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HYDRAULIC STIMULATION RISK ASSESSMENT - SANTOS SOUTHWEST QUEENSLAND TENEMENTS

Human Health and Ecological Risk Assessment - Schlumberger Chemicals

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REPORT

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Executive Summary

Introduction

Santos Ltd (Santos) engaged Golder Associates Pty Ltd (Golder) to prepare this desktop risk assessment of hydraulic stimulation activities for conventional oil and gas production in their Southwest Queensland (SWQ) tenements. This Hydraulic Stimulation Risk Assessment (HSRA) is undertaken to meet Department of Environment and Heritage Protection (DEHP) Environmental Authority (EA) consent conditions.

This desktop HSRA is presented in two report volumes, as follows:

- Volume One (Reference: 127666004 011 R) discusses the environmental and geological settings within which Santos' stimulation operations take place and the general techniques for the drilling, completion and stimulation of wells. The report also discusses why hydraulic stimulation is essential in SWQ and outlines Santos' current forward program for fracture-stimulation, although it should be noted that for a variety of reasons (including but not limited to future production performance and / or access-related issues such as the flooding of the Cooper Creek system), the forward program is frequently reviewed and is subject to change.
- Volume Two and Volume Three (this report) relates specifically to the stimulation fluids proposed to be used by Stimulation Service Providers on Santos wells in the SWQ conventional oil and gas fields. This report considers the ecological and human health toxicity of the chemical constituents in the stimulation fluids, and includes an exposure pathway assessment and risk characterisation based on a review of complete exposure pathways and controls to mitigate exposure. Volume Two relates to *Halliburton* stimulation fluids, while Volume Three relates to *Schlumberger* fluids.

This report specifically addresses the requirements of EA conditions related to the assessment of Schlumberger chemical constituents for:

- YF140HTD 30Q N2 stimulation fluid
- ThermaFRAC 40 stimulation fluid
- Slickwater stimulation fluid.

The report also considers a lesser volume of *32%HCL* also used during stimulation. Chemical information disclosed included each of the chemical constituents in the fluids considered, and the mass of each constituent in a typical fluid mixture.

Comparison of Conventional Oil and Gas Operations to Coal Seam Gas (CSG) Operations

There are key differences between CSG and conventional oil and gas production, both in the geographic and geological setting of the resource and the methodology for accessing the resource, that have a substantial bearing on the risk profile presented by stimulation activities. These include:

- Santos' conventional oil and gas operations in SWQ are located in an arid, sparsely populated area of central Australia. Whilst groundwater is an important water supply to support the rural land uses, the extent of water supply development is limited (commensurate with the small population base);
- In Santos' SWQ operations, the hydrocarbon reservoirs generally occur in anticlines capped with thick, laterally-extensive low permeability formations that isolate the reservoirs from overlying water-bearing formations; and
- The oil and gas reservoirs in the SWQ study area are very deep, of the order of 1500 to 3000 m below ground level, which provides hundreds to over a thousand metres vertical separation between the formations in which stimulation activities are proposed and the shallow groundwater resources. There is also no requirement to remove formation water in order to facilitate gas flow, with the possible exception of well blow downs on a case by case frequency.

Hence, the combination of the remote project location, low population density (and limited water supply development), and the substantial vertical separation of oil and gas reservoirs from primary groundwater supply aquifers results in an inherently low risk profile with regard to stimulation activities.

Environmental Setting and Environmental Values

Santos operates conventional gas and oil fields within scattered petroleum production tenements that, along with Santos' exploration licences, cumulatively cover approximately 30,000 km^2 of Southwest Queensland. These tenements, exploration licenses and the land surrounding the Santos tenements comprise the Santos SWQ *study area*. The study area is described in detail within Volume One of the SWQ HSRA report.

The terrain in the study area is generally characterised by low undulating topography (hills and ridges) between the various river and creek systems and associated floodplains. The area is sparsely developed, and generally comprises rural communities and homesteads that are largely engaged in farming and livestock. The oil and gas reservoirs which are the targets for hydraulic stimulation lie within the Cooper Basin and the overlying Eromanga Basin.

Based on an understanding of the environmental setting, this risk assessment considered the following key environmental values:

Groundwater environmental values:

- Town water supply;
- Stock and domestic water supply;
- Sandstone aquifers of the Great Artesian Basin (GAB); and
- Groundwater Dependant Ecosystems (GDEs).

Surface water environmental values:

- Protection of aquatic ecosystems;
- Recreation and aesthetics: primary recreation with direct contact, and visual appreciation with no contact; and
- Cultural and spiritual values.

Terrestrial environmental values:

- Protection of flora and fauna, particularly small mammals, reptiles and birds with a greater potential to come into contact with flowback water in Flare Pits.

Environmental values are further considered and evaluated in Volume One of the SWQ HSRA report.

Hydraulic Stimulation Process Description Summary

With regard to the process of hydraulic stimulation, the requirements of the EA approval conditions are considered within Volume One of the SWQ HSRA report, with the following specific information included:

- Practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation;
- Indicative details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority;
- A description of Santos' well mechanical integrity testing program;
- Process control and assessment techniques to be applied for determining the extent of stimulation activity(ies) (e.g. microseismic measurements, modelling etc.); and
- A process description of the stimulation activity to be applied, including equipment and a comparison to best international practice.

Evaluation of Exposure Pathways

Potential exposure pathways were evaluated for on-site (i.e. within the well lease), and for off-site (i.e. anything beyond the well lease boundary). Potentially complete exposure pathways were evaluated for workers, trespassers, native fauna and flora and livestock. The environment immediately surrounding the well lease (i.e. off-site) throughout the study area may vary from lease to lease, but was considered to potentially include homesteads (adult and child residents), water supply bores, creeks or wetlands/waterholes, livestock and native flora and fauna.

The on-site assessment indicated that the majority of potential exposure pathways were unlikely or incomplete, given the application of operational controls by Santos.

One potentially complete exposure pathway was identified, which is direct contact to the flowback water in the Flare Pit by small fauna (i.e. rodents, lizards and birds). Santos has indicated that all reasonable measures will be implemented to discourage entry of small native fauna into the well lease area during hydraulic stimulation operations. In addition, the potential for this exposure pathway to occur will be substantially reduced by improvement of flowback fluid containment, with Santos trialling new methods from 2013.

Potential off-site exposure pathways were evaluated for homesteads, livestock, native flora and fauna and aquatic ecosystems. Three possible chemical sources were identified: injected hydraulic stimulation fluids, sediments from Flare Pits and flowback water. The exposure assessment concluded:

- Subsurface exposure to stimulation fluids is controlled by Santos' well design, well integrity testing procedures and operational monitoring, and this pathway (whereby stimulation fluids could escape into the formation and contaminate adjacent aquifers that are used for domestic or stock water supply) is considered unlikely or incomplete.
- Based on an understanding of the Eromanga and Cooper Basin geology and hydrogeology, and the nature and extent of groundwater supply development, exposure to residual stimulation chemicals through subsurface pathways is considered unlikely and incomplete, due to:
  - Significant vertical offset between the benifical use aquifers and the shallowest hydrocarbon reservoirs (oil reservoirs of the Cadna-Owie Formation - 400 to 800 m). These formations are separated by low permeability formations and form a thick, competent and regionally extensive seal. The vertical offset to gas reservoirs is much greater (1,000 m to 1,800 m).
- Within formations that host both aquifers and hydrocarbon reservoirs (e.g. Hooray Sandstone), the water-bearing zones are separated from hydrocarbon reservoirs by intra-formational seals. However there is not enough information available to discretise the internal stratigraphy of these formations. Where petroleum activities (including stimulation) occur within a formation that hosts both aquifers and hydrocarbon reservoirs, the lateral distance of the water supply bores accessing the aquifer to Santos' tenements was considered.
- The closest beneficial use bore to the Santos tenements targeting the Hooray Sandstone in the DEHP database records is the Whim Well, which is indicated as being located 20 km from the closest tenement with hydraulic stimulation activities proposed (the existence of this bore was unable to be confirmed during the WBBA). The closest observed bore, the Coothero Bore, is at least 25 km from the closest tenement proposed for hydraulic stimulation and more than 80 km from the closest tenement with activities proposed at a similar formation depth.
- At the surface, a spill or leak of flowback water from the Flare Pit was considered as a potential exposure scenario, however the implementation of operational controls, including use of liners in Flare Pits, removal of fluid and sediment using vacuum techniques and engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within the Flare Pits) is considered sufficient to limit the potential for uncontrolled releases of flowback water to the environment.

A further margin of safety is provided by Santos' evaluation of 'environmentally sensitive areas' when establishing well leases, which includes the establishment of buffers between petroleum (and stimulation) activities and features of potential environmental concern. Subsequently, the potential off-site exposure scenarios are considered unlikely and incomplete.

Hazard Assessment

The toxicity of the chemicals used in the hydraulic stimulation process by Schlumberger have been assessed for persistence, bioaccumulation and aquatic toxicity (PBT), terrestrial toxicity and human health toxicity including the physical hazards of fire and explosion. The review of toxicity is qualitative in that it has provided a relative ranking of chemicals considered to represent a high, moderate or low hazard in respect to the ecological or human health end points with qualification of health issues arising from the ranking.

The evaluation of the hazards was based on the available data obtained from a range of literature sources and databases. As a consequence, data are limited to the quantity and quality of information available in those sources. A measure of the data completeness for the toxicological and hazard parameters used has been estimated using a percentage of the parameters for which data were available. An assessment of the quality of the available data is beyond the scope of this report. In the absence of verifying the data by going to the primary literature sources, the data used in this assessment has been confined to established, robust and reputable sources such as the World Health Organisation (WHO) and the United States Environment Protection Agency (US EPA) where available. As new toxicological data are generated and become available in the published literature, the information presented in this hazard evaluation and the associated conclusions may be subject to change. This has recently been realised as a consequence of new human health chemical hazard assessment approaches (NICNAS, 2013) and subsequently the chemicals supplied by Schlumberger (as presented in Table 4) have been reviewed on the basis of a new national approach which incorporates a weighting for specific toxicological parameters. Table 4includes a number of chemicals that had previously been assessed by Golder using a former methodology. These chemicals have now been re-assessed using the new national approach.

This hazard assessment did not consider the combined effects of the constituents when present in a mixture. Assessment of mixtures is considered beyond the scope of a screening level human health and ecological risk assessment.

Environmental Hazard

Approaches for environmental risk assessment of individual chemicals are inherently conservative and designed to over-estimate risk as a precautionary approach and in recognition of the uncertainty surrounding effects of mixtures.

Aquatic ecosystems

Of the fifty-two (52) individual hydraulic stimulation chemicals assessed, forty-four (44) were classified for aquatic hazard. Five of the forty-four (44) chemicals: sodium hydroxide, hydrochloric acid, magnesium chloride, potassium hydroxide and magnesium nitrate, were not scored for persistence as these chemicals readily dissociate in the environment. Two chemicals (guar gum and sodium carboxymethylhydroxypropyl guar) were not assessed due to insufficient data, but are qualitatively discussed.

Of the forty-four (44) chemicals classified, the following aquatic hazard classifications were assigned:

- twenty-two (22) were classified low hazard;
- fourteen (14) were classified moderate hazard; and
- eight (8) were classified high hazard.

The eight chemicals classified as a high aquatic hazard were considered to be chemicals of potential concern (COPC), these were:

- Dicoco dimethyl quarternary ammonium chloride;
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride;
- Sodium tetraborate;

- Nitrogen, liquid form;
- Boric acid;
- Magnesium silicate hydrate (talc);
- Hydrogen peroxide (impurity); and
- Zirconium dichloride oxide.

Of the high aquatic hazard chemicals identified, the following further interpretations are provided:

- Nitrogen, liquid form. Nitrogen is only a liquid at low temperature and pressure, conditions which will not prevail in the hydraulic stimulation fluid or at the drill pad. At atmospheric temperature and pressure nitrogen is a gas. The extent that nitrogen will have reacted with other constituents in the hydraulic stimulation mixture before volatilisation, is not known.
- Boric acid, magnesium silicate hydrate (talc), hydrogen peroxide, zirconium dichloride oxide and sodium tetraborate are considered as high hazards in this assessment based primarily on persistence. Review and interpretation of the aquatic toxicity data suggest these five chemicals present a low to moderate aquatic toxicity hazard.
- Dicoco dimethyl quarternary ammonium chloride is considered a high hazard based primarily on its toxicity. The toxicity data available for this chemical are limited (only acute fish and invertebrate data available) however review and interpretation of the persistence and bioaccumulation data suggest this chemical presents a low to moderate aquatic hazard.
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride is considered a high hazard based on its high persistence and aquatic toxicity. As with dicoco dimethyl quarternary ammonium chloride the toxicity data available for this chemical is limited with only acute fish and plant data available.

It is noted that only one (liquid nitrogen) of the eight high aquatic hazard chemicals is expected to be in concentrations greater than 0.1% in a stimulation fluid mixture (as indicated by the fluid disclosures) and five of the high aquatic hazard chemicals are expected to be at concentrations less than 0.01%.

Given the management controls in place to prevent releases to the environment, potential aquatic hazards from individual hydraulic stimulation chemicals, are considered unlikely to be realised.

Terrestrial ecosystems

Of the 52 hydraulic stimulation chemicals, seven chemicals were not assessed due to insufficient data and six were not assessed because they were considered to be essentially sand, leaving 39 chemicals for assessment of terrestrial toxicity.

The following organic chemicals were assessed to have the potential to pose a higher hazard in the terrestrial environment relative to the other chemicals assessed based on persistence and potential to biomagnify:

- Cetylethylmorpholinium ethyl sulphate;
- Tetramethylammonium chloride;
- Surrogate for Octadecanoic acid, calcium salt;
- Decyldimethyl amine (impurity);
- Declydimethyl amine oxide;
- Surrogate for Vinylidene chloride/methacrylate; and
- Disodium ethylene diamine tetra acetate.

Six of the seven chemicals shown above are expected to be in concentrations less than 0.1% in a stimulation fluid mixture (as indicated by the fluid disclosures), with only one chemical (tetramethylammonium chloride) expected at concentrations up to 1%.

Tetramethylammonium chloride, decyldimethyl amine oxide and disodium ethylene diamine tetra acetate have low volatility but they are not likely to persist in the terrestrial environment as illustrated by a moderate to rapid half-life and low potential to bioaccumulate.

Surrogate for octadecanoic acid, calcium salt and decyldimethyl amine (impurity) both have a high potential to biomagnify but due to a moderate half-life and low to moderate volatility they are not likely to persist in the terrestrial environment.

Surrogate for vinylidene chloride/methacrylate (1,1 DCE) has the potential to persist in the terrestrial environment due to a slow half-life however it has low potential to biomagnify and low volatility.

Given the management controls in place to prevent releases to the environment, potential hazards from individual hydraulic fracturing chemicals to terrestrial ecosystems are not expected to be realised.

Human Health Hazard

The hazard evaluation for human health undertaken on fifty-two chemicals in accordance with the IMAP Framework hazard ranking methodology indicated thirty-five of the chemicals assessed to be a Hazard Rank of 3 or 4.

The hazard evaluation for human health suggests that the dominant concerns are related to occupational hazards such as carcinogenicity, silicosis, skin, eye and respiratory irritancy or corrosivity and sensitisation. In some cases physical hazards of flammability and explosion prevail and are identified in this report. While extensive dilution of the hydraulic stimulation chemicals is anticipated such that potential exposure concentrations would be much reduced for fluids injected into the well and in flowback fluid, there are a number of hazards that are suggested from this human health evaluation. These include the potential for:

- Residual elevation of organic moieties e.g. some salts have an organic part that will be present following dissociation that may increase in environmental (surface or ground) waters.
- Changes in pH of environmental waters due to alkaline or acidic components.
- Certain metal concentrations to be elevated in environmental waters.
- Some additives to exert endocrine disruption effects.
- Certain inorganic substances to generate atmospheric particulates that may impact nearby communities.
- Volatile components to comprise nuisance or irritant effects should atmospheric concentrations be elevated in close proximity to communities.

These human health hazards may be assessed further, and/or managed as required. Diatomaceous Earth - calcined, crystalline silica (quartz), crystalline silica (crystobalite) and ethanol have been identified as a specific concern due to their classifications as confirmed human carcinogens and sodium bromate as a possible carcionogen. Boric acid and sodium tetraborate are also of specific concern due to their reproductive toxicity potential. Tetramethylammonium chloride is of specific concern due to lethal effects if ingested. It is noted, however, that the fluid disclosure information indicates that all but one (crystalline silica) of the highest hazard chemicals are expected to be at concentrations less than 0.1 % mass fraction (of the individual fluids). Furthermore, the evaluation of exposure pathways has indicated that the potential for surface water and groundwater to be impacted by hydraulic stimulation fluid chemicals is considered to be low.

Benzene, toluene, ethylbenzene and xylene (BTEX) and polycyclic aromatic hydrocarbon (PAH) compounds were not identified in the product disclosures of the stimulation fluids provided to Golder.

Qualitative Assessment of Fluids

Schlumberger collected two stimulation fluid samples for chemical testing. The two samples were tested for Polyaromatic Hydrocarbons (PAHs), while a single sample was tested for BTEX.

The reported BTEX and PAH concentrations were below the laboratory LOR. BTEX concentrations were reported below the DEHP regulated criteria for hydraulic stimulation fluid additives in Queensland.

These results may indicate that stimulation fluids are not contributing substantial amounts of BTEX and PAH into the subsurface regions, however, some qualification of this statement is required as a result of residual uncertainties. These uncertainties require further exploration and reflect:

- Sample handling. Samples were heated and potentially volitiles were lost through evaporation.
- Limited sampling frequencies for the respective fluids examined.
- Confidence in the sampling integrity. Typically an environmental consultant would collect and transport environmental samples.
- Quality assurance / quality control (QA/QC). QA/QC samples were not collected, such as an inter- and intra- laboratory split.
- The sampling process and its consistency with hydraulic stimulation procedures at the time of sampling including spatial and temporal references, i.e. what was happening at the time of sampling and process locations, etc.

Overall Risk Evaluation and Management Measures

Considering the hazard assessment, exposure assessment and qualitative assessment of fluids flowback water at surface presents a possible, although unlikely, risk. However, with Santos operational controls and management, the overall risk to human health and environment associated with the chemicals involved in hydraulic stimulation are expected to be low. The management measures implemented through operational controls include:

- OH&S procedures implemented during hydraulic stimulation operations to prevent workers from direct contact with chemicals during spills and when handling makeup and flowback waters, and sediments.
- Santos operational procedures regarding well integrity verification and fracture design to stay within the target formation.
- Assigning buffers during establishment of well leases between petroleum operations and potential “environmentally sensitive areas” identified though database review and site-specific ecological assessments.
- Implementation of spill containment procedures during operations to prevent migration of and exposure to chemicals.
- Vacuum removal of sediments and fluids contained within Flare Pits, to prevent exposure to contaminants in fluids and windborne dust.
- Installation and maintenance of fences around Flare Pits to prevent access by trespassers, and installation of signs to indicate that well leases are work zones to be accessed by authorised personnel only.
- Installation and maintenance of fences around Flare Pits to prevent access by livestock and large native fauna.
- Lining of Flare Pits and improvement of fluid storage and containment methods, to prevent seepage of flowback water into the underlying aquifer; and
- Engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within Flare Pits) to limit the potential for uncontrolled surface releases of flowback water to the environment.

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List of Acronyms

Acronym	In full
1,1-DCE	1,1-Dichloroethene
AIHC	American Industrial Health Council
ALS	ALS Environmental (Testing Laboratory)
APVMA	Australian Pesticides and Veterinary Medicines Authority
BCF	Bioconcentration Factor
BTEX	Benzene, toluene, ethylbenzene and xylenes
CASRN	Chemical Abstracts Service Registry Number
CHEMS-1	US Chemical Hazard Evaluation for Management Strategies
COC	Chain of Custody
COPC	Chemical of potential concern
CSG	Coal seam gas
DEHP	Department of Environment and Heritage Protection
DERM	Department of Environment and Resource Management
DEWHA	Department of the Environment, Water, Heritage and the Arts
Dfe	Design for the Environment
DNA	Deoxyribonucleic acid
DTA	Direct Toxicity Assessment
EA	Environmental Authority
EC50	Exposure Concentration (that kills 50% of exposed organisms)
ECB	European Chemicals Bureau
E-FAST	Exposure, Fate Assessment Screening Tool
ECHA	European Chemicals Agency
ECOSAR	Ecological Structure Activity Relationships
EIS	Environmental Impact Statement
EPA	Environmental Protection Authority
EPHC	Environment Protection and Heritage Council
EPISUITE	Estimation Programs Interface Suite
GAB	Great Artesian Basin
GDE	Groundwater-dependant ecosystem
GHS	Globally Harmonised System of Classification and Labelling of Chemicals
HDPE	High Density Polyethylene
HHEWG	Human Health Expert Working Group
HQ	Hazard Quotients
HSRA	Hydraulic Stimulation Risk Assessment
HSDB	Hazardous Substance Data Bank
IARC	International Agency for Research on Cancer
IMAP	Inventory Multi-tiered Assessment and Prioritisation
K	Potassium
Koc	Soil Adsorption Partition Coefficient

Acronym	In full
Kow	Octanol / Water Partition Coefficient
L/kg	Liters per kilogram
LD (or LC)50	Lethal dose (or concentration) that kills 50% of exposed organisms
LOEC	Lowest Observed Effects Concentration
LOR	Limit of Reporting
MATC	Maximum Acceptable Toxicant Concentration
mg/L	Milligrams per liter
Na	Sodium
NATA	National Association of Testing Authorities
NChEM	(Australian) National Framework for Chemicals Environmental Management
NH4+	Ammonium
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NOEC	No Observed Effects Concentration
NTP	(US) National Toxicology Program
OECD	Organization of Economic Cooperation and Development
OH&S	Occupational Health and Safety
OSHA	(US) Department of Labour Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PBT	Persistence, Bioaccumulation and Toxicity
PNEC	Probable No Effect Concentration
PPE	Personal Protection Equipment
QA	Quality Assurance
QC	Quality Control
QSAR	Quantitative-Structure-Activity Relationship
SAR	Structure activity Relationships
SCCS	Scientific Community for Consumer Chemical Safety
SDS	Safety Data Sheet(s)
SRC	Syracuse Research Group
SRN	Sample Receipt Number
SWQ	South West Queensland
TEP	Toxicity Equivalency Potential
TGS	Tight gas sands
UN	United Nations
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environment Protection Agency
WBBA	Water Board Baseline Assessment
WERD	Water Entitlement Register Database
WHO	World Health Organization
WOE	Weight of Evidence

1.0 INTRODUCTION

1.1 Preamble

On 29 June 2012 Santos Ltd (Santos) submitted an application to the Department of Environment and Heritage Protection (DEHP) for Santos' Southwest Queensland (SWQ) Environmental Authorities (EAs). Project activities covered under the application to DEHP included stimulation activities (henceforth referred to as "hydraulic stimulation") of conventional oil and gas reservoirs.

To meet EA consent conditions, a formal risk assessment of hydraulic stimulation activities is required and subsequently, Golder Associates Pty Ltd (Golder) has been engaged by Santos to prepare a Hydraulic Stimulation Risk Assessment (HSRA).

This desktop HSRA is presented in two volumes, as follows:

- Volume One (Reference: 127666004 011 R) discusses the environmental and geological settings within which Santos' stimulation operations take place and the general techniques for the drilling, completion and stimulation of wells. The report also discusses why hydraulic stimulation is essential in SWQ and outlines Santos' current forward program for fracture-stimulation, although it should be noted that for a variety of reasons (including but not limited to future production performance and / or access-related issues such as the flooding of the Cooper Creek system), the forward program is frequently reviewed and is subject to change.
- Volume Two and Volume Three (this report) relates specifically to the stimulation fluids proposed to be used by *Stimulation Service Providers* on Santos wells in the SWQ conventional oil and gas fields. The report considers the ecological and human health toxicity of the chemical constituents in the stimulation fluids, and includes an exposure pathway assessment and risk characterisation based on a review of complete exposure pathways and controls to mitigate exposure. Volume Two relates to *Halliburton* stimulation fluids, while Volume Three relates to *Schlumberger* fluids.

This reporting structure has been developed to accommodate the chemical assessment requirements of various hydraulic stimulation fluids as they are introduced to the Australian market, for which the remainder of the EA conditions relating to the environmental setting and stimulation process description remain consistent over time. This reporting structure also affords greater ability to manage commercial-in-confidence issues associated with certain stimulation fluids.

This report specifically addresses the requirements of EA conditions related to the assessment of Schlumberger chemical constituents for :

- YF140HTD 30Q N2 stimulation fluid
- ThermaFRAC 40 stimulation fluid
- Slickwater stimulation fluid

The report also considers a lesser volume of *32%HCL* also used during stimulation. Chemical information disclosed included each of the chemical constituents in the fluids considered, and the mass of each constituent in a typical fluid mixture. The fluid disclosure information is proprietary and has not been included in this report.

This report should be read in conjunction with report entitled, *Hydraulic Fracturing Risk Assessment, Site Setting and Fracturing Process* [Volume One], (reference: 127666004-011-R-Rev0); which discusses the environmental and geological settings within which Santos' stimulation operations take place in Southwest Queensland (SWQ) and the general techniques for the drilling, completion and stimulation of wells. The same report also evaluates exposure pathways and Santos management and control measures.

1.1.1 EA Consent Conditions

The July 2012 model conditions (J11) included in the *Environmental Protection Act 1994, Level 1 Environmental Authority, Chapter 5A Petroleum Activity* (APPENDIX A) indicate that prior to undertaking well stimulation activities, the holder of the EA must develop a risk assessment to ensure that hydraulic

stimulation activities are managed to prevent environmental harm. Subsequently, Santos has been negotiating draft EA conditions, although these negotiations have not been finalised and therefore the July 2012 conditions are referenced: *The* **stimulation** *risk assessment must include, but not necessarily be limited to* (refer to Table 1):

Table 1: Summary of Consent Conditions Related to Stimulation Fluid Chemical Assessment

	Condition	Report Volume
(a)	a process description of the **hydraulic stimulation** activity to be applied, including equipment and a comparison to best international practice	One
(b)	provide details of where, when and how often **hydraulic stimulation** is to be undertaken on the tenures covered by this environmental authority	One
(c)	a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s)	One
(d)	naturally occurring geological faults	One
(e)	seismic history of the region (e.g. earth tremors, earthquakes)	One
(f)	proximity of overlying and underlying aquifers	One
(g)	description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation	One
(h)	identification and proximity of **landholders' active groundwater bores** in the area where **hydraulic stimulation** activities are to be carried out	One
(i)	the environmental values of groundwater in the area	One
(j)	an assessment of the appropriate **limits of reporting** for all indicators relevant to **hydraulic stimulation** monitoring in order to accurately assess the risks to environmental values of groundwater	-
(k)	description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity	One
(l)	consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers	One
(m)	a description of the well mechanical integrity testing program	One
(n)	process control and assessment techniques to be applied for determining extent of **hydraulic stimulation** activities (e.g. microseismic measurements, modelling etc.)	One
(o)	practices and procedures to ensure that the **hydraulic stimulation** activities are designed to be contained within the target gas producing formation	One
(p)	groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow	One
(q)	a description of the chemicals used in hydraulic stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after hydraulic stimulation	Two

(r)	a mass balance estimating the concentrations and absolute masses of chemicals that will be reacted, returned to the surface or left in the target gas producing formation subsequent to hydraulic stimulation	Three
(s)	an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after **hydraulic stimulation** including: (i). toxicological and ecotoxicological information of chemicals used (ii). information on the persistence and bioaccumulation potential of the chemicals used (iii). identification of the **hydraulic stimulation** fluid chemicals of potential concern derived from the risk assessment	Three
(t)	an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in **hydraulic stimulation** activities	Three
(u)	identification and an environmental hazard assessment of using radioactive tracer beads in **hydraulic stimulation** activities	One
(v)	an environmental hazard assessment of leaving chemicals used in **stimulation fluids** in the target gas producing formation for extended periods subsequent to **hydraulic stimulation**	Three
(w)	human health exposure pathways to operators and the regional population	Three
(x)	risk characterisation of environmental impacts based on the environmental hazard assessment	Three
(y)	potential impacts to landholder bores as a result of **hydraulic stimulation** activities	Three
(z)	an assessment of cumulative impacts, spatially and temporally of the **hydraulic stimulation** activities to be carried out on the tenures covered by this environmental authority	-
(aa)	potential environmental or health impacts which may result from **hydraulic stimulation** activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration	One and Three

1.2 Risk Assessment Process

This report discusses the constituents used by Schlumberger[1] with regard to toxicity to human health and the environment. The techniques used to assess the human health and environmental hazards of the constituents are described in the following sections. Where there was insufficient chemical and/or toxicological information to assess the hazards of individual constituents, an appropriate surrogate chemical was selected or an assessment was not performed.

The scope of the qualitative risk assessment comprises of:

- **Issue identification** (Volume One) - A description of the current environmental setting (including a description of potential receiving environments and the various factors which act upon them, including climatic influences), detailed geological and hydrogeological information, gas well integrity and a description of the hydraulic stimulation process including an identification of the constituents of the hydraulic stimulation fluid.
- **Exposure Assessment** (This Volume) – The exposure assessment comprises an evaluation of surface and subsurface exposure pathways assessment.
- **Hazard assessment** (This Volume) – An evaluation of the environmental hazard of relevant chemical additives in the hydraulic stimulation fluid based on aquatic toxicity, environmental persistence and bioaccumulation. The environmental hazard assessment provides a relative ranking of the chemical additives and those chemicals considered to represent a high hazard are identified as chemicals of potential concern (COPC) for further assessment. An evaluation of terrestrial and human health toxicity is also presented and chemicals posing the highest relative hazard to human health and terrestrial ecosystems are identified; and
- **Risk Characterisation** (This Volume) – A qualitative evaluation of environmental and human health risk associated with the hydraulic stimulation activities based on the identification of complete exposure pathways and hazard identification.

Human health risk assessment is limited to assessment of effects on one population: *humans*. Ecological risk assessment is concerned with assessment of effects on the ecosystem (populations and communities) and therefore is not limited to one receptor.

Since 2010, Golder has previously assessed many stimulation fluid constituents to meet EA conditions. Throughout this time Golder has updated the assessment approach to reflect national and international regulatory changes, and therefore, chemicals previously assessed using a former approach have now been re-evaluated using the current hazard assessment approach as described in later sections.

The approach for chemicals assessed for ecological risk prior to 2013 considered guidance, such as “Guideline on Ecological Risk Assessment” (NEPC, Schedule B (5), 1999) which refers to draft guidance prepared by EPA Victoria (Gibson *et al.*, 1997). These guidance documents focus on risks to terrestrial environments although the overall approach for assessment or risk is the same. The human health risk assessment was undertaken in general accordance with national guidelines for risk assessment recommended by enHealth (enHealth-Environmental Health Risk Assessment, “Guidelines for Assessing Human Health Risks from Environmental Hazards”, June 2004).

The most recent chemicals assessed (during 2013) entail updates reflecting:

- Recent changes in national hazard assessment frameworks for health (NICNAS, 2013). NICNAS recently documented a national approach (IMAP) to ranking chemicals for evaluation in Australia in order to prioritise their national chemical assessment program. The framework has been developed by an expert government committee and thus provides a highly defensible position should the Golder hazard assessment be questioned by the Regulator or groups such as the National Toxics Network (NTN).

[1] Water was not assessed because it is an intrinsic constituent of all living organisms and is not inherently toxic.

- Evolving international regulatory changes in hazard classification systems (global harmonisation system) that have been introduced into Australia (e.g. that have changed requirements in Safety Data Sheets) and have focussed on new areas of toxicity.

This hazard assessment did not consider the combined effects of the constituents when present in a mixture. Assessment of mixtures is considered beyond the scope of a screening level human health and ecological risk assessment.

If, in the future, conditions, hydraulic stimulation methodologies and/or regulatory requirements change, and/or additional exposure pathways to additional receiving environments are identified, further evaluation of the associated risks may be warranted.

1.3 Limitations

Your attention is drawn to the document - “Limitations”, which is included in APPENDIX B of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

2.0 EXPOSURE ASSESSMENT

This aspect of risk assessment provides perspective on the potential for chemicals of potential concern (COPC) to become available and be taken up by human and other ecological species. Exposure assessment seeks to qualify or quantify such uptake by considering the human population groups and other organisms or group of organisms (receptors) which may be exposed to the COPCs identified for the study, and outlines the mechanisms (exposure pathways) by which these receptors may be exposed.

The assessment of exposure involves the evaluation of the data available for the study and the arising issues; the details associated with the surrounding environment that influence fate and transport processes; the nature of planned operations that use the COPC; the physico-chemical characteristics of the COPC and the respective potential exposure pathways consistent with the planned operations. This allows the nature of the potential exposure to be identified taking into consideration the fate and transport potential of the COPC.

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

- Source of COPC - how the chemical entered 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).

If any one of these steps (source, transport media, exposure point or route) is not present, the exposure pathway is incomplete and further assessment of risks is not required. Conclusions regarding the completeness of exposure pathways may change over time in response to new information or developments, and as such should be periodically reviewed for verification.

2.1 Identification of Exposure Pathways and Populations

A detailed description of the study area environment is provided in Volume One. In general, the area is sparsely developed, and comprises rural communities and homesteads that are largely engaged in farming and livestock production. The identification of exposure pathways and populations or ecological receptors has been split into those considered relevant for on-site (i.e. within the well lease), and those relevant for off-site (i.e. anything beyond the well lease boundary). A general description of the well lease is provided in Volume One. Individual configurations of well leases may change, however the general layout is considered adequate for the identification of exposure pathways and receptors.

The environment surrounding the well lease (i.e. off-site) may vary. In order to provide a conservative assessment it has been assumed there is a homestead with a water supply bore located down gradient of the well lease. It is further assumed that the distance to the homestead is over two kilometres which thus limits the potential consideration of:

- Vapour intrusion concerns into dwellings.
- The environmental distribution of chemicals as vapours producing odours or particulates that may deposit onto roof tops and indirectly into potable water supplies; and
- The potential for entrainment of chemicals used in and around the well leases into the indoor environment of homesteads and into areas where local (homegrown) food crops may be produced.

It has also been assumed that an ephemeral creek, livestock and native flora and fauna, are present in the surrounding environment. This hypothetical assumption was considered for the purposes of the exposure pathway assessment, and may not actually occur in the vicinity of a hydraulically stimulated well.

2.1.1 On-site Exposure Pathways

A well lease is a defined area that contains all of the equipment and infrastructure required to hydraulically fracture a well. A typical well lease is described in Volume One. Of particular note for the exposure assessment are the Flare Pit and the Blender Unit. The Flare Pit is fenced.

As such a well lease is an occupational environment and accordingly it is unnecessary to consider any on-site residential scenarios. Workers are typically housed in existing camps or camps specifically designed for hydraulic stimulation (frac camps). According to Santos procedures (Hydraulic Fracture Stimulation Procedures, Rev1, 2005), '*The frac camp should not be located within one kilometre of operations*'. If a camp is located within one kilometre, a risk assessment must be performed and management approval obtained.

The environmental receptors on a well lease are limited. Livestock and large native animals such as kangaroos are deterred from entering the pad by human activity. However Santos has indicated that cattle and kangaroos have been noted on well leases infrequently. Smaller fauna such as rodents, lizards, snakes and birds are known to enter well leases.

As described in Volume One, stimulation fluid is blended on site to the specific requirements of the fracture design. The additives required for the fracture are brought onto site and stored in storage containers, blender unit or sand trailer. Blending of the fluid is a contained and completely automated process. A typical stimulation operation is of limited duration (two to three days). As such the chemicals are on site for a short period of time prior to and during the stimulation event. The likelihood of occupational or environmental exposure to these additives prior to injection during normal operation is considered low, as long as robust operational management measures are present and implemented appropriately. Potential occupational exposure to hydraulic stimulation chemicals associated with a spill prior to injection is considered to be dealt with under appropriate occupational health and safety procedures and has not been considered further in this report.

The primary pathways for environmental and occupational exposures outside of spills are considered to be dermal, ingestion and inhalation and ingestion of particulates. Inhalation of volatile chemicals is considered to be of lesser concern as there are limited indoor or confined environments with all activities conducted outside, however, large atmospheric emissions in close proximity to the source would require evaluation from both an acute and chronic exposure perspective.

