
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	404 g/L* [soluble]	2	ECHA
pH	ca 11.5**	2	ECHA
Flammability	No	1	ECHA

*GLP-compliant study. The water solubility was overestimated, possibly due to the high temperature (during dissolution) or due to gel formation.

**pH value from water solubility test.

Aqueous solutions are strongly alkaline. At 25°C, the pH of 1, 5 and 10 wt% sodium carbonate solutions are 11.37, 11.58, and 11.70, respectively (Eggeman, 2001).

III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, sodium carbonate will be found predominantly in the aquatic environment where it dissociates completely to sodium (Na^+) and carbonate (CO_3^{2-}) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

Addition of sodium carbonate to an aquatic ecosystem will result in an increase in alkalinity and a tendency to increase the pH. The carbonate ions will react with water, forming bicarbonate (HCO_3^-) and hydroxide (OH^-) ions until an equilibrium is reached. A re-equilibration takes place when carbonate (CO_3^{2-}) is dissolved in water according to the following equations:

$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ pKa=10.33

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ pKa = 6.35

Only a small fraction of the dissolved CO_2 is present as H_2CO_3 (carbonic acid), the major part is present as CO_2. The amount of CO_2 in water is in equilibrium with the partial pressure of CO_2 in the atmosphere. The CO_2/ HCO_3^-/ CO_3^{2-} equilibria are the major buffer of the pH of freshwater.

Based on the above equations, CO_2 is the predominant species at a pH smaller than 6.35, while HCO_3^- is the predominant species at a pH in the range of 6.35-10.33 and CO_3^{2-} is the predominant species at a pH higher than 10.33.

A release of sodium carbonate into the aquatic environment from the use of sodium carbonate could potentially increase the sodium concentration and the pH in the aquatic environment. Table 2 shows the concentration of sodium carbonate needed to increase the pH to values of 9.0, 10.0, and 11.0.

Table 2: Sodium Carbonate Concentration (mg/L) Needed to Increase pH (DeGroot et al., 2002; taken from OECD, 2002b).

Buffer capacity*	Final pH**		
	9.0	10.0	11.0
0 mg/L HCO_3^- (distilled water)	11.1 (0.6)	16 (6.1)	603 (61)
20 mg/L HCO_3^- (10th percentile of 77 rivers)	2.7 (21)	32 (26)	766 (81)
106 mg/L HCO_3^- (mean value of 77 rivers)	9.7 (107)	102 (112)	1467 (167)
195 mg/L HCO_3^- (90th percentile of 77 rivers)	17 (196)	175 (201)	2192 (256)

*The initial pH of a bicarbonate solution with a concentration of 20-195 mg/L is 8.3 (calculated).

**The final concentration of bicarbonate is given in parentheses.

Na^+ and CO_3^{2-} ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues (OECD 2002b).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

There are limited toxicity data on sodium carbonate. It has a low order of acute toxicity by the oral, dermal, and inhalation routes. It is not a skin irritant, but it is an eye irritant. Sodium carbonate is not expected to be systemically available in the body from oral exposure due to its dissociation in bodily fluids and the neutralisation of the carbonate ion in the stomach. No developmental toxicity was seen in studies with rats, mice, or rabbits.

B. Toxicokinetics and Metabolism

Sodium carbonate will dissociate in bodily fluids into sodium (Na^+) and carbonate (CO_3^{2-}) ions. The oral uptake of sodium carbonate would lead to neutralisation of carbonate in the stomach by the gastric acids which would lead to bicarbonate and/or carbon dioxide (CO_2) formation. It is unlikely that an oral uptake of sodium carbonate would disrupt the acid-base balance of the body because CO_2 formation in the stomach would alleviate the high amounts of carbonate that would be present in the stomach from an acute exposure. The equation that describes this reaction is:

$HCO_3^- + H^+ \leftrightarrow \square H_2CO_3 \leftrightarrow CO_2 + H_2O$

C. Acute Toxicity

An acute oral LD_{50} of sodium carbonate monohydrate in rats is 2,800 mg/kg, and the acute dermal LD_{50} in rabbits is >2,000 mg/kg (OECD, 2002a,b; ECHA). [Kl. scores = 1]

An acute inhalation toxicity study was conducted on an aerosol of sodium combustion products, which contain predominantly sodium carbonate. The 2-hour inhalation LC_{50} values for this aerosol to guinea pigs, mice and rats were 800, 1,200 and 2,300 mg/m^3, respectively. The median aerodynamic diameter of the aerosol was 0.77 $\pm$ 2.1µm (OECD, 2002a, b; ECHA). [Kl. score = 1]

D. Irritation

As reviewed in the OECD-SIDS documents (OECD, 2002a,b), skin irritation studies in laboratory animals and human volunteers with sodium carbonate either as a 50% solution or as a solid showed slight to no skin irritation.

Sodium carbonate is an eye irritant (OECD, 2002a,b; ECHA). A dose of 0.1 ml sodium carbonate monohydrate was irritating to the eyes of rabbits and, in another study, 0.1 ml of sodium carbonate (anhydrous) was highly irritating to rabbit eyes. However, 0.1 g sodium carbonate (anhydrous) was found not to be an eye irritant. [Kl scores of 1, 2, 1, respectively]

E. Sensitisation

No studies were identified.

F. Repeated Dose Toxicity

No studies were identified by the oral, inhalation or dermal routes.

G. Genotoxicity

In Vitro Studies

Sodium carbonate did not induce primary DNA damage in an *E. coli* chromotest (Olivier and Marzin, 1987; OECD, 2002a, b). [Kl. score = 3]

In Vivo Studies

No studies were identified.

H. Carcinogenicity

No studies were identified.

I. Reproductive Toxicity

No studies were identified.

J. Developmental Toxicity

Pregnant rats were dosed by oral gavage with 0, 2.45, 11.4, 52.9 or 245 mg/kg sodium carbonate on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 245 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

Pregnant mice were given doses of sodium carbonate (3.4 to 340 mg/kg) by oral gavage on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 340 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

Pregnant rabbits were dosed by oral gavage with 0, 1.79, 8.31, or 179 mg/kg sodium carbonate on gestational days 6 to 15. No maternal or developmental toxicity was observed. The NOAEL for maternal and developmental toxicity is 179 mg/kg-day, the highest dose tested (OECD, 2002a, b). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

There are no repeated dose toxicity studies conducted on sodium carbonate by any route of exposure. Developmental toxicity studies conducted by the oral route in three animal species showed no developmental effects at the highest doses tested. Sodium carbonate dissociates to sodium and carbonate ions in bodily fluids, and significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms.

Sodium carbonate is used in many countries (e.g., U.S. and EU) as a food additive. It is regarded as a Generally Recognized as Safe (GRAS) substance in food with no limitation other than current good manufacturing practice (OECD, 2002a, b).

Therefore, a toxicological reference value was not derived for sodium carbonate.

The Australian drinking water guideline values for sodium (180 ppm, aesthetic) and pH may be applicable (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium carbonate does not exhibit the following physico-chemical properties:

- Flammability
- Explosivity
- Oxidising potential.

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium carbonate is of low toxicity concern to aquatic and terrestrial organisms.

B. Aquatic Toxicity

Acute Studies

The results of the aquatic toxicity studies conducted on sodium carbonate are presented in Table 3.

Table 3: Aquatic Toxicity Studies on Sodium Carbonate (OECD, 2002a,b)

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Bluegill sunfish	96-h LC_{50}	300	2	OECD, 2002a, b
Mosquitofish	96-h LC_{50}	740	2	OECD, 2002a, b
Bluefill sunfish	24-h LC_{50}	385	4	OECD, 2002a, b
Molly	50-h LC_{50}	297	4	OECD, 2002a, b
Ceriodaphnia dubia	48-h EC_{50}	200 - 227	2	OECD, 2002a, b

There are other studies conducted on invertebrates, but the results of these studies were not included in Table 3 because of the low reliability of the data (OECD, 2002a, b). No studies on algae were identified (OECD, 2002a, b).

C. Terrestrial Toxicity

No studies were identified.

D. Calculation of PNEC

The OECD-SIDS SIAR on sodium carbonate states the following regarding the aquatic toxicity studies on sodium carbonate (OECD, 2002b):

> "In general the available toxicity studies with sodium carbonate were not conducted according to current standard guidelines. In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with sodium carbonate. In general, mortality of the test organisms was found at concentrations higher than 100 mg/l but for *Amphipoda*, salmon and trout lethal effects were already observed at 67-80 mg/l although these studies had a low reliability. The main factor explaining the acute aquatic toxicity of sodium carbonate is most likely the increase of the pH."
>
> "Because the natural pH, bicarbonate and also the sodium concentration (and their fluctuations in time) varies significantly between aquatic ecosystems, it is not considered useful to derive a generic PNEC or $PNEC_{added}$."

Based on the information above, PNEC values for freshwater, sediment, and soil were not derived for sodium carbonate.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sodium carbonate is an organic salt that dissociates completely to sodium and carbonate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both sodium and

carbonate ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

Sodium and carbonate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sodium carbonate is not expected to bioaccumulate.

No chronic aquatic toxicity data exist on sodium carbonate; however, the acute $EC(L)_{50}$s are >1 mg/L in fish, invertebrates and algae. Therefor, sodium carbonate does not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELLING

A. Classification

Eye Irritant Category 2

B. Labelling

Warning

C. Pictograms



X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Immediately flush eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. If symptoms persist, seek medical attention.

Skin Contact

Wash with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Do not induce vomiting. Rinse mouth with water. Never give anything by mouth to an unconscious person. If symptoms persist, get medical attention.

B. Firefighting Information

Extinguishing Media

Water fog, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

Decomposition in fire may produce toxic gases.

Special Protective Equipment for Fire fighters

Full protective clothing and approved self-contained breathing apparatus.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment. Avoid creating and breathing dust.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilled

Scoop up and remove.

D. Storage and Handling

General Handling

Avoid contact with eyes and skin. Avoid creating or inhaling dust.

Storage

Store away from acids. Store in a cool, dry location.

E. Exposure Controls/Personal Protection

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure limit for sodium carbonate.

Engineering Controls

Use in a well ventilated area. Localised ventilation should be used to control dust levels.