The main areas on site that are considered for occupational and environmental exposure is the lined Flare Pit used for flowback fluid storage and this is discussed in more detail below.

2.1.1.1 Flare Pit

The Flare Pit is constructed during the drilling phase, to provide containment for fluids associated with well fluids management (flowback fluids etc.) post drilling. The Flare Pit is used during stimulation as the initial reservoir for flowback fluids. The fluid is held in the pit to allow the sediment to settle and until it is removed via vacuum truck for off-site disposal. Santos has indicated that Flare Pits are lined with high-density polyethylene (HDPE) and fenced following the drilling phase and prior to hydraulic stimulation activities.

Human exposure to the water in the Flare Pit during normal operation would be limited but may occur if the Flare Pit or liner becomes damaged and requires repair. Normal OH&S procedures are expected to limit workers exposure to flowback water under these scenarios. Human and/or ecological exposure may occur in the event of a flood where the freeboard is breached.

Exposure to the sediment in the Flare Pit may occur if the Flare Pit is drained and the sediments dry out and contribute to wind borne dust. However, sediments are also removed from the pit via vacuum truck for off-site disposal as soon as practicable. Dust generation from a small volume of residual sediments is not likely to be of concern to human or ecological receptors and has not been considered further. Should the scale of operations result in multiple areas of residual sediments in closer proximity to townships then such an exposure pathway would warrant re-evaluation.

Cooper Basin activities are remote, and trespassers are unlikely to access the site even if the pad is not fully secure and accidental or deliberate exposure to chemicals in the flowback water in the Flare Pit is considered unlikely to occur.

Ecological exposures to stimulation chemicals within the Flare Pit may occur from contact with the flowback water or from contact with sediments following drainage. Although Flare Pits are fenced, ecological receptors may include livestock, kangaroos and other small native mammals, reptiles, plants, soil microorganisms and birds.

Santos has indicated HDPE lined Flare Pits are the minimum standard for the containment of flowback fluids however, continuous improvement is fostered.

2.1.1.2 Measures to Limit Exposure

Typically implemented measures to limit on-site exposure include:

- Exposure to trespassers is limited through ensuring all Flare Pits are securely fenced. Signs are clearly displayed indicating the well lease is a work zone and is to be entered by authorised personnel only.
- Exposure to livestock is limited through regular maintenance of fences.
- Exposure to sediments in the HDPE lined Flare Pits is limited by effective removal and off-site disposal.

A summary of the on-site qualitative exposure assessment is provided in Table 2.

Table 2: On-site Exposure Assessment Summary

Source	Exposure Scenario	Receptors	Exposure Pathways	Likelihood of Exposure Scenario	Comments
High-density polyethylene (HDPE) lined Flare Pit or tank sediments	Entry to pit or excavation/stockpiling of pit sediments	Workers, trespassers	Ingestion, dermal, inhalation of volatiles	Unlikely	OH&S procedures and PPE limit workers exposure to sediment. Associated risks are covered in inductions that all personnel and contractors must attend.
	Entry to lined Flare Pit or transportable tank	Native terrestrial fauna (small fauna - mammals, reptiles, birds)	Ingestion, dermal, uptake	Possible	The presence of humans and hydraulic stimulation activities are expected to deter majority of wildlife during operations. Flare Pits have stock proof fencing at all times. Flare Pits do not contain food or habitat for terrestrial fauna.
	Flare Pit sediments become windblown dusts	Workers, trespassers	Inhalation of dusts, indirect exposures through re-entrainment mechanisms	Possible	Sediments / residues are removed from site using vacuum truck and appropriately treated and disposed as soon as practicable. Flare Pits have stock proof fencing at all times.
	Flare Pit dries and pit sediments become windblown dusts	Native terrestrial fauna (mammals, reptiles, birds), terrestrial flora	Inhalation of dusts, deposition of dust on foliage	Possible	The presence of humans and hydraulic stimulation activities are expected to deter wildlife during operations, and sediments / residues are removed from site and appropriately treated and disposed as soon as practicable. Volume of dusts is expected to be insufficient to smother terrestrial flora. Risk of smothering is greatest for terrestrial flora in the immediate vicinity of the well lease. Provided flora populations are not unique to the area of the well lease, re-colonisation is expected post-stimulation activities.
	Flare Pit dries and pit sediments become windblown dusts, contaminating surrounding soil.	Native terrestrial fauna (mammals, reptiles, birds), terrestrial flora	Ingestion, inhalation, uptake via roots, deposition of dust on foliage	Unlikely	The presence of humans and hydraulic stimulation activities are expected to deter wildlife during operations. Volume of dusts is expected to be insufficient to smother terrestrial flora. Risk of smothering is greatest for terrestrial flora in the immediate vicinity of the well lease. Sediments / residues are removed from site and disposed as soon as practicable.

Source	Exposure Scenario	Receptors	Exposure Pathways	Likelihood of Exposure Scenario	Comments
Flowback water HDPE lined Flare Pit or tank.	Working with Flare Pit inlet, liner, or extraction.	Workers	Ingestion, dermal, inhalation of volatiles, inhalation/ingestion of aerosols	Possible	OH&S procedures and PPE limit workers exposure to flowback water. Associated risks are covered in inductions that all personnel and contractors must attend.
	Entry (accidental or deliberate) to Flare Pit.	Trespassers	Ingestion, dermal inhalation of volatiles, inhalation/ingestion of aerosols	Possible	Trespassers entry is limited via fencing and signage. Trespassers can be entirely precluded from areas.
	Entry to Flare Pit.	Native terrestrial fauna (small fauna - mammals, reptiles, birds)	Ingestion	Observed	The presence of humans and hydraulic stimulation activities are expected to deter majority of wildlife during operations. Flare Pits have stock proof fencing at all times. Flare Pits do not contain food or habitat for terrestrial fauna.
	Entry (accidental or deliberate) to Flare Pit.	Livestock	Ingestion	Unlikely	Flare Pits have stock proof fencing at all times. Flare Pits do not contain food or habitat for stock. Fences and grids with routine maintenance can be effective at precluding livestock from well leases however, some livestock have been observed in well lease areas.
Hydraulic stimulation chemicals	Spill, leak of well delivery system failure during surface handling. Supply or disposal vehicle accident on site	Workers	Ingestion, dermal inhalation of volatiles, inhalation/ingestion of aerosols indirect exposures through re-entrainment mechanisms	Unlikely	OH&S, PPE and spill containment, procedures adequately address this exposure. Associated risks are covered in inductions that all personnel and contractors must attend.
	Spill, leak of well delivery system failure during surface handling. Supply or disposal vehicle accident on site	Terrestrial fauna (mammals, reptiles, birds), terrestrial flora	Ingestion, dermal	Unlikely	The presence of humans and hydraulic stimulation activities is expected to deter wildlife. The greatest hazard is to terrestrial flora in the immediate vicinity of a spill. Provided flora populations are not unique to the area of the well lease, re-colonisation is expected post-completion of stimulation activities.

Source	Exposure Scenario	Receptors	Exposure Pathways	Likelihood of Exposure Scenario	Comments
Flowback water	Spill, leak, delivery system failure or overflow	Workers, trespassers	Ingestion, dermal, inhalation (volatiles and aerosol)	Possible	OH&S procedures and PPE limit workers exposure to flowback water. Associated risks are covered in inductions that all personnel and contractors must attend.
	Spill, leak, delivery system failure or overflow	Terrestrial fauna (mammals, reptiles, birds), terrestrial flora	Ingestion, dermal, uptake via roots	Possible	The presence of humans and hydraulic stimulation activities is expected to deter wildlife. The greatest hazard is to terrestrial flora in the immediate vicinity of a spill. Provided flora populations are not unique to the area of the well lease, re-colonisation is expected post-spill clean-up.

2.1.2 Off-site Exposure Pathways

The off-site environment is considered to be anything outside the boundary of the well lease. As discussed in Volume One the study area is sparsely developed with the predominant land use being for livestock. Volume One indicates the location of wells to be hydraulically stimulated and indicates there are no major towns or homesteads within close proximity of a stimulation well.

As discussed in Volume One, published research indicates, on the basis of water level and water quality analysis (including major and minor ion chemistry and stable isotope analysis), that the surface water features in the study area (typically consisting of semi-permanent waterholes that form between episodic flood event) do not receive shallow groundwater recharge (Hamilton et al., 2005; Bunn et al., 2006; Costelloe et al., 2007, Cendon et al., 2010). The reported characteristic quality of groundwater in the shallow unconsolidated aquifers in the study area is saline, and the water quality and isotopic signature is distinct from that of the fresher water in the water holes of the Channel Country. In addition, reported water levels in the shallow aquifer are inferred to be below the base of the surface water features in the study area, such that water holes, and flowing river channels during flood events, are considered to be losing water features (i.e. exhibit leakage of water into the ground but do not receive groundwater baseflow). Hence, the potential exposure pathway comprising leakage of hydraulic stimulation fluid down to shallow groundwater, off-site migration with groundwater flow and discharge to an aquatic environment associated with a surface water feature is considered to be an incomplete exposure pathway in the study area and has therefore been excluded from further consideration.

In the majority of instances the well lease sites where hydraulic stimulation will be conducted will be remote from water supply bores and will maintain an appropriate buffer distance from environmentally sensitive areas.

Table 3 provides a summary of the possible sources, exposure scenarios, human populations, ecological receptors and exposure pathways considered relevant for off-site. The main possible sources identified are: the hydraulic stimulation fluid, sediments in a Flare Pit and flowback water. These are discussed in more detail below.

2.1.2.1 Exposure to Hydraulic Stimulation Fluid

Potential human and ecological exposures to stimulation fluid are unlikely but theoretically could occur due to casing failures or through fractures into overlying aquifers. However, Santos currently uses an extensive system of procedures to minimise the likelihood of the fracture (and then the fluid) leaving the target area and the loss of well integrity; these are described in Volume One. The systems include extensive testing programs and operational and systems monitoring to ensure hydraulic stimulation activities are confined to the target units. If a loss of integrity is identified in a well immediate measures are employed to decommission or rectify the situation.

On this basis it is considered unlikely that exposure to stimulation fluids could occur due to the fluid escaping the target formation and contaminating adjacent aquifers that are used for domestic or stock water supply.

This conclusion is supported by a study completed by Osborn et al (2011) which evaluated aquifers overlying the Marcellus and Utica shale formations of north-eastern Pennsylvania and upstate New York. The study evaluated a number of issues associated with hydraulic stimulation including:

'*Concerns for impacts to groundwater resources, from (i) fluid (water and gas) flow and discharge to shallow aquifers due to the high pressure of the injected stimulation fluids in the gas wells'*

The study evaluated groundwater from 68 private water wells which ranged in depth from 36 to 190 m. The area of the study is undergoing an expansion of gas well drilling and hydraulic stimulation and is in an area with extensive fracture systems with several major faults and lineaments. The study found:

'*No evidence for contamination of the shallow wells near active drilling sites from deep brines and/or stimulation fluids''*

A second source of possible human and ecological exposure to hydraulic stimulation fluids is residual fluid in the target formation. It is conservatively assumed that up to 40% of fluid may remain in the target formation immediately following stimulation. Based on the depth and separation of the target formations in the Cooper and Eromanga Basin, it is considered unlikely that exposure would occur if chemicals in the residual fluid migrate down gradient in the target formation. Residual stimulation fluids captured during the production stage of the well operations would act to reduce the residual volume in the reservoir over time, and would be managed in accordance with the produced formation water management systems.

As indicated in Volume One, the results of the bore inventory in the study area indicated that the closest water supply bores installed in proximity of a hydrocarbon-bearing formation (Hooray Sandstone) to Santos production wells potentially targeting the same formation is 25 km. Residual hydraulic stimulation fluid constituents in groundwater would be expected to attenuate well within this distance. This conclusion is based on review of the information in the DEHP registered bore database, and the available results of an ongoing Water Bore Baseline Assessment program to verify the information in the database. This conclusion is subject to review, if warranted, on the basis of future bore inventory results and fracture locations.

2.1.2.2 Exposure to Sediments in the Flare Pit

Potential off-site human and ecological exposure to the sediment could occur if the Flare Pit is drained and the sediments were left to dry out and contribute to wind-borne dust. However, sediment is removed via vacuum truck and disposed of off-site. The volume of residual sediments in the Flare Pit is considered to be small and unlikely to be of concern to either humans or ecological receptors.

2.1.2.3 Exposure to Flow Back Water

Potential off-site human and ecological exposure to chemicals in the flowback water is unlikely but could possibly occur under a range of conditions. Exposure scenarios are considered unlikely to include the potential for releases or infiltration of flowback water into shallow aquifers that are used for domestic or stock water supply or which discharge to surface water, and direct releases to surface water.

For this exposure pathway to be complete there must be all of the following:

- A failure of the HDPE lining of the Flare Pit.
- A high permeability unit beneath the well lease that is able to transmit the flowback water to an underlying aquifer; and
- A shallow aquifer present in the subsurface beneath the well lease, that is either used as water supply or discharges into a creek.

If any of the above conditions are missing, no exposure will occur. The surface lithology of the Cooper Creek drainage was described as comprising a thick layer of low permeability “mud” overlying sand beds that host the shallow, saline aquifer (e.g. Nanson et al., 2008). The fine-grained surface deposits would substantially reduce the potential for infiltration of leaking flowback water to reach the shallow aquifer, and the shallow “water table” aquifers have been reported to be saline to the extent that they are unsuitable for most beneficial uses (e.g. Cendon et al., 2010). The shallowest groundwater supply in the study area is typically sourced from either the Glendower Formation or the Winton Formation, which underlie the Quaternary unconsolidated sediments. Surface water bodies have been reported to be disconnected from the shallow groundwater system.

The concentrations of stimulation chemicals in the flowback water are expected to be lower than those injected due to the capture of first flush, although flowback water is likely to contain concentrations of ‘geogenic’ chemicals from the hydrocarbon reservoir. However, the toxicity of those chemicals is expected to rapidly decrease due to dissolution, and the relatively rapid biodegradation and volatilisation of many of the chemicals. The likelihood of exposure to stimulation chemicals under this scenario in concentrations likely to be of concern is considered to be low.

2.1.2.4 Spills and Overflows from Flare Pits

Potential off-site human and ecological exposure to flowback water is considered unlikely but could possibly occur in the event of a spill or overflow from the Flare Pit. However, the Flare Pit has been designed to exclude stormwater and will be operated with a minimum of 300 mm freeboard to limit the potential for overflow. On this basis, a release could only occur during a prolonged period (weeks) of heavy rainfall. The probability of a spill or overflow event occurring is further reduced by minimising the duration that flowback fluids are stored in the Flare Pit. In addition, the toxicity of the chemicals in the flowback fluid is likely to rapidly reduce based on the dissociation of the inorganic chemicals, and the relatively short biotransformation half-lives of the majority of organic chemicals. In the event of a release, human and ecological receptors could possibly be exposed however sampling of soil, groundwater and surface water (if relevant) in the affected area would be required to determine if unacceptable exposures had occurred.

2.1.2.5 Management Measures to Reduce Off-site Exposure

Management measures that are implemented to reduce the potential for off-site exposure or to assess the potential for exposure include:

- HDPE lining of Flare Pits to prevent seepage of flowback water into an underlying aquifer. This is already undertaken as a minimum standard.
- Establishment of buffers during establishment of well leases between petroleum operations and potential “environmentally sensitive areas” identified though database review and site-specific ecological assessment where warranted.
- Establishment of buffers prior to stimulation activities, between the stimulation initiation point and private water bores identified though water bore baseline assessment.
- Vacuum removal and disposal of the sediments during fluid drainage of the Flare Pit.
- Soil, groundwater and surface water sampling of affected area recommended following any spill/ overflow of a Flare Pit.

Table 3 provides a summary of the possible sources, exposure scenarios, populations and receptors and exposure pathways considered relevant for off-site exposure concerns.

Table 3: Off-Site Exposure Assessment Summary

Source	Exposure Scenario	Receptors	Exposure Pathways	Likelihood of exposure scenario	Comment
Hydraulic stimulation fluids	Stimulation fluid escapes into aquifer via a well casing failure, or a fault/ fracture/ unconformity in formation/strata, and fluids enter aquifer used down gradient for stock and domestic water supply	Residents: adults and children Livestock	Ingestion, dermal, inhalation Ingestion	Unlikely	The exposure scenario is unlikely given the pathway linking source to receptor is predominantly absent. The shallowest occurrence of groundwater is generally at a depth that precludes hydraulic connection with surface water features resulting in a lack of GDEs within the study area. The well lease sites are remote with limited human inhabitants in the proximity of the operations – groundwater supply development is accordingly very limited, with large vertical or lateral separation of water supply wells from hydrocarbon reservoirs. Extraction of groundwater for domestic and livestock use is limited in the study area, as evidenced by the small number of registered bores (and even smaller number whose existence was confirmed during recent bore inventory and baseline assessment). The closest groundwater to surface water discharge points occur at significant distances down-hydraulic gradient of the well lease sites (i.e. of the order of 100 km or more). Exposure concentrations of hydraulic stimulation chemicals at the receptor are likely to be insignificant. Management measures include Santos operational procedures i.e. well integrity testing and design of fracture to stay with the target formation. No recorded instances in peer-reviewed literature of stimulation chemicals in down gradient water supplies (Osborn et al 2011).
	Stimulation fluid escapes into aquifer via a well casing failure, or a fault/fracture/unconformity in formation/strata, and fluids enter aquifer that discharges to surface water	Aquatic ecosystems	Direct exposure	Unlikely	
	Residual stimulation fluid in the formation migrates down gradient and enters a spring or water supply bore	Residents, aquatic ecosystems, livestock	Ingestion, dermal, inhalation	Unlikely	

Source	Exposure Scenario	Receptors	Exposure Pathways	Likelihood of exposure scenario	Comment
Flare Pit or tanks sediments	Flare Pit dries and sediments become windblown dusts, contaminating surrounding soil	Native terrestrial flora and fauna, stock, Residents adults and children	Direct exposure/ inhalation/ ingestion of dusts	Unlikely	Sediments / residues are removed from site using vacuum truck and appropriately treated and disposed as soon as practicable.
Flowback water	Seepage of chemicals to a shallow aquifer used downgradient for domestic water supply	Residents: adults and children	Ingestion, dermal, inhalation	Unlikely	Flare Pits are lined as a minimum standard, with improvements planned from 2013. The shallowest aquifer in the Quaternary sediments is reported to be very saline, and is covered by a thick layer of low permeability mud which substantially limits infiltration. Extraction of groundwater for domestic and livestock use is limited in the study area, with a small number of bores whose existence was confirmed during a bore inventory. Identified bores are typically remote from the well lease operations, or access groundwater resources that would be very unlikely to be affected by surface seepage of flowback fluid; hence exposure pathway is considered to be incomplete.
	Seepage of chemicals to a shallow aquifer used downgradient for stock water supply	Livestock	Ingestion	Unlikely	
	Seepage of chemicals to a shallow aquifer that discharges to surface water	Aquatic ecosystems	Direct exposure	Unlikely	
	Spill or leak from Flare Pit or tank overflow	Terrestrial fauna (mammals, reptiles, birds), terrestrial flora	Ingestion, dermal, uptake	Possible	Possible overflows during prolonged periods of high rainfall (>300 mm of rainfall required) based on freeboard control requirements. Freeboard is closely monitored and managed to prevent overflow. The greatest hazard is to terrestrial flora in the immediate vicinity of an overflow. Provided flora populations are not unique to the area, re-colonisation is expected post-overflow event. Likelihood of occurrence can be reduced through minimising storage duration, and transition to storage tanks for flowback water storage. The toxicity of fluid is likely to decrease rapidly due to short biotransformation half-lives of most chemicals.

2.2 Identification of Complete Exposure Pathways

2.2.1 On-site Exposure Pathways

The potential on-site exposure pathways are discussed in Section 2.1.1. Potential exposures were evaluated for workers, trespassers, small fauna, flora and soil microorganisms.

Based on information provided by Santos, there does not appear to be complete exposure pathways identified for on-site workers under normal circumstances, provided the following conditions are met:

- Adequate OH&S procedures are adhered to that prevent direct contact and inhalation exposure with chemicals during spills and when handling flowback water or sediments; and
- Sediments in the Flare Pits are disposed of appropriately.

Exposure of trespassers is considered to be an unlikely occurrence. Exposure to sediments or flowback water is a complete exposure pathway (ingestion, dermal and inhalation) if trespassing occurs on unsecured sites. Exposure will be limited through ensuring all Flare Pits are securely fenced with signage clearly displayed to indicate that the well lease is a work zone and access is restricted to authorised personnel.

Exposure pathways to the flowback water in the Flare Pit for large native fauna (i.e. kangaroos) and livestock can be considered incomplete on the basis of the fencing that Santos will establish and maintain around the Flare Pit, during operations and while flowback water is stored on site.

Exposure pathways (direct contact) for small fauna (i.e. soil microorganisms, plants, small mammals, snakes, lizards and birds) is considered complete for exposure to the flowback water in the Flare Pits, with practical measures implemented by Santos to minimize potential exposures.

2.2.2 Off-site Exposure Pathways

The on-site exposure pathways are discussed in Section 2.1.2. The most likely potential exposures were evaluated for residents, livestock, native flora and fauna and aquatic ecosystems. Three possible sources were identified: hydraulic stimulation fluids, sediments from the Flare Pit and flowback water.

Exposures were considered unlikely for all scenarios based on the engineering (liners) and operational controls that are being implemented by Santos, and the geographical remoteness of the stimulation activities. In the unlikely event that an uncontrolled release was to occur potential exposures could include direct contact and inhalation exposures for residents, livestock, native flora and fauna and aquatic ecosystems. The probability of a release from a Flare Pit occurring can be reduced through minimising the duration of flowback fluid storage. In addition, the toxicity of the chemicals in the flowback fluid are likely to rapidly reduce through dissociation of organic chemicals and the relatively short biotransformation half-lives of the majority of the organic chemicals, although it is noted that additional assessment of flowback fluid quality is recommended to support this conclusion.

The potential exposure to stimulation fluids due to entry into an overlying water supply aquifer via a well casing breach or a natural preferential pathway (fault/fracture) is considered unlikely. Santos has established operational procedures to foster well integrity and that fractures are contained within the target formation. The exposure pathways associated with residual fluid in the target formation is discussed in Section 2.1.2.1.

The potential exposure to sediments in the Flare Pit becoming windblown dusts (direct contact/inhalation and ingestion of dust) and contaminating surrounding soil is considered unlikely. Sediments are removed via a vacuum truck during fluid removal and the residual volume of pit sediments is likely to be insufficient to result in concentrations in soil that would be of concern in the surrounding terrestrial environment.

The potential for seepage of flowback fluids from the Flare Pit into an underlying aquifer and migration to a domestic water supply or discharge into a creek are considered unlikely. Santos is designing Flare Pits with liners to prevent the loss of fluids into the subsurface. If releases were to occur, the typical surface lithology in the study area comprises a thick layer of fine-grained material overlying the sand beds that host a saline aquifer (e.g. Nanson et al., 2008). The fine-grained material will substantially reduce the infiltration potential of released fluids, and the shallowest aquifer is generally too saline for most beneficial uses (e.g. Cendon et al., 2010). The shallowest groundwater resource developed for water supply in the study area is the Tertiary Glendower Formation, which underlies the unconsolidated Quaternary sediments.

2.2.3 Residual Stimulation Fluids in Target Formations

The depths to oil target formations in the study area exceed a depth of 1,300 mbgl, and typical depths of hydraulic stimulation operations targeting gas formations occur at depths greater than 2,000 m bgl. The exposure pathways associated with injected hydraulic stimulation fluids are considered to include water supply bores screened either within the oil target formation itself, or in an aquifer formation immediately adjacent to the target formation.

2.2.3.1 Groundwater Extraction in the Eromanga Basin

Due to the depth (1,300 mbgl) and variable water quality of the oil target formations in the Eromanga Basin, and of the presence of shallower resources of suitable quality and yield, groundwater from the target formations is not typically used by the few pastoralists and residential users within the study area.

The following observations are made based on the proximity of water supply wells to oil and gas well locations in Volume One:

- The average offset between the base of the deepest (Hutton Sandstone) aquifer and the top of the Permian gas reservoirs is of the order of 200 to 300 m, with most of the intervening section consisting of impermeable mudstones and shales. However, landholder bores generally access the shallowest viable aquifer which, in the vicinity of the site, can be the shallow Glendower or Winton Formations. The vertical offset between these aquifers and the top of the gas-bearing Permian interval is of the order of 1,300 m to 1,800 m for the Glendower and 1,000 m to 1,500 m for the Winton.
- The active landholder bores in the oil fields of the *study area* range from approximately 3 to 10 km from the nearest proposed oil fracture stimulation target well. The upper-most formation proposed for hydraulic stimulation is the Wyandra Sandstone (Upper Cadna-Owie). The nearest bore, Mt Margaret No 14, targets the relatively shallow Winton formation for stock purposes. The vertical distance at this location between the Winton Formation and the Wyandra Sandstone is at least 750 m.
- The active landholder bores within, or near, the gas fields of the *study area* range from approximately 25 to 90 km away from the nearest proposed hydraulic stimulation location. The upper-most targets proposed for hydraulic stimulation are formations within the Nappamerri Group. The vertical distance between the Hooray Sandstone and the Nappamerri group at this location is greater than 600 m; and
- The Coothero Bore was observed during the WBBA, and according to DEHP, targets the Hooray Sandstone for stock water. The Coothero Bore is located approximately 44 km from the nearest proposed location for gas production, and more than 80 km from the nearest location proposed for oil production from the Hooray Sandstone.

Hence, based on the available information, it appears unlikely that a complete exposure pathway exists in the study area for hydraulic stimulation fluids to reach a water supply well.

2.2.3.2 Groundwater Extraction in the Cooper Basin

Due to the significant depth of the Cooper Basin aquifers, these have not been accessed for water supply and are only intercepted while targeting gas production. This is supported by WERD and DEHP Groundwater Databases and a recent Water Bore Baseline Assessment.

While no known water supply wells are completed within the Cooper Basin, although significantly separated, water supply development in the Eromanga Basin is considered as the next vertically closest aquifer in the study area (as discussed above). However, the important water supply aquifers of the Eromanga Basin are separated from the Cooper Basin reservoir formations by a major structural unconformity and basal aquitard units of the Eromanga Basin, and therefore, hydraulic connection is limited.

Based on the absence of water supply development in the Cooper Basin formations, and the limited hydraulic connectivity and significant vertical distance between the Cooper Basin and Eromanga Basin formations, the potential for a complete exposure pathway for either an environmental or water supply receptor is considered to be very low.

3.0 PRODUCT DESCRIPTION

This report specifically addresses the requirements of EA conditions related to the assessment of chemical constituents for the *Schlumberger YF140HTD 30Q N2* stimulation fluid, ThermaFRAC 40 stimulation fluid and Slickwater stimulation fluid. The report also considers a lesser volume of *32%HCL* also used during stimulation.

3.1 Chemical Constituents

A list of the individual hydraulic stimulation fluid chemicals considered in this risk assessment (52 in total) and their respective Chemical Abstracts Service Registry numbers (CAS RN) is provided in Table 4. This list is similar to, but will inevitably vary from, other published sources of hydraulic stimulation fluid compositions, as the specific hydraulic stimulation fluid mixtures are proprietary products of the hydraulic stimulation contractors and their product suppliers.

None of the stimulation fluid chemical constituents presented contained benzene, toluene, ethylbenzene, xylenes (BTEX) or polycyclic aromatic hydrocarbons (PAHs). It is noted, however, that total petroleum hydrocarbons (TPH), PAHs and BTEX occur naturally in conventional oil and gas condensate and it is possible that these chemicals may naturally be present in the reservoir groundwater used in the hydraulic stimulation process. In terms of the reaction by-products of these chemicals, none of the known reaction by-products are likely to exhibit higher toxicity than the parent compounds. However, it is recognised that geochemical the hazard assessment approach developed for assessment of hydraulic stimulation chemicals used herein has been refined since the initial assessment prepared by Golder in 2010. The refinements are summarised below and in the referred sections of this report:

- Assessment of terrestrial toxicity hazard was included in the assessments conducted after 2011.
- Since 2012 the assessment of aquatic toxicity has been updated and is described in more detail in Section 4.4 (Environmental Hazard Classes).
- The human health hazard assessment was refined in 2013 to reflect changes in NICNAS as described in Section 6.4 (New Hazard Assessment Approach – IMAP Framework).

At Santos' request, chemicals which have been previously assessed by Golder (of which there were 36 in total, refer Golder Report 127666004-018-R-Rev A) have been included herein. Seventeen of the 36 previously assessed chemicals were classified for hazard using the former environment hazard and human health approaches, with the remainder assessed using the refined approaches (described above). For this current report, the environment and human health hazard assessments have all been updated to the new method where applicable.

Table 4: Hydraulic Stimulation Chemicals Sorted into Organic and Inorganic

Chemical Type	Chemical Name	CAS RN
Organic (33)	Cholinium chloride	67-48-1
	Guar gum	9000-30-0
	Vinylidene chloride/methacrylate copolymer	25038-72-6
	Tetrasodium ethylene diamine tetra acetate	64-02-8
	Polyethylene glycol monolaurate	9005-64-5
	5-chloro-2-methyl-2h-isothiazolol-3-one	26172-55-4
	Propan-2-ol	67-63-0
	2-methyl-2h-isothizol-3-one	2682-20-4
	Sodium gluconate	527-07-1
	Polylactide resin	9051-89-2
	2,2,2"-nitrilotriethanol	102-71-6
	Polyethylene glycol monohexyl ether	31726-34-8
	Sodium glycolate (impurity)	2836-32-0

Chemical Type	Chemical Name	CAS RN
	Dicoco dimethyl quarternary ammonium chloride	61789-77-3
	Disodium ethylene diamine tetra acetate	139-33-3
	Trisodium ethylene diamine tetra acetate	150-38-9
	Trisodium nitriloacetate (impurity)	5064-31-3
	Cetylethylmorpholinium ethyl sulfate	78-21-7
	Ethanol	64-17-5
	Acrylamide, 2-acrylamido-2-ethylpropanesulfonic acid, sodium salt polymer	**38193-60-1**
	Alkyl (C12-16) dimethylbenzyl ammonium chloride	**68424-85-1**
	Butyl diglycol	**112-34-5**
	Decyldimethyl amine (impurity)	**1120-24-7**
	Decyl-dimethyl amine oxide	**2605-79-0**
	Fumaric Acid	**110-17-8**
	Hydroxypropyl cellulose	**9004-64-2**
	Pentaethylenehexamine	**4067-16-7**
	Sodium-carboxyl-methyl-hydroxyl-propyl guar	**68130-15-4**
	Tetraethylenepentamine	**112-57-2**
	Tetramethylammonium chloride	**75-57-0**
	Triethylenetetramine	**112-24-3**
	L-Glutamic Acid	**56-86-0**
	Octadecanoic acid calcium salt	**1592-23-0**
Inorganic (19)	Crystalline Silica, Quartz	14808-60-7
	Hydrochloric Acid	7647-01-0
	Sodium Hydroxide	1310-73-2
	Crystalline silica, cristobalite	14464-46-1
	Nitrogen, liquid form	7727-37-9
	Boric acid	10043-35-3
	Diatomaceous earth, calcined	91053-39-3
	Magnesium nitrate	10377-60-3
	Magnesium silicate hydrate (talc)	14807-96-6
	Magnesium chloride	7786-30-3
	Ceramic materials and wares, chemicals	66402-68-4
	Sodium bromate	7789-38-0
	Sodium thiosulphate	7772-98-7
	Non-crystaline silica	7631-86-9
	Potassium hydroxide	1310-58-3
	Sodium tetraborate	1330-43-4
	Silica gel	112926-00-8
	Hydrogen Peroxide (impurity)	**7722-84-1**
	Zirconium dichloride oxide	**7699-43-6**

Notes

Chemical names in bold indicate chemicals that have not been previously assessed by Golder.

3.2 Mass Balance Calculations

A quantitative mass balance assessment of hydraulic stimulation fluid components was undertaken based on the information provided by Schlumberger. Three fluids systems were provided by Schlumberger: *YF140HTD 30Q N2* with an acid spearhead, named *32%HCL*, *ThermaFRAC 40* and *Slickwater*. For the combined fluid mixtures, Schlumberger provided the total volume of each fluid, a list of individual chemical names and mass fraction (%) of each.

In a typical stimulation stage, approximately 930L of 32*%HCL* is used, while approximately 227,000L of *YF140HTD 30Q N2* is used. In a typical *ThermaFRAC 40* or *Slickwater* stimulation stage, approximately 2.6 ML of fluid is used for each stimulation system. However, each individual well stimulation stage is specifically designed and therefore, exact volumes of fluids will vary to suit the stimulation stage design.

For the combined fluid mixture, Schlumberger provided the total volume of each fluid, a list of individual chemical names and mass fraction (%) of each. The composition of the hydraulic stimulation fluids and calculated total mass and injected concentrations of the individual chemicals are summarised in Table D1, APPENDIX D. The fluid compositions in Table D1 were divided into chemical additives, proppants and water.

Mass and mass fraction calculations were based on information provided by the stimulation service provider in their “Stimulation Fluid Disclosure” (note that mass and volumes were provided in imperial units and were converted to SI units) (Appendix G) Table 5 presents the estimated mass of additives, proppant and water included in the stimulation fluid systems *per stimulation stage*. It is noted that up to 10 *stimulation stages* may be undertaken per gas production well.

Table 5: Indicative Component Mass per Stimulation Stage

Fluid System	32%HCL and YF140HTD 30Q N2	Slickwater	ThermaFRAC 40
Typical fluid Volume[1]	~ 228,027L	~ 2,649,500L	~ 2,649,500L
Additives	~ 52,423kg (~23 %)** N2 additive	~ 174 kg (~0.01 %)	105,085 kg (~3 %)
Proppant	~ 27,386 kg (~12 %)	~ 476,270 kg (~17 %)	344,726 kg (~13 %)
Water*	~ 148,218 kg (~65 %)	~ 2,173,000 kg (~82 %)	2,225,580 kg (~84 %)

Notes: Fluid volume per stimulation stage, as indicated in the stimulation service provider’s fluid disclosure. *Assuming that density of total typical fluid volume is 1 kg/l.

The additives for each of the hydraulic stimulation formulations comprises predominantly of water (65 – 84 %), with a secondary component consisting of proppant (12 – 17%) and a minor fraction which consists of additives (0.007 – 3%).

Following completion of the hydraulic stimulation process, a percentage fraction of the injected hydraulic stimulation fluids are recovered upon flowback. However, it should be noted that most of the additives would have undergone chemical transformations in the sub-surface. In addition the formation also contributes certain amount of water and dissolved salts to the flowback. Studies performed by the USEPA (2004) indicated that approximately 60% of the hydraulic stimulation fluid volume is recovered in the first three weeks. The volume of flowback is heavily dependent if the shales are considered to contain water or not. If it is conservatively assumed that 40% of the hydraulic stimulation fluid volume remains in the formation (reasonable “worst case”) this would correspond to 174 – 105,085 kg per stimulation stage; or 1740 – 1,050,850 kg per production well where up to ten stimulation stages are performed (excluding proppant).

4.0 AQUATIC HAZARD ASSESSMENT

An environmental hazard assessment was undertaken to classify the hydraulic stimulation chemicals based on persistence (P), bioaccumulation (B) and toxic (T) potential (hereafter referred to as PBT). Using PBT, hydraulic stimulation chemicals were classified into one of three hazard groups: low, moderate or high. Chemicals classified as high hazard were considered to be chemicals of potential concern (COPC). Identification of a chemical as a COPC did not indicate an unacceptable hazard, nor did it include an evaluation of whether there was a link between source, pathway, and receptor. A high hazard classification indicated the need to evaluate exposure to these chemicals in greater detail. A discussion of possible exposure pathways (to people and the environment) is presented earlier in Section 2.0 and a qualitative (in the absence of exposure concentrations) characterisation of risk is presented in Section 7.0.

The environmental hazard assessment approach developed for this study used national and international guidance for assessment of PBT in the risk assessment, classification, and regulation of chemicals. The guidance used is predominantly focussed on hazard to aquatic receptors. The available guidance for assessment of hazard to terrestrial receptors is somewhat limited. Consequently in the assessment of environmental hazard, aquatic and terrestrial toxicity were considered separately. This section presents the environmental hazard and includes assessment of toxicity to aquatic receptors. Section 5.0 presents the assessment of toxicity to terrestrial ecological receptors. Section 6.0 presents the human health toxicity assessment.