Personal Protection Equipment

Respiratory Protection: In case of insufficient ventilation, wear suitable respiratory equipment. Dust/mist respirator.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. Transport Information

Sodium Carbonate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

C	Centigrade
ECHA	European Chemicals Agency
EU	European Union
GD	gestational day
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
GRAS	Generally Recognized as Safe
IUPAC	International Union of Pure and Applied Chemistry
kg	kilogram
kPa	kilopascal
L	litre
LOAEL	lowest observed adverse effect level
m	metre
mg/m3	milligrams per cubic meter
mm	millimetre
µg	microgram
mg	milligram
mL	millilitre
NOAEL	no observed adverse effect level
OECD	Organisation for Economic Co-operation and Development
Kl	Klimisch scoring system
Pow	octanol/water partition coefficient
PNEC	Predicted No Effect Concentration
ppm	parts per million

REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

SODIUM CITRATE

This dossier on sodium citrate does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium citrate in its use in drilling muds and water treatment systems. The information presented in this dossier was obtained primarily from the OECD-SIDS documents on citric acid (OECD 2001a,b) and 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).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Trisodium 2-hydroxypropane-1,2,3-tricarboxylate dihydrate

CAS RN: 6132-04-3

Molecular formula: $C_6H_5Na_3O_7.2H_2O$ or $C_6H_9Na_3O_9$

Molecular weight: 294.10

Synonyms: Sodium citrate; sodium citrate dihydrate; sodium citrate, anhydrous; anhydrous sodium citrate; trisodium citrate dihydrate; trisodium 2-hydroxypropane-1,2,3-tricarboxylate dihydrate

SMILES: C(C(=O)[O-])C(CC(=O)[O-])(C(=O)[O-])O.O.O.[Na+].[Na+].[Na+]

Citric acid is an ubiquitous natural substance that is an intermediate in the basic physiological tricarboxylic acid (TCA) cycle in every eukaryote cell.

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Citrate

Property	Value	Klimisch score	Reference
Physical state at 20ºC and 101.3 kPa	Crystalline solid	2	ECHA
Melting Point	>150ºC	2	ECHA
Boiling Point	Not available; decomposition	-	ECHA
Density	1.857 @ 20ºC	2	ECHA
Vapor Pressure	0 Pa @ 25ºC	2	ECHA
Partition Coefficient (log K_{ow})	-1.72	4	ECHA
Water Solubility	Very soluble	4	ECHA
Flash Point	290ºC	4	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

A. Summary

Sodium citrate is readily biodegradable. It is not expected to bioaccumulate. Due to its high water solubility, citric acid is unlikely to adsorb to soil or sediment.

B. Biodegradation

Sodium citrate dissociates in aqueous solutions to sodium (Na^+) and citrate ($C_6H_5O_7^-$) ions. Sodium citrate can be considered readily biodegradable based on the results of the ready and inherent aerobic biodegradation studies on citric acid listed in Table 2.

Table 2: Biodegradation Studies on Citric Acid (OECD 2001a,b)

Test System	Results*	Notes	Klimisch Score
Modified Sturm	97% (CO_2 evolution); 100% (DOC removal)	Readily biodegradable; exposure period not stated	2
Closed Bottle Test	BOD_{30}/COD Ratio = 90%	Readily biodegradable	2
BOD_5/COD Ratio	BOD_5 = 526 mg; COD = 728 mg; BOD_5/COD Ratio = 0.72	Readily biodegradable; concentration of test substance and activated sludge not stated	2
BOD_1/ThOD Ratio	BOD_1/ThOD Ratio = 13%	-	2
BOD_{20}/ThOD Ratio	BOD_{20}/COD Ratio = 98%	Readily biodegradable; initial test substance concentration 720 mg/L	2
Zahn-Wallen Test	85%, 1 day (DOC removal)	Inherently biodegradable	2
Zahn-Wallen Test	98%, 7 days (DOC removal)	Inherently biodegradable	
Coupled Units Test	93% (COD removal)	Ultimately biodegradable; exposure period not stated.	2

C. Environmental Distribution

Absorption/desorption

No experimental data are available for sodium citrate or citric acid. Using KOCWIN program in EPISuite™ (EPA, 2016), the estimated K_{oc} value for citric acid from the K_{ow} value of -1.08 is 0.3617 L/kg.

D. Bioaccumulation

The log K_{ow} for sodium citrate is -1.72. Thus, sodium citrate is not expected to bioaccumulate.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sodium citrate exhibits low toxicity by the oral and dermal routes. It is non-irritating to the skin and eyes; and is not a skin sensitizer. Minimal toxicity and no carcinogenic effects were observed in rats given oral doses of citric acid for up to two years. Citric acid and sodium dihydrogen citrate were not mutagenic to bacteria, but *in vitro* studies on citric acid using human lymphocytes showed genotoxic effects. *In vivo* genotoxicity studies on citric acid were negative. There were no reproductive or developmental effects in rats given oral doses of citric acid.

B. Acute Toxicity

No studies are available for sodium citrate.

The acute oral LD_{50} for citric acid in male rats was reported to be 11,700 mg/kg (ECHA) [Kl. score = 2]. The acute oral LD_{50} values for citric acid in mice are 5,400 and 5,790 mg/kg (ECHA) [Kl. score = 2].

The acute dermal LD_{50} value for citric acid in rats is >2,000 mg/kg (ECHA) [Kl. score = 1].

C. Irritation

Application of 0.5 g sodium citrate to the skin of rabbits for 4 hours under semi-occlusive conditions was non-irritating. The mean of the 24, 48, and 72-hour scores were 0.00 for both erythema and edema (ECHA) [Kl. score = 1].

Instillation of 0.1 g of sodium citrate into the eyes of rabbits was non-irritating. The mean of the 24, 48, and 72-hour scores were 0.00 for iridial lesions, corneal opacity, conjunctival redness, and chemosis (ECHA) [Kl. score = 1].

D. Sensitization

Sodium citrate was not considered a skin sensitizer in a guinea pig maximization test (ECHA) [Kl. score = 1].

E. Repeated Dose Toxicity

Oral

Female rabbits were given 0 or 7.7% sodium citrate (1,500 mg/kg-day) in their feed for 150 days. There were no treatment-related effects. The NOAEL is 1,500 mg/kg-day (ECHA) [Kl. score = 4].

Male rats were given 0, 1.2, 2.4, or 4.8% citric acid in their feed for 6 weeks. The daily intakes were reported to be 1,150, 2,260, or 4,670 mg/kg-day. The high-dose animals had mild blood and urine parameter changes and slight degeneration of the thymus gland and spleen. The NOAEL is 2.4% in the diet or 2,260 mg/kg-day (OECD, 2001a,b). [Kl. score = 4]

Rats were given 3% or 5% citric acid in their diet for two years. The estimated daily intakes were 1,200 and 2,000 mg/kg-day, respectively. A slight decrease in growth was reported in the 2% group, but no tissue abnormalities in the major organs. The NOAEL is 1,200 mg/kg-day (OECD, 2001a,b). [Kl. score = 4]

Inhalation

No studies are available.

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

Sodium dihydrogen citrate was not mutagenic in bacterial reverse mutation assays with strains of *S. typhimurium* with and without metabolic activation (ECHA). [Kl. score = 2]

Citric acid was not mutagenic in bacterial reverse mutation assays with strains of *S. typhimurium* or *E. coli* with and without metabolic activation (OECD, 2001a,b; ECHA). [Kl. score = 2]

Peripheral human lymphocytes were treated with 50 to 3,000 μg/ml citric acid. A statistically significant dose-dependent increase in the micronuclei was observed. In another set of studies by the same laboratory, there was a statistically significant and dose-related increase in the number of cells with aberrations, including sister chromatid unions. The study authors reported that the pH of the medium was unchanged (ECHA). [Kl. score = 2]

In Vivo Studies

Citric acid was not mutagenic in a dominant lethal assay when male rats were given either a single oral dose of citric acid (1.2 to 120 mg/kg) or a single oral dose on five consecutive days (300 to 3,500 mg/kg) (OECD 2001a,b) [Kl. score = 2]. There were no increases in chromosomal aberrations in the bone marrow of rats given either a single oral dose of citric acid (1.2 to 120 mg/kg) or a single oral dose on five consecutive days (300 to 3,500 mg/kg) (ECHA) [Kl. score = 2].

G. Carcinogenicity

Oral

There was no evidence of carcinogenicity in rats given 3% or 5% citric acid in feed (1,200 or 2,000 mg/kg/day, respectively) for two years (OECD, 2001a,b). [Kl. score = 4]

H. Reproductive Toxicity

In a non-standard repeat dose dietary study (duration and frequency not specified), 5% citric acid in feed did not affect either the number of young born to mice or rats or their subsequent survival up to the point of weaning (ECHA). [Kl. score = 4]

I. Developmental Toxicity

Pregnant female rats were dosed by oral gavage with 0, 2.95, 13.7, 63.6, or 295 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 295 mg/kg-day, the highest dose tested (OECD, 2001a,b; ECHA). [Kl. score = 2]

Pregnant female rats were dosed by oral gavage with 0, 2.41, 11.2, 52, or 241 mg/kg citric acid on GD 6-15. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 241 mg/kg-day, the highest dose tested (OECD, 2001a,b; ECHA). [Kl. score = 2]

Pregnant female rabbits were dosed by oral gavage with 0, 4.25, 19.75, 91.70, or 425 mg/kg citric acid on GD 6-18. No maternal or developmental effects were noted. The NOAEL for maternal and developmental toxicity is 425 mg/kg-day, the highest dose tested (OECD, 2001a,b; ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

The toxicological reference values developed for sodium citrate 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, 2011).

A. Non-Cancer

Oral

There are no adequate studies on sodium citrate for the derivation of an oral reference dose and a drinking water guidance value. However, sodium citrate dissociates in aqueous media to sodium and citrate ions. In a two-year dietary study, the only effect seen in rats fed either 3 or 5% citric acid (approx. 1,200 or 2,000 mg/kg-day) was a slight decrease in growth in the 5% dose group. In the absence of statistical analysis of the body weight gain data, a conservative approach was taken, and the 5% dose group was considered an LOAEL. The NOAEL of 3% citric acid in the diet (1,200 mg/kg-day) will be used for determining the oral reference dose (RfD) and the drinking water guidance value for sodium citrate.

To convert the NOAEL of 1,200 mg/kg-day (as citric acid) to a NOAEL for sodium citrate, the following molecular weights were used:

Molecular weight of citric acid = 192.12

Molecular weight of sodium citrate = 294.10

NOAEL = 1,200 mg/kg-day x 294.10/192.12 = 1,837 mg/kg-day (1,837 mg/kg-day as sodium citrate)

The NOAEL of 1,837 mg/kg-day (as sodium citrate) will be used for determining the oral Reference dose (RfD) and the drinking water guidance value.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
- UF_A (interspecies variability) = 10
- UF_H (intraspecies variability) = 10
- UF_L (LOAEL to NOAEL) = 1
- UF_{Sub} (subchronic to chronic) = 1
- UF_D (database uncertainty) = 1

Oral RfD = 1,837/(10 x 10 x 1 x 1 x 1) = 1,837/100 = 18 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (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 = (18 x 70 x 0.1)/2 = 63 mg/L

The Australian drinking water guideline value for sodium is 180 mg/L based on aesthetics (ADWG, 2011).

B. Cancer

Citric acid was not carcinogenic to rats in a chronic dietary study. Thus, no cancer reference value was derived for sodium citrate.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium citrate does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium citrate is of low toxicity concern to aquatic organisms.

B. Aquatic Toxicity

Acute Studies

No studies are available on sodium citrate.

The 48-hour LC_{50} values for citric acid in *Leuciscus idus melanotus* (golden orfe) from two separate laboratories were 440 mg/L and 760 mg/L (ECHA) [Kl. scores = 2]. The 96-hour LC_{50} for citric acid in *Lepomis macrochirus* (fathead minnow) is >100 mg/L (ECHA) [Kl. score = 2).

The 24-hour EC_{50} value for citric acid in *Daphnia* is 85 mg/L in un-neutralized test solution and 1,535 mg/L in a neutralized solution (OECD, 2001a,b; ECHA). [Kl. score = 2]

The 8-day toxicity threshold value (EC_0) for citric acid in *Scenedesmus quadricauda* is 640 mg/L (ECHA; OECD, 2001a,b). [Kl. score = 2]

Chronic Studies

No studies are available.

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

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

PNEC water

Experimental results on citric acid are available for three trophic levels. Acute $E(L)C_{50}$ values are available for only fish (440 mg/L) and *Daphnia* (1,535 mg/L, neutralized). On the basis that the data consist of short-term results from two trophic levels, an assessment factor of 1,000 has been applied to the lowest reported effect concentration of 440 mg/L for fish. The $PNEC_{water}$ for citric acid is 0.44 mg/L, or 0.67 mg/L for sodium citrate.

PNEC sediment

There are no toxicity data for sediment-dwelling organisms. Therefore, the $PNEC_{sed}$ was calculated using the equilibrium partitioning method. The $PNEC_{sed}$ for sodium citrate is 0.42 mg/kg wet weight.

The calculations are as follows:

$PNEC_{sed} = (K_{sed\text{-}water}/BD_{sed}) \times 1000 \times PNEC_{water}$
$= (0.807/1280) \times 1000 \times 0.67$
$= 0.422$

Where:
$K_{sed\text{-}water}$ = suspended matter-water partition coefficient (m^3/m^3)
BD_{sed} = bulk density of sediment (kg/m^3) = 1,280 [default]

$K_{sed\text{-}water} = 0.8 + [0.2 \times Kp_{sed}/1000 \times BD_{soilid}]$
$= 0.8 + [0.2 \times 0.014/1000 \times 2400]$
$= 0.807$

Where:
Kp_{sed} = solid-water partition coefficient (L/kg).

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

$Kp_{sed} = K_{oc} \times f_{oc}$
$= 0.3617 \times 0.04$
$= 0.014$

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for citric acid is estimated to be 0.3617 L/kg.
F_{oc} = fraction of organic carbon suspended sediment = 0.04 [default].

PNEC soil

There are no toxicity data for terrestrial or soil organisms. Therefore, the $PNEC_{soil}$ was calculated using the equilibrium partitioning method. The $PNEC_{soil}$ for sodium citrate is 0.003 mg/kg soil dry weight.

The calculations are as follows:

$PNEC_{soil} = (Kp_{soil}/BD_{soil}) \times 1000 \times PNEC_{water}$
$= (0.007/1500) \times 1000 \times 0.67$

= 0.003

Where:

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

$Kp_{soil} = K_{oc} \times f_{oc}$
= 0.3617 x 0.02
= 0.007

Where:

K_{oc} = organic carbon normalised distribution coefficient (L/kg). The K_{oc} for citric acid is estimated to be 0.3617 L/kg.
F_{oc} = fraction of organic carbon in soil = 0.02 [default].

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009, ECHA, 2008).

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

The log K_{ow} values for sodium citrate are -1.72. Thus, sodium citrate does not meet the screening criteria for bioaccumulation.

There are no adequate chronic aquatic toxicity studies on citric acid or sodium citrate. The acute $E(L)C_{50}$ values for citric acid are >1 mg/L in fish and invertebrates. Thus, it does not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELING

The information in this section is for sodium citrate.

A. Classification

Not classified.

B. Labelling

No signal word.

C. Pictogram

None

X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

In the case of contact, immediately flush eyes with plenty of water for at least 15 minutes. If symptoms persist, seek medical advice.

Skin Contact

Wash thoroughly with soap and water.

Inhalation

If inhaled, remove from area to fresh air. Get medical attention if respiratory irritation develops or if breathing becomes difficult.

Ingestion

Rinse mouth with water and then drink plenty of water. Never give anything by mouth to an unconscious person. If symptoms develop, seek medical advice.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Water spray, carbon dioxide, foam, dry chemical.

Specific Exposure Hazards

No data are available.

Special Protective Equipment for Firefighters

Wear self-contained breathing apparatus.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Use appropriate protective equipment.

Environmental Precautions

Prevent from entering sewers, waterways, or low areas.

Steps to be Taken if Material is Released or Spilt

Pick up with absorbent material. Dispose of contaminated material as prescribed.

D. STORAGE AND HANDLING

General Handling

No special measures necessarily provided product is used correctly.

Other Handling Precautions

Avoid eye and skin contact.

Storage

Keep container tightly closed and in a dry and well-ventilated place. Keep in a cool place.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium citrate.

Engineering Controls

None

Personal Protection Equipment

Respiratory Protection: Respiratory protection is not required.

Hand Protection: Chemical resistant protective gloves.

Skin Protection: Body protection must be chosen depending on activity and possible exposure.

Eye protection: Safety glasses with side-shields.

Other Precautions: Handle in accordance with good industrial hygiene and safety practice. Eyewash fountains and safety showers must be easily accessible.

F. TRANSPORT INFORMATION

Sodium citrate is not considered hazardous for purposes of transportation by road or rail. An Australian Dangerous Goods Code is not required.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. 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.

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level

mg/kg	milligrams per kilogram
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
USEPA	United States Environmental Protection Agency
µm	micrometre

SODIUM HYDROXIDE

This dossier on sodium hydroxide does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium hydroxide in its use in drilling muds and hydraulic fracturing fluids. The information presented in this dossier was obtained from the OECD-SIDS documents on sodium hydroxide (OECD, 2002a, b) and 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).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium hydroxide

CAS RN: 1310-73-2

Molecular formula: HNaO

Molecular weight: 40 g/mol

Synonyms: Caustic soda, soda lye, NaOH

SMILES: O[Na]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Physico-Chemical Properties of Sodium Hydroxide

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid	2	Lide, 2009; ECHA
Melting Point	318°C (solid, 100%); 52°C (60% solution)	2	ECHA
Boiling Point	1,388°C @ 101.325 kPa	2	Lide, 2009; ECHA
Density	2.13 g/cm^2, 20°C (100%) 1.43 g/cm^2, 20°C (40%)	2	Lide, 2009; ECHA
Vapour Pressure	1 Pa @ 513°C	2	Lide, 2009; ECHA
Partition Coefficient (log Kow)	Not applicable	-	-
Water Solubility	Very soluble	2	Lide, 2009; ECHA
Dissociation Constant (pKa)	14.8 @ 25°C	2	Lide, 2009; ECHA
pH of 5% NaOH solution	14	2	O'Neil, 2006

Sodium hydroxide (NaOH) is a strong alkaline substance that dissociates completely in water to sodium (Na^+) and hydroxyl (OH^-) ions.

III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, sodium hydroxide will be found predominantly in the aquatic environment where it dissociates completely to sodium (Na^+) and hydroxyl (OH^-) ions. Both ions are ubiquitous in the environment (UNEP, 1995).

The addition of sodium hydroxide to an aquatic ecosystem may increase the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ ($pKa_1 = 6.35$)
$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ ($pKa_2 = 10.33$)

A release of sodium hydroxide into the aquatic environment from the use of NaOH could potentially increase the sodium concentration and the pH in the aquatic environment. Table 2 shows the concentration of sodium hydroxide needed to increase the pH to values of 9.0, 10.0, 11.0, and 12.0.

Table 2: Sodium Hydroxide Concentration (mg/L) Needed to Increase pH (DeGroot et al., 2002; taken from OECD, 2002b).

Buffer capacity*	Final pH			
	9.0	10.0	11.0	12.0
0 mg/L HCO_3 (distilled water)	0.4	4.0	40	400
20 mg/L HCO_3 (10th percentile of 77 rivers)	1.0	8.2	51	413
106 mg/L HCO_3^- (mean value of 77 rivers)	3.5	26	97	468
195 mg/L HCO_3^- (90th percentile of 77 rivers)	6.1	45	145	525

*The initial pH of a bicarbonate solution with a concentration of 20-195 mg/L was 8.25 to 8.35.

Na^+ and OH^- ions will not adsorb on the particulate matter or surfaces and will not accumulate in living tissues (OECD, 2002b).

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Limited toxicity data exist for sodium hydroxide (NaOH). Depending on the concentration, solutions of NaOH are corrosive, irritating, or non-irritating. These solutions cause direct effects to the skin, eyes, respiratory tract, and gastrointestinal tract. Vapors from aqueous solutions of KOH can cause respiratory irritation. NaOH is not a skin sensitiser. There are no repeated dose, reproductive, and developmental toxicity studies on potassium hydroxide.

B. Toxicokinetics/Metabolism

Sodium hydroxide dissociates completely in aqueous solutions to sodium (Na^+) and hydroxyl (OH^-) ions. Sodium is an essential nutrient involved in fluid and electrolyte balance and is required for normal cellular function (Ganong, 1995). Sodium is the major extracellular cation in the body; the total body content is tightly regulated (Ganong, 1995).

C. Acute Toxicity

There are no oral toxicity guideline studies on sodium hydroxide. An oral LD_{50} of a 1 to 10% solution of NaOH in rabbits was reported to be 325 mg/kg (expressed as 100% NaOH) (OECD, 2002a,b). Mortality was also observed when a 1% NaOH solution was dosed, but in this case, the applied volume was relatively high (24 mL per kg body weight) (OECD, 2002a,b).

Acute toxicity studies were not identified for the inhalation and dermal route.

D. Irritation

Animal studies have shown that an 8% NaOH solution is corrosive to the skin. In humans, 0.5 to 4% NaOH concentrations produced skin irritation; and, based on the results of two different human patch tests, a NaOH solution that is slightly less than 0.5% would be non-irritating to human skin (OECD, 2002a,b).

Results from animal eye irritation studies indicate that a 0.2-1.0% NaOH solution would be non-irritating, while 1.2 or >2% NaOH solutions would be corrosive (OECD, 2002a,b).