4.1 Chemical Information Sheets

In order to assess environmental hazard, readily available chemical and physical properties and aquatic ecotoxicological data were collated for the chemicals assessed. This information was compiled into a chemical information sheet for each chemical. The chemical information sheets are presented in APPENDIX F. The data used in the environmental hazard assessment of each chemical, are discussed in the following paragraphs.

4.1.1 Chemical and Physical Properties

Physical and chemical properties that affect the fate and behaviour of chemicals in the environment and that were used in the assessment of environmental P and B were obtained from the following sources in order of priority:

1) The Safety Datasheets (SDS) provided to Golder by Schlumberger (provided in APPENDIX C for reference).

2) Hazardous Substances Databank (HSDB), a toxicology database on the U.S. National Library of Medicine's Toxicology Data Network.

3) Modelled data from USEPA (2012) EPISUITE™ (Estimation Programs Interface Suite™ for Microsoft® Windows) modelling software (only when data were not available from the SDS or the HSDB); and

4) For data poor chemicals, an internet search for reputable agencies or researchers who may have published data.

USEPA (2012) EPISUITE™ software was developed by Syracuse Research Corporation (SRC) for the USEPA Office of Pollution Prevention and Toxics. EPISUITE™ provides a package of modelling software programs that can estimate physical/chemical, environmental fate and ecotoxicity data for organic chemicals. Inorganic chemicals should not be evaluated using EPISUITE™ because the estimation methods used are developed based on organic chemicals.

In using EPISUITE™, the following limitations for modelling organic chemicals are noted:

1) Chemicals that rapidly hydrolyse are unsuitable to be modelled namely, acid halides[2], isocyanates[3], sulphonyl chlorides[4], siloxanes[5], and alpha-chloro ethers. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

2) Data generated for organic salts may not be reliable, namely cationic salts of Group I, Group II, transition metals, Actinides, and Lanthanides. These should not be profiled because there are not adequate data in the estimation models databases to predict properties with confidence. Organic salts however of Sodium (Na), Potassium (K), and Ammonium (NH_4^+) may be evaluated reliably. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

3) Organo-metallic compounds should not be evaluated. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

4) Highly reactive compounds should not be modelled. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling; and

5) High molecular weight compounds with a molecular weight greater than 1000 should not be modelled. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

The EPISUITE™ estimation programs are simple to use, requiring only one input (e.g., CAS RN or SMILES notation[6]) from the user and a nomination of the program to be used based on the data required by the user. EPISUITE™ includes a database of chemical and physical properties, algorithms, and Quantitative Structure Activity Relationships (QSAR) models with which to estimate parameters. The following programs were used to generate physical and chemical data for this study:

- KOWWIN™ - octanol/water partition coefficient (K_{ow}).
- HENRYWIN™ - Henry's Law Constant.
- BIOWIN™ - Biodegradation rate.
- LEV3EPI™ - Fugacity model to estimate partitioning to soil air, water and sediment.
- KOCWIN™ - Soil organic carbon partition coefficient (K_{oc}); and
- BCFBAF™ - Bioconcentration factor.

4.1.2 Aquatic Toxicity Information

Acute and chronic aquatic ecotoxicological data were obtained from the following sources in order of priority:

1) Safety Data Sheets (SDS) provided to Golder under this contract.

2) USEPA (2012) ECOTOXicology Database Version 4.0.

3) Australasian Journal of Ecotoxicology; and

4) HSDB.

[2] Acid halides are organic compounds containing the group -COX where X is a halogen atom (e.g., fluorine, chlorine, bromine, iodine). The inherent reactivity of acid halides precludes their free existence in nature; all are made by synthetic processes.

[3] Isocyanates are salts or esters of isocyanic acid, they are nitrogen based and may be described as neutral derivatives of primary amines. Isocyanates are represented by the general formula RNCO where R typically represents an alkly (a monovalent radical, such as ethyl or propyl, having the general formula CnH2n +1) or aryl (an organic group derived from an aromatic hydrocarbon by removal of one hydrogen), but sometimes is linked to elements such as sulphur (S), silicon (Si), phosphorous (P), nitrogen (N), or the halogens (e.g., fluorine, chlorine, bromine, iodine).

[4] Sulfonyl chlorides have the general formula R-SO_2-Cl which hydrolyse readily and are reactive with alcohols and amines.

[5] Siloxanes may be organic or inorganic and are made up of silicon, oxygen, plus (usually) carbon and hydrogen. They have the structural unit R_2SiO, where R is an alkyl group, usually methyl.

[6] SMILES (**S**implified **M**olecular **I**nput **L**ine **E**ntry **S**ystem) string is a linear notation for chemical structures.

Where ecotoxicological data were not available for the chemicals of interest or a suitable surrogate, data were modelled using ECOSAR™ software version 1.11 dated July 2012. ECOSAR™ (which stands for Ecological Structure Activity Relationships) estimates the toxicity of chemicals to fish, aquatic invertebrates and microalgae in water. Toxic effect predictions are made using a set of QSARs models. QSARs predict the aquatic toxicity of untested chemicals based on their structural similarity to chemicals for which aquatic toxicity data are available. The toxicity data used to build the QSARs come from a database of publicly available and confidential data submitted to the US EPA New Chemicals Program. The QSARs used in ECOSAR™ correlate a compound's physicochemical properties and its aquatic toxicity within specific chemical classes, and applies rules for selecting the appropriate chemical class for the compound. ECOSAR™ generates acute (short-term) toxicity and, when available, chronic (long-term or delayed) toxicity.

In using ECOSAR™, the following limitations are noted:

1) ECOSAR™, is designed to be used by individuals with some knowledge of environmental toxicology and organic chemistry, it is not designed to be used by individuals without experience in these fields.

2) Inorganic chemicals (e.g., sodium chloride, and non-polar inorganics such as titanium dioxide) should not be evaluated using ECOSAR™. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

3) Organo-metallic chemicals[7] should not be evaluated using ECOSAR™. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

4) For chemicals that rapidly hydrolyse or highly reactive chemicals it is suggested that evaluations using ECOSAR™ should take into consideration the degradation products in addition to the parent compounds. As a general rule, where:

   - Half-life < 1 hour, an assessment of degradation products may be recommended.
   - Half-life = 1 hour – 14-days, an assessment of parent and degradation products may be recommended.
   - Half-life > 14-days, an assessment of the parent product may be recommended.

5) Complex salts[8] with a complex organic cation and anion are difficult to model using ECOSAR™. In cases such as these the anion, cation and dissociation products should be taken into consideration. Based on the individual compounds it should be modelled as a single compound (neutralized with both cation and anion attached) or as separate individual compounds (dissociated with no charge). No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling, either as compounds or as individual components.

6) Compounds with a molecular weight greater than 1,000 should not be evaluated using ECOSAR™. However, many polymers are made up of dimers, trimers and oligomers with a molecular weight of less than 1,000 and therefore the individual components could be assessed using the ECOSAR™ model separately. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling, either as compounds or as individual components.

7) The ECOSAR™ model does not have the ability to take into consideration molecular conformation, and therefore cannot distinguish between stereoisomers, optical isomers, tautomers, or specific conformations. This is important as three dimensional molecular properties or molecular conformation can be important as this relates to absorption, binding, and resulting toxicity potential of a chemical; and

[7] Organo-metalls are chemicals that contain carbon bonded to a metal species such as methyl mercury compounds.

[8] Complex salts such as potassium ferricyanide ($K_3Fe(CN)_6$) which consists of a complex ion that does not dissociate in solution, differ from simple inorganic salts such as sodium chloride (NaCl) that readily dissociates in solution.

8) Chemicals with unknown or variable composition (UVCs, such as oligomers, natural fats, or a product mixture) may have different results using ECOSAR™ depending on the composition assessed with the model. For chemicals such as these the representative structures would need to be identified and noted or all possible compositions would need to be assessed. No chemicals meeting this description in the list of hydraulic stimulation chemicals considered for this risk assessment were subject to modelling.

4.2 Hazard Versus Risk

The approach presented in the following paragraphs is an assessment of environmental hazard, rather than environmental risk. Risk assessment of chemicals in the environment is based on a comparison between the levels to which an organism in a particular environmental compartment (e.g. water) is exposed, and a maximum level which an organism can tolerate based on a defined exposure scenario (in an environmental compartment) without significant adverse effect. The environmental hazard assessment presented herein, is not a risk assessment *per se* because it does not consider likely exposure concentrations for most of the hydraulic stimulation chemicals. A qualitative assessment of the risk will be conducted based on an identification of relevant exposure pathways associated with the hydraulic stimulation fluid COPC.

Approaches to ranking or screening chemicals for the purposes of assessing relative “hazard” or “risk” can include likelihood and consequence matrices. In these matrices, a chemical may be scored high for consequence (which may be a function of PBT) but low for likelihood (which may be a function of whether the chemical is considered likely to be present in the environment at hazardous concentrations). Overall, such a chemical may then score a relatively lower hazard or risk than would be identified from its consequence (or PBT) score alone. The environmental hazard assessment approach here works on the premise of potential for PBT; that is, the data that may apply to “consequence”. “Likelihood” of exposure was assessed for fluid and flowback mixtures, not individual chemicals (refer section 2.0).

4.3 Hazard Assessment Approach

The environmental hazard assessment approach developed for this study is consistent with national and international guidance for assessment of potential for PBT in the risk assessment, classification, and regulation of chemicals. Physical and chemical properties that affect the fate and behaviour of chemicals in the environment (including degradation rates, partition coefficients, and aquatic ecotoxicological data) were used in assessment of environmental PBT potential.

The Australian National Framework for Chemicals Environmental Management (NChEM) guidance manuals were consulted in preparation of the environmental hazard assessment approach, namely:

- EPHC (2009a). Environmental Risk Assessment Guidance Manual for Industrial Chemicals; and
- EPHC (2009b). Environmental Risk Assessment Guidance Manual for Agricultural and Veterinary Chemicals.

These guidance manuals present the data requirements and methodology for assessment for environmental hazard and risk assessment of industrial and agriculture and veterinary chemicals, consistent with international best practice. NChEM guidance was prepared by the National Environment Protection and Heritage Council (EPHC) for the Department of the Environment, Water, Heritage and the Arts (DEWHA). DEWHA undertakes environmental risk assessments of industrial chemicals for the National Industrial Chemicals Notification and Assessment Scheme (NICNAS) and agricultural and veterinary chemicals for the Australian Pesticides and Veterinary Medicines Authority (APVMA).

In addition, the following literature was consulted for PBT assessment guidance:

- ANZECC and ARMCANZ (2000). Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, National Water Quality Management Strategy, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000.
- CCME (2008) Canadian Council of Ministers of the Environment, The National Classification System for Contaminated Sites (NCSCS) Guidance Document.
- Christensen et al. (2003) Assessment Tools under the New European Union Chemicals Policy.

- Environment Canada (2003) Existing Substances Branch Guidance Manual for the Categorization of Organic and Inorganic Substances on Canada's Domestic Substances List, Determining Persistence, Bioaccumulation Potential, and Inherent Toxicity to Non-human Organisms.
- European Commission (2003) Technical Guidance Document on Risk Assessment in support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances, Part II Chapter 3 Environmental Risk Assessment.
- ECETOC (2005) Risk Assessment of PBT Chemicals.
- Franke et al. (1994) The Assessment of Bioaccumulation.
- Langley (1993) Refining Exposure Assessment. In: The Health Risk Assessment and Management of Contaminated Sites. Proceeding of the Second National Workshop on the Health Risk Assessment and Management of Contaminated Sites.
- Swann et al. (1983) A rapid method for the estimation of the environmental parameters octanol/water partition coefficient, soil sorption constant, water to air ratio, and water solubility. Residue Reviews; and
- UNECE (2011) Globally Harmonised System (GHS) of Classification and Labelling of Chemicals. Revision 4. Part 4 Environmental Hazards and Annex 9 Guidance on hazards to the aquatic environment.

The above guidance is predominantly focussed on hazard to aquatic receptors. Guidance for assessment of hazard to terrestrial receptors is limited. The following sources were consulted in developing an approach for assessment of hazard to terrestrial receptors:

- European Commission (2003) Technical Guidance Document on Risk Assessment in support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances, Part II Chapter 3 Environmental Risk Assessment; and
- National Environment Protection Council (NEPC) (2013). National Environment Protection (Assessment of Site Contamination) Amendment Measure.

4.4 Environmental Hazard Classes

The environmental hazard assessment approach presented herein uses several lines of evidence (LOE) that were assessed in a weight of evidence (WOE) framework. Physical, chemical and toxicological parameters selected for assessment of potential for PBT were assigned values that equate to the following hazards:

- High Hazard
- Moderate Hazard; and
- Low Hazard

Golder has refined this approach on a variety of projects including for assessment of hydraulic stimulation chemicals. The specific refinements for stimulation fluid risk assessment are described in the paragraphs below and were implemented in stimulation fluid risk assessment prepared during and after 2012. The changes were made to increase the reliability and robustness of the assessment and entailed:

- Replacing chemical scoring with chemical classifications of low, moderate and high hazard. Hazard may be assigned using numeric or non-numeric approaches. Golder's experience using numeric indices is that greater sensitivity (than is possible) in the assessment of hazard is implied when generating statistical averages (e.g., to one or more decimal place). For example, using a numeric score of 1, 2, and 3 for low, moderate, and high hazard respectively for a variety of parameters, average scores of 1.7 or 2.2 may be calculated but do not reflect reality. These scores imply differences in hazard where none may be determined. Assessment of hazard via a non-numeric, descriptive approach avoids this implied sensitivity.

- Assessment of additional aquatic toxicity data and benchmarks to provide greater weight in the hazard assessment towards chronic aquatic toxicity in order to capture the available chronic effect data, which are frequently limited[9].
- Measured and predicted biodegradation studies[10] to capture the available biodegradation data. The previous approach was limited to a single study of anaerobic biodegradation in water for which data were often limited.
- Revision of the bioconcentration factor (BCF) benchmarks to better reflect the Australian guidance[11].
- A percentage calculation of data gaps in an individual chemical assessment as a measure of reliability.

At Santos' request, chemicals which had been previously assessed by Golder have been included herein. Some of the previously assessed chemicals were classified for hazard using the PBT approach in use prior to 2012, whereas others had been assessed using the refined PBT approach (described above) post-2012. For the current report, all chemicals were evaluated using the post 2012 methodology, which necessitated updating some previously assessed chemicals.

Hazard was assigned to individual parameters representative of P, B, or T. The LOE were used to assign an overall hazard classification (based on the WOE) for each chemical. There were no minimum data requirements (i.e. in some instances a hazard was evaluated on few data for each of P, B, or T). In order to quantify this uncertainty, a measure of data gaps was calculated for each chemical. In the assessment of T, the highest hazard assigned to either acute or chronic data was adopted as the final hazard classification for T. The approach for assessment of T differed from P and B because some chemicals have few aquatic ecotoxicological data. This resulted in weighting of the assessment towards T and is considered conservative and appropriate for a screening level risk assessment.

Not all the physical and chemical parameters collated for the hydraulic stimulation chemicals presented in the chemical information sheets (refer to APPENDIX F) were used in the environmental hazard assessment.

The hazard benchmarks set for this study are considered a relative assessment. The benchmarks were assigned with the intent of incorporating the precautionary principle(i.e., designed to be inherently conservative and therefore biased towards capturing, rather than rejecting chemicals that are likely to pose PBT hazard).

The individual hazards assigned to the respective benchmarks for each parameter are presented in Section 4.6.

4.5 Assessment of Organic Versus Inorganic Substances

The approach for the aquatic hazard assessment of inorganic and organic substances differs. The approach for the assessment of inorganic substances was devised based predominantly on guidance published by Environment Canada (2003). Following the Environment Canada (2003) approach, toxicity is considered in conjunction with persistence. The assessment of bioaccumulation potential of inorganic chemicals is more difficult to interpret in hazard assessment and was not included in the approach presented herein.

Non-metal-containing inorganic substances may be assessed following guidance for organic substances.

Justification for the hazard assigned to the individual parameters and the adopted ranges are discussed in the following section.

[9] The previous approach considered two assessments for each of chronic and acute toxicity. As acute toxicity data tends to predominate for data poor substances, the assessments were expanded to nine assessments (six for chronic studies, three for acute studies) to increase weighting towards chronic toxicity studies where data were available.

[10] Measured and predicted studies include: aerobic ready biodegradation, inherent aerobic biodegradadation, ultimate biodegradation, primary biodegradation, and anaerobic biodegradation.

[11] BCF benchmarks were revised from 30 and 100 to 1,000 and 5,000.

4.6 Environmental Hazard Assessment Parameters

The physical, chemical and aquatic ecotoxicological data collated and assessed in the aquatic environmental hazard assessment are presented in the chemical information sheets (refer to APPENDIX F) and summarised in Table 6 below.

Table 6: Physical, Chemical and Toxicological Parameters used in Environmental Hazard Assessment

PBT	Applicable to Organic / Inorganic Chemicals	Parameter	Units
Persistence	Inorganic / Organic	Solubility	mg/L
	Organic	Henry's Law constant	atm m^3/mol
	Organic	log K_{oc}	L/kg
	Organic	EPISUITE™ Ready biodegradability	Qualitative
	Organic	EPISUTE™ Ultimate Biodegradation (Biowin 3)	Qualitative
	Organic	EPISUTE™ Primary Biodegradation (Biowin 4)	Qualitative
	Organic	EPISUTE™ Anaerobic Biodegradation (Biowin 7)	Qualitative
Bioaccumulation	Organic	BCF	unitless
	Organic	log K_{ow}	unitless
Toxicity	Inorganic / Organic	Aquatic ecotoxicological data for: Plants Invertebrates Fish Acute L(E)C50 Chronic NOEC Chronic LOEC/MATC//EC50	mg/L

The following sections describe in more detail the parameters used, the benchmarks set, and the hazard assigned.

4.6.1 Data gaps

Where data were unavailable for a chemical, and/or data could not be modelled using EPISUITE™ the parameter was excluded from the environmental hazard assessment. An overall hazard was assigned for each of grouping for P, B and T based on the WOE (i.e., there were no minimum data requirements). In some instances a hazard was evaluated on few data for each of P, B, or T. Because of this it was necessary to quantify the extent of data gaps. This is expressed as a percentage in the PBT summary in Table D2 (APPENDIX D).

4.6.2 Surrogates

In the environmental hazard evaluation, consideration was given to the available environmental fate, persistence and toxicity information presented in the SDS. Where additional information was required to assess environmental hazard, data were sought for the appropriate chemical constituent namely, the active ingredient(s). Where data for active ingredients were unavailable, data for a suitable surrogate chemical were adopted. Surrogate chemicals were selected on the basis of structural similarity (or structure activity relationships, SAR), functional groups present, relevant precursors or breakdown products, data availability, and professional judgement. The approach taken assumes that the chemical and physical parameters of the surrogate are predominantly the same as the chemical in question. Use of surrogates is supported by relevant guidance (Environment Canada, 2003; NEPC, 1999; and UNECE, 2011) and is considered to be scientifically defensible.

Where chemicals were assessed using a surrogate, this is documented in this report for transparency. Where chemicals could not be assessed using a surrogate, a hazard value could not be assigned due to insufficient data.

4.6.3 Persistence

The approach for assessment of persistence for inorganic and organic chemicals differs.

Inorganic chemicals were assessed based on solubility, and solubility was considered in conjunction with toxicity.

Organic chemicals were assessed based on solubility, Henry's Law Constant, K_{oc}, and degradation rates.

4.6.3.1 Solubility

Aqueous solubility is measured in units of mg/L (or g/m^3) at temperatures of 20°C – 25°C. Aqueous solubility is temperature dependent. The solubility of a chemical will influence the rate of migration (or mobility) of that chemical in the environment. An increase in solubility leads to a decrease in adsorption to soil and greater mobility (Langley, 1993). Poor solubility may result in low bioavailability and lower biodegradation rates. A poorly soluble chemical may be considered to have a tendency to persist and therefore have more time to exert a toxic effect. Conversely, high solubility could also imply greater mobility, greater bioavailability and greater hazard. Solubility, rather than effective solubility[12], was adopted in this hazard assessment for simplicity. Effective solubility is a more accurate measure of chemical availability and mobility. However, effective solubility cannot be reliably predicted or modelled and is dependent on the chemical mixture and environmental factors (e.g. pH, temperature, oxidising or reducing conditions, etc.). Solubility is a conservative and simple measure of mobility and availability of a chemical in groundwater and hence was used in this hazard assessment.

Organic substances with low water solubility typically have high predicted bioaccumulation factors and / or high log K_{ow} and hence may be considered highly bioaccumulative unless there is evidence to suggest otherwise (Environment Canada, 2003).

Inorganic substances generally need to be dissolved in water to exert deleterious effects (to aquatic receptors) and consequently solubility should be considered in conjunction with aquatic toxicity, as recommended by Environment Canada (2003). Environment Canada (2003) recommends that when the solubility of the substance is greater than the acute toxicity, the substance is likely to pose a hazard. Herein, the lowest acute ecotoxicological endpoint obtained for the chemical of interest was used for data considered in assessment of toxic potential). Where solubility data were not found for the inorganic chemicals considered, solubility was assumed to be greater than acute toxicity. This is conservative and results in a high hazard classification.

Low solubility was signed a high hazard (based on likelihood of persistence and high bioaccumulation tendency) for organic chemicals. Conversely, low solubility was assigned a low hazard for inorganic chemicals. The hazard category benchmarks adopted in this study are summarised in Table 7 and Table 8 for organic and inorganic substances, respectively. These were derived based on professional judgement (noting that the UNECE (2009) consider a substance with a solubility of less than 1 mg/L to be poorly soluble).

Table 7: Solubility Benchmarks for Organic Substances

Hazard Category	Hazard Symbol	Solubility (mg/L)
High Hazard	●	<10
Moderate Hazard	◖	10 – 100
Low Hazard	○	>100

[12] Effective Solubility is the solubility of a compound that will dissolve from a chemical mixture (e.g., gasoline). The effective solubility of a compound from a chemical mixture is less than its aqueous solubility

Table 8: Solubility Benchmarks for Inorganic Substances

Hazard Category	Hazard Symbol	Solubility (mg/L)
High Hazard	●	>10
Moderate Hazard	◖	1 – 10
Low Hazard	O	<1

The benchmarks for the assessment of solubility in conjunction with aquatic toxicity for inorganic chemicals are presented in Table 9. The benchmarks were set following Environment Canada (2003). Because only two categories exist, a moderate hazard is not possible.

Table 9 Benchmarks for Solubility Considered in Conjunction with Acute Toxicity (Inorganic Substances)

Hazard Category	Hazard Symbol	Solubility & Toxicity (mg/L)
High Hazard	●	Solubility > Acute toxicity
Low Hazard	O	Solubility < Acute toxicity

4.6.3.2 Henry's Law Constant

Henry's Law is a partition coefficient which is a measure of the tendency of a substance to partition into air from water at constant temperature and pressure. It can be used as a measure of environmental fate and transport of a substance. Henry's Law Constant is calculated using vapour pressure, molecular weight and water solubility for a chemical and is commonly expressed either as 'dimensionless' (i.e., no units) or in 'dimensions' (i.e., units of atmospheres (atm) m^3/mol or Pa m^3 mol-1). Henry's Law Constant data were used in the environmental hazard assessment even though one of the parameters on which it is based (namely solubility) is assessed and scored separately.

Organic chemicals with a low Henry's Law Constant (i.e., low volatility and high solubility) are likely to be more persistent in the environment. Organic chemicals with a high Henry's Law Constant (i.e., high volatility, low water solubility) are likely to be less persistent in the environment. Organic chemicals with a low Henry's Law Constant were considered to present a greater environmental hazard in this assessment.

Henry's Law Constant benchmarks were assigned based on ranges provided in CCME (2008), Langley (1993) and professional judgement. The benchmarks are summarised in Table 10.

Inorganic chemicals were not assessed using Henry's Law Constant.

Table 10: Benchmarks for Henry's Law Constant

Hazard Category	Hazard Symbol	Henry's Law Constant (atm m3/mol)
High Hazard	●	$<6.1x10^{-09}$
Moderate Hazard	◖	$6.1x10^{-09}$- $6.1x10^{-05}$
Low Hazard	O	$>6.1x10^{-05}$

4.6.3.3 Soil Adsorption Partition Coefficient (K_{oc})

The soil organic carbon-water partitioning coefficient is the ratio of the mass of a chemical that is adsorbed in the soil per unit mass of organic carbon in the soil. It is a measure of the tendency for organic substances to be adsorbed by soil or sediment. K_{oc} values are useful in predicting the mobility of organic contaminants in soil and sediment. Higher K_{oc} values correlate to less mobile organic chemicals while lower K_{oc} values correlate to more mobile organic chemicals. Organic chemicals with lower mobility (greater persistence) are considered in this assessment to be a greater environmental hazard. The benchmarks for K_{oc} used are presented in Table 11. These benchmarks were derived after consideration of information provided in CCME (2008); Langley (1993) and Swann et al. (1983) and professional judgement.

Table 11: Log K_{oc} Benchmarks

Hazard Classification	Hazard Symbol	Log Koc Range (L/kg)
High	●	<3.7
Moderate	◖	2.7-3.7
Low	O	>2.7

4.6.3.4 Biodegradation

Degradation takes into account physical, biological, and chemical changes in a chemical over time (Langley, 1993). Biodegradation is "the process by which organic substances are decomposed by micro-organisms (mainly aerobic bacteria) into simpler substances such as carbon dioxide, water and ammonia" (UN, 1997 cited in OECD, 2010). The rate of biodegradation is generally described as percentage degradation over a period of days (28 days is often the benchmark), but sometimes longer or shorter exposure periods are reported. The longer the time taken for a substance to degrade, the more environmentally persistent that chemical is considered to be. Lower percentages of biodegradation over 28 days were considered to be indicative of higher environmental hazard.

The benchmarks assigned were based on guidance in Environment Canada (2003), UNECE (2011), the European Commission (2003) and professional judgement.

The following biodegradation data were sought:

- Aerobic Ready Biodegradability;
- Ultimate Biodegradation;
- Primary Biodegradation; and
- Anaerobic Biodegradation.

The use of more than one biodegradation measure was to capture appropriate measures of biodegradation for the likely environmental exposures to hydraulic stimulation chemicals. Summary details of the tests are described below.

i) **Aerobic Ready biodegradation**. The aerobic ready biodegradability test is considered a stringent test likely to generate slower degradation rates than may actually occur in the natural environment or in a sewage treatment plant. It employs a high concentration of the test chemical and biodegradation rates are measured via non-specific parameters such as dissolved organic carbon, biological oxygen demand, and carbon dioxide production. Ready biodegradability testing is commonly used as the first screen to test for biodegradation potential and employs the use of microorganisms that are not pre-adapted to degradation of the chemical substance. A negative result in a test for ready biodegradability does not necessarily mean that the chemical will not be degraded under relevant environmental conditions;

ii) **Anaerobic biodegradation**. Anaerobic biodegradation testing is a screening test to measure the potential for biodegradation under anoxic conditions. The test substance (the only source of added organic carbon in the test) is exposed to diluted anaerobically digested sludge. Biodegradability of the test substance is measured via increased headspace pressure resulting from the evolution of carbon dioxide, methane and total inorganic carbon. The test is performed at 35°C to simulate the temperature in heated digesters or anaerobic sludge treatment. This temperature favours anaerobic biodegradation of chemicals with low or moderate toxicity to anaerobic bacteria. On the other hand, because this test uses a high concentration of test substance, negative results may be observed for some chemicals that would otherwise be biodegradable at lower concentrations. Anaerobic biodegradation half-lives were sought on the basis that the groundwater environment is likely to be anaerobic;

iii) **Ultimate biodegradation**. Ultimate biodegradation[13] testing aims to measure the time taken for a test substance to biodegrade completely into simple molecules e.g. carbon dioxide, biomass, water and other inorganic substances like ammonia; and

iv) **Primary biodegradation**. Primary biodegradation[14] testing measures the disappearance of the compound as a result of its biotransformation to another product

A summary of the nominated aerobic ready biodegradation and anaerobic biodegradation benchmarks and the associated hazards assigned are presented in Table 12. These data were generated by EPISUTE™ BIOWIN™ and represent one of two potential outputs and hence a moderate hazard is not possible.

Table 12: Ready Aerobic and Anaerobic Biodegradation Benchmarks

Hazard Classification	Hazard Symbol	Aerobic Ready Biodegradability (EPISUITE™)	Anaerobic Biodegradation (EPISUITE™ BIOWIN 7)
High	●	No	≤0.5 Does not biodegrade fast
Low	○	Yes	≥0.5 Biodegrades fast

A summary of the nominated Ultimate Survey Biodegradation and Primary Biodegradation benchmarks and associated hazards are presented in Table 13. These data were generated using EPISUITE™ and BIOWIN™.

Table 13: Ultimate and Primary Biodegradation Benchmarks

Hazard Classification	Hazard Symbol	Ultimate Survey Biodegradability (EPISUITE™ BIOWIN 3)	Primary Biodegradation (EPISUITE™ BIOWIN 4)
High	●	<2 (2 equates to months, 1 equates to longer than months)	<2 (2 equates to months, 1 equates to longer than months)
Moderate	◖	2 – 3 (2 equates to months, 3 equates to weeks)	2-3 (2 equates to months, 3 equates to weeks)
Low	○	>3 (3 equates to weeks, 4 equates to days, 5 equates to hours)	>3 (3 equates to weeks, 4 equates to days, 5 equates to hours)

4.6.4 Bioaccumulation

Bioaccumulation potential was assessed for organic chemicals only and using two parameters: BCF and log K_{ow}, as discussed below.

Bioaccumulation was not assessed for inorganic chemicals because the bioaccumulation of inorganic chemicals is difficult to predict and was considered beyond a screening level risk assessment.

[13] Ultimate biodegradation is a measure of inherent biodegradability. Inherent biodegradability is similar to ready biodegradability testing with the exception that a low concentration of the test substance is used with a greater proportion of microorganisms that may be pre-adapted to the test substance. The conditions of an inherent biodegradation test are optimised to achieve rapid biodegradation. Inherent aerobic biodegradation data may over estimate the potential for biodegradation in the natural environment.

[14] Primary biodegradation is a measure of inherent biodegradability.

4.6.4.1 Octanol / Water Partition Coefficient (K_{ow})

The octanol-water partition coefficient (K_{ow}) is the ratio of the solubility of a chemical in octanol divided by its solubility in water. It is a measure of the preference for an organic substance to dissolve in an organic solvent or water and is used as a measure of lipophilicity and movement of a substance across a cell membrane. It is usually expressed as Log K_{ow}. It can be used to estimate environmental fate and transport of a chemical.

There is general consensus in the literature that a Log K_{ow} of less than 3.5 represents low or moderate potential to bioaccumulate, and a Log K_{ow} of greater than 3.5 represents an increased potential to bioaccumulate. UNECE (2009) consider that substances with Log K_{ow} less than 4 have no potential to bioaccumulate. UNECE (2009) and CCME (2008) consider that substances with Log K_{ow} greater than 4 have the potential to bioaccumulate. The European Commission (2003) consider that substances with Log K_{ow} greater than 4.5 have the potential to bioaccumulate. The benchmarks used in this study are summarised in Table 14 and were largely based on the classes provided by European Commission (2003), UNECE (2009), CCME (2008) and professional judgment.

Log K_{ow} is assessed for organic chemicals only.

Table 14: Log K_{ow} Benchmarks

Hazard Classification	Hazard Symbol	Log Kow (unitless)
High	●	>5
Moderate	◖	3-5
Low	O	<3

4.6.4.2 Bioconcentration Factor (BCF)

The bioconcentration factor (BCF) is a measure of the tendency for a substance in water to accumulate in organisms, in particular fish. This parameter is an important determinant for uptake into organisms, potential for biomagnification and secondary poisoning (food chain transfer to higher trophic levels). The higher the BCF, the greater the potential for bioconcentration and secondary poisoning. The benchmarks assigned are summarised in Table 15. These benchmarks were assigned after consideration of information provided in ANZECC and ARMCANZ (2000), Franke et al. (1994), European Commission (2003), UNECE (2009) and professional judgment. The benchmarks presented by Franke et al. (1994) were more conservative than those presented by ANZECC and ARMCANZ (2000), the European Commission (2003) and UNECE (2009). As ANZECC and ARMCANZ (2000), European Commission (2003) and UNECE (2011) guidance were prepared with significant peer review by international scientific experts in their development, these guidance frameworks were given precedence over Franke et al. (1994). BCF was assessed for organic chemicals only.

Table 15: BCF Benchmarks

Hazard Classification	Hazard Symbol	BCF (unitless)
High	●	>5000
Moderate	◖	1000 - 5000
Low	O	<1000

4.6.5 Toxicity

There were frequently insufficient data to enable an assessment of both acute and chronic toxicity hence the highest hazard assigned to either the acute and chronic data was adopted as the classification of hazard for toxic (T) potential for the hydraulic stimulation chemicals. This resulted in weighting of the assessment towards T. This was considered conservative and appropriate for a screening level hazard assessment.

4.6.5.1 Aquatic Ecotoxicology

To assess the toxic (T) potential of the chemicals, readily available acute (i.e., predominantly L(E)C_{50}[15]) and chronic (i.e., NOEC[16], LOEC[17], MATC[18] and non-lethal EC_{50}) data for aquatic organisms were collated.

Chronic aquatic ecotoxicology data are preferred over acute because exposure occurs over a longer time-period, usually during a significant period of the organism's life-cycle or during a sensitive life-stage. However, acute ecotoxicological data dominate in the literature compared to chronic data. Acute toxicity is relevant if the anticipated environmental exposure concentrations are in the acute toxicity concentration range. The receptor groupings considered (plants, invertebrates and fish) and endpoints considered (acute, chronic) were given equal weighting.

As freshwater aquatic organisms were considered the most likely aquatic receptor exposed to hydraulic stimulation chemicals albeit the likelihood for exposure is low (refer Section 2.0), freshwater ecotoxicological data were used in the assessment of toxic potential. There are generally few aquatic ecotoxicological data available for amphibians and reptiles, and no guidance was found in the international literature on the assessment of hazard for these receptor groups. Hence these receptors groups were excluded from the assessment of T.

The data obtained from USEPA ECOTOX database were screened as follows:

- Endpoints selected included mortality (acute), growth (chronic) and reproduction (chronic) for plants, invertebrates and fish;
- Chronic mortality exposures were not considered;
- Studies longer than 7 d were considered to be chronic (with the exception of microalgae);
- Studies shorter than 24 hrs were not considered; and
- L(E)C_x endpoints other than L(E)C_{50} were not considered (namely EC_0, EC_{100}, EC_{10}, EC_{20}, etc).

Although included in the environmental hazard assessment, NOECs are not statistical or empirical point estimates of ecological effect. NOECs are hypothesis-based and reflect the test design (i.e., concentrations of exposure) rather than the dose-response curve. However, NOECs are well documented in the literature and are commonly used in ecological risk assessment and in derivation of risk-based ecological guidelines. Additional chronic endpoints namely LOEC, MATC and EC_{50} were included in the hazard assessment to reduce the uncertainly associated with NOEC data.

Chronic data modelled using ECOSAR™ represent the geomean of NOEC and LOEC endpoints. Because the hazard assessment differentiated between NOEC and LOEC in assessment, these ECOSAR data were not used.

The chronic aquatic ecotoxicology ranges (for plants, invertebrates and fish) were assigned after consideration of information provided in European Commission (2003); UNECE (2009) and professional judgement. As a conservative approach to assessment of T, the lowest chronic effect concentration for each of NOEC, LOEC/MATC/EC_{50}, and the lowest acute effect concentration for L(E)C_{50} were used. The benchmarks adopted for chronic aquatic toxicological data are summarised in Table 16 and Table 17.

Table 16: Chronic Aquatic Toxicity NOEC Benchmarks

Hazard Classification	Hazard Symbol	Chronic Aquatic NOEC (mg/L)
High	●	<0.01
Moderate	◖	0.01 – 0.1
Low	○	>0.1

[15] Lethal (or effect) concentration that kills (or effects) 50% of the test population.

[16] No observed effect concentration.

[17] Lowest observed effect concentration.

[18] Maximum acceptable tolerable concentration.