E. Sensitisation

Male volunteers were exposed on the skin of their back to solutions of 0.063 to 1.0% NaOH in the induction phase of a human patch test. After 7 days the volunteers were challenged to a concentration of 0.125% NaOH. The irritant response correlated well with the concentration of NaOH, but an increased response was not observed when the previously patch tested sites were re-challenged. Based on this study, sodium hydroxide is not a skin sensitiser (OECD, 2002a, b; ECHA). [Kl. score = 2]

F. Repeated Dose Toxicity

No studies were identified for the oral and dermal route. An inhalation study was conducted in rats exposed to aerosols of solutions of NaOH ranging from 5% to 40%. Exposures were twice weekly (hours/day and total exposure days unspecified). All animals in the 40% solution group died within a month mostly from bronchopneumonia. At the lower concentrations, respiratory tract lesions were observed; an NOAEL was not identified (NIOSH, 1975).

G. Genotoxicity

In Vitro Studies

Several *in vitro* studies have been conducted on NaOH (OECD, 2002a, b; ECHA). Although these studies reported negative results, they are considered unreliable (Kl. score = 3) due to methodological or reporting deficiencies.

In Vivo Studies

Several *in vivo* studies have been conducted on NaOH (OECD, 2002a,b; ECHA). Although these studies reported negative results, they are considered unreliable (Kl. score = 3) due to methodological or reporting deficiencies.

H. Carcinogenicity

No studies were identified.

I. Reproductive Toxicity

No valid studies were identified regarding toxicity to reproduction in animals after oral, dermal or inhalation exposure to NaOH.

J. Developmental Toxicity

No valid studies were identified regarding developmental toxicity in animals after oral, dermal or inhalation exposure to NaOH (OECD, 2002a, b; ECHA).

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

Oral and dermal repeated dose, reproductive, and developmental toxicity studies have not been conducted on NaOH. A repeated dose toxicity study was conducted by the inhalation route, but the methodology and documentation preclude its use for deriving a toxicological reference value. These toxicity studies would have questionable usefulness because of the corrosive/irritating nature of NaOH, which would limit the amount absorbed. NaOH dissociates to sodium and hydroxyl ions in bodily fluids, and a significant amount of these ions are already ingested in foods. Furthermore, both ions are present in the body and are highly regulated by homeostatic mechanisms. Thus, a toxicological reference value was not derived for NaOH.

The Australian drinking water guideline values for sodium (180 ppm, aesthetic) and pH may be applicable (ADWG, 2011).

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium hydroxide does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential.

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Aquatic Toxicity

The OECD-SIDS SIAR on NaOH states the following regarding the aquatic toxicity studies on NaOH (OECD, 2002b):

> "At concentrations reported in publications and study reports, the toxicity has been assumed to be due to hydroxide only, because at these effect concentrations the concentration of sodium is too low to explain the effects. However, it should be realised that the results of toxicity tests with NaOH depend on the buffer capacity of the test medium. In a highly buffered test medium, the hydroxyl ion will be neutralised, and the observed toxicity will be low, while in a poorly buffered test medium the pH will increase rapidly and therefore the observed toxicity will be relatively high. Besides the direct effects (pH change) NaOH could also have indirect effects. The pH change could influence the speciation of other chemicals and therefore increase and/or decrease the toxicity, e.g.; NH_3 is more toxic than NH_4^+."

There are no guideline studies on NaOH; the studies summarised below have Klimisch scores of 3 or 4.

Acute Fish

The 24-hour LC_{50} to *Carassius auratus* (goldfish) is 160 mg/L. At 100 mg/L, which was equivalent to a pH of 9.8, no mortality was observed. The 48-hour LC_{50} to *Leuciscus idus melanotus*, is 189 mg/L. The 96-hour LC_{50} of *Gambusia affinis* (mosquitofish) is 125 mg/L. At 84 mg/L, no effects on the fish were observed. The pH was 9 at 100 mg/L.

Acute Invertebrate

The 48-hour LC_{50} is 40 mg/L for *Ceriodaphnia cf. dubia*. The toxicity threshold concentration of NaOH for *Daphnia magna* was reported to range from 40 to 240 mg/L.

Acute Algae

No studies were identified.

B. Terrestrial Toxicity

No studies were identified.

C. Calculation of PNEC

The OECD-SIDS SIAR on NaOH states the following regarding the aquatic toxicity studies on NaOH (OECD, 2002b):

> "In many cases pH, buffer capacity and/or medium composition were not discussed in the publications, although this is essential information for toxicity tests with NaOH. This is the most important reason why most of the studies, mentioned above were considered invalid. Although valid acute ecotoxicity tests and chronic ecotoxicity tests with NaOH are not available, there is no need for additional testing with NaOH. A significant number of acute toxicity tests are available, and the results of the tests are more or less consistent. Altogether they give a sufficient indication of acute toxicity levels of sodium hydroxide."
>
> "Furthermore, acute toxicity data cannot be used to derive a PNEC or a PNEC added for sodium hydroxide. Aquatic ecosystems are characterised by an alkalinity/pH, and the organisms of the ecosystem are adapted to these specific natural conditions. Based on the natural alkalinity of waters, organisms will have different optimum pH conditions, ranging from poorly buffered waters with a pH of 6 or less to very hard waters with pH values up to 9. A lot of information is available about the relationship between pH and ecosystem structure and also natural variations in pH of aquatic ecosystems have been quantified and reported extensively in ecological publications and handbooks."
>
> "Normally a PNEC or a PNEC added has to be derived from the available ecotoxicity data. A PNEC added is a PNEC which is based on added concentrations of a chemical (added risk approach). Based on the available data it is not considered useful to derive a PNEC or a PNEC added for NaOH because:
> - The natural pH of aquatic ecosystems can vary significantly between aquatic ecosystems,
> - Also, the sensitivity of the aquatic ecosystems to a change of the pH can vary significantly between aquatic ecosystems and
> - The change in pH due to an anthropogenic NaOH addition is influenced significantly by the buffer capacity of the receiving water."
>
> "Although a PNEC or a PNEC added was not calculated for NaOH, there is a need to assess the environmental effect of a NaOH (alkaline) discharge. Based on the pH and buffer capacity of effluent and receiving water and the dilution factor of the effluent, the pH of the receiving water after the discharge can be calculated. Of course, the pH change can also be measured very easily via a laboratory experiment or by conducting field measurements. The change in pH should be compared with the natural variation in pH of the receiving water and based on this comparison it should be assessed if the pH change is acceptable."

Based on the information above, PNEC values for freshwater, sediment, and soil were not derived for sodium hydroxide.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

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

Sodium and hydroxide ions are essential to all living organisms, and their intracellular, and extracellular concentrations are actively regulated. Thus, sodium hydroxide is not expected to bioaccumulate.

No chronic toxicity data exist on sodium hydroxide; however, the acute $E(L)C_{50}$ values are >1 mg/L in fish, invertebrates and algae. Thus, sodium hydroxide does not meet the screening criteria for toxicity.

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

IX. CLASSIFICATION AND LABELLING

A. Classification

Metal Corrosive Category 1
Skin Corrosive, Category 1A
Eye Damage, Category 1

EU Concentration Limits:

≥5%: Skin Corrosive 1A

≥2 to <5%: Skin Corrosive 1B

≥0.5%to <2%: Skin Irritant Category 2

≥0.5% to <2%: Eye Irritant Category 2

In addition to the hazard statements corresponding the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH071: Corrosive to the Respiratory Tract.

B. Labelling

Danger

C. Pictograms



X. SAFETY AND HANDLING

A. First Aid

Eye Contact

Flush with plenty of fresh water for 15 minutes holding eyelids open, lifting eyelids occasionally to ensure complete removal of the product. Remove contacts, if present and easy to do. DO NOT allow rubbing of eyes or keeping eyes closed. Seek medical attention.

Skin Contact

Rinse with soap and plenty of water for several minutes. Remove contaminated clothing. Seek medical attention immediately.

Inhalation

Remove person to fresh air. Apply artificial respiration if not breathing. Seek medical attention.

Ingestion

Rinse mouth with water (only if the person is conscious), but do not administer fluids. Do NOT induce vomiting. Seek medical attention immediately.

B. Fire Fighting Information

Extinguishing Media

Carbon dioxide, water spray, foam, dry chemical.

Specific Exposure Hazards

Containers may explode when heated. May form explosive mixtures with strong acids. Hazardous combustion products may include the following materials: halogenated compounds, metal oxides/oxides, sodium monoxide.

Special Protective Equipment for Firefighters

Full protective clothing and approved self-contained breathing apparatus required for firefighting personnel.

C. Accidental Release Measures

Personal Precautions

Use appropriate protective equipment and avoid direct contact. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Ventilate the area before entry.

Environmental Precautions

Prevent spills from entering storm drains or sewers and contact with soil.

Steps to be Taken if Material is Released or Spilt

Use an absorbent material to recover as much product as possible, then, rinse the affected area with water to dilute the residue. Disposal of leftover product and used containers should be carried out in accordance with all local, state and federal regulations.

D. Storage and Handling

General Handling

Wear appropriate personal protective equipment. Avoid contact with eyes, skin or clothing. Avoid breathing mist, vapours or spray. Use only with adequate ventilation. Wash hands after use. Launder contaminated clothing.

Storage

Store away from acids. Keep container closed when not in use. Store in a cool well-ventilated area.

E. Exposure Controls / Personal Protection

Occupational Exposure Standards

The workplace exposure standard for sodium hydroxide in Australia is 2 mg/m^3 as a peak limitation, with a sensitisation notation. A peak limitation is defined by Safe Work Australia as a maximum or peak airborne concentration of a substance determined over the shortest analytically practicable period of time which does not exceed 15 minutes.

Engineering Controls

Good general ventilation should be used. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection: Use a mask or approved air-purifying respirator with appropriate cartridge or canister in spray applications or in confined spaces.

Hand Protection: Wear impervious gloves to prevent skin contact and absorption of this material. Rubber or Neoprene gloves may afford adequate skin protection.

Skin Protection: Wear appropriate clothes (i.e., coveralls). Use non-slip footwear.

Eye protection: Wear eye protection in situations where splash or thick mists are possible.

Other Precautions: Avoid contact with skin, eyes and clothing. When using, do not eat or drink. Wash hands thoroughly with soap and water before eating or drinking. Remove contaminated clothing and launder before reuse.

F. Transport Information

For sodium hydroxide solutions of >5%:
Australian Dangerous Goods
UN1824, Corrosive liquid, (Sodium hydroxide solution)
Class 8
Packing Group: II

Lower concentrations of sodium hydroxide may require a different packing group or may not require any hazard code if the concentration of NaOH is low enough not to be considered a corrosive material.