Table 17: Chronic Aquatic Toxicity LOEC/MATC/EC50 Benchmarks

Hazard Classification	Hazard Symbol	Chronic Aquatic NOEC (mg/L)
High	●	<0.1
Moderate	◖	0.1 – 1
Low	○	>1

The acute aquatic ecotoxicity benchmarks (for plants, invertebrates and fish) were assigned after consideration of information provided in European Commission (2003); UNECE (2005) and professional judgement. The acute aquatic toxicity benchmarks are summarised in Table 18. The acute toxicity studies represent lethal endpoints.

Table 18: Acute Aquatic Toxicity L(E)C/50 Benchmarks

Hazard Classification	Hazard Symbol	Acute Aquatic L(E)C50 (mg/L)
High	●	<1
Moderate	◖	1 – 100
Low	○	>100

4.6.6 Environmental Hazard Classification

The environmental hazard classification assigned was based on the WOE for multiple LOE. The classifications were based on the available data, even if there were data gaps. Consequently a measure of data gaps was assigned to quantify this uncertainty.

It should be noted that T classifications for a number of chemicals were based on modelled, rather than measured data. The modelled ecotoxicological data were from ECOSAR™ (discussed in Section 4.1.2). There is uncertainty associated with modelled data. The twenty-three (23) chemicals for which modelled toxicological data were used are shown below in Table 19.

Table 19: List of Chemicals Assessed Using Modelled ECOSAR™ Data

Chemical	CAS RN
Surrogate for sodium gluconate	526-95-4
Surrogate for polylactide resin	50-21-5
Polyethylene glycol monohexyl ether	31726-34-8
Sodium glycolate	2836-32-0
Cetylethylmorpholinium ethyl sulphate	78-21-1
2,2’2”-nitrilotriethanol	102-71-6
Polyethylene glycol sorbitan monolaurate	9005-64-5
Dicoco dimethyl quarternary ammonium chloride	61789-77-3
Disodium ethylene diamine tetra acetate	139-33-3
Trisodium ethylene diamine tetra acetate	150-38-9
Tetrasodium ethylene diamine tetra acetate	64-02-8
Trisodium nitriloacetate	5064-31-3
5-chloro-2-methyl-2h-isothiazol-3-one	26172-55-4
2-methyl-2h-isothiazol-3-one	2682-20-4
Propan-2-ol	67-63-0
Alkyl (C12-C16) dimethylbenzyl ammonium chloride	68424-85-1
Decyldimethyl amine	1120-24-7
Decyl-dimethyl amine oxide	2605-79-0
L-Glutamic acid	56-86-0

Chemical	CAS RN
Pentaethylenehexamine	4067-16-7
Triethylenetetramine	112-24-3
Surrogate for acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	38193-60-1
Surrogate for hydroxpropyl cellulose	9004-64-2

Surrogate chemicals were used for chemicals where the physico-chemical and/or toxicological data were insufficient. The six (6) chemicals assessed using surrogates are presented in Table 20.

Table 20: List of Surrogate Chemicals

Chemical	CAS RN	Surrogate descriptor
1,1 DCE	75-35-4	Surrogate for Vinylidene chloride/methacrylate
Gluconic acid	526-95-4	Surrogate for sodium gluconate
Lactic Acid	50-21-5	Surrogate for polylactide resin
2-Acrylamido-2-methylpropanesulfonic acid	5165-97-9	Surrogate for acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer
Decanoic acid	57-11-4	Surrogate for octadecanoic acid, calcium salt
Hydroxypropyl methylcellulose	9004-65-3	Surrogate for hydroxypropyl cellulose

A further group of six (6) inorganic chemicals presented in Table 21 below were not assessed as these were considered to chemically equivalent to sand and / or chemically inert.

Table 21: Chemicals Equivalent to Sand and / or Chemically Inert

Chemical	CAS RN
Crystalline silica, quartz	14808-60-7
Crystalline silica, cristobalite	14464-46-1
Non-crystalline silica	7631-86-9
Surrogate for Ceramic materials and wares	1335-58-7
Diatomaceous earth	91053-39-3
Silica gel, pptd., cryst.-free	112926-00-8

Of the fifty-two (52) hydraulic stimulation chemicals assessed, forty-four (44) were classified for aquatic hazard. Of these forty-four (44) chemicals, twenty-two (22) were classified low hazard, fourteen (14) were classified moderate hazard, and eight (8) were classified high hazard. Of the remaining eight (8) chemicals, six (6) were not subject to PBT assessment as discussed earlier and presented in Table 21, while the remaining two, guar gum and sodium carboxymethylhydroxypropyl guar, are discussed below.

Guar gum and sodium carboxymethylhydroxypropyl guar, were not assessed for PBT as there were insufficient data to quantitatively assess persistence or bioaccumulation. However, the USEPA (2005) reviewed human and ecological hazards of hydroxypropoyl guar gum (a similar compound to carboxymethylhydroxypropyl guar and guar gum and considered likely to exhibit similar properties). Hydroxypropyl guar gum is used as a thickener in pesticide formulations. USEPA (2005) considered hydroxypropyl guar to be readily biodegradable and of low acute and chronic toxicity to aquatic and terrestrial organisms. On this basis, carboxymethylhydroxypropyl guar and guar gum are considered to be a low hazard to aquatic receptors.

Five chemicals, sodium hydroxide, hydrochloric acid, magnesium chloride, potassium hydroxide and magnesium nitrate were not scored for persistence as these chemicals readily dissociate in the environment.

The hydraulic stimulation chemical environmental hazard classifications of the forty-four (44) chemicals are summarised in Table 22, with the detailed PBT values for each chemical provided in Table D2, Appendix D.

Table 22: Hydraulic Stimulation Chemicals Environmental Hazard Classifications

Rank	Name For Report	CAS RN	Overall Hazard Classification	Data Gaps %
High	Dicoco dimethyl quarternary ammonium chloride	61789-77-3	●	39%
	Alkyl (C12-C16) dimethylbenzyl ammonium chloride	68424-85-1	●	39%
	Sodium tetraborate	1330-43-4	●	55%
	Nitrogen, liquid form	7727-37-9	●	55%
	Boric acid	10043-35-3	●	9%
	Magnesium silicate hydrate (talc)	14807-96-6	●	64%
	Hydrogen peroxide (impurity)	7722-84-1	●	27%
	Zirconium dichloride oxide	7699-43-6	●	64%
Moderate	Polyethylene glycol monohexyl ether	31726-34-8	◖	39%
	Cetylethylmorpholinium ethyl sulfate	78-21-7	◖	39%
	5-chloro-2-methyl-2h-isothiazolol-3-one	26172-55-4	◖	17%
	2-methyl-2h-isothizol-3-one	2682-20-4	◖	44%
	Decyldimethyl amine (impurity)	1120-24-7	◖	22%
	Decyl-dimethyl amine oxide	2605-79-0	◖	11%
	Pentaethylenehexamine	4067-16-7	◖	28%
	Tetramethylammonium chloride	75-57-0	◖	22%
	Ethanol	64-17-5	◖	22%
	Sodium hydroxide	1310-73-2	◖	64%
	Sodium thiosulfate	7772-98-7	◖	45%
	Potassium hydroxide	1310-58-3	◖	73%
	Magnesium chloride	7786-30-3	◖	64%
	Surrogate for Octadecanoic acid, calcium salt	57-11-4	◖	44%
Low	Cholinium chloride	67-48-1	○	28%
	2,2',2"-nitrilotriethanol	102-71-6	○	22%
	Sodium bromate	7789-38-0	○	82%
	Sodium glycolate (impurity)	2836-32-0	○	33%
	Disodium ethylene diamine tetra acetate	139-33-3	○	11%
	Trisodium ethylene diamine tetra acetate	150-38-9	○	50%
	Trisodium nitriloacetate (impurity)	5064-31-3	○	33%
	Surrogate for sodium gluconate	526-95-4	○	50%
	Surrogate for polylactide resin	9051-89-2	○	33%
	Tetrasodium ethylene diamine tetra acetate	64-02-8	○	39%

Rank	Name For Report	CAS RN	Overall Hazard Classification	Data Gaps %
	Polyethylene glycol sorbitan monolaurate	95005-64-5	O	44%
	Propan-2-ol	67-63-0	O	39%
	Butyl diglycol	112-34-5	O	33%
	Fumaric acid	110-17-8	O	39%
	L-glutamic acid	56-86-0	O	33%
	Tetraethylenepentamine	112-57-2	O	33%
	Triethylenetetramine	112-24-3	O	28%
	Hydrochloric acid	7647-01-0	O	64%
	Magnesium nitrate	10377-60-3	O	73%
	Surrogate for vinylidene chloride/methacrylate copolymer	75-35-4	O	22%
	Surrogate for acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	5165-97-9	O	28%
	Surrogate for hydroxypropyl cellulose	9004-65-3	O	50%

4.6.7 Identification of Chemicals of Potential Concern (COPC) to Aquatic Ecosystems

Based on the hazard classification of the individual hydraulic stimulation chemicals (as presented in Table 22), the eight chemicals classified as a high hazard were considered to be COPC, these were:

- Dicoco dimethyl quarternary ammonium chloride;
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride;
- Sodium tetraborate;
- Nitrogen, liquid form;
- Boric acid;
- Magnesium silicate hydrate (talc);
- Hydrogen peroxide (impurity); and
- Zirconium dichloride oxide.

The certainty of the hazard classification varies depending on the extent of data gaps and the reliance on modelled data. The percent of data gaps was calculated for all chemicals and is presented in Table 22. The percentage data gaps ranged from 9% to 82% for the chemicals assessed.

Of the eight high aquatic hazard chemicals identified in Table 22, the following further interpretations are provided:

- Only one (liquid nitrogen) chemical is expected to be in concentrations greater than 0.1% in a stimulation fluid mixture (as indicated by the fluid descriptions), and five of the high aquatic hazard chemicals (dicoco dimethyl quaternary ammonium chloride, sodium tetraborate, zirconium dichloride oxide, magnesium silicate hydrate (talc) and hydrogen peroxide (impurity)) are expected to be at concentrations less than 0.01%.

- Nitrogen is only a liquid at low temperature and pressure, conditions which will not prevail in the hydraulic stimulation fluid or at the drill pad. Nitrogen is a gas at atmospheric temperature and pressure. The extent that nitrogen will have reacted with other constituents in the hydraulic stimulation mixture before volatilisation, is not known. Mixtures and their assessment are discussed further in section 4.6.8.
- Boric acid, magnesium silicate hydrate (talc), hydrogen peroxide, zirconium dichloride oxide and sodium tetraborate are considered as high hazards in this assessment based primarily on persistence. Review and interpretation of the aquatic toxicity data suggest these five chemicals present a moderate to low aquatic toxicity hazard.
- Dicoco dimethyl quarternary ammonium chloride is considered a high hazard based primarily on its toxicity. The toxicity data available for this chemical is limited (only acute fish and invertebrate data available) however and review and interpretation of the persistence and bioaccumulation data suggest this chemical presents a moderate to low aquatic hazard in terms of P and B.
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride is considered a high hazard based on its high persistence and aquatic toxicity. As with dicoco dimethyl quarternary ammonium chloride, the toxicity data available for this chemical is limited, with only acute fish and plant data available.

Given the management controls in place to prevent releases to the environment, potential aquatic hazards from individual hydraulic stimulation chemicals, are considered unlikely to be realised.

4.6.8 Evaluation of Mixture Toxicity

It is noted that the EA requirements in (s) refer to the provision of "...assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation".

The environmental hazard assessment did not consider the combined effects of the hydraulic stimulation chemicals when present in a mixture. Assessment of mixtures is considered beyond the scope of a screening level assessment. Approaches for environmental risk assessment of individual chemicals are inherently conservative and designed to over-estimate risk as a precautionary approach and in recognition of the uncertainty surrounding effects of mixtures.

Methodologies for estimating combined effects of mixtures are being developed. There are two recognised models for joint action, these are:

- Predictive concentration addition; and
- Response addition.

Predictive concentration addition applies to mixtures of chemicals with the same mechanisms of action. That is, the toxic effect manifests in the same manner (e.g., narcosis) at the same location (e.g., central nervous system) for the different chemicals assessed.

Response addition applies to chemical mixtures with different mechanisms of action.

The majority of chemical mixtures (based predominantly on the research of mixture toxicity of organic chemicals) conform to concentration addition (NEPC, 2013). Warne (in NEPC, 2013) concluded following review of the literature on mixture toxicity that the concentration addition approach over-estimated toxicity (i.e., is more conservative) compared to response addition. This is consistent with opinion in the current, international literature where the approach for assessment of mixtures remains the concentration addition approach as a default, conservative position. Following this approach, the assessment of mixture effects in a risk assessment is concluded by summing hazard quotients (HQ) into a hazard index (HI).

The Australian national water quality management strategy (ANZECC & ARMCANZ, 2000) guidance recommends the use of direct toxicity assessment (DTA) for assessment of mixture impacts on the environment. Direct toxicity assessment (DTA) entails collection of an environmental sample containing the chemical mixture and undertaking ecotoxicological testing (exposing test organisms to the environmental sample and measuring effect).

Recent international reviews on mixture toxicity by Kortenkamp et al., (2009) and the European Commission (2012) have documented the current scientific knowledge and regulatory approaches for assessment of mixtures. These reviews acknowledge the constraints in assessing impacts from mixtures on the environment but do not offer new approaches for mixture assessment. Instead these reviews make recommendations for identified chemical mixtures (generally with widespread commercial and global usage) to be prioritised for risk assessment in order to better evaluate possible human and environmental health effects.

Given the limited, endorsed mixture toxicity assessment guidance for Australia or elsewhere, assessment of the hydraulic stimulation fluid mixtures by identification and assessment of the individual chemicals (based on the identified active ingredients or their surrogates) is considered conservative and appropriate for a screening level assessment. However, as the EA requires provision of "...*assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation"*, further assessment of hazards from the hydraulic stimulation fluid mixture is recommended. The scope of the mixture assessment should be confirmed with DEHP given the uncertainties, cost and timeframe implications associated with desktop studies (e.g., adoption of a hazard index approach) as opposed to laboratory-based studies (e.g., DTA testing).

4.7 Exclusions and Limitations

The environmental hazard assessment is a qualitative assessment of environmental hazard. The following limitations with regard to the hazard assessment and source data are noted:

- The approaches consulted for assessment of PBT in devising the environmental hazard assessment approach were predominantly focussed on the assessment of organic chemicals. There was limited guidance for PBT assessment of inorganic chemicals.
- The hazard assessment approach relied in part on professional judgment and the evaluator's subjectivity in designating the parameter ranges for each parameter assessed.
- The assessment did not consider, *inter alia*.
  - Breakdown or reactive products of the chemicals that may pose more or less of an environmental hazard than the parent compound.
  - The quality, adequacy or accuracy of the available information sourced, noting that only sources considered to be reputable were used.
  - Endocrine disruption effects that are not assessed by standard ecotoxicological tests.
  - The combined effects of these chemicals when present in mixture (see comments in Section 4.6.8 regarding mixture toxicity information).
- The environmental hazard assessment approach did not adequately assess chemicals which were:
  - Hydrophilic i.e., highly soluble with low K_{ow}. Where aquatic ecotoxicological data were limited for these types of chemicals, toxicity may be underestimated because there is potential for these chemicals to be highly toxic.
  - Poorly biodegradable, of low acute toxicity, but were bioaccumulative (based on the BCF or K_{ow}). These chemicals may exert chronic effects via accumulation in tissues over time.
- The data collated in the chemical information sheets (presented in APPENDIX F) were treated the same regardless of whether the data were measured experimental values or modelled / calculated values.
- It is noted in relation to the aquatic ecotoxicological data:
  - The species *Daphnia magna* are a sensitive species, displaying sensitivity to chemicals greater than other invertebrate species.

  - The test endpoint description in the (secondary) sources consulted was relied upon although it should be noted that true chronic and acute NOEC, LOEC, MATC and L(E)C50 depend on a variety of factors such as test duration, species tested, stage in the life-cycle, etc. which can only be verified by review of the primary literature.
  - Sources of Australian aquatic ecotoxicological data were consulted but the information was very limited. Furthermore, many species reported in the Australian literature were not necessarily indigenous species; and

- There were no minimum data requirements (i.e. some chemicals were assessed based on few data for each of P, B, or T). In order to quantify this uncertainty, a measure of data gaps expressed as a percentage is identified in Table 22.

5.0 TERRESTRIAL TOXICITY ASSESSMENT

The previous section presented the assessment of environmental hazard based on P, B and T, where the toxic (T) potential was limited to aquatic receptors. As the following terrestrial receptors (soil microorganisms, plants and animals (vertebrates and invertebrates)) are considered possible or likely receptors[19] that may come into contact with hydraulic stimulation fluid chemicals, an assessment of hazard to terrestrial receptors was developed in accordance with guidance presented in the following frameworks:

- European Commission (2003) Technical Guidance Document on Risk Assessment in support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances, Part II Chapter 3 Environmental Risk Assessment; and
- National Environment Protection Council (NEPC) (2013). National Environment Protection (Assessment of Site Contamination) Amendment Measure.

5.1 Methodology

The methodology for selection, collation and assessment of terrestrial toxicological data for the purposes of assessing potential hazard to terrestrial receptors from the stimulation fluid chemicals is described in the following paragraphs.

Note that the approach for assessment of hazard to terrestrial receptors differs from the assessment of hazard presented in Section 4.3. Collation of physico-chemical and toxicological data for PBT hazard assessment (as was done with the aquatic toxicological data) was not undertaken. The available physical, chemical, and toxicological data were not considered sufficiently robust for a PBT assessment. Consequently the COPC to terrestrial receptors were identified based on the terrestrial toxicological data. Physico-chemical data was then used to assess the likelihood for environmental exposure (discussed in Section 5.1.2 below). This approach results in a semi-quantitative or qualitative assessment of hazard to terrestrial receptors.

5.1.1 Terrestrial Toxicological Data Sources

Where terrestrial toxicological data are available, this may be limited to results from short-term tests using earthworms and plants, rather than (preferred) long-term test results (European Commission, 2003). Studies that assess effects on soil function are rarely available in the literature, and the potential for food chain transfer (e.g., secondary poisoning via bioaccumulation) is not assessed via ecotoxicological studies. This can pose challenges for development of soil screening criteria protective of terrestrial receptors. To address these data deficiencies, the approach developed was to use QSARs to predict toxicity (using aquatic data), and laboratory mammal toxicological data as lines of evidence to identify COPC for terrestrial receptors. This approach has been adopted in this report based on guidance in the European Commission (2003) and NEPC (2013). However, guidance on assessment of effects on soil function was not found during the preparation of this report.

The European Commission (2003) suggest that the equilibrium partitioning method can be applied to aquatic data to identify a probable no effect concentration (PNEC) for soil organisms. The equilibrium partitioning method uses aquatic toxicological data combined with chemical partitioning properties (between soil and water) and soil density to predict the toxicity to soil organisms. This method cannot replace toxicity data for soil organisms and should only be considered as a screen for identifying substances requiring further testing (EC, 2003). The Amended NEPM (NEPC 2013) similarly recommends the use of the equilibrium partitioning method only where QSARs are unavailable.

[19] Note that the exposure pathway assessment of this report (Section 7.0) lists the sources, pathways of exposure, and receptors that may come into contact with the hydraulic stimulation fluid chemicals.

The approach adopted was to draw from the large dataset of laboratory mammal (rat, mouse, and rabbit) toxicological data and use these animals as surrogates for the potential mammalian terrestrial receptors (e.g., livestock and native mammalian fauna) that may come in contact with stimulation fluid chemicals on or near to a well lease. It is acknowledged that these data are limited in application as they generally comprise acute (LC50) data for receptors that are not of direct interest for the possible stimulation fluid exposures involved. Moreover, toxicological data from laboratory mammals are unsuitable surrogates for other terrestrial receptors such as reptiles, birds, invertebrates and plants.

The following sections (5.1.1.1 to 5.1.1.2) list the sources of information and data used to collate and generate terrestrial toxicological data.

5.1.1.1 Toxicological Databases

Laboratory mammalian, earthworm, and plant data were sourced from readily available databases and literature. Acute oral LD50 laboratory data for rats, mice and rabbits were selected from sources such as the European Chemicals Bureau (ECB IUCLID), HSDB and USEPA ECOTOX. The studies used to generate laboratory mammal data are designed with the aim of assessing chemical hazard to human health. Consequently the relevance of these studies to Australian mammalian receptors is uncertain. Given the paucity of terrestrial toxicological data for the stimulation fluid chemicals on Australian fauna, rabbits and mice were considered as the best surrogates for mammalian receptors potentially present on well leases.

Earthworm data (e.g., from USEPA ECOTOX database) were used where the toxicological endpoint was mortality or reproduction and reported in units of milligrams of chemical per kilogram soil (mg/kg). Earthworm studies with other endpoints (e.g., behaviour) and/or units in other forms (e.g., micro-grams per cm^2) were not considered.

Similarly, plant data (e.g., from USEPA ECOTOX database) were used where the toxicological endpoint (e.g., NOEC) was reproduction or population (e.g., biomass or abundance) and reported in milligrams of chemical per kilogram of soil (mg/kg). Plant studies with other endpoints (e.g., foliar damage) and/or units in other forms (e.g., % or mg/mL of applied solution) were not considered.

5.1.1.2 QSARs

As indicated previously, QSARs are empirical relationships between the toxicity of contaminants to a particular test organism and one or more physicochemical properties of the contaminant (NEPC 2013). QSARs are derived for contaminants with either the same mechanism of action or similar molecular structure (NEPC 2013).

Three QSARs were used to derive additional terrestrial data for this report. NEPC (2013) reference the QSAR of Huzelbos et al. (1991) which predicts the concentration at which 50% growth inhibition (EC50, in units of micro-mol per litre) in lettuce (*Lactuca sativa*) would occur. The equation for the QSAR uses the chemical property log K_{ow} (described in Section 0 and recorded on the chemical information sheets). The QSAR equation of Huzelbos et al. (1991) is:

$$\log EC50 = -0.72 \log K_{ow} + 3.37$$

The Hulzelbos et al. (1991) QSAR was used to predict toxicity of organic chemicals to terrestrial plants, acknowledging that lettuce is not a native flora species, nor of relevance as receptor on a well lease. This QSAR provided the main dataset of terrestrial plant toxicity for the chemicals assessed. It could not be used for inorganic chemicals.

The second QSAR used was that of van Gestel (1992), which predicts the toxicity of earthworms (as the NOEC) in units of mg chemical per kg soil. This QSAR is referenced both by the European Commission (2003) and NEPC (2013) and uses equilibrium partitioning to predict the toxicity of a chemical in soil using aquatic toxicity data. It is not suitable for chemicals with a log K_{ow} greater than 4 or for chemicals with a specific mode of action (e.g., endocrine disruptors).

The van Gestel (1992) QSAR was used to predict the toxicity of organic chemicals to earthworms and uses soil density (RHO in kg soil per m^3 of soil) and the soil to water partitioning coefficient (K_d in m^3 water per m^3 soil), in combination with the NOEC (in mg/L) for the aquatic environment. The equation is:

$NOEC_{soil} = K_d/RHO_{soil} * NOEC_{water} * 1000$

The soil to water partitioning coefficient (K_d, m^3water/m^3soil) is a function of both the fraction organic carbon content (f_{oc} in kg organic carbon per kg of soil) of soil and the soil organic carbon partitioning coefficient (K_{oc} in L water per kg organic carbon), and the equation is:

$K_d = f_{oc} \times K_{oc}$

A f_{oc} of 0.01 and bulk density of 1.6 g/cm^3 for soil was assumed in the use of this QSAR.

The third QSAR used was that used in the ECOSAR™ modelling programme. The programme uses the log K_{ow} to estimate toxicity (14-day LC50) to earthworms in units of mg/L. The equation is:

Log 14-d LC50 (mmol/L) = - 0.1037 log K_{ow} + 0.4476

The programme converts the units from mmol/L to mg/L. ECOSAR™ was used to estimate the toxicity of the stimulation fluid chemicals to earthworms.

5.1.2 Use of Physico-chemical Data

Following guidance in NEPC (2013), the relative importance of an exposure pathway to a terrestrial receptor can be determined by assessment of the chemicals-specific properties, and the soil-specific properties that affect chemical bioavailability and environmental fate. Some physicochemical properties of chemicals, for example, partitioning between octanol and water (K_{ow}), partitioning from soil to water (K_d), and volatility (using Henry's law constant (K_H)), can be used to predict the most important exposure pathways for a chemical in terrestrial environments. Organic and inorganic chemicals have different physicochemical properties that control their environmental fate. Consequently, different methods apply to assessment of organic vs. inorganic chemical exposures in terrestrial environments.

The environmental fate of organic chemicals is largely controlled by the following physicochemical properties:

- Half-life (t ½), Table 23.
- Henry's Law Constant (K_H), Table 24; and
- The octanol-water partition coefficient (K_{ow}) which, in general, determines a chemicals potential to cause secondary poisoning.

5.1.2.1 Half-life

The half-life (t½) of a chemical is a measure of persistence (P) in the environment. It represents the time taken for 50% of the chemical to be lost from the environment. The loss may occur through biodegradation (microbial mediated degradation) or abiotic pathways (hydrolysis, oxidation, reduction, etc.). The more persistent a contaminant in the environment (that is, larger t½), the longer is the potential exposure time of species to the contaminant and the more deleterious the effects that could occur (NEPC 2013).
Table 23 (taken from NEPC 2013) provides benchmarks for assessment of persistence in terrestrial ecosystems using half-life.

Table 23: Half Life Benchmarks

Classification	T ½ (days)
Degrades Fast	<22.5
Degrades Moderately Fast	22.5 – 45
Degrades Slow	>45

5.1.2.2 Henry's Law Constant

Henry's law constant (K_H) is a measure of the volatility of a chemical. The higher the volatility (or value of K_H) the more of the contaminant will volatilise and be found in the soil air spaces and in the atmosphere. K_H is a temperature-dependent constant. Vapour transport for many contaminants may constitute an important pathway of loss and exposure to organisms (NEPC 2013). Together with half-life (t ½) of the chemical, K_H was used to assess the potential for transfer and persistence of the chemical in the soil.

NEPC (2013) have provided benchmarks for assessment of volatility of chemicals in terrestrial ecosystems. This is reproduced in Table 24 below.

Table 24: Henry's Law Constant Benchmarks

Classification	Henry's Law Constant (dimensionless)
Highly volatile (H)	>2.5 x 10^{-3}
Moderately volatile (M)	2.5 x 10^{-7} - 2.5 x 10^{-3} *
Not volatile (L)	< 2.5 x 10^{-7}

* It is noted that NEPC (2013) provides a range for moderately volatile of 2.5x10^{-7} to 2.5x10^{-5}, leaving two orders of magnitude (2.5x10^{-5} to 2.5x10^{-3}) unclassified. It was assumed that this was an error and the moderately volatile range has been extended from 2.5x10^{-5} to 2.5x10^{-3}.

5.1.2.3 Octanol-water Partition and Organic Carbon-water Coefficient

The octanol-water partition coefficient (K_{ow}) is the ratio of the concentration of a chemical that is dissolved in n-octanol to that dissolved in water at equilibrium and at a specified temperature. It is used to estimate the potential for chemicals to accumulate in tissue, both plant and animal (NEPC, 2013).

Chemicals with high log K_{ow} values are more likely to accumulate in plants and soil invertebrates than chemicals with low K_{ow} values. If further magnification of these chemicals occurs in the food chain, a predator might experience toxicity while its prey does not. This effect is known as secondary poisoning. Chemicals with log K_{ow} values below 3 were not considered to biomagnify. Chemicals with log K_{ow} values greater than 4 were considered to be highly fat soluble and lipophilic, and therefore posing the potential to biomagnify and result in secondary poisoning.

For the purpose of this report, and consistent with NEPC (2013), the log K_{ow} values of chemicals were divided into two classes. These were:

- Low, log K_{ow} <4: the chemical has a low potential to biomagnify.
- High, log K_{ow} ≥ 4: the chemical has a high potential to biomagnify.

5.1.3 Summary of Approach

In summary, toxicological data, as measured endpoints (e.g., LD50) or based on measurement data (e.g. PNEC) or as modelled data from QSAR were collated in a step-wise process. Figure 1 indicates that steps followed for the collection of terrestrial toxicological data.

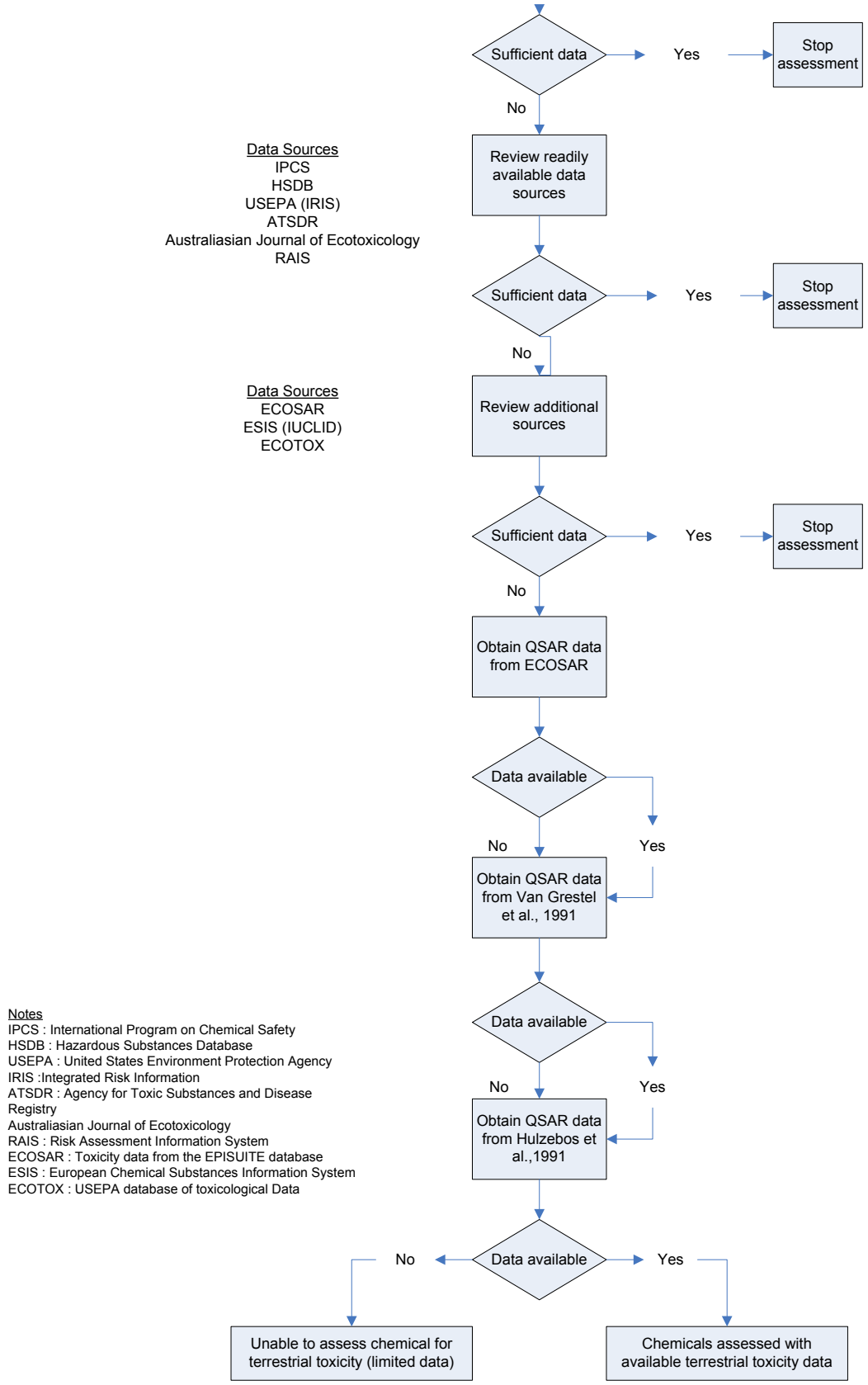

Figure 1: Approach Used for Collation and Generation of Terrestrial Toxicological Data

5.2 Results

Out of the fifty-two stimulation chemicals:

- seven chemicals were not assessed for terrestrial hazard due to insufficient data. These chemicals were liquid nitrogen, magnesium nitrate, magnesium silicate hydrate (talc), sodium thiosulfate, hydrogen peroxide (impurity), guar gum and sodium carboxymethylhydroxypropyl guar.
- six chemicals were not assessed because they were considered to be sand, (refer to Table 21 in Section 4.6.6), and
- thirty-nine were assessed for terrestrial hazard.

5.2.1 Mammalian Acute Oral LD50

Acute oral LC50 data for mammals were found for thirty (30) of the chemicals. The lowest LD50 values for rats, mice and rabbits were selected and are presented in Table 25.

5.2.2 QSAR Data

The lettuce QSAR of Huzelbos et al. (1991) was used to predict plant toxicity for thirty-one of the organic chemicals. The EC50 for this QSAR reports in micromole per litre, however, these units were converted to mg/L for ease of comparison. The results of this QSAR are also shown in Table 25.

The earthworm QSAR of van Gestel (1992) was used to predict soil invertebrate toxicity for twenty-seven organic chemicals. The results of this QSAR are also shown in Table 25.

The earthworm QSAR of the ECOSAR programme in EPISUITE was used to predict toxicity to earthworms of eighteen chemicals. The results of this QSAR are shown in Table 25.

5.2.3 Summary of Toxicological Data

A summary of the terrestrial toxicological data (including measured and modelled) collated is presented in Table 25 below.

Table 25: Summary of Terrestrial Toxicological Data

Chemical	CAS RN	Earthworm[4] (mg/L)	Lowest LD50 (mg/kg/bw)	Lettuce EC50[5] (mg/L)	Earthworm QSAR LC50[6] (mg/kg)
Choline chloride	*67-48-1*	1,340	3,400[1]	1.70E+05	5.11
Hydrochloric acid	*7647-01-0*		50[3]		
Sodium hydroxide	*1310-73-2*		140[1]		
Boric acid	*10043-35-3*		2,660[1]		
Surrogate for Vinylidene chloride/methacrylate	*75-35-4*	121	194[1]	6.65E+00	3.65
Tetrasodium ethylene diamine tetra acetate	*64-02-8*			2.71E+12	961
Polyethylene glycol sorbitan monolaurate	*9005-64-5*	261,000	18,000[1]	8.74E+04	5.25E+08
5-chloro-2-methyl-2h-isothiazolol-3-one	*26172-55-4*	278	481[2]	6.16E+02	0.0232
Magnesium chloride	*7786-30-3*		2,800[7]		
Propan-2-ol	*67-63-0*	158	3,600[1]	1.30E+02	9.68
2-methyl-2h-isothiazol-3-one	*2682-20-4*			1.07E+03	0.0053
Surrogate for sodium gluconate	526-95-4	8,584		1.02E+04	
Surrogate for polylactide resin	9051-89-2	2,948	1,810[1]	6.97E+02	3.56
2,2',2"-nitrilotriethanol	102-71-6		2,200[7]	1.84E+03	20.6

Chemical	CAS RN	Earthworm[4] (mg/L)	Lowest LD50 (mg/kg/bw)	Lettuce EC50[5] (mg/L)	Earthworm QSAR LC50[6] (mg/kg)
Polyethylene glycol monohexyl ether	31726-34-8	812		3.58E+02	0.0105
Sodium glycolate (impurity)	2836-32-0	2,750	6,700[1]	1.25E+06	219
Dicoco dimethyl quarternary ammonium chloride	61789-77-3	241		1.68E-02	6,680
Disodium ethylene diamine tetra acetate	139-33-3		400[1]	2.09E+11	5.41
Trisodium ethylene diamine tetra acetate	150-38-9		2,150[1]	2.47E+12	
Trisodium nitriloacetate (impurity)	5064-31-3		681[1]	1.13E+10	30.3
Cetylethylmorpholinium ethyl sulphate	78-21-7	299		3.94E-02	
Potassium hydroxide	1310-58-3		273[1]		
Alkyl (C12-C16) dimethylbenzyl ammonium chloride	68424-85-1	406	426[7]	1.32E+00	631
Butyl diglycol	112-34-5	424	2,000[1]	1.50E+02	389
Decyldimethyl amine (impurity)	1120-24-7			2.67E-01	0.0006
Decyl-dimethyl amine oxide	2605-79-0			1.04E+00	0.0004
Fumaric acid	110-17-8	3,212	9,300[1]	1.27E+02	38.9
L-Glutamic acid	56-86-0		2,300[1]	1.56E+05	0.0084
Pentaethylenehexamine	4067-16-7		1,600[7]	2.39E+05	1.73
Tetraethylenepentamine	112-57-2		2,100[1]	5.36E+03	52.3
Tetramethylammonium chloride	75-57-0	834	50[7]	2.63E+05	0.0002
Triethylenetetramine	112-24-3		1,600[7]	2.77E+04	1.77
Ethanol	64-17-5	134	5,600[1]	1.81E+02	0.172
Sodium bromate	7789-38-0		301[8]		
Sodium tetraborate	1330-43-4		2660[1]		
Zirconium dichloride oxide	7699-43-6		1,227[7]		
Surrogate for Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	5165-97-9		16,000[9]	7.16E+05	0.0625
Surrogate for Octadecanoic acid	57-11-4	1,196	4,600[1]	7.92E-04	53,200
Surrogate for Hydroxypropyl cellulose	9004-65-3	4,675		7.22E+06	

[1] Hazardous Substances Data Bank (HSBD) (2012).
[2] International Uniform Chemical Information Database (IUCLID) (2012).
[3] International Program for Chemical Safety (INCHEM)(2012).
[4] ECOSAR (2012)
[5] Huzelbos et al. (1991)
[6] van Gestel (1992)
[7] ChemIDplus (2013)
[8] QSAR Toolbox (2013)
[9] United States Environmental Protection Agency (USEPA) (2012)

5.3 Hazard Assessment

5.3.1 Toxicological Data

Examination of the data in Table 25 shows some consistencies and inconsistencies in findings between data sources for highest hazard chemicals. Tetramethylammonium chloride ranks highest for mammalian toxicity and the van Gestel (1992) earthworm QSAR model but does not rank in the top three for the Huzelbos et al (1991) lettuce QSAR or earthworm ECOSAR QSAR model. Surrogate for Vinylidene chloride/methacrylate copolymer ranks highest for the earthworm ECOSAR QSAR model and ranks in the top three for mammalian toxicity but does not rank in the top three for the other two models. Surrogate for Octadecanoic acid, calcium salt ranks highest for the Huzelbos et al. (1991) lettuce QSAR but does not rank in the top three for the other models. Decyldimethyl amine (impurity) ranks in the top three for the Huzelbos et al. (1991) lettuce QSAR and the van Gestel (1992) earthworm QSAR but does not rank in the top three for the other two models. Disodium ethylene diamine tetra acetate, Cetylethylmorpholinium ethyl sulphate, Propan-2-ol, decyl dimethyl amine oxide and ethanol appear only once in the top three ranks for each of mammalian toxicity, Huzelbos et al (1991) lettuce QSAR, earthworm ECOSAR QSAR and van Gestel 1992 earthworm QSAR models.