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. REFERENCES

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
DEWHA	Department of the Environment, Water, Heritage and the Arts
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
IUPAC	International Union of Pure and Applied Chemistry
LOAEL	lowest observed adverse effect level
mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
ppm	parts per million
RfD	oral Reference Dose
SDS	Safety Data Sheet
SIDS	Screening Information Data Set
SMILES	simplified molecular-input line-entry system

SODIUM HYPOCHLORITE

This dossier on sodium hypochlorite does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sodium hypochlorite in its use in water treatment systems. The information presented in this dossier was obtained primarily 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).

I. SUBSTANCE IDENTIFICATION

Chemical Name (IUPAC): Sodium hypochlorite

CAS RN: 7681-52-9

Molecular formula: NaClO

Molecular weight: 74.44

Synonyms: Sodium hypochlorite; hypochlorous acid, sodium salt; bleach; chlorine bleach

SMILES: [O-]Cl.[Na+]

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sodium Hypochlorite

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Yellow, limpid liquid with a chlorinated odour	1	ECHA
Melting Point	-28.9°C	1	ECHA
Boiling Point	>60.4°C (decomposition)	1	ECHA
Density	1.3 @ 21.2°C*	1	
Vapour Pressure	ca. 2.5 kPa @ 20°C	2	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Very soluble	-	ECHA
Flash Point	>111°C @ 101.3 kPa	1	ECHA
Auto flammability	-	-	-
Oxidizing properties	None	1	ECHA
pH (5% solution) pH (1% solution)	12.52 @ 19.1°C 10.30 @ 21.3°C	1	ECHA
Viscosity	1.4-1.6 mPa.s @ 20°C 1.4-1.6 mPa.s @ 40°C		ECHA

*Sodium hypochlorite with 24.3% available chlorine.

In water, sodium hypochlorite (NaOCl) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion.

The hypochlorite ion (ClO^-) is in equilibrium with hydrochlorous acd (HOCl) in water and chlorine gas (Cl_2), with the relative amounts determined by pH, temperature and ionic strength of the water. At very extremely low pH, chlorine gas (Cl_2) is essentially un-hydrolyzed and it thus the dominant species of chlorine. Note that the term free chlorine refers to Cl_2. Between pH 2 and 7, hydrochlorous acid (HOCl) is the dominant form; at pH 7.4 and 20°C, there is the equimolar contribution of HOCl and ClO^-.

The chemical reactions are as follows:

$Cl_2 + H_2O \rightleftharpoons HOCl + HCl$

$HOCl \rightleftharpoons ClO^- + H^+$

Free chlorine reacts with ammonia and certain nitrogen compounds to form N-chlorinated compounds. With ammonia, chlorine forms chloramines (monochloramine, dichloramine, and nitrogen chloride or trichloramine (APHA, 2012). These compounds constitute what is termed combined chlorine. These compounds are more persistent than the free chlorine. Monochloramine contributes significantly to the combined available chlorine in the water. N-chloramines are intentionally produced in water treatment to extend the effectiveness of chlorination.

Free chlorine and combined chlorine may be present simultaneously in a water sample. The term total chlorine or total residual chlorine (TRC) refers to the sum of free chlorine and combined chlorine that is present in a water sample.

III. ENVIRONMENTAL FATE PROPERTIES

Sodium hypochlorite (NaOCl) dissociates into the sodium (Na^+) ion and the hypochlorite (ClO^-) ion in aqueous media. Biodegradation is not applicable to sodium hypochlorite. Sunlight (UV light) will rapidly decompose sodium hypochlorite to sodium chloride (OxyChem 2014). Sodium hypochlorite and its dissociated ions are ubiquitous in the environment. They are not expected to adsorb to soil or sediment and are not bioaccumulative.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Aqueous solutions of sodium hypochlorite can be irritating to corrosive to the skin, eyes, and gastrointestinal tract, depending on the concentration. Inhalation of vapours for aqueous solutions of sodium hypochlorite can cause respiratory irritation. It is not a skin sensitizer. Lifetime studies have shown no toxicity or carcinogenic effects in rats and mice when given sodium hypochlorite in their drinking water. While sodium hypochlorite has been positive in some *in vitro* genotoxicity studies, the *in vivo* studies have been negative. Sodium hypochlorite is not a reproductive or developmental toxicant.

B. Acute Toxicity

The oral LD_{50} of a sodium hypochlorite solution (12.2% active chlorine) in rats was 8,830 mg/kg, which was calculated to be 1,100 mg/kg based on average Cl_2 (ECHA) [Kl. score = 2]. The oral LD_{50} of undiluted sodium hypochlorite in rats was 8,910 mg/kg (ECHA [Kl. score = 2]. The oral LD_{50} of sodium hypochlorite (given as a12.5% solution) was 5,230 mg/kg.

The dermal LD_{50} in rabbits is >20,000 mg/kg (ECHA). [Kl. score = 2]

The 1-hour LC_{50} in rats is >10.5 mg/L (ECHA). [Kl. score = 2]

C. Irritation

A 12.5% solution of sodium hypochloride was irritating to the skin of rabbits when 0.5 ml was applied for 24 hours under semi-occlusive conditions. The mean of the 24 and 72 hours scores were: 2.16 for erythema and 1.04 for edema (ECHA) [Kl. score = 2]. Application of 0.1 ml of sodium hypochlorite (5.25% solution) to the intact skin of rabbits for 24 hours under semi-occlusive conditions was slightly irritating but not sufficient for classification as an irritant. The 24 and 72-hour mean scores were: 1.17 for erythema and 0.13 for edema (ECHA) [Kl. score = 2]. In another study, application of sodium hypochlorite (5.25% solution) to the intact skin of rabbits and guinea pigs was slightly irritating (ECHA) [Kl. score = 2].

Instillation of 0.1 g of sodium hypochlorite into the eyes of rabbits was irritating without full recovery after 7 days (ECHA) [Kl. score = 2].

D. Sensitization

Sodium hypochlorite was not a skin sensitizer in guinea pig maximisation tests (ECHA). [Kl. score = 2]

E. Repeated Dose Toxicity

Oral

Male and female F344/N rats were given in their drinking water 0, 0.025, 0.05, 0.1, 0.2 0.4% sodium hypochlorite solution for 90 days. The concentrations correspond to daily intakes of: 0, 12.5, 25, 50, 100, 200 mg/kg-day for males and 14.3, 28.6, 57.2, 114.4, 228.8 mg/kg-day for females, assuming a daily water consumption of 25 ml and mean body weights of 0.5 for males and 0.35 g for females). There were deaths during the study. Body weight gain was significantly reduced in the $\geq$0.2% males and 0.4% females. There were no treatment-related changes noted at necropsy, although several animals, particularly in the 0.4% group, appeared emaciated. Absolute weights of the lung, liver and spleen of males and the salivary gland, lung, heart and brain of females were significantly lower in the 0.4% groups compared to controls. Biochemical changes in the $\geq$0.2% groups indicated possible liver toxicity, but there were no corresponding histopathological changes in the liver; nor was there any other treatment-related histopathological changes. The NOAEL for this study is 0.1% in drinking water (50 and 57 mg/kg-day for males and females, respectively) (Hasewaga et al., 1986; ECHA). [Kl. score = 1]

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm for males and 0, 1,000, and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25, and 50 mg/kg-day for males; and 0, 57, and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 ml). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of treated females) were significantly decreased. The NOAELs are 50 and 114 mg/kg-day for males and females, respectively (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. No significant dose-related changes in haematology and clinical chemistry. In rats, the incidences of non-neoplastic lesions (chronic nephropathy in treated males, granulomatous changes in the liver of

treated females) were significantly decreased. The NOAELs are 167 and 200 mg/kg-day for males and females (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 3.5, 7, 13.75 mg/kg/day for males and 0, 4, 8, 15.7 mg/kg/day for females assuming a body weight of 0.5 and 0.35 g and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end of the studies. There were no treatment-related lesions in rats at the 14-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NO(A)EL > 275 ppm (13.75 mg/kg/day for males and 15.7 mg/kg/day for females) (NTP, 1992).

Male and female B6C3F_1 mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 11.7, 23.3, 45.8 mg/kg/day for males and 0, 14, 28, 55 mg/kg/day for females assuming a body weight of 30 and 25 g and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice are aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and their respective controls. There were no treatment-related lesions in mice at the 15-week or at the 66-week interim evaluations. There were no non-neoplastic lesions that were clearly attributable to the consumption of chlorinated water. The applied chlorine concentrations were well tolerated; there were no treatment-related clinical signs, mortalities, haematological or histopathological findings. The NOAEL was >275 ppm (45.8 mg/kg/day for males and 55 mg/kg/day for females) (NTP, 1992).

Inhalation

No studies were located.

Dermal

No studies were located.

F. Genotoxicity

In Vitro Studies

The *in vitro* genotoxicity studies on sodium hypochlorite are summarised in Table 2.

Table 2: In Vitro Genotoxicity Studies on Sodium Hypochlorite

Test System	Results[a]		Klimisch Score	Reference
	-S9	+S9		
Bacterial reverse mutation (*S. typhimurium* TA98, TA100)	-	+ (TA100 only)	2	ECHA
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA102)	-	NC	1	ECHA
Bacterial reverse mutation (*S. typhimurium* TA98, TA100, TA1535, TA1537	-	+ (TA 100 only)	1	ECHA
Chromosomal aberration (Chinese Hamster Lung cells)	[b]	+	2	ECHA
Chromosomal aberration (human HE2144 fibroblasts)	Ambiguous	NC	2	ECHA
E. coli PQ37 – SOS Chromotest [DNA repair]	-	-	2	ECHA
S. cerevisiae gene mutation assay	+	-	2	ECHA
Comet assay (human lymphocytes)	+	NC	2	ECHA

[a]+, positive; -, negative; NC, not conducted.
[b]No results since all concentrations were cytotoxic.

In Vivo Studies

The *in vivo* studies on sodium hypochlorite are presented below in Table 3. Sodium hypochlorite was not mutagenic or genotoxic.

Table 3: *In Vivo* Genotoxicity Studies on Sodium Hypochlorite

Test System	Results*	Klimisch Score	Reference
Mouse bone marrow micronucleus (intraperitoneal, 1 or 4 consecutive days)	-	1	ECHA
Mouse bone marrow micronucleus (oral gavage, 1 or 5 consecutive days)	-	2	ECHA
Mouse bone marrow chromosomal aberration (oral gavage, 1 or 5 consecutive days	-	2	ECHA
Rat liver and kidney 8-hydroguanosine [DNA adduct] levels (oral, single dose)	-	2	ECHA
Mouse sperm head morphology	Ambiguous	2	ECHA

*+, positive; -, negative

G. Carcinogenicity

Oral

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm for males and 0, 1,000, and 2,000 ppm for females. The corresponding doses were estimated to be: 0, 25, and 50 mg/kg-day for males; and 0, 57, and 114 mg/kg-day for females (assuming body weights of 0.5 mg for males and 0.35 mg for females and a daily water intake of 25 ml). Survival was similar across all groups. Water consumption was comparable across all groups. There was no evidence of carcinogenicity in the treated animals (Kurokawa et al. 1986; Hasegawa et al., 1986; ECHA).

Male and female B6C3F1 mice were given sodium hypochlorite in their drinking water for 103-104 weeks. The concentrations were 0, 500, 1000 ppm (corresponding to 83.3 and 166.7 mg/kg-day for males; and 100 and 200 mg/kg-day). Survival was similar across all groups. Body weight gain was reduced in both male and female rats. Water consumption was comparable among all groups. There was no evidence of carcinogenicity in the treated mice (Kurokawa et al., 1986; ECHA).

Male and female F344/N rats were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 3.5, 7, 13.75 mg/kg/day for males and 0, 4, 8, 15.7 mg/kg/day for females assuming a body weight of 500 and 350 g and a water consumption of 25 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the rats aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose rats received a mean daily dose of approximately 20 mg/kg for the first 13 weeks, which decreased to 13-14 mg/kg during the second year. Survival of rats was similar among treated groups and their respective controls. Survival of all groups of male rats was less than 50% at the end of the studies. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in F344/N rats receiving 70, 140, or 275 ppm (NTP, 1992).

Male and female B6C3F_1 mice were given sodium hypochlorite in their drinking water for 104 weeks. The concentrations were 0, 70, 140, 275 ppm (corresponding to 0, 11.7, 23.3, 45.8 mg/kg/day for males and 0, 14, 28, 55 mg/kg-day for females assuming a body weight of 30 and 25 g and a water consumption of 5 mL/day). Palatability was the principal factor limiting the concentrations of available chlorine in the study. There was a dose-related decrease in water consumption by animals receiving chlorinated water. Decreased water consumption was evident during the first week and continued throughout the study. Toward the end of the studies, the effect on water consumption was less than during the first weeks. The animals showed no physiological alterations due to decreased water consumption, and there was no clinical or haematological evidence of dehydration. Because body weight and water consumption changed as the mice are aged, the amount of available chlorine ingested during the study varied. The mean daily dose (mg/kg body weight) was higher during the first 13 weeks than during the second year of the studies. High-dose mice received a mean daily dose of approximately 35-44 mg/kg for the first 13 weeks, which decreased to 20-23 mg/kg during the second year. Survival was similar among treated groups and their respective controls. There were no neoplasms lesions that were clearly attributable to the consumption of chlorinated water. Sporadically renal neoplasms occurred in the low and high-dose males. This is an unusual finding in mice. Therefore, additional step sections of the kidney were prepared which revealed further incidences of

renal hyperplasia in all groups including control and a carcinoma in the low dose group. Nearly all the additional neoplasms seen in the step sections were small (microscopic) adenomas believed to be the probable precursor of renal tubule carcinoma. Since no additional renal neoplasms were found in the mid and high-dose groups and since focal hyperplasia, a potential pre-neoplastic lesion, was found at similar incidences in the control and dosed groups, the small number of renal tubule cell neoplasms in male mice were not considered related to the consumption of chlorinated water. Under the conditions of this 2-year drinking water study, there was no evidence of carcinogenic activity of chlorinated water in male or female $B6C3F_1$ mice receiving 70, 140, or 275 ppm (NTP, 1992).

H. Reproductive Toxicity

In a one-generation reproductive toxicity study, male and female Long-Evans rats were given in their drinking water 0, 1, 2, or 5 mg/kg-day sodium hypochlorite. Males were dosed 56 days prior to and during mating. Females were dosed 14 days prior to mating, during mating, gestation, and until lactation day 21. There were no adverse effects on reproduction or development, including histopathology of the reproductive organs in males and females, sperm parameters in males, and histopathologic effects in the non-reproductive organs in females. The NOAEL for reproductive and developmental toxicity is 5 mg/kg-day (Carlton et al., 1986; ECHA). [Kl. score = 2]

I. Developmental Toxicity

Female SD rats were given in their drinking water 0, 1, 10, or 100 mg/L sodium hypochlorite for 2.5 months prior to mating and throughout gestation. Maternal toxicity was not examined. There were no treatment-related effects on viability, fetal weights, and external appearances of the fetuses in all dose groups. The fetuses of the $\geq$10 mg/L groups had a non-statistically significantly higher percentage of skeletal defects compared to controls. The 100 mg/L group also had a non-statistically significantly higher rate of soft-tissue defects. These defects consisted of three cases of adrenal agenesis, one right-sided heart, one case of improper orientation of the apex of the heart, and one atrio-ventricular valve enlargement. The 100 mg/L group had a statistically significantly higher number of total defects; whereas the 1 mg/L dose had a lower percentage of defects compared to controls. In the absence of a clear dose-response and a relatively higher incidence of defects in the control animals, these findings were not considered to be of toxicological relevance. The NOAEL for developmental toxicity in this study was considered to be 100 mg/L, corresponding to 50 mg/kg-day (Abdel-Rahmen et al., 1982; ECHA). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

A. Non-Cancer

An oral toxicological reference value was not derived for sodium hypochlorite.

The Australian drinking water guideline values for chlorine are 5 mg/L (health) and 0.6 mg/L (aesthetics).

B. Cancer

Sodium hypochlorite was not carcinogenic to rats or mice in chronic drinking water studies; thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sodium hypochlorite does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

Sodium hypochlorite is very toxic to aquatic organisms. The acute and subacute oral toxicity of sodium hypochlorite to birds are of low concern.

B. Aquatic Toxicity

A number of studies that have been conducted on the toxicity of sodium hypochlorite (or calcium hypochlorite) of aquatic organisms. A comprehensive summary of these studies is beyond the scope of this dossier.

In developing a water quality guideline for chlorine, ANZECC reviewed the literature on the effects of the following chemicals: chlorine gas (Cl_2) bubbled in water, sodium hypochlorite or hypochlorous acid; and ammonium sulfate or chloride and NaOCl at various combinations (molar ratios, pH values) to form monochloramine or dichloramine (ANZECC, 2000). The summary of the data measured as total residual chlorine (µg Cl/L) for freshwater fish and invertebrates is as follows:

Freshwater fish

The 24-96 hour LC_{50} values for seven species were 70- 840 µg/L. Two of the values for *O. mykiss* were 14 and 29 µg/L (Basch et al., 1971).

Freshwater crustaceans

The 24-48 LC_{50} values for three species of *cladocerans* were 12-16 µg/L. Two of the 48-hour LC_{50} values were 5 and 6 µg/L, measured under a continuous flow of test solution (Taylor, 1993).

The chronic NOEC from a 10-day *C. dubia* immobilisation study was 48 µg/L. In another chronic test, the NOEC of a 10-day *C. dubia* reproductive impairment test was 48 µg/L (Manning et al., 1996).

Freshwater Mollusc

The 24-48 hour LC_{50} values in one *Nitocris* species was 7,700 to 15,600 µg/L. The chronic 168-hour LC_{50} value for a periphyton was 32 µg/L.

Other species

The 24-48 LC_{50} values for the freshwater annelid *Aelosoma headleyi* were 1,680 to 3,200 µg/L. The 24-48 hour LC_{50} values for three species of insects were 710 to 1,350 µg/L. The 48-hour LC_{50} values for the freshwater rotifer *Philodina acuticornis* was 50 to 100 µg/L.

C. Terrestrial Toxicity

The acute oral LD_{50} value of sodium hypochlorite (12.5% solution) to bobwhite quail is >2,510 mg/kg (ECHA). [Kl. score = 2]

The 8-day oral LC_{50} value of sodium hypochlorite (12.5% solution) to bobwhite quail and mallard duck is >5,620 ppm (ECHA). [Kl. score = 2]

D. Calculation of PNEC

PNEC water

The ANZECC water quality guideline (2000) used acute and chronic laboratory toxicity data for the derivation of a trigger value for chlorine. The guideline for freshwater is: "A freshwater moderate trigger value of 3 µg Cl/L measured as total residual chlorine was derived using the statistical distribution method with 95% protection. This figure was obtained from the application of the default ACR of 10 instead of the empirical ACR of 2.7 from the geometric mean of 8 figures. The smaller ACR would have resulted in a value not protective of some species under continuous exposure to chlorine for at least 48 hours".

PNEC sediment

No experimental toxicity data on sediment organisms are available. K_{ow} and K_{oc} parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning method cannot be used to calculate the $PNEC_{sed}$. Based on its properties, no adsorption of sodium hypochlorite to sediment is to be expected, and the assessment of this compartment will be covered by the aquatic assessment.

PNEC soil

No experimental toxicity data on soil organisms are available. The environmental distribution of sodium hypochlorite is dominated by its water solubility. Sorption of sodium hypochlorite should probably be regarded as a reversible situation, *i.e.*, the substance is not tightly nor permanently bound. K_{oc} and K_{ow} parameters do not readily apply to inorganics, such as sodium hypochlorite. Thus, the equilibrium partitioning methods cannot be used to calculate the $PNEC_{soil}$. Based on its properties, sodium hypochlorite is not expected to significantly adsorb to soil, and the assessment of this compartment will be covered by the aquatic assessment.

VIII. PBT ASSESSMENT

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009, ECHA, 2008).

Sodium hypochlorite is an inorganic salt that dissociates completely in water to sodium (Na^+) and hypochlorite (ClO^-) ions. Biodegradation is not applicable to these inorganic ions; For the purposes of this PBT assessment, the persistent criteria are not considered applicable to this inorganic salt.

As an inorganic salt, neither sodium hypochlorite nor its dissociated ions are expected to accumulate. Thus, sodium hypochlorite does not meet the criteria for bioaccumulation.

The lowest NOEC from chronic aquatic toxicity studies is <0.1 mg/L in invertebrates. Thus, sodium hypochlorite meets the criteria for toxicity.

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

IX. CLASSIFICATION AND LABELLING

A. Classification

For sodium hypochlorite solutions that are <20%:

- Corrosive to Metals Category 1
- Skin Corrosion Category 1B
- Eye Damage Category 1
- Acute Aquatic Category 1
- Chronic Aquatic Category 2

In addition to the hazard statements corresponding to the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH031: Contact with acids liberates toxic gas.

B. Labelling

Dangerous

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact

Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact

For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of the body with soap and fresh water. Get medical attention immediately.

Inhalation

Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if the victim is not breathing. Get medical attention immediately.

Ingestion

Do not induce vomiting. Rinse mouth and lips with plenty of water if a person is conscious. Do not use mouth-to-mouth method if the victim had ingested the substance. Get medical attention immediately.

Notes to Physician

Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media

Use dry chemical, carbon dioxide, water spray or fog, or foam.