For the organic chemicals, for which the most data are available, the three most hazardous chemicals using the different techniques are shown in Table 26 below:

Table 26: Highest Hazard Organic Chemicals for Terrestrial Receptors Using the Different Datasets

Mammalian LD50 data	Lettuce QSAR (Huzelbos et al. 1991)	Earthworm QSAR (van Gestel 1992)	Earthworm QSAR (EPISUITE)
Tetramethylammonium chloride	Surrogate for Octadecanoic acid, calcium salt (Decanoic acid 57-11-4)	Tetramethylammonium chloride	*Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)*
Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)	Cetylethylmorpholinium ethyl sulphate	Decyl dimethyl amine oxide	Ethanol
Disodium ethylene diamine tetra acetate	Decyldimethyl amine (impurity)	Decyldimethyl amine (impurity)	Propan-2-ol

Chemical names in italics – indicate chemicals that were assessed using the pre-2012 PBT approach.

On the basis of Table 26, nine (9) organic chemicals: tetramethylammonium chloride, surrogate for ocatdecanoid acid, calcium salt, surrogate for vinylidene chloride/methacrylate, disodium ethylene diamine tetra acetate, cetylethylmorpholinium ethyl sulphate, propan-2-ol, decyl dimethyl amine oxide, decyldimethyl amine (impurity) and ethanol have the highest toxicity to terrestrial plants and invertebrates. These chemicals were assessed for persistence and bioaccumulation using the physico-chemical data described in Section 5.1.2 and is discussed further in Section 0.

Data for the inorganic chemicals were limited. The three QSARs could not be used. NEPC (2013) provides only limited discussion on how the environmental fate and persistence of inorganic substances should be assessed. Further assessment of the hazards of the inorganic chemicals to terrestrial receptors has not been undertaken. The three highest hazard inorganic chemicals ranked using the mammalian LD50 data are:

- Hydrochloric acid;
- Sodium hydroxide; and
- Potassium hydroxide.

5.3.2 Persistence and Bioaccumulation of the Organic Chemicals

The nine (9) high hazard organic chemicals identified in Section 5.3.1 were classified based on the half-life as described in Section 5.1.2.1. Surrogate for vinylidene chloride/methacrylate, and cetylethylmorpholinium ethyl sulphate, were shown to be the most persistent with the slowest half life. Tetramethylammonium chloride, surrogate for octadecanoic acid, calcium salt, decyldimethyl amine (impurity), decyldimethyl amine oxide and propan-2-ol were assessed to be moderately persistent. Disodium ethylene diamine tetra acetate and ethanol were the least persistent (Table 27).

Table 27: Soil Half-life (t ½) Classification for High Hazard Organic Chemicals

Chemical	CAS RN	Half-life in Soil (days)	Half-life in Soil (t ½) Classification
Tetramethylammonium chloride	75-57-0	30	Moderate
Surrogate for Octadecanoic acid, calcium salt (Decanoic acid 57-11-4)	1592-23-0	30	Moderate
Cetylethylmorpholinium ethyl sulphate	78-21-7	75	Slow
Decyldimethyl amine (impurity)	1120-24-7	30	Moderate
Decyldimethyl amine oxide	2605-79-0	30	Moderate
Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)	25038-72-6	75	Slow
Ethanol	64-17-5	17.3	Fast
Propan-2-ol	67-63-0	30	Moderate
Disodium ethylene diamine tetra acetate	139-33-3	17.3	Fast

The nine high hazard organic chemicals identified in section 5.3.1 were classified based on the Henry's Law constant benchmarks presented in Section 5.1.2.2; the results are summarised in Table 28. Tetramethylammonium chloride, cetylethylmorpholinium ethyl sulphate, decyldimethyl amine oxide and disodium ethylene diamine tetra acetate were classified as having low volatility, and are therefore considered likely to persist longer than the other organic chemicals. Surrogate for octadecanoic acid, calcium salt, ethanol and propan-2-ol were classified as moderately volatile. Decyldimethyl amine (impurity) and surrogate for vinylidene chloride/methacrylate was classified as having the highest volatility and are therefore the least persistent.

Table 28: Henry's Law Constant Classification for High Hazard Organic Chemicals

Chemical	CAS RN	Henry's Law (atm m^3/mol at 25°C)	Henry's Law (dimensionless)	Henry's Law Constant Classification
Tetramethylammonium chloride	75-57-0	4.20E-12	1.72E-11	Low volatility
Surrogate for Octadecanoic acid, calcium salt (Decanoic acid 57-11-4)	1592-23-0	4.67E-07	1.91E-06	Moderately volatility
Cetylethylmorpholinium ethyl sulphate	78-21-7	3.56E-16	1.46E-15	Low volatility
Decyldimethyl amine (impurity)	1120-24-7	4.68E-04	1.92E-03	Highly volatile
Decyldimethyl amine oxide	2605-79-0	3.67E-10	1.50E-09	Low volatility
Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)	25038-72-6	2.61E-02	1.07E-01	Highly volatile
Ethanol	64-17-5	5.00E-06	2.05E-05	Moderately volatile
Propan-2-ol	67-63-0	8.10E-06	3.32E-06	Moderately volatile
Disodium ethylene diamine tetra acetate	139-33-3	1.18E-23	4.84E-23	Low volatility

Based on the octanol-water partitioning coefficient classification in Section 5.1.2.3, surrogate for octadecanoic acid, calcium salt, cetylethylmorpholinium and decyldimethyl amine (impurity) were classified as high potential to biomagnify. The remaining six chemicals are considered to have low potential for biomagnification (refer to Table 29).

Table 29: Low K_{ow} Classification for High Hazard Chemicals

Chemical	CAS RN	Log Kow	Potential to Biomagnify
Tetramethylammonium chloride	75-57-0	-4.18	Low
Surrogate for Octadecanoic acid, calcium salt (Decanoic acid 57-11-4)	1592-23-0	8.23	High
Cetylethylmorpholinium ethyl sulphate	78-21-7	6.17	High
Decyldimethyl amine (impurity)	1120-24-7	4.46	High
Decyldimethyl amine oxide	2605-79-0	3.69	Low
Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)	25038-72-6	2.13	Low
Ethanol	64-17-5	-0.31	Low
Propan-2-ol	67-63-0	0.05	Low
Disodium ethylene diamine tetra acetate	139-33-3	-11.17	Low

5.3.3 Identification of Terrestrial Chemicals of Potential Concern (COPC)

Using the three physico-chemical measures in combination it was possible to identify the COPC to terrestrial receptors posing a potential high hazard (see Table 30).

Table 30: Henry's Law Constant Classification for High Hazard Organic Chemicals

Chemical	CAS RN	Half-life in Soil (t ½) Classification	Potential to Biomagnify	Henry's Law Constant Classification	Primary Exposure Route
Tetramethylammonium chloride	75-57-0	Moderate	Low	***Low volatility***	Direct toxicity
Surrogate for Octadecanoic acid, calcium salt (Decanoic acid 57-11-4)	1592-23-0	Moderate	***High***	Moderately volatile	Direct toxicity
Cetylethylmorpholinium ethyl sulphate	78-21-7	***Slow***	***High***	***Low volatility***	Direct toxicity
Decyldimethyl amine (impurity)	1120-24-7	Moderate	***High***	Highly volatile	Direct toxicity
Decyldimethyl amine oxide	2605-79-0	Moderate	Low	***Low volatility***	Direct toxicity
Surrogate for Vinylidene chloride/methacrylate (1,1 DCE 75-35-4)	25038-72-6	***Slow***	Low	Highly volatile	Direct toxicity
Ethanol	64-17-5	Fast	Low	Moderately volatile	Direct toxicity
Propan-2-ol	67-63-0	Moderate	Low	Moderately volatile	Direct toxicity
Disodium ethylene diamine tetra acetate	139-33-3	Fast	Low	***Low volatility***	Direct toxicity

Cells in bold, underline and italics = Classified as persistent or possessing a high potential to biomagnify.

The organic chemicals classified as high hazard in Section 0 were assessed according to their toxicological and physio-chemical properties. The following organic chemicals were assessed to have the potential to pose a higher environmental hazard relative to the other chemicals assessed based on persistence and potential to biomagnify:

- Cetylethylmorpholinium ethyl sulphate;
- Tetramethylammonium chloride;
- Surrogate for Octadecanoic acid, calcium salt;
- Decyldimethyl amine (impurity);
- Declydimethyl amine oxide;
- Surrogate for Vinylidene chloride/methacrylate; and
- Disodium ethylene diamine tetra acetate (impurity).

Of the seven high terrestrial hazard chemicals identified above, the following further interpretations are provided:

- Six of the seven chemicals are expected to be in concentrations less than 0.1% in a stimulation fluid mixture (as indicated by the fluid descriptions), with only one chemical (tetramethylammonium chloride) expected at concentrations up to 1%.
- Tetramethylammonium chloride, decyldimethyl amine oxide and disodium ethylene diamine tetra acetate have low volatility but they are not likely to persist in the terrestrial environment as illustrated by a moderate to rapid half-life and low potential to bioaccumulate.
- Surrogate for octadecanoic acid, calcium salt and decyldimethyl amine (impurity) both have a high potential to biomagnify but due to a moderate half-life and moderate to high volatility they are not likely to persist in the terrestrial environment.
- Surrogate for vinylidene chloride/methacrylate (1,1 DCE) has the potential to persist in the terrestrial environment due to a slow half-life however it has low potential to biomagnify and high volatility.

Given the management controls in place to prevent releases to the environment, potential terrestrial hazards from individual hydraulic stimulation chemicals, are considered unlikely to be realised.

5.4 Limitations and Uncertainties

The terrestrial environmental hazard assessment is a relative assessment and not a comprehensive evaluation of environmental hazards. The following limitations with regard to the terrestrial hazard assessment and source data were noted:

- Sources of Australian terrestrial ecotoxicological data were consulted but the information was limited. No terrestrial ecotoxicological data on the assessed chemicals were available for Australian birds, mammals, reptiles or flora.
- The terrestrial toxicological data used in this report do not include endpoints that assess effects on soil function or secondary poisoning via bioaccumulation in the food chain. Assessment of impacts via secondary poisoning has been assessed qualitatively from the chemical-specific physical and chemical data.
- The terrestrial toxicity assessment was largely based on modelled data of lettuce and earthworm that may not be receptors present in soil on well leases. Modelled data introduces greater uncertainty compared to use of measured data.
- The effects of exposure to the inorganic chemicals identified as posing a higher hazard relative to other chemicals could not be fully assessed.
- The terrestrial toxicity assessment identifies chemicals with the highest hazard relative to the chemicals assessed. Actual hazard is based on the exposure concentration and exposure scenario, as discussed in Section 2.0.
- Toxicological data were obtained for surrogates for a number of chemicals; and
- The data collated in the chemical information sheets (presented in APPENDIX F, where presented) were treated the same regardless of whether the data were measured experimental values or modelled / calculated values.

6.0 HUMAN HEALTH TOXICITY ASSESSMENT

6.1 Objective

As discussed in Section 4.2, the assessment of toxicity represents an assessment of hazard rather than risk for 52 the chemicals nominated by Santos as present in the Schlumberger stimulation fluids *YF140HTD 30Q N2*, ThermaFRAC 40 and Slickwater.

In terms of elements of the risk assessment process, the hazard assessment identifies a potential due to intrinsic properties of the chemical of interest, the exposure assessment provides information on the likelihood of the hazard being realised, and the risk characterisation provides a qualitative or semi-quantitative measure of the potential for the hazard to be realised.

The aim of the hazard assessment is therefore to provide a qualitative hazard ranking of chemicals based on human health toxicity and other hazardous endpoints to identify COPC. Further evaluation of the risk posed by the COPC is provided with an evaluation of exposure pathways. There are qualifiers related to the hazard ranking process. These are summarised in the concluding comments of each human health hazard profile presented in APPENDIX E.

The end result of the human health hazard assessment is to provide direction for the mitigation of environmental and occupational health hazards that have the potential to be realised. This may be achieved by suitable management measures or in some cases, additional investigations (e.g., sampling and analytical programs and further risk assessment).

The human health hazard ranking methodology used by Golder has evolved with changes in methodological approaches to chemical toxicity hazard ranking processes and hazard classification methodology. Golder initially devised a human health hazard ranking system in 2010. Since then a national chemical hazard ranking methodology has been introduced. In addition a large number of chemical hazard data and classifications have become available via the European Chemicals Agency. The ranking method used in the current report incorporates these updates, and has been used for each of the chemicals, as described in Section 6.4. Overall conclusions (Sections 7.0 and 8.0) for the three Schlumberger stimulation fluids are based on an assessment of all 52 chemicals.

6.2 Human Health Hazard Ranking

Human health hazard ranking may adopt a variety of approaches depending on the project or site-specific needs. A variety of hazard ranking or chemical screening methods are available in the published, peer-reviewed literature. Some of these methods are described in the following paragraphs.

Pennington and Bare (2001) described two methods developed by the US EPA: the Waste Minimisation Prioritization Tool (WMPT); and the Toxic Equivalency Potential (TEP). The WMPT examines screening in terms of key physical-chemical properties and includes measures for persistence, bioaccumulation and toxicity (PBT) that are calculated. Each PBT measure is scored to provide a single measure of relative concern. TEPs evaluate chemical fate, multi-pathway exposure and toxicity using a model-based approach. The TEP approach was considered by the authors to represent a less subjective and thus improved approach. TEPs are based on a generic version of CalTox - an integrated multimedia fate, multi-pathway exposure and toxicity model initially developed for human health risk assessments. The authors further stated that "*in typical applications and given the currently available transformation data, neither approach should be used to provide insights beyond a qualitative basis such as high, medium and low concern*" (p 910).

Pittinger et al. (2003) described seven discrete hazard and risk assessment tools and proposed a systematic framework to assist users in selecting the appropriate tool for a given application. The framework used a hazard-risk continuum with varying amount and specificity of data requirements. The continuum commenced with toxicity and physical-chemical properties on the hazard end, and progressed to site-specific risk assessment. Pittinger et al. (2003) discussed approaches from:

- The American Industrial Health Council (AIHC).
- European Risk Ranking Method (EURAM).
- US Chemical Hazard Evaluation for Management Strategies (CHEMS-1).

- US Risk Screening Environmental Indicators.
- US EPA Clusters Scoring System for particular tasks.
- Exposure, Fate Assessment Screening Tool (E-FAST) used in US EPA's New Chemicals Program; and
- The OECD's "Tools for R&D Screening" which is part of the OECD's Chemical Risk Management Program.

Logue et al. (2011) published an approach that used indoor air exposure data and air guidelines to rank 267 chemicals. Thirty-one chemicals were identified as posing hazards with nine as priority pollutants. Dunn (2009) presented an approach for a relative risk ranking of select substances on the Canadian National Pollutant Release Inventory using the CHEMS-1 model listed by Pittinger et al. (2003) discussed above.

OECD (2001) published an initial approach to a harmonised integrated classification system for human health and environmental hazards of chemical substances and mixtures, which was updated to a Globally Harmonised System of Classification and Labelling of Chemicals (GHS) in 2003, with subsequent updates in 2005, 2007, 2009 and then in 2011 (UNECE, 2011). These guidelines provide categorisation across ten toxicity parameters and provide specific guidance for separation into those categories based on available toxicological data. The approach ranks within the respective categories but not across the toxicological parameters.

While the paper by Dunn (2009) highlights the use of CHEMS-1 in the Canadian approach to the National Pollutant Release inventory, the model does not include some elements that have more recently been included in evaluations by agencies such as the US EPA Design for the Environment (DfE). DfE focuses on the principles of green chemistry and applies these principles to work towards the replacement of hazardous chemicals by safer chemicals and considers a broader range of variables.

Recent green chemistry initiatives such as "*The Green Screen for Safer Chemicals*" (Clean Production Organisation, 2009) provide comprehensive ranking approaches embodying health risk assessment principles with the objectives of achieving safer chemical use. These approaches integrate data and categorisations from the following environment agencies: US EPA, the European Union/Commission (EU), United Nations Economic Commission for Europe (UNECE) GHS, International Agency for Research on Cancer (IARC), and US National Toxicology Program (NTP) sources to establish Very High (VH), High (H), Moderate (M), and Low (L) categories. The basis of these evaluations is to produce an overall categorisation into four benchmarks with 'Benchmark 4' reflecting a preferred safer chemical – a "green" objective. While the green chemistry initiative objectives differ somewhat from the objectives of the hydraulic stimulation hazard ranking described in this report, the basis to the use of data reflects current approaches in hazard categorisation and includes toxicological parameters drawn from the UN GHS, IARC and other reputable sources. The hydraulic stimulation hazard approach also includes a consideration of endocrine disruptor potential and physical hazards such as explosive capability and flammability. The approach has been employed with suitable adjustments for human health hazard ranking of hydraulic stimulation chemicals. This is discussed in the following sections.

6.3 Human Health Hazard Assessment Parameters

A description of each parameter is provided below, along with the threshold values for each parameter as presented in the "*Green Screen for Safer Chemicals*". The threshold values for these parameters as presented in the "*Green Screen for Safer Chemicals*" are drawn from the following sources:

- EU's recently enacted chemicals policy legislation (Registration, Evaluation and Authorization of Chemicals–REACH) (EU 2006).
- UNECE (2011) Globally Harmonized System of Classification and Labelling of Chemicals (GHS). Fourth revised edition. United Nations, New York and Geneva.
- The International Agency for Research on Cancer (IARC) monographs on Carcinogens, available at http://monographs.iarc.fr.
- US Environmental Protection Agency, Design for Environment Program. (USEPA DfE) 2005a. Environmental Profiles of Chemical Flame-Retardant Alternatives for Low-Density Polyurethane Foam.

- US Department of Health and Human Services, Public Health Service, National Toxicology Program (US NTP). 2005. Report on Carcinogens, Eleventh Edition.
- State of California, Environmental Protection Agency, Office of Environmental Health Hazard Assessment. 2006. Chemicals Known to the State to Cause Cancer or Reproductive Toxicity.
- Japan Ministry of Environment. 1998. Endocrine Disrupting Chemicals Database, Table of Chemicals Suspected of Having Endocrine Disrupting Effects; and
- US Department of Labour Occupational Safety and Health Administration (OSHA) List of OSHA carcinogens.

6.3.1 Acute Toxicity

Acute toxicity refers to the occurrence of adverse effects following exposure to a single dose of a substance or multiple doses within a 24 hour period (OECD 2009). In toxicity studies acute effects are often characterised by lethality, commonly reported in lethal dose or concentration at which 50% of the animals tested die (LD50 or LC50). Non-lethal acute effects are sometimes included. Routes of administration commonly used are the oral, dermal and inhalation pathways. The threshold values for acute toxicity are presented in Table 31.

Table 31: Acute Toxicity (oral, dermal or inhalation) Threshold Values

High	Medium	Low
■ LD50 <50 mg/kg bodyweight (oral) ■ LD50 <200 mg/kg bodyweight (dermal) ■ LC50 <500 ppm (gas) ■ LC50 <2.0 mg/L (vapour) ■ LC50 <0.5 mg/L (dust or mist) ■ US EPA Extremely Hazardous Substance List ■ GHS Category 1 or 2	■ LD50 50-2000 mg/kg bodyweight (oral) ■ LD50 200-2000 mg/kg bodyweight (dermal) ■ LC50 500-5000 ppm (gas) ■ LC50 2-20 mg/L (vapour) ■ LC50 0.5-5 mg/L (dust or mist) ■ GHS Category 3 or 4	■ No basis for concern identified

6.3.2 Corrosion/Irritation of the Skin or Eye/s

Skin corrosion is the production of irreversible damage to the skin namely, visible necrosis through the epidermis and into the dermis following the application of a substance for up to four hours (OECD, 2009). Corrosion is often indicated by ulcers and bleeding and after 14 days discolouration of the skin, alopecia and scars. Skin irritation is the production of reversible damage to the skin following application of a substance (OECD, 2009).

Serious eye damage (i.e. corrosion) is indicated by tissue damage of the eye or serious physical decay of vision following application of the anterior surface of the eye which is not fully reversible within 21 days (OECD, 2009). Eye irritation is indicated by changes in the eye following application of the anterior surface of the eye which is fully reversible within 21 days (OECD, 2009).

The threshold values for corrosion/Irritation of the skin or eye are presented in Table 32.

Table 32: Corrosion/Irritation of the Skin or Eye Threshold

High	Medium	Low
■ Evidence of irreversible effects in studies of human populations ■ Weight of evidence of irreversible effects in animal studies ■ GHS Category 1 (skin or eye)	■ Evidence of reversible effects in humans or animals ■ GHS Category 2 or 3 — skin irritation ■ GHS Category 2A or 2B — eye	■ No basis for concern identified

6.3.3 Sensitisation of the Skin or Respiratory System

A respiratory sensitiser is a substance that will lead to hypersensitivity of the airways following inhalation of the substance (OECD, 2009). A skin sensitiser is a substance that will lead to an allergic response following skin contact (OECD 2009).

The threshold values for sensitisation of the skin or respiratory system are presented in Table 33.

Table 33: Sensitisation of the Skin or Respiratory System Threshold

High	Medium	Low
■ Evidence of adverse effects in humans; ■ Weight of evidence demonstrates potential for adverse effects in humans ■ GHS Category 1 – (skin or respiratory) ■ Positive responses in predictive Human Repeat ■ Insult Patch Tests (HRIPT) (skin)	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified

6.3.4 Carcinogenicity

A carcinogen is a substance or a mixture which induces cancer or increases its incidence. The classification of a substance or mixture as a carcinogenic hazard is based on its inherent properties and does not provide information on the level of human cancer risk which the use of a substance may represent (OECD, 2009).

The threshold values for carcinogenicity are presented in Table 34.

Table 34: Carcinogenicity Thresholds

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans ■ NTP known or reasonably anticipated to be human carcinogen ■ OSHA carcinogen ■ California Prop 65 ■ IARC Group 1 or 2A ■ EU Category 1 or 2 ■ GHS Category 1A or 1B	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity ■ IARC Group 2B ■ EU Category 3 ■ GHS Category 2	■ No basis for concern identified ■ IARC Group 3 or 4

6.3.5 Developmental Toxicity

Developmental toxicity refers to the *in utero* effects such as death, malformations, functional deficits and developmental delays (enHealth, 2004). It can also include delayed toxicity associated with epigenic effects during the sensitive phases of foetal development.

The threshold values for developmental toxicity are presented in Table 35.

Table 35: Developmental Toxicity Threshold

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans ■ NTP Centre for the Evaluation of Risks to Human Reproduction ■ California Prop 65	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified ■

6.3.6 Mutagenicity/Genotoxicity

Mutagenesis occurs when chemicals cause changes in the genetic material which can be transmitted during cell divisionThe OECD (2009) indicates a mutagen is a chemical that may cause mutations in the germ cells of humans that can be transmitted to the progeny. A mutation is defined as a permanent change in the amount or structure of the genetic material in a cell. The more general terms genotoxic and genotoxicity apply to agents or processes which alter the structure, information content or segregation of deoxyribonucleic acid (DNA) (OECD, 2009).

The threshold values for mutagenicity and genotoxicity are presented in Table 36.

Table 36: Mutagenicity/Genotoxicity Thresholds

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans ■ EU Category 1 or 2 ■ GHS Category 1A or 1B	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity ■ EU Category 3 ■ GHS Category 2	■ No basis for concern identified

6.3.7 Reproductive Toxicity

Reproductive toxicity includes adverse effects on sexual function and fertility in adult males and female as well as developmental toxicity in the offspring (OECD, 2009). This may include effects on mating behaviour, gonadal function, oestrous cycling, conception, implantation, parturition and lactation (Draft enHealth, 2010).

The threshold values for reproductive toxicology are presented in Table 37.

Table 37: Reproductive Toxicity Thresholds

High	Medium	Low
■ GHS Category 1A or 1B ■ EU Category 1 or 2 ■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans ■ NTP Centre for the Evaluation of Risks to Human Reproduction	■ GHS Category 2Suggestive animal studies of adverse effects ■ EU Category 3 ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified

6.3.8 Neurotoxicity

Neurotoxicity refers to any adverse effects on the structure or functional integrity of the developing or adult nervous system. Neurotoxic effects may involve a spectrum of biochemical, morphological, behavioural, and physiological abnormalities whose onset can vary from immediate to delayed following exposure to a toxic substance, and whose duration may be transient or persistent (US Department of Food and Drug Administration, 2000).

The threshold values for neurotoxicity are presented in Table 38.

Table 38: Neurotoxicity Thresholds

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified

6.3.9 Endocrine Disruption

Endocrine disruptors are chemicals that may interfere with the body's endocrine system and produce adverse developmental, reproductive, neurological, and immune effects (OECD, 2009).

The threshold values for endocrine disruption are presented in Table 39.

Table 39: Endocrine Disruption Thresholds

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates that mechanisms of action lead to adverse effects	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity ■ EU Draft List - Category 1 or 2 ■ Japanese list	■ No basis for concern identified

6.3.10 Systemic Toxicity/Organ Effects

This relates to substances that produce specific non- lethal organ toxicity arising either from a single or repeated dose. All significant health effects that can impair function, reversible and irreversible, immediate and/or delayed are included (OECD, 2009).

The threshold values for systemic toxicity / organ effects are presented in Table 40.

Table 40: Systemic Toxicity Thresholds

High	Medium	Low
■ GHS Category 1 — organ/systemic toxicity following single or repeated exposure ■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans	■ GHS Category 2 or 3 single exposure ■ Category 2 repeated exposure ■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified

6.3.11 Immune System Effects

The threshold values for immune system effects are presented in Table 41.

Table 41: Immune System Effect Thresholds

High	Medium	Low
■ Evidence of adverse effects in humans ■ Weight of evidence demonstrates potential for adverse effects in humans	■ Suggestive animal studies of adverse effects ■ Analogue data ■ Chemical class known to produce toxicity	■ No basis for concern identified

6.3.12 Explosive Potential

An explosive substance is a solid or liquid which is capable by chemical reaction of producing gas at such high temperature and pressure and at such a speed as to cause damage to the surroundings (OECD, 2009).

The threshold values for explosive potential effects are presented in Table 42.

Table 42: Explosive Potential Threshold Values

High	Medium	Low
■ GHS Category: Unstable Explosives or Divisions 1.1, 1.2 or 1.3	■ GHS Category: Divisions 1.4, 1.5	■ No basis for concern identified

6.3.13 Flammable Potential

A flammable liquid has a flash point of not more than 93˚C (OECD, 2009). A flammable solid is readily combustible or may cause or contribute to fire through friction. A readily combustible solid is a powdered, granular or pasty substance which is dangerous if it can be ignited by brief contact with an ignition source and the flame spreads rapidly (OECD, 2009).

The threshold values for flammable potential effects are presented in Table 43.

Table 43: Flammable Potential Thresholds

High	Medium	Low
■ GHS Category 1 - Flammable Gases ■ GHS Category 1 - Flammable Aerosols ■ GHS Category 1 or 2 — Flammable Liquids	■ GHS Category 2- Flammable Gases ■ GHS Category 2- Flammable Aerosols ■ GHS Category 3 or 4 — Flammable Liquids	■ No basis for concern identified

6.4 Hazard Assessment Approach (IMAP Framework)

Each of the 52 chemicals present in the three Schlumberger stimulation fluids assessed in this report have been assessed using the methodology based on the Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework recently published by the National Industrial Chemicals Notification and Assessment Scheme (NICNAS, 2013).

This framework has been designed to enable prioritisation of chemicals by hazard, exposure and use in the community for the purposes of national chemical assessment programs. This involves hazard bands, exposure bands and five broad categories: cosmetic, domestic, commercial, site-limited and non-industrial. The exposure assessment considers volumes and uses multipliers in conjunction with the hazard assessment to provide the risk characterisation for prioritisation and subsequent national assessment of the chemical. Integral to this process is review of international classifications and assessments following the prioritisation process with further increasingly detailed Tier I, Tier II and Tier III assessments.

The IMAP Framework for hazard assessment uses a hierarchy of indicators developed and agreed by the Human Health Expert Working Group (HHEWG) which reflects the following weighting:

- Carcinogenicity, Genotoxicity, Reproductive/developmental toxicity, Endocrine disruption, Neurotoxicity
- Acute toxicity
- Repeat dose toxicity
- Sensitisation
- Irritation.

This facilitates a Hazard Banding which is structured across five bands from Hazard Band 4 (highest) to Hazard Band 0 (lowest). The approaches employed within the IMAP framework adopt global harmonisation practices for classification and labelling of chemicals with assessment thresholds.

Table 44 summarises the classification of the 52 stimulation chemicals for human health hazard.

Of the 52*[20] Chemicals assessed:

- 8 were ranked as non-hazardous (Hazard Rank 0)
- 8 were ranked as low hazard (Hazard Rank 1)
- 1 was ranked as medium hazard (Hazard Rank 2)
- 28 were ranked as high hazard (Hazard Rank 3)
- 7 were ranked as very high hazard (Hazard Rank 4).

Of the seven substances that were classified as IMAP Hazard Rank 4, crystalline silica (quartz) has the highest concentration of up to 1% in a stimulation fluid mixture (as indicated by the fluid disclosures). Note that the carcinogenicity of this substance is via the inhalation pathway which is not considered to be relevant when the substance is present within the fluid mixture. The remaining six Hazard Rank 4 substances (ethanol, crystalline silica (cristobalite), diatomaceous earth, boric acid, sodium bromate and sodium tetraborate) are expected to be at concentrations of less than 0.1%.

[20] Note that 5-chloro-2-methyl4-isothiazolol-3-one and 2-methyl-4-isothizol-3-one classified together

Table 44: Summary of Human Health Hazard Classification and Potential Outcomes (as per the IMAP Framework Ranking Approach)

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Cholinium Chloride	67-48-1	1	Readily dissociates / dilutes in water.	Mild skin irritant effects.
Guar Gum	9000-30-0	3	Insoluble in water. Unlikely to bioaccumulate.	Classified as a respiratory sensitiser, mildly irritating to the skin
Poly(vinylidene chloride-co-methyl acrylate)	25038-72-6	1	Insoluble in water. Physiochemical properties are not readily available.	Potential respiratory tract and skin irritant.
Tetrasodium ethylene diamine tetra acetate	64-02-8	3	Dilutes in water. Binds to metal substances. Unlikely to bioaccumulate.	Serious eye irritation (irreversible eye damage)
Polyethylene glycol monolaurate	9005-64-5	1	Physiochemical properties are not readily available.	Mild skin irritation
5-chloro-2-methyl-4-isothiazolol-3-one	26172-55-4	3	Rapid metabolisation. Does not bioaccumulate in tissues.	Acutely toxic (corrosive when ingested), skin sensitiser, serious eye damage/irritation, skin corrosion/irritation.
2-methyl-4-isothizol-3-one	2682-20-4			
Propan-2-ol	67-63-0	1	Miscible in water and is chemically stable.	Irritation of the eyes and the respiratory tract and acute toxicity
Sodium glucolate	527-07-1	0	Dilutes in water. Likely to be biodegradable, unlikely to bioaccumulate.	Non hazardous substance.
Polylactide resin	9051-89-2	1	Dispersible in water. Likely to be biodegradable, unlikely to bioaccumulate.	Can be an irritant to skin and eyes.
2,2,2,-nitrilotriethanol	102-71-6	2	Readily dissociates / dilutes in water.	Potential local effects (irritation) in the respiratory tract, skin sensitisation.

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Polyethylene glycol monohexyl ether	31726-34-8	3	Readily dissociates / dilutes in water. Environmental distribution and adverse outcomes anticipated to be negligible.	Respiratory tract and skin irritant. Serious eye damage.
Sodium glycolate (impurity)	2836-32-0	3	Readily dissociates to Glycolic acid which is soluble in water	Severe skin burns and eye damage. Irritation of the respiratory tract.
Dicoco dimethyl quaternary ammonium chloride	61789-77-3	3	Dilutes in water. Likely to be biodegradable, unlikely to bioaccumulate.	Severe skin burns and eye damage.
Disodium ethylenediamine tetra acetate	139-33-3	3	Soluble in water and doesn't adsorb strongly to soil and sediments. Not readily biodegradable but can biodegrade under certain conditions.	Mild irritation of the skin and severe irritation of the eye.
Trisodium ethylenediaminetetraacetate	150-38-9	3	Dilutes in water. Binds to metal substances. Unlikely to bioaccumulate.	Serious eye irritation (irreversible eye damage). Causes skin irritation and may cause respiratory irritation. Harmful if swallowed or inhaled.
Trisodium nitrilotriacetate	5064-31-3	3	Dilutes in water. Binds to metal substances. Unlikely to bioaccumulate.	Serious eye irritation (irreversible eye damage). Harmful if swallowed.
Cetylethylmorpholinium ethyl sulphate	78-21-7	3	Dilutes in water. Likely to be biodegradable, unlikely to bioaccumulate.	Serious eye irritation (irreversible eye damage).
Ethanol	64-17-5	4	Fully water miscible at ambient temperatures. degradation characteristics preclude sustained environmental persistence and distribution.	Group 1 Carcinogen. Systemic and organ toxicity, mutagenic, developmental and reproductive effects and cancer at various sites following sustained repeated ingestion.

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Surrogate for Acrylamide, 2-acrylamido-2-ethylpropanesulfonic acid, sodium salt polymer (2-Acrylamido-2-methylpropane sulfonic acid)	5165-97-9, surrogate for 35641-59-9	1	Dilutes in water. Unlikely to be biodegradable.	Skin irritant effects.
Alkyl (C12-16) dimethylbenzyl ammonium chloride	68424-85-1	3	Dilutes in water. Limited aqueous microbial degradation, potential for persistence and distruibution.	Severe skin burns and eye damage (corrosive – irreversible effects).
Butyl diglycol	112-34-5	3	Dilutes in water, evaporates slowly. Highly mobile in soil. Exists only as vapour in the atmosphere and is biodegradable in aerobic environments.	Severe eye irritation. It has a low order of acute oral toxicity but moderate chronic toxicity following inhalation.
Decyldimethyl amine (impurity)	1120-24-7	3	High volatilisation potential. Dilutes in water. Expected to undergo rapid degradation in agueous systems. Environmental persistence / distribution not expected.	Severe skin burns and eye damage (corrosive – irreversible effects). Harmful if swallowed.
Decyl-dimethyl amine oxide	2605-79-0	3	Low volatilisation potential. Dilutes in water. Expected to undergo rapid degradation in agueous systems. Environmental persistence / distribution not expected.	Eye irritant effects (corrosive – irreversible effects).
Fumaric Acid	110-17-8	1	Readily dissociates / dilutes in water.	Eye irritant effects (reversible).
Hydroxypropyl cellulose (Hydroxypropyl methylcellulose used as a surrgote; CAS #9004-65-3)	9004-64-2	0	Readily dissociates / dilutes in water.	Non hazardous substance.

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Pentaethylenehexamine	4067-16-7	3	Readily dissociates / dilutes in water.	Severe skin burns and serious eye damage (corrosive – irreversible effects). Harmful if swallowed or when in contact with skin. May cause an allergic skin reaction.
Sodium-carboxyl-methyl-hydroxyl-propyl guar	68130-15-4	3	Dilutes in water. Likely to be biodegradable, unlikely to bioaccumulate.	Respiratory effects (asthma). Skin and eye irritant effects
Tetraethylenepentamine	112-57-2	3	Dilutes in water. Likely to be biodegradable. Exists in vapour and particulate phases if released to atmosphere.	Severe skin burns and serious eye damage. May cause an allergic skin reaction and respiratory tract irritation. Harmful if swallowed or whenin contact with the skin (acute toxicity) with repeat dose studies demonstrating oral and dermal effects.
Tetramethylammonium chloride	75-57-0	3	Dilutes in water. Not readily biodegradable. Exists in vapour and particulate phases if released to atmosphere. High mobility if released to soil.	Acute toxicity – fatal if swallowed. Toxic when in contact with the skin. Skin irritant effects.
Triethylenetetramine	112-24-3	3	Dilutes in water. Limited information on environmental behaviour	Acute dermal toxicity. Skin sensitiser and severe irritant to eyes and skin..
L-Glutamic Acid	56-86-0	0	Readily dissociates / dilutes in water.	Non hazardous substance.
Octadecanoic acid calcium salt	1592-23-0	0	If released into water is expected to adsorb to suspended solids and sediment. Expected to be biodegradable in water.	Non hazardous substance.

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Crystalline Silica, Quartz	14808-60-7	4	Does not degrade under standard temperature and pressure conditions and thus distribution is widespread	Carcinogenicity via the inhalation pathway.
Hydrochloric Acid	7647-01-0	3	Dissociates readily to chloride and hydronium ions, decreasing the pH of the water.	Acute toxicity via inhalation and corrosive properties (lung, eyes, skin and mucous membranes)
Sodium Hydroxide	1310-73-2	3	Dissociates readily in water. Effects on water alkalinity and direct effects on plants and animal tissues from acute environmental exposures where exposure to dusts and concentrated solutions may result.	Acute toxicity and corrosive and irritating to the skin and eyes.
Crystalline Silica, cristobalite	14464-46-1	4	Does not degrade under standard temperature and pressure conditions and thus distribution is widespread	Carcinogenicity via the inhalation pathway.
Nitrogen, liquid form	7727-37-9	3	Liquid nitrogen would rapidly convert to gaseous form and be lost to atmosphere. The release of liquid nitrogen to atmosphere can lead to the condensation of oxygen, which presents a physical fire and explosion risk as it creates a localised enrichment of oxygen.	The risks associated with liquid nitrogen arise from the physical conditions (i.e. extremely low temperature and high pressure) under which it exists. These include the potential for frostbite and burns.
Boric Acid	10043-35-3	4	Dissociates in water to form a weak acid.	Potential reproductive toxicity and eye irritant.

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Diatomaceous earth, calcined	91053-39-3	4	Insoluble in water. Unlikely to bioaccumulate. Would settle into soils and sedimants and become indistinguishable from those materials	Carcinogenicity via the inhalation pathway (due to presence of the crystalline silica fraction)
Magnesium nitrate	10377-60-3	3	Water soluble inorganic salt. It is very hygroscopic and in air quickly forms the hexahydrate with the formula Mg(NO3)2.6H2O.	Solution can cause skin irritation and serious (irreversible) eye damage.
Magnesium silicate hydrate (talc)	14807-96-6	1	Relatively inert and non-reactive.	Mild skin and eye irritant
Magnesium chloride	7786-30-3	0	Magnesium chloride in solution dissociates to magnesium and chloride ions. Magnesium is an essential mineral in all life	Non hazardous to human health
Ceramic materials and wares	66402-68-4	3	Insoluble in water, persistent, non bioaccumulative.	Serious eye irritation (irreversible eye damage).
Sodium Bromate	7789-38-0	4	Readily dissociates / dilutes in water.	Probable human carcinogen,
Sodium thiosulphate	7772-98-7	0	Dilutes in water. Likely to be biodegradable, unlikely to bioaccumulate.	Non hazardous to human health.
Non crystalline silica	7631-86-9	0	Insoluble in water. Unlikely to bioaccumulate.	Non hazardous substance, nuisance dust when inhalable.
Potassium hydroxide	1310-58-3	3	Readily dissociates / dilutes in water.	Severe skin burns and eye damage (irreversible effects). If aerosols/mist occur, they will cause direct local effects on respiratory tracts

Substance	CAS No	IMAP Hazard Ranking	Environmental Behaviour	Key Determinants and Potential Hazard Outcomes
Surrogate for Sodium tetraborate (Borax)	1303-96-4 (surrogate for 1330-43-4)	4	Readily dissociates to boric acid / dilutes in water. Waterborne boron may also be adsorbed by soils and sediments and may persist.	Skin, eye and respiratory irritant effects. Reproductive toxicity potential.
Silica gel	112926-00-8	0	Low solubility. Would settle into soils and sediments and become indistinguishable from those materials.	Non hazardous to human health. Hazard limited to dust generation.
Hydrogen Peroxide (impurity)	7722-84-1	3	Readily dissociates / dilutes in water.	Severe burns and eye damage (corrosive – irreversible effects). Potential to cause respiratory irritation. Severe health effects if swallowed or inhaled.
Zirconium dichloride oxide	7699-43-6	3	Readily dissociates / dilutes in water.	Causes severe skin burn and eye damage (corrosive)..

6.5 Uncertainty Analysis and Concluding Comments

The evaluation of the hazards presented in Table 44 is based on the available data obtained from the selected sources presented in Section 6.3. As a consequence it is limited to the quantity and quality of information available in those sources. A measure of the data completeness for the toxicological and hazard parameters used has been estimated using a percentage of the parameters for which data were available. An assessment of the quality of the available data is beyond the scope of this report. In the absence of verifying the data by going to the primary literature sources, the selection of data for use in the assessment has been confined to established, robust and reputable sources such as WHO and US EPA where available. As new toxicological data are generated and becomes available in the published literature, the information presented in this hazard evaluation and the associated conclusions may be subject to change. Specific areas where such information is being generated include the areas of endocrine disruptors and nanotoxicity. The latter has at this stage not been a focus of these current evaluations due to the paucity of available peer-reviewed information but may be required as new information becomes available.

The hazard evaluation for human health suggests that the dominant concerns are related to occupational hazards such as carcinogenicity, silicosis, skin, eye and respiratory irritancy or corrosivity and sensitisation. In some cases physical hazards of flammability and explosion prevail and are identified in this report. While extensive dilution of the hydraulic stimulation chemicals is anticipated such that exposure concentrations will be much reduced compared to concentrations injected into the well, and in flowback fluid, there are a number of environmental hazards that are suggested from this human health evaluation. These include the potential for:

- Residual elevation of organic moieties. e.g. some salts have an organic part that will be present following dissociation that may increase in environmental waters.
- Changes in pH of environmental waters due to alkaline or acidic components.
- Elevations of certain metal concentrations in environmental waters.
- Some additives to exert endocrine disruption effects.
- Certain inorganic substances to generate atmospheric particulates that may impact nearby communities.

Volatile components to comprise nuisance or irritant effects should atmospheric concentrations be elevated in close proximity to communities. These environmental hazards may be assessed further, and/or managed as required. Acrylonitrile has been identified as a specific concern due to it classification as a probable human carcinogen and the possibility that aqueous degradation in some cases may be limited necessitating further examination of site-specific degradation potential. It is noted, however, that the evaluation of exposure pathways has indicated that the potential for surface water and groundwater, to which humans could be exposed, to be impacted by hydraulic stimulation fluid chemicals is considered to be low.

7.0 RISK CHARACTERISATION

Risk characterisation is the final step in a risk assessment process. It traditionally involves the incorporation of the exposure assessment and toxicological dose-response data. In this qualitative risk assessment the process has embodied a hazard assessment and discussion of potential exposure pathways as part of a qualitative assessment of risk.

7.1 Discussion of Hazard Assessment

A hazard assessment of the chemicals used in the hydraulic stimulation process by Santos contractor Schlumberger have been assessed through the evaluation of PBT for aquatic toxicity, various data sources for terrestrial toxicity, and human health toxicity including physical hazards such as fire and explosion. The review of hazards is qualitative in that it has provided a relative ranking of chemicals.

It should be noted that the selection of a substance as a COPC does not indicate an unacceptable risk; rather it indicates that potential exposures to these chemicals should be evaluated in greater detail to assess whether they might present an unacceptable risk. Further assessment usually entails evaluation of likely environmental concentrations and refinement of the exposure assessment.

The hazard assessment incorporates the assessment of toxicity and is based on the assumption that the pure substance is present; this is not true of either the stimulation fluid or the resultant concentration in the environment. The concentration of chemicals in the stimulation fluid during a release into the environment is expected to be less than the starting concentration calculated in the mass balance. The concentrations are expected to be reduced due to chemical processes during the stimulation process that result in transformation of the chemicals to simpler end products. In addition chemicals will be subject to degradation, dispersion and adsorption all of which will result in attenuation of chemical concentrations with distance from the radius of stimulation.

7.1.1 Aquatic and Terrestrial Assessment

Of the fifty-two individual hydraulic stimulation chemicals assessed, forty-four were classified for aquatic hazard. Five of the fifty-two chemicals: sodium hydroxide, hydrochloric acid, magnesium chloride, potassium hydroxide and magnesium nitrate, were not scored for persistence as these chemicals readily dissociate in the environment. Two chemicals (guar gum and sodium carboxymethylhydroxypropyl guar) were not assessed due to insufficient data, but are qualitatively discussed. An additional four chemicals were not assessed due to being equivalent to sand and/or chemically inert.

Of the forty-four chemicals classified, the following aquatic hazard classifications were assigned:

- twenty-two were classified low hazard;
- fourteen were classified moderate hazard; and
- eight were classified high hazard.

The eight chemicals classified as a high aquatic hazard were considered to be COPC, these were:

- Dicoco dimethyl quarternary ammonium chloride;
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride;
- Sodium tetraborate;
- Nitrogen, liquid form;
- Boric acid;
- Magnesium silicate hydrate (talc);
- Hydrogen peroxide (impurity); and
- Zirconium dichloride oxide.

Of the high aquatic hazard chemicals identified, the following further interpretations are provided:

- Nitrogen, liquid form. Nitrogen is only a liquid at low temperature and pressure, conditions which will not prevail in the hydraulic stimulation fluid or at the drill pad. At atmospheric temperature and pressure nitrogen is a gas. The extent that nitrogen will have reacted with other constituents in the hydraulic stimulation mixture before volatilisation, is not known.
- Boric acid, magnesium silicate hydrate (talc), hydrogen peroxide, zirconium dichloride oxide and sodium tetraborate are considered as high hazards in this assessment based primarily on persistence. Review and interpretation of the aquatic toxicity data suggest these five chemicals present a low to moderate aquatic toxicity hazard.
- Dicoco dimethyl quarternary ammonium chloride is considered a high hazard based primarily on its toxicity. The toxicity data available for this chemical are limited (only acute fish and invertebrate data available) however review and interpretation of the persistence and bioaccumulation data suggest this chemical presents a low to moderate aquatic hazard.
- Alkyl (C12-C16) dimethylbenzyl ammonium chloride is considered a high hazard based on its high persistence and aquatic toxicity. As with dicoco dimethyl quarternary ammonium chloride the toxicity data available for this chemical is limited with only acute fish and plant data available.

It is noted that only one (liquid nitrogen) of the eight high aquatic hazard chemicals is expected to be in concentrations greater than 0.1% in a stimulation fluid mixture (as indicated by the fluid descriptions) and five of the high aquatic hazard chemicals are expected to be at concentrations less than 0.01%.

Given the management controls in place to prevent releases to the environment, potential aquatic hazards from individual hydraulic stimulation chemicals, are considered unlikely to be realised.

Of the fifty-two hydraulic stimulation chemicals, seven chemicals were not assessed due to insufficient data and six were not assessed because they were considered to be essentially sand, leaving 39 chemicals for assessment of terrestrial toxicity.

The following organic chemicals were assessed to have the potential to pose a higher hazard in the terrestrial environment relative to the other chemicals assessed based on persistence and potential to biomagnify:

- Cetylethylmorpholinium ethyl sulphate;
- Tetramethylammonium chloride;
- Surrogate for Octadecanoic acid, calcium salt;
- Decyldimethyl amine (impurity);
- Declydimethyl amine oxide;
- Surrogate for Vinylidene chloride/methacrylate; and
- Disodium ethylene diamine tetra acetate.

Six of the seven chemicals shown above are expected to be in concentrations less than 0.1% in a stimulation fluid mixture (as indicated by the fluid descriptions), with only one chemical (tetramethylammonium chloride) expected at concentrations up to 1%.

Tetramethylammonium chloride, decyldimethyl amine oxide and disodium ethylene diamine tetra acetate have low volatility but they are not likely to persist in the terrestrial environment as illustrated by a moderate to rapid half-life and low potential to bioaccumulate.

Surrogate for octadecanoic acid, calcium salt and decyldimethyl amine (impurity) both have a high potential to biomagnify but due to a moderate half-life and low to moderate volatility they are not likely to persist in the terrestrial environment.

Surrogate for vinylidene chloride/methacrylate (1,1 DCE) has the potential to persist in the terrestrial environment due to a slow half-life however it has low potential to biomagnify and low volatility.

Given the management controls in place to prevent releases to the environment, potential hazards from individual hydraulic fracturing chemicals to terrestrial ecosystems are not expected to be realised.

7.1.2 Human Health Assessment

The hazard evaluation for human health undertaken on the fifty-two chemicals in accordance with the IMAP Framework hazard ranking methodology indicated thirty-five of fifty-two chemicals assessed under this methodology to be a Hazard Rank of 3 or 4. Of the Hazard Rank 4 chemicals, all but one chemical (crystalline silica) are expected to be at concentrations less than 0.1% in a fluid mix (based on the fluid disclosure information provided by Schlumberger). Crystalline silica is not expected at a concentration above 1%.

The hazard evaluation for human health suggests that the dominant concerns are related to occupational hazards such as carcinogenicity, silicosis, skin, eye and respiratory irritancy or corrosivity and sensitisation. In some cases physical hazards of flammability and explosion prevail and are identified in this report. While extensive dilution of the hydraulic stimulation chemicals is anticipated such that potential exposure concentrations will be much reduced compared to concentrations injected into the well and in flowback fluid, there are a number of hazards that are suggested from this human health evaluation, as previously discussed in section 6.5.

7.2 Discussion of Exposure Assessment

Potential exposure pathways were evaluated for on-site (i.e. within the lease) and those relevant for off-site (i.e. anything beyond the well lease boundary). Potentially complete exposure pathways were evaluated for workers, trespassers, native fauna and flora and livestock. The environment immediately surrounding the well lease (i.e. off-site) throughout the study area may vary from lease to lease, but was considered to potentially include homesteads (adult and child residents), water supply bores, creeks or waterholes, livestock and native flora and fauna.

The on-site assessment indicated that the majority of potential exposure pathways were unlikely or incomplete, given the application of operational controls by Santos.

One potentially complete exposure pathway was identified, which is direct contact to the flowback water in the Flare Pit for small fauna (i.e. rodents, lizards and birds). All reasonable measures will be implemented to discourage entry of small native fauna into the well lease area during hydraulic stimulation operations.

Potential off-site exposure pathways were evaluated for homesteads, livestock, native flora and fauna and aquatic ecosystems. Three possible sources were identified: hydraulic stimulation fluids, sediments from Flare Pit and flowback water. The exposure assessment concluded:

- Based on understanding of the Eromanga and Cooper Basin geology and hydrogeology, and Santos' well integrity testing procedures and operational monitoring, exposure to residual stimulation chemicals through subsurface pathways is considered unlikely and incomplete; and
- At the surface, a spill or leak of flowback water from the Flare Pit was considered possible, however the implementation of operational controls, including use of liners in Flare Pits, removal of fluid and sediment using vacuum techniques and engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within the Flare Pits) is considered sufficient to limit the potential for uncontrolled releases of flowback water to the environment. A further margin of safety is provided by Santos' evaluation of 'environmentally sensitive areas' when establishing well leases, which includes the establishment of buffers between petroleum (and stimulation) activities and features of potential environmental concern. Subsequently, the potential off-site exposure scenarios are considered unlikely and incomplete.

7.3 Qualitative Risk Assessment of Fluids

A preliminary characterisation of typical stimulation fluids, comprising a limited suite of chemical analyses was undertaken. Flow back fluids were not characterised.

The initial chemical suite and assessment was to assist in further identification of potential hazards to humans and the environment using reported concentrations of stimulation fluid constituents, prior to stimulation being undertaken.

7.3.1 Methodology for Qualitative Risk Assessment

7.3.1.1 Field Work and Sampling Approach

The objective of the sampling was to provide a preliminary comparison against DEHP guidelines, prior to stimulation being undertaken. The approach is not a definitive representation of chemical or physical parameters, as this would ideally require a broad suite of analytes, larger number of samples over a longer time frame.

Schlumberger indicated that the following sampling procedure was adopted:

- On 17 July and 12 August, 2013, a Schlumberger laboratory technician collected four stimulation fluids samples at their office in Chinchilla, Queensland.
- Each fluid sample was placed in two sample bottles prepared by the analytical laboratory. The sample bottle was filled to the top to minimise loss of volatile chemicals, and oxidation of the sample.
- Samples collected on 17 July were labled *YF120w/L07/* and *YF140 HDT*, and samples collected on 12 August were labelled ThermaFRAC 40 Additives, ThermaFRAC 40 Polymer and Slickwater. These samples could not be mixed as mixing caused the fluid to coagulate, which was not practical for the laboratory to test without significant dilution.
- Disposable gloves were used during sampling.
- The fluid sample was placed in a chilled, insulated container and delivered to the laboratory.

The general sample collection, storage and transport procedures indicated by Schlumberger appear to be consistent with good industry practice. However the following QA/QC limitations were noted:

- No blind duplicate samples were noted in the laboratory analytical reports.
- No rinsate blank samples were noted in the laboratory analytical reports. Typical frequency is one rinsate blank per sample batch submitted to the laboratory.
- No trip blank or trip spike samples were noted in the laboratory analytical reports. Typical frequency is one trip spike and one trip blank per analytical batch.
- No reagent blank samples were noted in the laboratory analytical reports. For any product sample prepared as a dilution, a sample of the diluting fluid (reagent blank) should also be submitted for analysis to assess for the presence of impurities.
- Chain of custody (CoC) and sample receipt notice (SRN) documentation were not provided for review along with the laboratory analytical reports as evidence of proper procedure.

7.3.1.2 Laboratory Quality Control

Typical laboratory quality control measures include laboratory duplicate samples, method blanks, laboratory control spikes, matrix spikes, and surrogate spikes. Each of these measures assesses a separate aspect of the laboratory procedures for analytical bias due to the laboratory methods, equipment, or sample properties. Of these, only evidence of surrogate spikes was reported on the laboratory reports. The absence of other laboratory control data may be due to small sample batches, which are insufficient to warrant the full standard suite of laboratory QC samples.

ALS typically supplies quality control summary reports along with its laboratory reports, which may include additional information in this regard. However, if provided, these were not passed on to Golder for review.

7.3.1.3 Assessment of QA/QC

With regard to potential future product sampling and analysis, it is recommended that samples are either submitted in larger batches, or a minimum level of laboratory QA/QC is specified on the CoC for each batch such that a broader suite of laboratory QC measures can be assessed.

While the limited information provided by Schlumberger in regard to sample preparation, storage and transport to the laboratory is generally consistent with good industry practice, there were omissions to the standard QA/QC protocols without which it is not possible to validate the integrity of the laboratory data for its suitability for interpretive use.

7.3.1.4 Analytical Approach

ALS Environmental (ALS) was engaged to perform chemical analyses. ALS is registered by the National Association of Testing Authorities (NATA) for the analyses performed. Analysis of the fluid samples included a limited range of parameters.

- Polycyclic aromatic hydrocarbons (PAH) – 5 samples.
- Benzene, toluene, ethylbenzene, xylenes (BTEX) – 4 samples.

The laboratory certificates are also presented in APPENDIX G.

7.3.2 Fluid Risk Assessment

The purpose of the stimulation fluid assessment was a preliminary, qualitative comparison against DEHP guidelines. The BTEX results for the fluids are summarised in Table 45. Make-up water and flowback fluids were not assessed.

Table 45: Summary of BTEX Analytical Results for Fluids (µg/L)

Analyte	DEHP Criteria	YF120w/L07	YF140 HDT[1,2]	ThermaFRAC additives	ThermaFRAC polymer	Slickwater
Benzene	1	-	<0.12	<0.05	<0.05	<0.05
Toluene	180	-	<0.5	3.7	<0.5	<0.5
Ethylbenzene	80	-	<0.12	0.07	<0.05	<0.05
o-Xylene	350	-	<0.12	<0.05	<0.05	<0.05
m & p-Xylene	275[3]	-	<0.25	<0.05	<0.05	<0.05

Notes:

1) The laboratory reported that sample YF140 HTD has been heated to reduce viscosity of the gel. As such volatile analytes may have been lost through evaporation.
2) YF140 HTD required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly
3) Combined criteria of 75 µg/L for m-xylene and 200 µg/L for p-xylene .

The reported BTEX and PAH concentrations were below the laboratory LOR and DEHP regulated criteria (for BTEX) for hydraulic stimulation fluid additives in Queensland with the exception of the ThermaFRAC 40 samples.

- There were two samples analysed for ThermaFRAC, with sample IDs annotated with “additives” and “polymer”.
  - The “additives” sample reported PAH concentrations below the LOR, however reported detectable concentrations of toluene and ethylbenzene (below the prescribed concentrations in Table 1) and styrene (for which there is no specific prescribed concentration in relation to stimulation fluids, refer to Table 2). The reported styrene concentration (0.25 µg/L) was below the health-based (30 µg/L) and aesthetic (4 µg/L) values in the NHMRC & NRMMC (2011) *Australian Drinking Water Guidelines*; no ecological trigger value is available for styrene in the ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*.

- The “polymer” sample reported BTEX concentrations below the LOR, however reported detectable concentrations of three PAHs (benzo(ghi)perylene (0.2 µg/L); naphthalene (0.7 µg/L), phenanthrene (0.3 µg/L); refer to Table 2). With regard to Australian water quality criteria, both naphthalene and phenanthrene were below the ANZECC & ARMCANZ (2000) trigger values. No ecological criterion is available for benzo(ghi)perylene, and no Australian health-based criteria are available for the three chemicals.

The information provided by Schlumberger in relation to BTEX and PAH analysis of its disclosed stimulation fluids has limitations in both its representation of all of the disclosed fluids and specific additives, and also in the limited QA/QC data available with which to validate the analytical results. These limitations would be required to be reported in conjunction with discussion of the analytical results.

7.4 Overall Evaluation of Risk

Considering the hazard and exposure assessment and operational controls discussed, the overall risk to human health and environment associated with the chemicals involved in hydraulic stimulation are expected to be low. These operational controls include:

- OH&S procedures implemented during hydraulic stimulation operations to prevent workers from direct contact and inhalation exposure to chemicals during spills and when handling flowback water or sediments.
- Assigning buffers during establishment of well leases between petroleum operations and potential “environmentally sensitive areas” identified though database review and site-specific ecological assessment where warranted.
- Establishment of buffers prior to stimulation activities, between the stimulation initiation point and private water bores identified though water bore baseline assessment.
- Implementation of spill containment procedures during operations to prevent migration of and exposure to chemicals.
- Removal of sediments and fluids contained within drained Flare Pits to prevent exposure to contaminants in windborne dust.
- Installation and maintenance of fences around the Flare Pits to prevent access by trespassers and installation of signs to indicate well leases are a work zones to be accessed by authorised personnel.
- Installation and maintenance of fences around Flare Pits to prevent access by livestock and large native fauna.
- Santos operational procedures regarding well integrity verification and fracture design to stay within the target formation.
- Lining of Flare Pits as a minimum standard, and evaluation of improved containment methods in 2013, to prevent seepage of flowback water into the underlying aquifer.
- Engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within the Flare Pits) to limit the potential for uncontrolled surface releases of flowback water to the environment.

7.5 Other Considerations

7.5.1 Noise and Vibration

The activities associated with hydraulic stimulation have the potential to generate noise or vibration that could potentially impact nearby receptors. However, given the remote nature of Cooper Basin stimulation activities the presence of nearby receptors is considered unlikely. In addition, whilst the proposed activities will take place on a continuous basis, they will be undertaken sequentially for short periods of time at different sites over a wide area. As a result individual sensitive receivers are only likely to be exposed to the effects of noise and vibration from these activities for a few weeks at a time. On this basis, risk associated with noise and vibration to offsite receptors has not been considered further in this report.

Potential for onsite noise and vibration exposure to workers exist during hydraulic stimulation activities. Santos and stimulation service provider's equipment are subject to noise emission testing by a professional third party. Prevention of exposure to workers is managed through Santos OH&S procedures.

8.0 CONCLUSIONS

8.1 Environmental Setting

Santos operates conventional gas and oil fields across petroleum tenements within an approximately 30,000 km^2 portion of Southwest Queensland. These tenements and the land surrounding the Santos tenement boundaries comprise the Santos SWQ *study area*.

The terrain in the study area is generally characterised by low undulating topography (hills and ridges) between the drainage channel systems of the Cooper Creek. The area is sparsely developed, and generally comprises rural communities and homesteads that are largely engaged in farming and livestock.

It is within the stratigraphy that comprises the Eromanga Basin and the underlying Cooper Basin that oil and gas reservoirs are located which contain the proposed target formations for hydraulic stimulation. A detailed description of key geological and hydrogeological features is provided in Volume One, including geological models for the study area, target hydrocarbon-bearing sandstone formations (oil in the Eromanga Basin formations at depths ranging from 700 to 1,200 mbgl, and gas in the Cooper Basin formations at depths of 1,500 to greater than 2,000 mbgl), their hydraulic characteristics, adjacent aquifers and aquitards, structural features including faults and fracture characteristics (and their potential to behave as barriers or conduits), regional and local seismicity characteristics, aquifer environmental values and the location of groundwater users.

In terms of the environmental setting, Volume One of the SWQ HSRA has provided specific information which addresses the requirements anticipated of the EA conditions regarding hydraulic stimulation that will apply to existing and new areas.

Based on understanding of the environmental setting, this qualitative risk assessment considered the key environmental values as follows:

Groundwater environmental values:

- Town water supply;
- Stock and domestic water supply;
- Sandstone aquifers of the GAB; and
- GDEs.

Surface water environmental values:

- Protection of aquatic ecosystems;
- Recreation and aesthetics: primary recreation with direct contact, and visual appreciation with no contact; and
- Cultural and spiritual values.

Terrestrial environmental values:

- Protection of flora and fauna, particularly small mammals, reptiles and birds with a greater the potential to come into contact with flowback water in Flare Pits.

The report has considered each in terms of the risk to aquatic ecosystems, terrestrial ecosystems and human health.

8.2 Hydraulic Stimulation Process Description Summary

With regard to the process of hydraulic stimulation, information addressing the anticipated EA approval conditions (with reference to the model conditions) is located within Volume One of the SWQ HSRA, including:

- Practices and procedures to ensure that the stimulation activity(ies) is designed to be contained within the target gas producing formation.
- Provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority.
- A description of the well mechanical integrity testing program.
- Process control and assessment techniques to be applied for determining extent of stimulation activity(ies) (e.g. microseismic measurements, modelling etc).
- A process description of the stimulation activity to be applied, including equipment and a comparison to best international practice.

8.3 Toxicological Evaluation

The toxicity of the chemicals used in the hydraulic stimulation process by Schlumberger has been assessed for persistence, bioaccumulation and aquatic toxicity (PBT), terrestrial toxicity and human health toxicity including the physical hazards of fire and explosion. The review of toxicity is qualitative and has provided a ranking of chemicals considered to represent a high, moderate or low hazard in respect to the ecological or human health end points with qualification as appropriate.

A preliminary quantitative assessment has also been undertaken, with Schlumberger collecting a total of two fluid samples of stimulation fluids for chemical analysis. The two samples were tested for PAHs and BTEX. The concentrations of BTEX were reported below the DEHP BTEX standard.

8.4 Evaluation of Exposure Pathways

Potential exposure pathways were evaluated for on-site (i.e. within the well lease), and those relevant for off-site (i.e. anything beyond the well lease boundary). The on-site assessment indicated that the majority of possible exposures were unlikely or incomplete. One complete exposure pathway was identified, which is direct contact to the flowback water in the Flare Pit for small fauna (i.e. lizards and birds). All reasonable measures will be conducted to discourage entry of small native fauna into the well lease area during hydraulic stimulation operations. Improvement of flowback water containment will further reduce the potential for this exposure scenario to occur.

For the off-site exposure assessment, it was assumed that potential off-site receptors could include homesteads (adult and child residents), water supply bores, creeks and waterholes, livestock and native flora and fauna. Three possible chemical sources were identified: injected hydraulic stimulation fluids, sediments from Flare Pit and flowback water. The exposure assessment concluded:

- Subsurface exposure to stimulation fluids is controlled by Santos' well integrity testing procedures and operational monitoring, and this pathway (whereby stimulation fluids could escape into the formation and contaminate adjacent aquifers that are used for domestic or stock water supply) is considered unlikley or incomplete.
- Based on an understanding of the Eromanga and Cooper Basin geology and hydrogeology, and the nature and extent of groundwater supply development, exposure to residual stimulation chemicals through subsurface pathways is considered unlikely and incomplete.

- At the surface, a spill or leak of flowback water from the Flare Pit was considered as a possible exposure scenario, however the implementation of operational controls, including use of liners in Flare Pits, removal of fluid and sediment using vacuum techniques and engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within the Flare Pits) is considered sufficient to limit the potential for uncontrolled releases of flowback water to the environment. A further margin of safety is provided by Santos' evaluation of 'environmentally sensitive areas' when establishing well leases, which includes the establishment of buffers between petroleum (and stimulation) activities and features of potential environmental concern. Subsequently, the potential off-site exposure scenarios are considered unlikely and incomplete.

8.5 Overall Risk Evaluation

Considering the hazard, exposure assessment and qualitative assessment of fluids, flowback water at surface presents inherent possible, albeit unlikely, risk. However, with Santos operational controls and management, the overall or residual risk to human health and environment associated with the chemicals involved in hydraulic stimulation are expected to be low. The management measures implemented through operational controls include:

- OH&S procedures implemented during hydraulic stimulation operations to prevent workers from direct contact with chemicals during spills and when handling flowback water or sediments.
- Santos operational procedures regarding well integrity verification and fracture design to stay within the target formation.
- Assigning buffers during establishment of well leases between petroleum operations and potential "environmentally sensitive areas" identified though database review and site-specific ecological assessment where warranted.
- Establishment of buffers prior to stimulation activities, between the stimulation initiation point and private water bores identified though water bore baseline assessment.
- Implementation of spill containment procedures during operations to prevent migration of and exposure to chemicals.
- Vacuum removal of sediments and fluids contained within Flare Pits, to prevent exposure to contaminants in fluids and windborne dust.
- Installation and maintenance of fences around the Flare Pits to prevent access by trespassers, and installation of signs to indicate that well leases are work zones to be accessed by authorised personnel.
- Installation and maintenance of fences around the Flare Pits to prevent access to the by livestock and large native fauna.
- Lining of Flare Pits and improvement of fluid storage and containment methods, to prevent seepage of flowback water into the underlying aquifer.
- Engineering and operational controls (grading of well leases, stormwater controls and maintenance of a minimum of 300 mm freeboard within the Flare Pits) to limit the potential for uncontrolled surface releases of flowback water to the environment.

The adequacy and appropriateness of these exposure controls will be routinely evaluated by Santos and modifications and revisions made, where necessary, to achieve continuous improvement.

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APPENDIX A

Regulatory Consent Conditions

Environmental Protection Act 1994

Level 1 Environmental Authority

Chapter 5A petroleum activity

Permit[1] Number: PEN1000XXXXX

DRAFT Coal Seam Gas Model Conditions

FOR REFERENCE AND DISCUSSION PURPOSES ONLY

Under section 310M of the *Environmental Protection Act 1994* this permit is issued to:

Principal Holder:
[*Insert Registered Company Name*]
[*Insert Registered Company Address*]
[*Insert ACN*]

Joint Holder(s):
[*Insert Joint Holder Name 1*]
[*Insert Joint Holder Name 2*]
[*Insert Joint Holder Name 3*]

in respect to carrying out a level 1 chapter 5A activity(ies) as per Section 23 of the *Environmental Protection Regulation 2008* on the relevant resource authorities listed below:

Project Name	Relevant Resource Authority(ies)

This environmental authority takes effect from [*insert date of effect*].

The anniversary date of this environmental authority is [*insert date of environmental authority*].

This environmental authority is subject to the attached schedule of conditions.

.....

Date

[*Insert Delegate Name*]
Delegate of Administering Authority
Department of Environment and Heritage Protection

[1] Permit includes licences, approvals, permits, authorisations, certificates, sanctions or equivalent/similar as required by legislation administered by the Department of Environment and Heritage Protection.

Additional advice about the approval

1. This approval is for the carrying out the following level 1 chapter 5A activity(ies):

Schedule 5 of the *Environmental Protection Regulation 2008*
2. A petroleum activity authorised under the *Petroleum (Submerged Lands) Act 1982*
3. A petroleum activity that is likely to have a significant impact on a Category A or B environmentally sensitive area
4. Extending an existing pipeline by more than 150 km under a petroleum authority
5. Constructing a new pipeline of more than 150 km under a petroleum authority
6. A petroleum activity carried out on a site containing a high hazard dam or a significant hazard dam
7. A petroleum activity involving injection of a waste fluid into a natural underground reservoir or aquifer
8. A petroleum activity, other than a petroleum activity mentioned in items 1 to 7, that includes 1 or more chapter 4 petroleum activities for which an aggregate environmental score is stated, namely: [*Insert each ERA number and full description including threshold for the purposes of determining the aggregate environmental score and the correct annual fee relevant to the application*] For example: ERA 8 – Chemical storage 10 cubic metres to 500 cubic metres of chemical or dangerous goods class 3 or class 1 or class 2 combustible liquids under AS1940. ERA 15 – Fuel burning operation using equipment capable of burning at least 500 kg per hour of fuel. ERA 60(1)(D) – Waste disposal facility (any combination of regulated waste, general waste and limited regulated waste – and < 5 tonne untreated clinical waste if in a scheduled area) >200,000t / year. ERA 63(2)(A) – Sewage treatment 21 to 100 EP.

2. This approval pursuant to the *Environmental Protection Act 1994* does not remove the need to obtain any additional approval for this activity which might be required by other State and / or Commonwealth legislation. Other legislation administered by the Department of Environment and Heritage Protection for which a permit may be required includes but is not limited to the:

- *Aboriginal Cultural Heritage Act 2003*
- *Queensland Heritage Act 1992*
- Contaminated land provisions of the *Environmental Protection Act 1994*
- *Forestry Act 1959*
- *Nature Conservation Act 1992*
- *Water Act 2000*
- *Water Supply (Safety and Reliability) Act 2008*

<<To be deleted>> Under the provisions of the Strategic Cropping Land Act 2011, an environmental authority application (included an amendment application) can not be issued until a protection decision or compliance certificate has been decided.