Specific Exposure Hazards

Containers may explode when heated. Emits toxic fumes under fire conditions. Contact with metals may evolve flammable hydrogen gas. Depending on conditions, decomposition products may include the following: metal oxide/oxides, chlorine, hydrogen chloride, oxygen.

Special Protective Equipment for Firefighters

Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if it can be done without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions

Ventilate enclosed areas. Do not walk through spilt material. Do not touch damaged containers or spilt material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing.

Environmental Precautions

Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilt

As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorised personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

Stop leak if it can be done without risk. Absorb or cover with dry earth, sand, or other non-combustible material and transfer to containers. Dike to collect large liquid spills.

D. STORAGE AND HANDLING

General Handling

Handle and open container with care. Use only with adequate ventilation. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent the release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

Storage

Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep from direct sunlight. Aqueous solutions of sodium hypochlorite will slowly evolve oxygen. Store invented containers. Store only in non-metallic containers. Keep away from acids. Do not store above 55°C.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

Workplace Australia has not established an occupational exposure standard for sodium hypochlorite.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal Protection Equipment

Respiratory Protection: If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much is based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection: Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection: Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling this product.

Eye Protection: Wear chemical splash goggles and face shield.

Other Precautions: Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate

techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

Australian Dangerous Goods
UN1791, Hypochlorite Solution (Sodium Hypochlorite)
Class: 8
Packing Group: III

Environmentally Hazardous Substance

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

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XIV. ACRONYMS AND GLOSSARY

°C	degrees Celsius
ADWG	Australian Drinking Water Guidelines
API	American Petroleum Institute
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HHRA	enHealth Human Risk Assessment
HPV	High Production Volume
IUPAC	International Union of Pure and Applied Chemistry
Kl	Klimisch scoring system
LOAEL	lowest observed adverse effect level

mg/kg	milligrams per kilogram
mg/L	milligrammes per litre
mg/m^3	milligrammes per cubic metre
MW	molecular weight
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NIOSH	National Institute for Occupational Safety and Health
NOAEC	No Observed Adverse Effect Concentration
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
OECD	Organisation for Economic Co-operation and Development
PBT	Persistent, Bioaccumulative and Toxic
PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	Reference Dose
SDS	Material Safety Data Sheet
SMILES	simplified molecular-input line-entry system
TGD	Technical Guidance Document
USEPA	United States Environmental Protection Agency
UVCB Materials	Unknown or Variable Composition, Complex Reaction Products and Biological
WAFs	water accommodated fractions
WHO	World Health Organisation
µm	micrometre

SULFURIC ACID

This dossier on sulfuric acid does not represent an exhaustive or critical review of all available data. Rather, it presents the most critical studies pertinent to the risk assessment of sulfuric acid in its use in drilling muds, hydraulic fracturing fluids, and water treatment systems. 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) and from the OECD-SIDS documents on sulfuric acid (OECD, 2001). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch *et al.*, 1997).

I. SUBTANCE IDENTIFICATION

Chemical Name (IUPAC): Sulfuric acid

CAS RN: 7664-93-9

Molecular formula: H_2SO_4

Molecular weight: 98.1 g/mol

Synonyms: Sulfuric acid; dihydrogen sulfate

SMILES: OS(=O)(=O)O

II. PHYSICO-CHEMICAL PROPERTIES

Table 1: Overview of the Physico-chemical Properties of Sulfuric Acid

Property	**Value**	**Klimisch score**	**Reference**
Physical state at 20°C and 101.3 kPa	Colorless, odorless viscous liquid	2	ECHA
Melting Point	10.4 to 10.5°C (100%) 3°C (98%)	2	ECHA
Boiling Point	290°C (100%) 335°C (98%)	2	ECHA
Density	1.8144 to 1.8304 g/cm^3 (90-100%)	2	ECHA

Vapor Pressure	0.485 hPa (75%)	1	ECHA
Partition Coefficient (log K_{ow})	Not applicable	-	-
Water Solubility	Miscible	2	ECHA
Dissociation constant	$pK_a = 1.92$	2	ECHA

III. ENVIRONMENTAL FATE PROPERTIES

Due to its high water solubility and low vapour pressure, sulfuric acid will be found predominantly in the aquatic environment where it dissociates completely to hydrogen (H^+) and sulfate (SO_4^{2-}) ions. Both ions are ubiquitous in the environment.

Addition of sulfuric acid to an aquatic ecosystem may decrease the pH depending on the buffer capacity of the receiving water. In general, the buffer capacity is regulated by the equilibria between CO_2, HCO_3^- and CO_3^{2-}:

$CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$ ($pKa_1 = 6.35$)

$HCO_3^- \leftrightarrow CO_3^{2-} + H^+$ ($pKa_2 = 10.33$)

A release of sulfuric acid into the aquatic environment from it use could potentially increase the SO_4^{2-} concentration and decrease the pH in the aquatic environment.

H^+ and SO_4^{2-} ions will not adsorb on particulate matter or surfaces and will not accumulate in living tissues.

IV. HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

Sulfuric acid is a corrosive liquid. Depending on the concentration, aqueous solutions of sulfuric acid are either corrosive, irritating, or non-irritating to the skin, eyes, and gastrointestinal tract. Vapors from aqueous solutions of sulfuric acid can cause respiratory irritation. Sulfuric acid is not acutely toxic by the oral route when administered as dilute solution. Subchronic inhalation studies show localized irritation to the upper respiratory tract of rats and mice, but no systemic toxicity. No repeated dose toxicity studies have been conducted by the oral route. Positive findings have been reported in some *in vitro* genotoxicity studies, which are considered to be the result of the pH change in the test system. No adequate reproductive or developmental studies have been conducted on sulfuric acid.

B. Acute Toxicity

The oral LD_{50} in rats of a diluted sulfuric acid solution (250 mg/mL) was reported to be 2,140 mg/kg (ECHA). [Kl. score = 2]

The 4-hour LC_{50} of sulfuric acid aerosol in rats is approximately 0.375 mg/L (ECHA). [Kl. score = 2]

No acute dermal toxicity studies are available.

C. Irritation

No studies are available.

D. Sensitization

No studies are available.

E. Repeated Dose Toxicity

Oral

No studies are available.

Inhalation

Female rats were exposed by inhalation to 0, 0.2, 1.0, or 5 mg/m^3 sulfuric acid mist 6 hours/day, 5 days/week for 5 or 28 days. Additional groups of female rats were exposed to 0 or 5 mg/m^3 sulfuric acid for 28 days followed by a 4- or 8-week recovery period. There were no deaths and no adverse effects on body or lung weights. The effects of the exposure were limited to the larynx. Squamous metaplasia and significant cell proliferation was seen following exposure to 1.38 and 5.52 mg/m^3 for 5 and 28 days. The effects showed decreased severity following the recovery periods. At 0.3 mg/m^3, there were no effects following 5 days of exposure, but minimal metaplasia with no proliferation was seen after 28 days, which was interpreted as an adaptive response to a respiratory irritant. The NOAEL is 0.3 mg/m^3 (ECHA). [Kl. score = 1]

Dermal

No studies are available.

F. Genotoxicity

In Vitro Studies

The use of non-physiological pH values in *in vitro* test systems can not only affect the mutagenic response of the test agent but can be mutagenic in their own right. Studies with sulfuric acid reporting negative results in Ames and positive in chromosomal aberration studies in CHO cells and in non-standard assays in developing sea urchin embryos are reported; the positive findings in these studies are considered to be a consequence of the low pH of the culture medium (Scott et al., 1991).

In Vivo Studies

No studies are available.

G. Carcinogenicity

Oral

No studies are available.

Inhalation

No adequate carcinogenicity studies are available.

H. Reproductive Toxicity

No studies are available.

I. Developmental Toxicity

Oral

No studies are available.

Inhalation

Pregnant female mice were exposed by inhalation to 0, 5.7, or 19.3 mg/m^3 sulfuric acid aerosol on GD 6-15. The mass median aerodynamic diameters (MMAD) were 1.6 μm and 2.4 μm, respectively. Body weight gain of the exposed females were not

significantly affected, but there was a significant reduction in food consumption during the first few days of exposure in the high-dose group. The high-dose females also had decreased liver weights. There was no evidence of toxicity in the respiratory tract of the exposed mice. No developmental toxicity was seen at either dose level. The NOAECs for maternal and developmental toxicity were 5.7 and 19.3 mg/m^3, respectively (ECHA; Murray et al., 1979). [Kl. score = 2]

Pregnant female rabbits were exposed by inhalation to 0, 5.7, or 19.3 mg/m^3 sulfuric acid aerosol on GD 6-18. The mass median aerodynamic diameters (MMAD) were 1.6 μm and 2.4 μm, respectively. A statistically significant decrease was seen in the maternal body weight gain in the high-dose animals during the first few days of exposure. A trend towards a dose-related increase in the incidence of subacute rhinitis and tracheitis was noted. No developmental toxicity was seen at either dose level. The NOAECs for maternal and developmental toxicity were 5.7 and 19.3 mg/m^3, respectively (ECHA; Murray et al., 1979). [Kl. score = 2]

V. DERIVATION OF TOXICOLOGICAL REFERENCE AND DRINKING WATER GUIDANCE VALUES

A. Non-Cancer

Oral

A toxicological reference value was not derived. Sulfuric acid dissociates in water to sodium and sulfate ions.

The Australian drinking water guideline values for pH is 6.5 to 8.5 (ADWG, 2011).

The Australian drinking water guideline value for sulfate is 500 mg/L based on health. Concentrations of >500 mg/L can have purgative effects (ADWG, 2011).

B. Cancer

There are no adequate carcinogenicity studies on sulfuric acid. Thus, a cancer reference value was not derived.

VI. HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Sulfuric acid does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability

- Oxidizing potential

VII. ENVIRONMENTAL HAZARD ASSESSMENT

A. Summary

The hazard of sulfuric acid for aquatic organisms is caused by the hydrogen ion (H^+). The toxicity values in terms of mg/L are not relevant because of the varying buffering capacity of different test systems and different aquatic ecosystems.

B. Aquatic Toxicity

Acute Studies

Table 2 lists the results of acute aquatic toxicity studies on sulfuric acid.

Table 2: Acute Aquatic Toxicity Studies on Sulfuric Acid

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Lepomis macrochirus	96-h LC_{50}	16-28*	2	ECHA
Daphnia magna	48-h EC_{50}	>100**	1	ECHA
Desmodesmus subspicatus	72-h EC_{50} NOEC	>100*** 100***	1	ECHA

*Fish were exposed to a series of pH, decreasing from 7.5 to 3.25. The 96-h LC_{50} was determined to be between 3.25 and 3.5, equivalent to 16 to 28 mg/L.
**Test solution was buffered to pH 8.0.
***Test solution was buffered to pH 8.1.