Applicants are advised to check with all relevant statutory authorities and comply with all relevant legislation.

3. This environmental authority does not authorise environmental harm unless a condition contained in this environmental authority explicitly authorises that harm. Where there is no condition, the lack of a condition shall not be construed as authorising harm.
4. This approval, issued under the *Environmental Protection Act 1994*, for the carrying out of a level 1 petroleum activity(ies) is not an authority to impact on water levels or pressure heads in groundwater aquifers in or surrounding coal seams. There are obligations to minimise or mitigate any such impact under other Queensland Government and Australian Government legislation.
5. Terms defined in Schedule M of this environmental authority are **bolded** in this document. Where a term is not defined in this environmental authority, the definition in the *Environmental Protection Act 1994*, its regulations and Environmental Protection Policies, then the *Acts Interpretation Act 1954* then the Macquarie Dictionary then the *Petroleum and Gas (Production and Safety) Act 2004* or its regulations must be used in that order.
6. This environmental authority does not authorise the taking of protected animals or the tampering with an animal breeding place as defined under the *Nature Conservation Act 1992* and its regulations.
7. The Duty to Notify is a requirement contained in the *Environmental Protection Act 1994* which applies to all persons. The duty to notify arises where a person carries out activities and becomes aware of the act of another person arising from or connected to those activities which causes or threatens serious or material environmental harm. If a person carries out a carrying out a chapter 5A activity, such as coal seam gas activities, the law requires that person to notify the administering authority where:

   - the activity negatively affects (or is reasonably likely to negatively affect) the water quality of an aquifer; or
   - the activity has caused the unauthorised connection of two or more aquifers.

   For more information about the Duty to Notify, refer to section 320A of the *Environmental Protection Act 1994* and/or the guideline, *The Duty to Notify of Environmental Harm* (EM467), published by the Department of Environment and Heritage Protection.
8. This environmental authority consists of the following schedules

SCHEDULE J ACTIVITIES WELL CONSTRUCTION, MAINTAINANCE AND HYDRAULIC FRACTURING

Drilling Activities

(J1) **Oil based drilling muds** must not be used in the carrying out of the petroleum activity(ies).

(J2) **Synthetic oil-based drilling muds** must not be used in the carrying out of the petroleum activity(ies).

(J3) Drilling activities must not result in the connection of the target gas producing formation and another aquifer.

(J4) Practices and procedures must be in place to detect, as soon as practicable, any fractures that have or may result in the connection of a target formation and another aquifer as a result of drilling activities.

Hydraulic Fracturing Activities

(J5a) **Hydraulic fracturing** activities are not permitted.

Where a risk assessment is not submitted as part of the Environmental Management Plan accompanying the environmental authority application, hydraulic fracturing will not be authorised and condition (J5a) applies, otherwise delete condition (J5a).

(J5b) Polycyclic aromatic hydrocarbons or products that contain polycyclic aromatic hydrocarbons must not be used in **hydraulic fracturing** fluids in concentrations above the **reporting limit**.

(J6) **Hydraulic fracturing** activities must not negatively affect water quality, other than that within the **stimulation impact zone** of the target gas producing formation.

(J7) **Hydraulic fracturing** activities must not cause the connection of the target gas producing formation and another aquifer.

(J8) The holder of this authority must ensure the internal and external mechanical integrity of the well system prior to and during **hydraulic fracturing** such that there is:

(a) no significant leakage in the casing, tubing, or packer; and

(b) there is no significant fluid movement into another aquifer through vertical channels adjacent to the well **bore** hole.

(J9) Practices and procedures must be in place to detect, as soon as practicable, any fractures that cause the connection of a target gas producing formation and another aquifer.

<<To be deleted>> Detection measures will need to be determined through the risk assessment and could include microseismic monitoring, tracer analysis and water quality signature analysis. Such measures will be required to be outlined in the Environmental Management Plan accompanying the application.

Stimulation Risk Assessment

(J10) Prior to undertaking **hydraulic fracturing** activities, a risk assessment must be developed to ensure that **hydraulic fracturing** activities are managed to prevent environmental harm.

(J11) The stimulation risk assessment must assessment must address issues at a relevant geospatial scale such that changes to features and attributes are adequately described and must include, but not necessarily be limited to:

(a) a process description of the **hydraulic fracturing** activity to be applied, including equipment and a comparison to best international practice;

(b) provide details of where, when and how often **hydraulic fracturing** is to be undertaken on the tenures covered by this environmental authority;

(c) a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s);

(d) naturally occurring geological faults;

(e) seismic history of the region (e.g earth tremors, earthquakes);

(f) proximity of overlying and underlying aquifers;

(g) description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation.

(h) identification and proximity of **landholders' active groundwater bores** in the area where **hydraulic fracturing** activities are to be carried out;

(i) the environmental values of groundwater in the area;

(j) an assessment of the appropriate **limits of reporting** for all indicators relevant to **hydraulic fracturing** monitoring in order to accurately assess the risks to environmental values of groundwater;

(k) description of overlying and underlying formations in respect of porosity, permeability, hydraulic conductivity, faulting and fracture propensity;

(l) consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers;

(m) a description of the well mechanical integrity testing program;

(n) process control and assessment techniques to be applied for determining extent of **hydraulic fracturing** activities (e.g. microseismic measurements, modelling etc);

(o) practices and procedures to ensure that the **hydraulic fracturing** activities are designed to be contained within the target gas producing formation;

(p) groundwater **transmissivity,** flow rate, hydraulic conductivity and direction(s) of flow;

(q) a description of the chemicals used in **hydraulic fracturing** activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after **hydraulic fracturing**;

(r) a mass balance estimating the concentrations and absolute masses of chemicals that will be reacted, returned to the surface or left in the target gas producing formation subsequent to **hydraulic fracturing**;

(s) an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after **hydraulic fracturing** including:

  (i) toxicological and ecotoxicological information of chemicals used;

  (ii) information on the persistence and bioaccumulation potential of the chemicals used;

  (iii) identification of the **hydraulic fracturing** fluid chemicals of potential concern derived from the risk assessment;

(t) an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in **hydraulic fracturing** activities;

(u) identification and an environmental hazard assessment of using radioactive tracer beads in **hydraulic fracturing** activities;

(v) an environmental hazard assessment of leaving chemicals used in **stimulation fluids** in the target gas producing formation for extended periods subsequent to **hydraulic fracturing**;

(w) human health exposure pathways to operators and the regional population;

(x) risk characterisation of environmental impacts based on the environmental hazard assessment;

(y) potential impacts to landholder bores as a result of **hydraulic fracturing** activities;

(z) an assessment of cumulative impacts, spatially and temporally of the **hydraulic fracturing** activities to be carried out on the tenures covered by this environmental authority; and

(aa) potential environmental or health impacts which may result from **hydraulic fracturing** activities including but not limited to water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.

<<To be deleted>> Conditions (J10) and (J11) can be deleted from the environmental authority in the event the applicant has submitted a Stimulation Risk Assessment with the application and to the satisfaction of the administering authority. In this event, amend condition (J12) to include the Stimulation Risk Assessment's reference details and date.

(J12) The stimulation risk assessment must be carried out for every well to be stimulated prior to **hydraulic fracturing** activities being carried out at that well.

<<To be deleted>> Condition (J12) provides flexibility to the applicant to develop risk assessments for each well or develop one overarching stimulation risk assessment providing that one document covers all relevant and site specific matters for each of the wells.

Water Quality Baseline Monitoring

(J13) Prior to undertaking any **hydraulic fracturing** activity, a baseline **bore** assessment must be undertaken of the water quality of:

(a) all **landholders' active groundwater bores** (subject to access being permitted by the landholder) that are spatially located within a two (2) kilometre horizontal radius from the location of the **hydraulic fracturing** initiation point within the target gas producing formation; and

(b) all **landholders' active groundwater bores** (subject to access being permitted by the landholder) in any aquifer that is within 200 metres above or below the target gas producing formation and is spatially located with a two (2) kilometre radius from the location of the **hydraulic fracturing** initiation point; and

(d) any other **bore** that could potentially be adversely impacted by the **hydraulic fracturing** activity(ies) in accordance with the findings of the risk assessment required by conditions (J10) and (J11).

(J14) Prior to undertaking **hydraulic fracturing** activities at a well, there must be sufficient water quality data to accurately represent the water quality in the well to be stimulated. The data must include as a minimum the results of analyses for the parameters in condition (J15)).

<<To be deleted>> Condition (J14) allows for flexibility regarding pre-hydraulic fracturing monitoring of water quality in a well. In the event that there is not sufficient water in a well prior to hydraulic fracturing, coal seam gas companies may use monitoring data from another unstimulated well or bore which is in the vicinity and which accurately represents the water quality in the well to be stimulated.

(J15) Baseline bore and well assessments must include relevant **analytes** and physico-chemical parameters to be monitored in order to establish baseline water quality and must include, but not necessarily be limited to:

(a) pH;

(b) electrical conductivity [μS/m];

(c) turbidity [NTU];

(d) total dissolved solids [mg/L];

(e) temperature [ºC];

(f) dissolved oxygen [mg/L]

(g) dissolved gases (methane, chlorine, carbon dioxide, hydrogen sulfide) [mg/L];

(h) alkalinity (bicarbonate, carbonate, hydroxide and total as $CaCO_3$) [mg/L];

(i) sodium adsorption ratio (SAR);

(j) anions (bicarbonate, carbonate, hydroxide, chloride, sulphate) [mg/L];

(k) cations (aluminium, calcium, magnesium, potassium, sodium) [mg/L];

(l) dissolved and total metals and metalloids (including but not necessarily being limited to: aluminium, arsenic, barium, borate (boron), cadmium, total chromium, copper, iron, fluoride, lead, manganese, mercury, nickel, selenium, silver, strontium, tin and zinc) [μg/L];

(m) total petroleum hydrocarbons [μg/L];

(n) **BTEX** (as benzene, toluene, ethylbenzene, ortho-xylene, para- and meta-xylene, and total xylene) [μg/L];

(o) polycyclic aromatic hydrocarbons (including but not necessarily being limited to: naphthalene, phenanthrene, benzo[a]pyrene) [μg/L];

(q) sodium hypochlorite [mg/L];

(r) sodium hydroxide [mg/L];

(s) formaldehyde [mg/L];

(t) ethanol [mg/L]; and

(u) gross alpha + gross beta or radionuclides by gamma spectroscopy [Bq/L].

Stimulation Impact Monitoring Program

(J16) A Stimulation Impact Monitoring Program must be developed prior to the carrying out of **hydraulic fracturing** activities which must be able to detect adverse impacts to water quality from **hydraulic fracturing** activities and must consider the findings of the risk assessment required by conditions (J10) and (J11) that relate to **hydraulic fracturing** activities and must include, as a minimum, monitoring of:

(a) the **stimulation fluids** to be used in **hydraulic fracturing** activities at sufficient frequency and which sufficiently represents the quantity and quality of the fluids used; and

(b) flow back waters from **hydraulic fracturing** activities at sufficient frequency and which sufficiently represents the quality of that flow back water; and

(c) flow back waters from **hydraulic fracturing** activities at sufficient frequency and accuracy to demonstrate that 150 % of the volume used in **hydraulic fracturing** activities has been extracted from the stimulated well; and

(d) all **bores** in accordance with condition (J13).

(J17) The Stimulation Impact Monitoring Program must provide for monitoring of:

(a) **analytes** and physico-chemical parameters relevant to baseline bore and well assessments to enable data referencing and comparison including, but not necessarily being limited to the **analytes** and physico-chemical parameters in condition (J16); and

(b) any other **analyte** or physico-chemical parameters that will enable detection of adverse water quality impacts and the inter-connection with a non-target aquifer as a result of **hydraulic fracturing** activities including chemical compounds that are actually or potentially formed by chemical reactions with each other or coal seam materials during **hydraulic fracturing** activities.

(J18) The Stimulation Impact Monitoring Program must provide for monitoring of the **bores** in condition (J16)(d) at the following minimum frequency:

(a) monthly for the first six (6) **months** subsequent to **hydraulic fracturing** activities being undertaken; then

(b) annually for the first five (5) **years** subsequent to **hydraulic fracturing** activities being undertaken or until **analytes** and physico-chemical parameters listed in condition (J15)(b), (J15)(n) – (J15)(u) are not detected in concentrations above baseline bore monitoring data on two (2) consecutive monitoring occasions.

<<To be deleted>> Monthly monitoring required by condition (J18)(a) may need to be extended beyond six (6) months depending on the outcomes of the risk assessment and the transmissivity of groundwater in the area.

(J19) The results of the Stimulation Impact Monitoring Program must be made available to any potentially affected landholder upon request by that landholder.

<<To be deleted>> There may be variations to the Stimulation Impact Monitoring in the event that a risk assessment for hydraulic fracturing activities is submitted to the administering authority with the application which includes sufficient data to demonstrate the quality and quantity of the stimulation fluids to be used in hydraulic fracturing activities. To reduce the suite of impact monitoring parameters in condition (J15), monitoring results of these parameters as sampled from on site hydraulic fracturing activities must be included. To vary the requirements of conditions (J16) – ***Error! Reference source not found.****, the risk assessment must include, for example:*

- *comprehensive characterisation data from replicate sampling of batch samples of stimulation additive mixtures intended to be used in hydraulic fracturing; and*
- *monitoring results of stimulation fluid blends as sampled at low pressure pumps associated with hydraulic fracturing activities;*
- *monitoring results of flow back waters;*
- *relevant current MSDS's for all additives to be used in stimulation fluids;*
- *whole effluent or direct toxicity assessments of additives and/or stimulation fluids;*
- *an assessment of all monitoring data and toxicity assessments against known water quality guidelines, including US EPA Drinking Water guidelines.*

APPENDIX B

Limitations

LIMITATIONS

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APPENDIX C

Safety Data Sheets

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 16 March 2012*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Surfactant F112**

Product Code: **F112**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: For industrial use only. Surfactant in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger Xi - Irritant.

Most important hazards R-phrase(s): Risk of serious damage to eyes.

Health hazards: May cause skin irritation.

S-phrase(s): S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S39 - Wear eye/face protection.

Environmental hazard: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Main physical hazards: None known.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Polyethylene glycol monohexyl ether	31726-34-8	500-077-5	7-13	Xi;R38,R41

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Consult a physician if necessary.

Skin contact: Wash off immediately with plenty of water for at least 15 minutes. Seek medical attention if irritation occurs.

Eye contact: Immediately flush eyes with water for .? minutes while holding eyelids open. Seek medical attention at once.

Ingestion: Do NOT induce vomiting. Call a physician or poison control centre immediately. Never give anything by mouth to an unconscious person. If vomiting occurs spontaneously, minimize the risk of aspiration by properly positioning the affected person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media: Water Fog, Alcohol Foam, CO2, Dry Chemical.

Extinguishing media which must not be used for safety reasons: None known.

Special protective equipment for firefighters: Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases: When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Do not get on skin or clothing. Wash thoroughly after handling.

Environmental precautions: Keep out of waterways.

Methods for cleaning up: Dam up. After cleaning, flush away traces with water.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions: Ensure adequate ventilation.
Safe handling advice: Avoid contact with skin and eyes. Wear suitable protective equipment.

Storage:

Technical measures/Storage conditions: Store in well ventilated area out of direct sunlight. Keep container tightly closed.

Packaging requirements: High density polyethylene (HDPE) drum or can.

Incompatible products: Strong bases, Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required.

Hand protection: Impervious gloves made of: Neoprene PVC

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Polyethylene glycol monohexyl ether	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Liquid
Odour: Alcohols
Colour: Clear Yellow

Important Health, Safety and Environmental Information

pH: 9-11
Boiling point/range: ~100 °C
Flash point: Does not flash.
Explosive properties:
Explosion data - sensitivity to mechanical impact: No information available.
Explosion data - sensitivity to static discharge: No information available
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None known
Relative density: ~ 1.0 (@ 20°C)
Solubility:
Water solubility: Soluble
Fat solubility: No information available.
Partition coefficient (n-octanol/water): See also section 12
Viscosity: 5-50 kPa.s (@ 16 °C)
Vapour density: No information available.
Vapour pressure: No information available.
Evaporation rate: No information available.

Other information

Melting point/range: 5 °C

10. STABILITY AND REACTIVITY

Stability: Stable under recommended storage conditions.

Conditions to avoid: Heat.

Materials to avoid: Strong bases, Oxidizing agents

Hazardous decomposition products: When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.

Hazardous polymerization: Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin: May cause skin irritation.

Eyes: Risk of serious damage to eyes.

Inhalation: No effect expected. Prolonged or repeated contact may cause mild irritation.

Ingestion: Accidental ingestion of small amounts is not expected to cause adverse effects. Swallowing large amounts may be harmful.

Sensitization - skin: Not known to cause allergic reaction.

Chronic Health Hazard

Carcinogenic effects: None known.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Polyethylene glycol monohexyl ether

Bioaccumulation: No information available

Persistence and degradability: No information available

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. TRANSPORT INFORMATION

UN number: None
Shipping name: Not regulated.

ADR/RID
Class: Not regulated

IMDG/IMO
Class or Div.: Not regulated

ICAO/IATA
Class or Div.: Not regulated

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

Indication of danger
- Xi - Irritant

R-phrase(s):
- R41 - Risk of serious damage to eyes.

S-phrase(s):
- S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S39 - Wear eye/face protection.

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 11 April 2011*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Hydrochloric Acid 32% Unihibited H32**

Product Code: **H032**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as an acidizing additive in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger: C - Corrosive.

Most important hazards
R-phrase(s): Causes burns. Irritating to respiratory system.
Health hazards: Causes severe eye burns. Causes severe skin burns. Causes burns to respiratory tract. Causes burns to mouth, throat and stomach.

S-phrase(s): S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

Safety Combination Phrases: S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.

Environmental hazard: None known.

Main physical hazards: Corrosive to metals.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification
Hydrochloric acid	7647-01-0	231-595-7	32	C;R34-37

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Seek medical attention at once. If breathing has stopped, begin artificial respiration.

Skin contact:	Take off contaminated clothing and shoes immediately. After contact with skin, wash immediately with plenty of soap and water for at least 15 minutes. Seek medical attention at once.
Eye contact:	Immediately flush eyes with water for 30 minutes while holding eyelids open. Seek medical attention at once.
Ingestion:	Do NOT induce vomiting. Drink large quantities of milk (preferred) or water. Give milk of magnesia. Seek medical attention at once.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:	The product itself does not burn. Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Wear self-contained breathing apparatus and protective suit.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	Gives off hydrogen by reaction with metals.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Avoid contact with eyes. Do not get on skin or clothing. Wash thoroughly after handling. Wear suitable protective equipment. See also section 8.
Environmental precautions:	Prevent further leakage or spillage. Keep out of waterways.
Methods for cleaning up:	Dam up. Neutralize with lime milk or soda and flush with plenty of water. Put into suitable containers for disposal. See also section 13.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions:	Ensure adequate ventilation.
Safe handling advice:	Keep airborne concentrations below exposure limits. Use personal protective equipment. See also section 8.

Storage:

Technical measures/Storage conditions:	Keep container tightly closed. Store in well ventilated area out of direct sunlight.
Packaging requirements:	High density polyethylene (HDPE) drum or can.

Incompatible products: Strong bases, Metals, Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation, Keep airborne concentrations below exposure limits

Respiratory protection: Use NIOSH approved respirator with organic vapor/acid gas protection (color coded yellow).

Hand protection: Impervious gloves made of: Neoprene Butyl Nitrile

Eye protection: Chemical splash goggles and face shield.

Skin and body protection: Chemical resistant suit. Chemical resistant boots.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Hydrochloric acid	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Liquid (fumes)
Odour: Pungent
Colour: Colorless, - , Light yellow

Important Health, Safety and Environmental Information

pH: < 2
Boiling point/range: 55 °C
Flash point: Not combustible
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None
Relative density: 1.2 (@ 16°C)
Solubility:
Water solubility: Soluble
Fat solubility: No information available.
Partition coefficient (n-octanol/water): Not applicable.
Viscosity: 1.7 mPa.s (@ 20 °C)
Vapour density: 1.3 (air = 1)
Vapour pressure: 18.9 kPa (@ 25°C)

Evaporation rate:	No data available.
Other information	
Melting point/range:	-35 °C

10. STABILITY AND REACTIVITY

Stability:	Stable under recommended storage conditions.
Conditions to avoid:	Heat.
Materials to avoid:	Bases, Metals, Oxidizing agents
Hazardous decomposition products:	Chlorine, chlorine oxides, hydrogen chloride. May release hydrogen gas (explosive) on contact with metals.
Hazardous polymerization:	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin:	Corrosive; rapidly causes pain, burns, redness, swelling and damage to tissue.
Eyes:	Corrosive. Rapidly causes pain, burns, corneal injury. May cause permanent damage and blindness.
Inhalation:	Corrosive. Short exposure can injure lungs, throat, and mucous membranes. Causes pain, burns, choking, and coughing.
Ingestion:	Corrosive. Causes pain and severe burns to mouth, throat and stomach.
Sensitization - skin:	Not known to cause allergic reaction.
Sensitization - lung:	Not known to cause allergic reaction

Chronic Health Hazard

Carcinogenic effects:	None known.
Mutagenic effects:	Not known to cause heritable genetic damage.
Teratogenic effects:	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity:	Not known to adversely affect reproductive functions and organs.
Target organ effects:	Eyes. Skin. Respiratory system.

Component	**LD50 / LC50**
Hydrochloric acid	- = 3124 ppm (Inhalation LC50; Rat) 1 h = 700 mg/kg (Oral LD50; Rat) > 5010 mg/kg (Dermal LD50; Rabbit)

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Hydrochloric acid

Bioaccumulation:	Not applicable
Persistence and degradability:	The methods for determining biodegradability are not applicable to inorganic substances
Freshwater Fish Species Data	LC50 96 h (Gambusia affinis) = 282 mg/L

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products:	Dispose of as special waste in compliance with local and national regulations
Contaminated packaging:	Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. TRANSPORT INFORMATION

UN number:	UN 1789
Shipping name:	HYDROCHLORIC ACID SOLUTION (32%)

ADR/RID

Class:	8
Classification Code:	C1
Packing Group:	II
ADR/RID-Labels	8
Hazard ID	80

IMDG/IMO

Class or Div.:	8
Packing Group:	II
EmS:	F-A, S-B

ICAO/IATA

Class or Div.:	8	
Packing group:	II	
Packing instruction (passenger aircraft):	851	**Max Net Qty/Pkg:** 1 L
Packing instruction (cargo aircraft):	855	**Max Net Qty/Pkg:** 30 L

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

contains: Hydrochloric acid .

Indication of danger:
- C - Corrosive

C

R-phrase(s):
- R34 - Causes burns.
- R37 - Irritating to respiratory system.

S-phrase(s):
- S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
- S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Text of R phrases mentioned in Section 3
- R37 - Irritating to respiratory system.
- R34 - Causes burns.

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End of Safety Data Sheet

Schlumberger

Safety Data Sheet

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 07/Jan/2013*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: **High-Temperature Gel Stabilizer J353L**

Product code: **J353L**

Company Identification:
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency telephone number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. Hazards Identification

Indication of danger The product is non-dangerous in accordance with Directive 1999/45/EC.

Most Important Hazards
Health hazards: Mild eye irritation.

Environmental hazard: None known.

Special precautions: Liberates poisonous sulfur dioxide gas on contact with acid

3. Composition/information on Ingredients

component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Sodium thiosulphate	7772-98-7	231-867-5	10 - 30	-

4. First Aid Measures

Inhalation: Move to fresh air.

Skin contact: Rinse with water.

Eye contact: Rinse with water.

Ingestion: Rinse mouth. Never give anything by mouth to an unconscious person.

5. Fire-fighting Measures

Suitable extinguishing media:	The product itself does not burn. Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	Thermal decomposition can lead to release of irritating gases and vapours.

6. Accidental Release Measures

Personal Precautions:	No special precautions required.
Environmental Precautions:	Large spills released to the environment may disturb the natural chemical balance of soil/fresh water. Prevent further leakage or spillage.
Methods for cleaning up:	Dam up. Put into suitable containers for disposal. After cleaning, flush away traces with water.

7. Handling and Storage

Handling:

Technical measures/Precautions:	DO NOT use metal containers.
Safe handling advice:	Keep away from direct sunlight. See also section 8.

Storage:

Technical measures/Storage conditions:	Keep away from direct sunlight.
Packaging requirements:	High density polyethylene (HDPE) drum or can.
Incompatible products:	Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: No special technical protective measures required

Respiratory protection: No information available.

Hand protection: Rubber gloves

Eye protection: It is good practice to wear goggles when handling any chemical.

Skin and body protection: No special precautions required. Remove and wash contaminated clothing before re-use.

Environmental exposure controls

Exposure limit(s)

component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Sodium thiosulphate	none	none

9. Physical and Chemical Properties

General information

Form: Liquid
Odour: None
Colour: light yellow

Important health, safety and environmental information

pH: 7 - 9
Boiling point/range: No data available
Flash Point: Does not flash.
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None
Relative density: 1.3 (@ 17°C)
Bulk density: Not applicable
Solubility:
Water solubility: Soluble
Fat solubility: Insoluble

Partition coefficient (n-octanol/water):	Not applicable
Viscosity:	No data available
Vapor density:	No data available
Vapor pressure:	No data available
Evaporation Rate:	No data available

Other information

Melting point/range:	No data available

10. Stability and Reactivity

Stability:	Stable under recommended storage conditions.
Conditions to Avoid:	None known.
Materials to avoid:	Oxidizing agents
Hazardous decomposition products:	Sulfur oxides.
Hazardous polymerization:	Hazardous polymerisation does not occur.

11. Toxicological Information

Local effects

skin:	No effect expected. Prolonged or repeated exposure may cause mild irritation.
Eyes:	May be mildly irritating.
Inhalation:	May be mildly irritating.
Ingestion:	No effect expected.
Sensitization - skin:	Not known to cause allergic reaction.
Sensitization - lung:	Not known to cause allergic reaction

Chronic Health Hazard:

Carcinogenic effects:	None known.
Mutagenic effects:	Not known to cause heritable genetic damage.
Teratogenic effects:	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity:	Not known to adversely affect reproductive functions and organs.
Target Organ Effects:	None known.

12. Ecological Information

Ecotoxicity

Aquatic toxicity: This product has no known eco-toxicological effects. See component information below.

Component Information

Sodium thiosulphate

Bioaccumulation: not applicable

Persistence and degradability: not applicable

Freshwater Fish Species Data 24000 mg/L LC50 (Gambusia affinis) = 96 h

13. Disposal Considerations

Waste from residues / unused products: In accordance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. Transport Information

UN number: Not classified as dangerous in the meaning of transport regulations

Shipping name: Not regulated

ADR/RID

Class: Not regulated

IMDG/IMO

Class or Div.: Not regulated

ICAO/IATA

Class or Div.: Not regulated

15. Regulatory Information

In accordance with the criteria of NOHSC

Indication of danger

• The product is non-dangerous in accordance with Directive 1999/45/EC

R-phrase(s):

• none

S-phrase(s):
• Exercise reasonable care and cleanliness

International Inventories

Australia (AICS):	All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. Other Information

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

Safety Data Sheet

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 05/Oct/2012*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: **Stabilizer J450**

Product code: **J450**

Company Identification:
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. Hazards Identification

Indication of danger The product is non-dangerous in accordance with Directive 1999/45/EC.

Most Important Hazards
Health hazards: May be mildly irritating to eyes. May cause sensitization by skin contact.

Environmental hazard: None known.

Main physical hazards: Combustible material.

3. Composition/information on Ingredients

component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
2,2`,2"-nitrilotriethanol	102-71-6	203-049-8	60 - 100	-

For the full text of the R phrases mentioned in this Section, see Section 16

4. First aid measures

INHALATION: Move to fresh air. Consult a doctor if necessary.

Skin contact: Wash off immediately with soap and plenty of water. Seek medical attention if irritation occurs.

Eye contact: Immediately flush eyes with water for 15 minutes while holding eyelids open. Seek medical attention.

Ingestion: Rinse mouth. Consult a doctor if necessary.

5. Fire-fighting measures

Suitable extinguishing media: Water Fog, Alcohol Foam, CO2, Dry Chemical.

Extinguishing media which must not be used for safety reasons: None known.

Special protective equipment for firefighters: Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases: Combustible material. When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.

6. Accidental release measures

Personal Precautions: Do not get on skin or clothing. Wash thoroughly after handling. See also section 8. Wear suitable protective equipment.

Environmental Precautions: Prevent further leakage or spillage. Keep out of waterways.

Methods for cleaning up: Dam up. Soak up with inert absorbent material. Shovel into suitable container for disposal. See also section 13.

7. Handling and Storage

Handling:

Technical measures/Precautions: Ensure adequate ventilation. Keep away from heat, sparks, and flame.

Safe handling advice: Keep airborne concentrations below exposure limits. Wear suitable protective equipment. See also section 8.

Storage:

Technical measures/Storage conditions: Do not store in contact with aluminum. Keep containers tightly closed in a dry, cool and well-ventilated place.

Packaging requirements: Steel or high density polyethylene (HDPE) container.

Incompatible products: Aluminium, Strong acids, Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: Control the source, Ensure adequate ventilation, Keep airborne concentrations below exposure limits

Respiratory protection: No personal respiratory protective equipment normally required. In case of insufficient ventilation, wear suitable respiratory equipment.

Hand protection: (Bad file name)

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
2,2`,2"-nitrilotriethanol	5 mg/m^3	none

9. Physical and Chemical Properties

General information

Form: Liquid
Odour: amine-like
Colour: colourless

Important health, safety and environmental information

pH: ~ 11
Boiling point/range: 121 °C
Flash Point: 196 °C
Method: Tag Closed Cup
Explosive properties:
Explosion data - sensitivity to mechanical impact: none
Explosion data - sensitivity to static discharge: none
Flammability Limits in Air:
lower: none

upper:	none
Oxidizing properties:	None known
Relative density:	1.1 (@ 20°C)
Bulk density:	not applicable
Solubility:	
Water solubility:	Soluble
Fat solubility:	No information available
Partition coefficient (n-octanol/water):	See also section 12
Viscosity:	140 mPa.s (@ 20 °C)
Vapor density:	1.1 (air = 1)
Vapor pressure:	< 0.001 kPa (@ 20°C)
Evaporation Rate:	no data available

OTHER INFORMATION

Melting point/range: -9 °C

10. Stability and Reactivity

Stability: Stable under recommended storage conditions.

Conditions to Avoid: Keep away from heat and sources of ignition.

Materials to avoid: Aluminium, Oxidizing agents, Strong acids

Hazardous decomposition products: When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.

Hazardous polymerization: Hazardous polymerisation does not occur.

11. Toxicological Information

Local effects

skin: May be mildly irritating. Prolonged or repeated exposure may damage skin.

EYES: May be mildly irritating.

INHALATION: No effect expected. Prolonged or repeated contact may cause mild irritation.

Ingestion: No effect expected.

Sensitization - skin: May cause sensitization by skin contact.

Sensitization - lung: Not known to cause allergic reaction

Chronic Health Hazard:

Carcinogenic effects: None known.

Mutagenic effects: Animal experiments showed mutagenic effects in cultured bacterial cells.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

Target Organ Effects: liver. kidney.

component	LD50 / LC50
2,2`,2"-nitrilotriethanol	- = 4190 mg/kg (Oral LD50; Rat) > 2000 mg/kg (Dermal LD50; Rabbit) > 16 mL/kg (Dermal LD50; Rat) mg/kg (oral-rat)

12. Ecological Information

ecotoxicity

Aquatic toxicity: See component information below.

Component Information

2,2`,2"-nitrilotriethanol

Bioaccumulation: log Pow = -1.4

Persistence and degradability: 57 % (OECD 301B)

Freshwater Fish Species Data 169 mg/L EC50 (Desmodesmus subspicatus) = 96 h 216 mg/L EC50 (Desmodesmus subspicatus) = 72 h

Fish toxicity: 96h LC50= >1000 mg/l (Scophthalamus maximus juvenile)

Freshwater Fish Species Data 10600 - 13000 mg/L LC50 (Pimephales promelas) = 96 h 1000 mg/L LC50 (Pimephales promelas) = 96 h 450 - 1000 mg/L LC50 (Lepomis macrochirus) = 96 h

Water Flea Data 1386 mg/L EC50 (Daphnia magna) = 24 h

13. Disposal Considerations

Waste from residues / unused products: In accordance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. Transport Information

UN number: none

Shipping name: Not regulated

ADR/RID

Class: Not regulated

IMDG/IMO

Class or Div.: Not regulated

ICAO/IATA

Class or Div.: Not regulated

15. regulatory information

In accordance with the criteria of NOHSC

Indication of danger
• The product is non-dangerous in accordance with Directive 1999/45/EC

R-phrase(s):
• none

S-phrase(s):
• Exercise reasonable care and cleanliness

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. other information

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

Safety Data Sheet

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 07/Jan/2013*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: **YF100HTD Crosslinker Delay Agent J480**

Product code: **J480**

Company Identification:
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency telephone number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. Hazards Identification

Indication of danger The product is non-dangerous in accordance with Directive 1999/45/EC.

Most Important Hazards
Health hazards: May be mildly irritating to eyes.

Environmental hazard: None known.

Main physical hazards: Dust.

3. Composition/information on Ingredients

component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Aliphatic acid salt		Listed	60 - 100	-

4. First Aid Measures

Inhalation: Move to fresh air.

Skin contact: Rinse with water.

Eye contact: Consult a doctor if necessary. Flush eyes with water as a precaution.

Ingestion: Consult a doctor if necessary. Rinse mouth.

5. Fire-fighting Measures

Suitable extinguishing media:	Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	Thermal decomposition can lead to release of irritating gases and vapours.

6. Accidental Release Measures

Personal Precautions:	Wear suitable protective equipment.
Environmental Precautions:	Prevent further leakage or spillage. Should not be released into the environment.
Methods for cleaning up:	Shovel into suitable container for disposal. After cleaning, flush away traces with water.

7. Handling and Storage

Handling:

Technical measures/Precautions: **Safe handling advice:**	Avoid dust formation. Provide appropriate exhaust ventilation at places where dust is formed.

Storage:

Technical measures/Storage conditions:	Store in well ventilated area out of direct sunlight. Keep containers tightly closed in a dry, cool and well-ventilated place.
Packaging requirements:	Paper bag (minimum 3 ply), or other industrial container designed for powders and granulated materials.
Incompatible products:	Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required.

Hand protection: Rubber gloves

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Aliphatic acid salt	none	none

9. Physical and Chemical Properties

General information

Form: powder
Odour: None
Colour: white - yellow

Important health, safety and environmental information

pH: 6.5 - 8
pH concentration: 10 g/l
Boiling point/range: Not applicable
Flash Point: Not applicable
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None
Flammability Limits in Air:
lower: No information available
upper: No information available
Oxidizing properties: None
Relative density: 1.2 (@ 20°C)
Bulk density: 650 kg/m^3
Solubility:

Water solubility:	590 g/l (@ 25°C)
Fat solubility:	No information available
Partition coefficient (n-octanol/water):	Does not bioaccumulate.
Viscosity:	Not applicable
Vapor density:	Not applicable
Vapor pressure:	Not applicable
Evaporation Rate:	Not applicable

Other information

Melting point/range: Decomposes @175 °C

10. Stability and Reactivity

Stability: Stable under recommended storage conditions.

Conditions to Avoid: Avoid dust formation.

Materials to avoid: Oxidizing agents

Hazardous decomposition products: When heated strongly or burned, oxides of carbon and harmful organic chemical fumes are released.

Hazardous polymerization: Hazardous polymerisation does not occur.

11. Toxicological Information

Local effects

skin: No effect expected.

Eyes: May be mildly irritating.

Inhalation: No effect expected.

Ingestion: No effect expected.

Sensitization - skin: Not known to cause allergic reaction.

Sensitization - lung: Not known to cause allergic reaction

Chronic Health Hazard:

Carcinogenic effects: None known.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

Target Organ Effects: None known.