The results in Table 2 suggest that the acute aquatic toxicity of sulfuric acid is driven by the low pH from the dissociated H^+ ions. The dissociated SO_4^{2-} ions do not contribute to the acute toxicity of sulfuric acid, which is supported by the aquatic toxicity studies on sodium sulfate (Table 3).

Table 3: Acute Aquatic Toxicity Studies on Sodium Sulfate

Test Species	Endpoint	Results (mg/L)	Klimisch score	Reference
Pimephales promelas	96-h LC_{50}	7,960	2	Mount *et al.* (1997)

Daphnia magna	48-h EC_{50}	4,736*	2	Davies and Hall (2007)

* Standard test conditions: 100 mg $CaCO_3$/L and Ca:Mg ratio of 0.7.

Chronic Studies

The NOEC for *Salvelinus fontinalis* (brook trout, a cold-water fish) based on reproduction was a pH value of 5.2, which is equivalent to 0.31 mg/L sulfuric acid (ECHA). [Kl. score = 2]

The 45-day LOEC (20% inhibition) for *Jordanella floridae* (flagfish, a warm-water fish) based reproduction, growth and survival was a pH value of 6.0, which is equivalent to 0.049 mg/L sulfuric acid. The NOEC, calculated as the LOEC/2, is 0.025 mg/L sulfuric acid (ECHA). [Kl. score = 2]

The 35-d NOEC for *Tanytarsus dissimilis* (midge) based on reproduction was at a pH value of 5.5, which is equivalent to 0.15 g/mL sulfuric acid (ECHA). [Kl. score = 2]

As with the acute studies, the chronic aquatic toxicity of sulfuric acid is driven by pH from the dissociated H^+ ions and not from the SO_4^{2-} ions. The lowest 7-day NOEC from a *Ceriodapnia dubia* reproduction study on sodium sulfate was 1,109 mg/L (Soucek, 2007).

C. Terrestrial Toxicity

No studies are available.

D. Calculation of PNEC

PNEC values were not derived for sulfuric acid because factors such as the buffer capacity, the natural pH, and the fluctuation of the pH are very specific for a certain ecosystem.

VIII. PBT Assessment

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU Reach Criteria methodology (DEWHA, 2009; ECHA, 2008).

Sulfuric acid is an inorganic acid that dissociates completely to hydrogen and sulfate ions in aqueous solutions. Biodegradation is not applicable to these inorganic ions; both ions are also ubiquitous and are present in most water, soil and sediment. For the purposes of

this PBT assessment, the persistent criterion is not considered applicable to sulfuric acid or its dissociated ions.

Hydrogen and sulfate ions are essential to all living organisms and their intracellular and extracellular concentrations are actively regulated. Thus, sulfuric acid is not expected to bioaccumulate.

The lowest NOEC from chronic aquatic toxicity studies on sulfuric acid is <0.1 mg/L. Thus, sulfuric acid meets the criterion for toxicity.

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

IX. CLASSIFICATION AND LABELING

A. Classification

Skin Corrosive Category 1A

EU Concentration Limits:

≥15%
Skin Corrosive Category 1A

≥5 to <15%
Skin Irritant Category 2
Eye Irritant 2

In addition to the hazard statements corresponding to the GHS classification for corrosive, the following non-GHS hazard statement is to be added to the SDS: AUH031: Contact with acids liberates toxic gas.

B. Labelling

Danger

C. Pictogram



X. SAFETY AND HANDLING

A. FIRST AID

Eye Contact
Immediately flush open eyes with plenty of water for at least 15 minutes. Remove contacts, if present and easy to do. Get medical attention immediately, preferably a physician for an ophthalmologic examination.

Skin Contact
For minor skin contact, avoid spreading material on unaffected skin. Remove and isolate contaminated clothing. Wash the contaminated area of body with soap and fresh water. Get medical attention immediately.

Inhalation
Move person to fresh air. Administer oxygen if breathing is difficult. Do not use mouth-to-mouth method if victim inhaled the substance; give artificial respiration with the air of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give artificial respiration if victim is not breathing. Get medical attention immediately.

Ingestion
Rinse mouth and lips with plenty of water if person is conscious. Do not induce vomiting. Do not use mouth-to-mouth method if victim had ingested the substance. Obtain medical attention immediately if ingested.

Notes to Physician
Treat as a corrosive due to pH of the material. All treatments should be based on observed signs and symptoms of distress in the patient.

B. FIRE FIGHTING INFORMATION

Extinguishing Media
Use dry chemical, carbon dioxide, water spray or fog, or foam.

Specific Exposure Hazards
Containers may explode when heated. Emits toxic fumes under fire conditions. Depending on conditions, decomposition products may include the following materials: oxides of sulfur.

Special Protective Equipment for Firefighters
Structural firefighter's protective clothing provides limited protection in fire situations only; it is not effective in spill situations where direct contact with the substance is possible. Wear chemical protective clothing that is specifically recommended by the manufacturer. It may provide little or no thermal protection. Wear positive pressure self-contained breathing apparatus (SCBA). Move containers from fire area if you can do it without risk.

C. ACCIDENTAL RELEASE MEASURES

Personal Precautions
Ventilate enclosed areas. Do not walk through spilled material. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapors, or spray. Do not get in eyes, on skin, or on clothing.

Environmental Precautions
Prevent entry into waterways, sewers, basements or confined areas.

Steps to be Taken if Material is Released or Spilled
ELIMINATE all ignition sources (no smoking, flares, sparks or flames in immediate area). As an immediate precautionary measure, isolate spill or leak area for at least 50 meters in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Do not get water inside container.

D. STORAGE AND HANDLING

General Handling
Handle and open container with care. Use only with adequate ventilation. Keep away from heat. Use caution when combining with water. DO NOT add water to corrosive liquid, ALWAYS add corrosive liquid to water while stirring to prevent release of heat, steam, and fumes. Wear appropriate personal protective equipment, avoid direct contact. Do not breath mist, vapours, or spray. Do not get in eyes, on skin, or on clothing. Do not ingest. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco.

Storage
Keep contain tightly closed. Store in a cool, dry, well-ventilated place. Keep away from incompatible materials. Keep from direct sunlight. Separate from alkalis.

E. EXPOSURE CONTROLS / PERSONAL PROTECTION

Occupational Exposure Standards

The workplace exposure standard for sulfuric acid in Australia is 1 mg/m^3 as an 8-hour TWA and 3 mg/m^3 as a 15-min STEL.

Engineering Controls

Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits.

Personal Protection Equipment

Respiratory Protection:
If workers are exposed to concentrations above the exposure limit, they must use appropriate, certified respirators. Use a properly fitted, air-purifying or air-fed respirator complying with an approved standard if a risk assessment indicates this is necessary. Respirator selection much be based on known or anticipated exposure levels, the hazard of the product and the safe working limits of the selected respirator.

Hand Protection:
Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary. Considering the parameters specified by the glove manufacturer, check during use that the gloves are still retaining their protective properties. It should be noted that the time to breakthrough for any glove material may be different for different glove manufacturers. In the case of mixtures, consisting of several substances, the protection time of the gloves cannot be accurately estimated.

Skin Protection:
Personal protective equipment for the body should be selected based on the task being performed and the risks involved and should be approved by a specialist before handling hydrochloric acid.

Eye protection*:*
Wear chemical splash goggles and face shield.

Other Precautions:
Wash hands, forearms, and face thoroughly after handling chemical products, before eating, smoking, and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

F. TRANSPORT INFORMATION

UN 1830 (SULFURIC ACID with more than 51% acid)
Class: 8
Packing Group: II

UN 2796 (SULFURIC ACID with not more than 51% acid)
Class: 8

Packing Group: II

XI. DISPOSAL

Disposal should be in accordance with all local, state, and federal regulations.

XII. REGULATORY INFORMATION

Australian AICS Inventory: Listed.

XIII. 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.

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APPENDIX E DOSE-BASED TRV

Commercial in Confidence

Appendix E
Derived Dose-Based Toxicity Reference Values
WMF Chemicals
Santos GLNG Gas Field Development Project

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Mammal		Avian Receptor	
			Test Animal			Test Animal		Northern Quoll		Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight	Derived TRV	Body Weight	Derived TRV
1-Hydroxyethylene (1,1 diphosphonic acid)	2809-21-4	384	Rat	0.35	2.8	mallard duck	1.58	0.8	3.1E+02	0.39	4.0E+00
Acetic Acid	64-19-7	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Adipic Acid	124-04-9	250	Rat	0.35	NA	NA	NA	0.8	2.0E+02	0.39	2.4E+02
Aluminium Hydroxychloride	1324-41-9	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Ammonia	7664-41-7	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Cationic acrylamide copolymer	69418-26-4	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Cationic Polymer	n/a	2000	Rat	0.35	NA	NA	NA	0.8	1.6E+03	0.39	1.9E+03
Dialuminium Chloride Pentahydroxide	12042-91-0	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Diethylene triamine penta(methylene phosphonic acid), sodium salt	22042-96-2	82.5	Rat	0.35	NA	NA	NA	0.8	6.7E+01	0.39	8.0E+01
EDTA Tetrasodium Salt	64-02-8	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Hydrogen Peroxide	7722-84-1	239	Rat	0.35	NA	NA	NA	0.8	1.9E+02	0.39	2.3E+02
Peroxyacetic Acid	79-21-0	23.4	Rat	0.35	NA	NA	NA	0.8	1.9E+01	0.39	2.3E+01
Phosphonic Acid	13598-36-2	250	Rat	0.35	NA	NA	NA	0.8	2.0E+02	0.39	2.4E+02
Polyacrylamide (anionic)	9003-05-8	5000	Rat	0.35	NA	NA	NA	0.8	4.1E+03	0.39	4.9E+03
Potassium Hydroxide	1310-58-3	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Sodium Bisulphite	7631-90-5	523	rat	0.35	NA	NA	NA	0.8	4.3E+02	0.39	5.1E+02
Sodium Carbonate	497-19-8	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Sodium Citrate Dihydrate	4/3/6132	#N/A	#N/A	#N/A	#N/A	NA	#N/A	0.8	#N/A	0.39	#N/A
Sodium Hydroxide	1310-73-2	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA
Sodium Hypochlorite	7681-52-9	NA	NA	NA	25.1	bobwhite quail	0.178	0.8	NA	0.39	2.1E+01
Sulphuric Acid	7664-93-9	NA	NA	NA	NA	NA	NA	0.8	NA	0.39	NA

Note:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable

1/ Avian NOAEL for Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione developed by applying an uncertainty factor of 10 to the NOEC for bobwhite quail.
Avian NOAEL for gluteraldehyde developed by applying an uncertainty factor of 100 to the LD50 for mallard duck.
2/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.