12. Ecological Information

Ecotoxicity

Component Information

Aliphatic acid salt

Bioaccumulation:	log Pow = <0
Persistence and degradability:	READILY BIODEGRADABLE
Algae toxicity:	72h EC50=>1000 mg/l (Skeletonema costatum)
Crustacean toxicity:	48h LC50= 1000 mg/l (Acartia tonsa)
Fish toxicity:	96h LC50= 3000 mg/l (Scophthalamus maximus juvenile)

13. Disposal Considerations

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Dispose of in accordance with local regulations

14. Transport Information

UN number: Not classified as dangerous in the meaning of transport regulations
Shipping name: Not regulated

ADR/RID
Class: Not regulated

IMDG/IMO
Class or Div.: Not regulated

ICAO/IATA
Class or Div.: Not regulated

15. Regulatory Information

In accordance with the criteria of NOHSC

Indication of danger
• The product is non-dangerous in accordance with Directive 1999/45/EC

R-phrase(s):
• none

S-phrase(s):
• Exercise reasonable care and cleanliness

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. Other Information

Prepared by: Chemical Regulatory Compliance

The information and recommendations contained herein are based upon tests believed to be reliable. However, Schlumberger does not guarantee their accuracy or completeness NOR SHALL ANY OF THIS INFORMATION CONSTITUTE A WARRANTY, WHETHER EXPRESSED OR IMPLIED, AS TO THE SAFETY OF THE GOODS, THE MERCHANTABILITY OF THE GOODS, OR THE FITNESS OF THE GOODS FOR A PARTICULAR PURPOSE. Adjustment to conform to actual conditions of usage may be required. Schlumberger assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet

Schlumberger

SAFETY DATA SHEET
Breaker J481

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

1.1. Product identifier

Product name Breaker J481

Product No. J481

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

Identified uses Fracturing additive.

Uses advised against No specific uses advised against are identified.

1.3. Details of the supplier of the safety data sheet

Supplier
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth
WA 6000

Manufacturer
Schlumberger
Woodlands Drive,
Kirkhill Industrial Estate,
Dyce. Aberdeen. AB21 0GW
Scotland.UK
Tel: +44(0)-1224 246690
Fax: +44(0)1224 246699
Email:SDS@slb.com

1.4. Emergency telephone number

USA: +1 281 595 3518 (24h)

SECTION 2: HAZARDS IDENTIFICATION

2.1. Classification of the substance or mixture

Classification (EC 1272/2008)

Physical and Chemical Hazards	Ox. Sol. 1 - H271
Human health	Acute Tox. 4 - H302;Skin Irrit. 2 - H315;Eye Irrit. 2 - H319
Environment	Not classified.

Classification (67/548/EEC) Xn;R22. Xi;R36/38. O;R9.

The Full Text for all R-Phrases and Hazard Statements are Displayed in Section 16.

2.2. Label elements

Contains SODIUM BROMATE

Label In Accordance With (EC) No. 1272/2008

Signal Word Danger

Hazard Statements

H271	May cause fire or explosion; strong oxidiser.
H302	Harmful if swallowed.
H315	Causes skin irritation.
H319	Causes serious eye irritation.

Precautionary Statements

P280	Wear protective gloves/protective clothing/eye protection/face protection.
P305+351+338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P314	Get medical advice/attention if you feel unwell.
P405	Store locked up.

Supplementary Precautionary Statements

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P220	Keep away from combustible materials.
P221	Take any precaution to avoid mixing with combustibles.
P270	Do not eat, drink or smoke when using this product.
P283	Wear fire/flame resistant/retardant clothing.
P264	Wash contaminated skin thoroughly after handling.
P321	Specific treatment (see medical advice on this label).
P370+378	In case of fire: Use foam, carbon dioxide, dry powder or water fog for extinction.
P301+312	IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell.
P302+352	IF ON SKIN: Wash with plenty of soap and water.
P306+360	IF ON CLOTHING: rinse immediately contaminated clothing and skin with plenty of water before removing clothes.
P313	Get medical advice/attention.
P330	Rinse mouth.
P332+313	If skin irritation occurs: Get medical advice/attention.
P337	If eye irritation persists:
P362	Take off contaminated clothing and wash before reuse.
P371+380+375	In case of major fire and large quantities: Evacuate area. Fight fire remotely du to the risk of explosion.
P501	Dispose of contents/container to …

2.3. Other hazards

Not Classified as PBT/vPvB by current EU criteria.

SECTION 3: COMPOSITION/INFORMATION ON INGREDIENTS

3.1. Substances

SODIUM BROMATE **60-100%**

CAS-No.: 7789-38-0 **EC No.: 232-160-4**

Classification (EC 1272/2008)	Classification (67/548/EEC)
Ox. Liq. 1 - H271	Xn;R22.
Acute Tox. 4 - H302	Xi;R36/38.
Skin Irrit. 2 - H315	O;R9.
Eye Irrit. 2 - H319	

The Full Text for all R-Phrases and Hazard Statements are Displayed in Section 16.

Composition Comments

The data shown is in accordance with the latest EC Directives.

SECTION 4: FIRST AID MEASURES

4.1. Description of first aid measures

Inhalation

Move the exposed person to fresh air at once. If respiratory problems, artificial respiration/oxygen. Get medical attention.

Ingestion

Rinse mouth thoroughly. Get medical attention.

Skin contact

Remove contaminated clothing immediately and wash skin with soap and water. Get medical attention promptly if symptoms occur after washing.

Eye contact

Make sure to remove any contact lenses from the eyes before rinsing. Promptly wash eyes with plenty of water while lifting the eye lids. Continue to rinse for at least 15 minutes. Get medical attention if any discomfort continues.

4.2. Most important symptoms and effects, both acute and delayed

Inhalation.

High concentrations of dust may irritate throat and respiratory system and cause coughing. May cause methemoglobinemia (blue skin)

Ingestion

May irritate and cause stomach pain, vomiting and diarrhoea. May cause drowsiness or dizziness.

Skin contact

Prolonged skin contact may cause redness and irritation.

Eye contact

Irritating and may cause redness and pain. Visual disturbances including blurred vision

4.3. Indication of any immediate medical attention and special treatment needed

Get medical attention.

SECTION 5: FIREFIGHTING MEASURES

5.1. Extinguishing media

Extinguishing media

Use fire-extinguishing media appropriate for surrounding materials.

5.2. Special hazards arising from the substance or mixture

Hazardous combustion products

When heated, vapours/gases hazardous to health may be formed. Bromine. Hypobromite (BrO) Hydrogen bromide (HBr).

Unusual Fire & Explosion Hazards

High concentrations of dust may form explosive mixture with air.

Specific hazards

50 Oxidising (fire-intensifying) substance.

5.3. Advice for firefighters

Special Fire Fighting Procedures

Containers close to fire should be removed immediately or cooled with water.

Protective equipment for fire-fighters

Self contained breathing apparatus and full protective clothing must be worn in case of fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

6.1. Personal precautions, protective equipment and emergency procedures

Wear protective clothing as described in Section 8 of this safety data sheet.

6.2. Environmental precautions

Do not allow to enter drains, sewers or watercourses. Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

Avoid generation and spreading of dust. Shovel into dry containers. Cover and move the containers. Flush the area with water.

6.4. Reference to other sections

Wear protective clothing as described in Section 8 of this safety data sheet.

SECTION 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

Avoid inhalation of dust and contact with skin and eyes. Avoid handling which leads to dust formation.

7.2. Conditions for safe storage, including any incompatibilities

Store in tightly closed original container in a dry, cool and well-ventilated place. Oxidising material - Keep away from flammable and combustible materials.

7.3. Specific end use(s)

Fracturing additive.

SECTION 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

Ingredient Comments

No exposure limits noted for ingredient(s).

8.2. Exposure controls

Protective equipment

Process conditions

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures

Provide adequate general and local exhaust ventilation.

Respiratory equipment

In case of inadequate ventilation or risk of inhalation of dust, use suitable respiratory equipment with particle filter (type P2).

Hand protection

Protective gloves must be used if there is a risk of direct contact or splash. Butyl rubber gloves are recommended. PVC gloves are recommended.

Eye protection

Use approved safety goggles or face shield.

Other Protection

Wear appropriate clothing to prevent any possibility of skin contact. Provide eyewash station.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. Information on basic physical and chemical properties

Appearance	Granular
Colour	White.
Odour	No characteristic odour.
Solubility	Soluble in water.
Melting point (°C)	340°C
Relative density	3.3 @20°C
Bulk Density	2060 kg/m3
pH-Value, Diluted Solution	6 -7 (10%)
Solubility Value (G/100G H2O@20°C)	360g/L
Decomposition temperature (°C)	< 380°C

9.2. Other information

SECTION 10: STABILITY AND REACTIVITY

10.1. Reactivity

Reacts strongly with strong acids, bases, organic chemicals and certain metal combinations. Oxidising material - Keep away from flammable and combustible materials.

10.2. Chemical stability

Stable under normal temperature conditions and recommended use.

10.3. Possibility of hazardous reactions

Hazardous Polymerisation

Will not polymerise.

10.4. Conditions to avoid

Avoid heat.

10.5. Incompatible materials

Materials To Avoid

Avoid contact with: Flammable/combustible material. Acids. Aluminium. Copper. Strong reducing agents.

10.6. Hazardous decomposition products

When heated, vapours/gases hazardous to health may be formed. Bromine. Hypobromite (BrO) Hydrogen bromide (HBr). High concentrations of dust may form explosive mixture with air. 50 Oxidising (fire-intensifying) substance.

SECTION 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Acute toxicity:

Acute Toxicity (Oral LD50)

300 mg/kg Rat

Acute Toxicity (Dermal LD50)

250 mg/kg Rabbit

Aspiration hazard:

Not anticipated to present an aspiration hazard based on chemical structure.

Inhalation

Dust in high concentrations may irritate the respiratory system.

Ingestion

Harmful if swallowed.

Skin contact

Irritating to skin.

Eye contact

May cause severe irritation to eyes.

Route of entry

Inhalation. Ingestion. Skin and/or eye contact.

Target Organs

Respiratory system, lungs Kidneys Blood Gastro-intestinal tract

SECTION 12: ECOLOGICAL INFORMATION

12.1. Toxicity

Acute Fish Toxicity

Not considered toxic to fish.

EC 50, 48 Hrs, Daphnia, mg/l 380mg/L

12.2. Persistence and degradability

Degradability

There are no data on the degradability of this product.

12.3. Bioaccumulative potential

Bioaccumulative potential

No data available on bioaccumulation.

12.4. Mobility in soil

Mobility:

The product is soluble in water.

12.5. Results of PBT and vPvB assessment

Not Classified as PBT/vPvB by current EU criteria.

12.6. Other adverse effects

None known.

SECTION 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

Waste is classified as hazardous waste. Disposal to licensed waste disposal site in accordance with the local Waste Disposal Authority.

Waste Class

EWC-code: 06 13 99 EWC-code: 16 03 03

SECTION 14: TRANSPORT INFORMATION

General	The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID).

14.1. UN number

Not applicable.

UN No. (ADR/RID/ADN)	1494
UN No. (IMDG)	1494
UN No. (ICAO)	1494

14.2. UN proper shipping name

Proper Shipping Name	SODIUM BROMATE

14.3. Transport hazard class(es)

ADR/RID/ADN Class	5.1
ADR/RID/ADN Class	Class 5.1: Oxidising substances.
IMDG Class	5.1
ICAO Class/Division	5.1

Transport Labels

14.4. Packing group

ADR/RID/ADN Packing group	II
IMDG Packing group	II
ICAO Packing group	II

14.5. Environmental hazards

Environmentally Hazardous Substance/Marine Pollutant

No.

14.6. Special precautions for user

EMS	F-H, S-Q
Emergency Action Code	1Y
Hazard No. (ADR)	50
Tunnel Restriction Code	(E)

14.7. Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code

General (Chemtags) The product is not covered by international regulation on the transport of dangerous goods (IMDG, IATA, ADR/RID). Not applicable.

SECTION 15: REGULATORY INFORMATION

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

Uk Regulatory References

Chemicals (Hazard Information & Packaging) Regulations. Control of Substances Hazardous to Health Regulations 2002 (as amended) Workplace Exposure Limits EH40.

EU Legislation

Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC, including amendments.

Water hazard classification

WGK 3

15.2. Chemical Safety Assessment

International Chemical Inventories

Contact REACH@slb.com for REACH information. Complies with the following national/regional chemical inventory requirements: Australia (AICS), Canada (DSL / NDSL), China (IECSC), Europe (EINECS / ELINCS), Japan (METI / ENCS), Korea (TCCL / ECL), New Zealand (NZIoC), Phillipines (PICCS), United States (TSCA).

SECTION 16: OTHER INFORMATION

Information Sources

Product information provided by the commercial vendor(s). Material Safety Data Sheet, Misc. manufacturers. LOLI. European Chemicals Bureau - ESIS (European Chemical Substances Information).

Revision Comments

Compiled or revised by Nicola Anderson.

Issued By	Bill Cameron
Revision Date	03-Jul-2012
Revision	0

Risk Phrases In Full

R9	Explosive when mixed with combustible material.
R22	Harmful if swallowed.
R36/38	Irritating to eyes and skin.

Hazard Statements In Full

H319	Causes serious eye irritation.
H315	Causes skin irritation.
H302	Harmful if swallowed.
H271	May cause fire or explosion; strong oxidiser.

Schlumberger

Safety Data Sheet

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 07/Jan/2013*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: **EB-Clean* J490 HT Encapsulated Breaker**

Product code: **J490**

Company Identification:
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency telephone number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. Hazards Identification

Indication of danger Xn - Harmful. O - Oxidizing.

Most Important Hazards
R-phrase(s): Explosive when mixed with combustible material HARMFUL IF SWALLOWED

Risk Combination Phrases Irritating to eyes and skin

Health hazards: MAY CAUSE RESPIRATORY TRACT IRRITATION.

S-phrase(s): S22 - Do not breathe dust
Safety Combination Phrases: S24/25 - Avoid contact with skin and eyes

Environmental hazard: None known.

Main physical hazards: Oxidizer. Explosive with dry ammonium salts.

3. Composition/information on Ingredients

component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Sodium bromate	7789-38-0	232-160-4	60 - 100	O;R9 Xi;R36/38 Xn;R22

4. First Aid Measures

Inhalation:	Move to fresh air. Seek medical attention if irritation occurs.
Skin contact:	Take off contaminated clothing and shoes immediately. After contact with skin, wash immediately with plenty of soap and water for at least 15 minutes. Seek medical attention.
Eye contact:	Immediately flush eyes with water for 15 minutes while holding eyelids open. Seek medical attention.
Ingestion:	Rinse mouth. Call a physician immediately. Do not induce vomiting without medical advice.

5. Fire-fighting Measures

Suitable extinguishing media:	Deluge with water. Other methods not effective.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	Thermal decomposition can lead to release of irritating gases and vapours.

6. Accidental Release Measures

Personal Precautions:	Avoid dust formation. Avoid contact with the skin and the eyes. Use personal protective equipment. See also section 8.
Environmental Precautions:	No special environmental precautions required.
Methods for cleaning up:	Sweep up and shovel into suitable containers for disposal. After cleaning, flush away traces with water. See also section 13.

7. Handling and Storage

Handling:

Technical measures/Precautions:	Ensure adequate ventilation. Provide appropriate exhaust ventilation at places where dust is formed.

Safe handling advice: Keep airborne concentrations below exposure limits. Do not breathe dust. Avoid contact with skin and eyes. Use personal protective equipment. See also section 8.

Storage:

Technical measures/Storage conditions: Keep material dry. Do not store, transport with or allow to contact combustible materials, corrosives, reducing agents or dry ammonium salts. Store in well ventilated area out of direct sunlight.

Packaging requirements: No information available.

Incompatible products: Dry ammonium salts, Acids, Combustible material, Reducing agents, Organics, Aluminium, Copper

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: Ensure adequate ventilation, Keep airborne concentrations below exposure limits

Respiratory protection: Half mask with a particle filter P2 (BS EN 143).

Hand protection: Impervious gloves made of: Butyl , PVC

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Sodium bromate	none	none

9. Physical and Chemical Properties

General information

Form: granules Resin-coated inorganic material

Odour:	None
Colour:	white

Important health, safety and environmental information

pH:	not applicable
Boiling point/range:	Decomposes
Flash Point:	Does not flash.
Explosive properties:	
Explosion data - sensitivity to mechanical impact:	None known
Explosion data - sensitivity to static discharge:	None known
Flammability Limits in Air:	
lower:	Not applicable
upper:	Not applicable
Oxidizing properties:	Oxidizer
Relative density:	No information available
Bulk density:	1790 kg/m^3
Solubility:	
Water solubility:	Soluble
Fat solubility:	No information available
Partition coefficient (n-octanol/water):	No information available
Viscosity:	Not applicable
Vapor density:	Not applicable
Vapor pressure:	Not applicable
Evaporation Rate:	Not applicable

Other information

Melting point/range:	No data available

10. Stability and Reactivity

Stability: Stable under recommended storage conditions.

Conditions to Avoid: Decomposes with heat.

Materials to avoid: Dry ammonium salts, Acids, Reducing agents, Organics, Aluminium, Copper, Combustible material

Hazardous decomposition products: Bromine, bromine oxides and hydrogen bromide. When heated strongly or burned, oxides of carbon and harmful organic chemical fumes are released. Hydrogen chloride.

Hazardous polymerization: Hazardous polymerisation does not occur.

11. Toxicological Information

Local effects

skin: Irritant; may cause pain, redness, dermatitis.

Eyes: Severe eye irritation. Causes pain and redness. Prolonged or repeated contact may cause mild burn.

Inhalation: Irritant; may cause pain and coughing.

Ingestion: Harmful if swallowed; large amounts may cause illness.

Sensitization - skin: Not known to cause allergic reaction.

Chronic Health Hazard:

Carcinogenic effects: None known.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

Target Organ Effects: blood. kidney. Lungs. See component information below.

component	LD50 / LC50
Sodium bromate	- = 400 mg/kg (oral-rat) mg/kg (oral-rat)

12. Ecological Information

Ecotoxicity

Aquatic toxicity: This product has no known eco-toxicological effects. See component information below.

Component Information

Sodium bromate

Bioaccumulation: not applicable
Persistence and degradability: not applicable
Crustacean toxicity: 48h LC50= 380 mg/l (Acartia tonsa)

13. Disposal Considerations

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. Transport Information

UN number: UN 1494
Shipping name: SODIUM BROMATE MIXTURE

ADR/RID

Class:		5.1
Classification Code:	O2	
Packing Group:	II	
ADR/RID-Labels	5.1	
Hazard ID	50	

IMDG/IMO

Class or Div.:		5.1
Label(s):	5.1	
Packing Group:	II	
EmS:	F-H, S-Q	

ICAO/IATA

Class or Div.:		5.1
Label(s)	5.1	
Packing group:	II	

15. Regulatory Information

In accordance with the criteria of NOHSC

Contains: Sodium bromate.

Indication of danger
- Xn - Harmful
- O - Oxidizing

R-phrase(s):
- R 9 - Explosive when mixed with combustible material
- R22 - Harmful if swallowed
- R36/38 - Irritating to eyes and skin

S-phrase(s):
- S22 - Do not breathe dust
- S24/25 - Avoid contact with skin and eyes

International Inventories

Australia (AICS):	All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. Other Information

Text of R phrases mentioned in Section 3
- R 9 - Explosive when mixed with combustible material
- R22 - Harmful if swallowed
- R36/38 - Irritating to eyes and skin

Section(s) revised: 1

Prepared by: Chemical Regulatory Compliance

End of Safety Data Sheet

Schlumberger

MATERIAL SAFETY DATA SHEET

(USA)

(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

Version: 2 *Revision date:* 17 April 2010

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product code: **J579**

Product name: **Proppant Transport Additive J579**

Company identification:

Schlumberger Technology Corporation
110 Schlumberger Drive
Sugar Land, Texas 77478, USA
Telephone: 1-281-285-7873

Emergency telephone number: **USA: +1-281-595-3518 (24hr)**

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Main physical hazards: No classified physical hazards.

Main health hazards: No classifiable hazards known. May cause mechanical irritation. Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough.

Main environmental hazards: None known.

Other Information: Dust.

Precautions: Keep away from heat, sparks, and flame. Avoid dust formation. Incompatible with oxidizing agents.

HMIS classification:

Form: Fibers **Color:** Off-white **Odor:** None

Principle routes of exposure:
Skin contact.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight % - Range
Synthetic organic polymer	Proprietary	60-100

4. FIRST AID MEASURES

General advice: Consult a physician if necessary.

Eye contact: Rinse with water. Seek medical attention if irritation occurs.

Skin contact: Wash off with soap and water.

Ingestion: Rinse mouth. Never give anything by mouth to an unconscious person.

Inhalation: Move to fresh air.

5. FIRE-FIGHTING MEASURES

Fire hazard: Combustible material.
Flash point: Not applicable.
Autoignition temperature: No data available.
Flammability limits in air:
Lower: Not applicable
Upper: Not applicable
Oxidizing properties: None.

Suitable extinguishing media:
Compatible with all types.

Extinguishing media which must not be used for safety reasons:
None known.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:
Thermal decomposition can lead to release of irritating gases and vapors.

Special protective equipment for firefighters:
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

NFPA rating:

Health:	**1**
Flammability:	**1**
Instability:	**0**
Special:	**None**

6. ACCIDENTAL RELEASE MEASURES

Main physical hazards: No classified physical hazards.
Other Information: Dust.
Personal precautions: Wear suitable protective equipment.
Methods for cleaning up: Sweep up and shovel into suitable containers for disposal.
Environmental precautions: Keep out of waterways.

7. HANDLING AND STORAGE

Handling:
Precautions: Keep away from heat, sparks, and flame. Avoid dust formation. Incompatible with oxidizing agents.
Safe handling advice: Wear suitable protective equipment.
Technical measures/ storage conditions: No special storage conditions required.
Packaging requirements: Polyethylene bag or drum with polyethylene liner.
Incompatible products: Oxidizing agents.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Control the source.
Hygiene measures: Exercise reasonable care and cleanliness.

Respiratory protection: If dust or mist is generated use NIOSH approved respirator with dust and mist protection (3M 8210).
Eye protection: It is good practice to wear goggles when handling any chemical.
Hand protection: Cotton gloves.
Skin and body protection: No special precautions required.

Occupational Exposure Limits

	ACGIH - TLVs			OSHA - PELs		
Component	**TWA / Ceiling**	**STEL**	**ACGIH - Skin**	**TWA / C**	**STEL**	**Final PELs - Skin**
Synthetic organic polymer	-	-	-	-	-	-

Particles Not Otherwise Regulated/Specified [PNOR or PNOS] (insoluble or poorly soluble):
- OSHA PEL's for Inert or Nuisance Dust are covered by PNOR limits: respirable fraction: 5 mg/m³; total dust 15 mg/m³.
ACGIH PNOS Recommendations: airborne concentrations should be kept below 3 mg/m³, respirable particulate, and 10 mg/m³, inhalable particles.

9. PHYSICAL AND CHEMICAL PROPERTIES

Chemical characterization: Synthetic polymer.
Fire hazard: Combustible material.
Form: Fibers
Color: Off-white
Odor: None
Odor threshold: No information available.
pH: Not applicable.
Boiling point/range: Not applicable.
Flash point: Not applicable.
Flammability limits in air:
Lower: Not applicable
Upper: Not applicable
Bulk density: Not applicable.
Melting point/range: Decomposes
Decomposition temperature: > 242 °C / 468 °F
Solubility:
Water solubility: Insoluble
Fat solubility: Insoluble.
Partition coefficient (n-octanol/water): Not applicable.
Relative density: 1.2 (@ 25°C)
Vapor pressure: Not applicable.
Vapor density: Not applicable.
Viscosity: Not applicable.
Evaporation rate: Not applicable.
% Volatile (VOC): None.

10. STABILITY AND REACTIVITY

Stability:
Stable.

Conditions to avoid:
Keep away from heat, sparks, and flame.

Incompatibility with other substances:
None known.

Hazardous decomposition products:
When heated strongly or burned, oxides of carbon and harmful organic chemical fumes are released.

Hazardous polymerization:
Hazardous polymerization does not occur.

Other Information:
Dust.

11. TOXICOLOGICAL INFORMATION

PRODUCT TOXICOLOGICAL INFORMATION

Acute Health Hazard

Eye contact: May cause mechanical irritation.
Skin contact: May cause mechanical irritation.
Ingestion: This is an unlikely route of exposure. May cause mechanical irritation.
Inhalation: Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough.
Sensitization - lung: Not known to cause allergic reaction.
Sensitization - skin: Not known to cause allergic reaction.
Toxicologically synergistic products: None known.

Chronic Health Hazard

Carcinogenic effects: None known.
Mutagenic effects: None known.
Teratogenic effects: None known.
Reproductive toxicity: None known.
Target organ effects: None known.

COMPONENT TOXICOLOGICAL INFORMATION

Component	Target Organ Effects	LD50 / LC50
Synthetic organic polymer	-	-

Component	IARC Group 1 or 2:	ACGIH - Carcinogens:	OSHA Listed Carcinogens	NTP:
Synthetic organic polymer	-	-	-	-

12. ECOLOGICAL INFORMATION

PRODUCT INFORMATION

Main environmental hazards: None known.

COMPONENT INFORMATION

Synthetic organic polymer

Bioaccumulation:	Not likely to bioaccumulate because of high molecular w eight
Persistence / degradability:	Partially biodegradable.
Crustacean toxicity:	48h LC50= >195 mg/l (Acartia tonsa)

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products:
Dispose of by sanitary landfilling or other acceptable method in accordance with local regulations.

Contaminated packaging:
Dispose of in accordance with local regulations. Send empty bags to sanitary landfill. Render other types of containers unuseable by puncturing or crushing and sanitary landfill unless prohibited by local regulations.

EPA RCRA Hazardous Waste Code:
None

14. TRANSPORT INFORMATION

DOT:

CERCLA RQ:	None
Hazard class:	Not regulated.
Proper shipping name:	Not regulated
Label(s):	None required.

IMDG/IMO

Shipping name:	Not regulated.
UN number:	None

ICAO/IATA

Shipping name:	Not regulated.
UN number:	None

TDG (Canada):

Shipping name:	Not regulated.
PIN:	None

Note 1:
For the applicable placard selection refer to the appropriate transport regulations; the selection may vary depending on the cargo size and categories of other hazardous materials in the cargo.

15. REGULATORY INFORMATION

International Chemical Inventories

USA, Toxic Substances Control Act inventory (TSCA):	This product complies with TSCA requirements.
IMPORTS, USA:	No import volume restrictions.
Canada, Domestic Substance List (DSL):	This product complies with DSL requirements.
IMPORTS, Canada:	No import volume restrictions.

U.S.A. Regulations

OSHA Hazard Communication Standard:
(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

EPA RCRA Hazardous Waste Code:
None

EPA, Sections 311 and 312 - Material Safety Data Sheet Requirements (40 CFR 370):

Immediate (Acute) Health Hazard:	None
Delayed (Chronic) Health Hazard:	None
Fire Hazard:	None
Sudden Release or Pressure Hazard:	None
Reactive Hazard:	None

EPA, Sections 313 - List of Toxic Chemicals (40 CFR 372):
This product contains the following substance(s), which appear(s) on the List of Toxic Chemicals:

Additional Regulatory Information

Synthetic organic polymer

EPA, CERCLA Section 102a/103 Hazardous Substances (40 CFR 302.4): None
CERCLA/SARA - Hazardous Substances and their RQs: None
EPA, SARA TITLE III Section 304, Extremely Hazardous Substances (40 CFR 355.40): None
California Proposition 65: None

International Hazard Class

WHMIS Hazard Class:
Non-controlled product.

16. OTHER INFORMATION

Current references:

1. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. *American Conference of Governmental Industrial Hygienists, Cincinnati OH.*
2. IARC Monograms on the Evaluation of the Carcinogenic Risk of Chemicals to Man. *World Health Organization, International Agency for Research on Cancer. Geneva, Switzerland.*
3. Annual Report on Carcinogens. National Toxicology Program. *U.S. Department of Heath and Human Services, Public Health Service.*
4. NIOSH Registry of Toxic Effects of Chemical Substances (RTECS). *National Institute for Occupational safety and Health. Cincinnati, OH.*
5. LOLI Database.

Explanation of terms:
ACGIH: American Conference of Governmental Industrial Hygienist
ACGIH-TL: Threshold Limit Value
DSL: Domestic Substance List
HMIRC: Hazardous Materials Information Review Commission
IARC: International Agency for Research on Cancer
NTP: National Toxicology Program
NIOSH: National Institute of Occupational Safety & Health
NIOSH-REL: Recommended Exposure Limit
OSHA: Occupational Safety & Health Administration
OSHA-PEL: Permissible Exposure Limit
TSCA: Toxic Substance Control Act (Inventory)

Occupational Exposure Limits indicators: TWA - Time Weighted Average; STEL - Short Term Limit; C - Ceiling Limit;units: [mg/m^3]

ACGIH Notations:
"Skin" refers to the potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors or by direct skin contact with the substance.
"A" notation indicates carcinogenicity as follows:
ACGIH classification: A1 - Confirmed Human Carcinogen; A2 - Suspected Human Carcinogen; A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans; A4 - Not Classifiable as a Human Carcinogen; A5 - Not suspected as a Human Carcinogen.
"SEN" refers to the potential for an agent to product sensitization as confirmed by human and animal data.

Section(s) revised: 8

Prepared by: Chemical Regulatory Compliance (CRC)

Revision date: 17 April 2010

End of the Material Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 18 March 2011*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Water Gelling Agent J580**

Product Code: **J580**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a gelling agent in oilfield applications.

2. HAZARDS IDENTIFICATION

Most important hazards

Health hazards: May be mildly irritating to eyes.

Environmental hazard: None.

Main physical hazards: Slick when wet. Dust.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification
Carbohydrate polymer		Listed	60-100	-

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. If not breathing, give artificial respiration. Call a physician immediately.

Skin contact: Rinse with water.

Eye contact: Rinse immediately with plenty of water, also under the eyelids. Consult a physician if necessary.

Ingestion: Rinse mouth. Consult a physician if necessary. Never give anything by mouth to an unconscious person.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media: Water Fog, Alcohol Foam, CO2, Dry Chemical.

Extinguishing media which must not be used for safety reasons: None known.

Special protective equipment for firefighters: Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases: Slick when wet.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Do not breathe dust.

Environmental precautions: Prevent product from entering drains. Should not be released into the environment.

Methods for cleaning up: Sweep up and shovel into suitable containers for disposal. Avoid dust formation. After cleaning, flush away traces with water.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions: Avoid dust formation.

Safe handling advice: Ensure adequate ventilation. Dust may form explosive mixture in air.

Storage:

Technical measures/Storage conditions: Keep material dry.

Packaging requirements: Bag with moisture barrier.

Incompatible products: Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required.

Hand protection: Rubber gloves.

Eye protection: Safety glasses with side-shields.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Carbohydrate polymer	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Powder
Odour: mild
Colour: Light yellow

Important Health, Safety and Environmental Information

pH: 5.5 - 7.5
pH concentration: 10 g/l
Boiling point/range: Not applicable.
Flash point: Not applicable.
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None known
Flammability Limits in Air:
lower: not determined.
upper: not determined.
Oxidizing properties: None
Relative density: 0.7 (@ 25°C)
Bulk density: > 430 kg/m^3
Solubility:
Water solubility: Gels on contact with water.
Fat solubility: Insoluble.
Partition coefficient (n-octanol/water): Does not bioaccumulate.
Viscosity: Not applicable.
Vapour density: Not applicable.
Vapour pressure: Not applicable.
Evaporation rate: Not applicable.

Other information

Melting point/range: Decomposes

10. STABILITY AND REACTIVITY

Stability: Stable at normal conditions.

Conditions to avoid:	Avoid dust formation.
Materials to avoid:	Oxidizing agents
Hazardous decomposition products:	When heated strongly or burned, oxides of carbon and harmful organic chemical fumes are released.
Hazardous polymerization:	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin:	No effect expected.
Eyes:	May cause slight irritation.
Inhalation:	Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough.
Ingestion:	This is an unlikely route of exposure. No effect expected.
Sensitization - skin:	Not known to cause allergic reaction.
Sensitization - lung:	Not known to cause allergic reaction

Chronic Health Hazard

Carcinogenic effects:	None known.
Mutagenic effects:	Not known to cause heritable genetic damage.
Teratogenic effects:	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity:	Not known to adversely affect reproductive functions and organs.
Target organ effects:	None known.

Component	**LD50 / LC50**
Carbohydrate polymer	- = 6770 mg/kg (Oral LD50; Rat)

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Carbohydrate polymer

Bioaccumulation:	Does not bioaccumulate
Persistence and degradability:	Readily biodegradable
Other information:	Listed on PLONOR list of OSPAR

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal
Send empty bags to sanitary landfill. Render other types of containers unuseable by puncturing or crushing and sanitary landfill unless prohibited by local regulations

14. TRANSPORT INFORMATION

UN number: None
Shipping name: Not regulated.

ADR/RID
Class: Not regulated

IMDG/IMO
Class or Div.: Not regulated

ICAO/IATA
Class or Div.: Not regulated

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

Indication of danger:
None

R-phrase(s):
None

S-phrase(s):
Exercise reasonable care and cleanliness

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Prepared by: Chemical Regulatory Compliance

The information and recommendations contained herein are based upon tests believed to be reliable. However, Schlumberger does not guarantee their accuracy or completeness NOR SHALL ANY OF THIS INFORMATION CONSTITUTE A WARRANTY, WHETHER EXPRESSED OR IMPLIED, AS TO THE SAFETY OF THE GOODS, THE MERCHANTABILITY OF THE GOODS, OR THE FITNESS OF THE GOODS FOR A PARTICULAR PURPOSE. Adjustment to conform to actual conditions of usage may be required. Schlumberger assumes no responsibility for results obtained or for incidental or consequential damages, including lost profits arising from the use of these data. No warranty against infringement of any patent, copyright or trademark is made or implied.

End of Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 06 May 2011*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Crosslinker L10**

Product Code: **L010**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Crosslinker in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger: T - Toxic.

Most important hazards R-phrase(s): May cause harm to the unborn child. May impair fertility.

Health hazards: May be mildly irritating to eyes. May be mildly irritating if inhaled.

S-phrase(s): S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). S53 - Avoid exposure - obtain special instructions before use.

Environmental hazard: None known.

Main physical hazards: Dust.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification
Boric acid	10043-35-3	233-139-2	60 - 100	Repr.Cat2;R60-61

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air.

Skin contact: Wash off immediately with soap and plenty of water removing all contaminated clothes and shoes. Seek medical attention if irritation occurs.

Eye contact: Flush eyes with water as a precaution. Seek medical attention if irritation occurs.

Ingestion: Rinse mouth. Drink large quantities of milk (preferred) or water. Seek medical attention.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media: The product itself does not burn. Use extinguishing media appropriate for surrounding material.

Extinguishing media which must not be used for safety reasons: None known.

Special protective equipment for firefighters: No special protective measures against fire required.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases: None known.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Wear suitable protective equipment. Do not breathe dust.

Environmental precautions: Should not be released into the environment.

Methods for cleaning up: Shovel into suitable container for disposal. After cleaning, flush away traces with water.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions: Ensure adequate ventilation.
Safe handling advice: Avoid dust formation. Avoid contact with skin and eyes.

Storage:

Technical measures/Storage conditions: Keep material dry. Keep containers tightly closed in a dry, cool and well-ventilated place.

Packaging requirements: Paper bag (minimum 3 ply), or other industrial container designed for powders and granulated materials.

Incompatible products: Strong bases

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required. In case of insufficient ventilation, wear suitable respiratory equipment. Suitable mask with particle filter P3 (European Norm 143).

Hand protection: Impervious gloves made of: Butyl PVC

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Boric acid	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Granules
Odour: None
Colour: White

Important Health, Safety and Environmental Information

pH: 5.1
pH concentration: 10 g/l
Boiling point/range: Decomposes
Flash point: Does not flash.
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None known
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None
Relative density: 1.4 (@ 20°C)
Bulk density: 500 kg/m^3
Solubility:
Water solubility: 46 g/l (@ 20°C)
Fat solubility: Insoluble.
Partition coefficient (n-octanol/water): Not applicable.
Viscosity: Not applicable.
Vapour density: Not applicable.
Vapour pressure: Not applicable.
Evaporation rate: Not applicable.

Other information

Melting point/range: >171 °C

10. STABILITY AND REACTIVITY

Stability: Stable under recommended storage conditions.

Conditions to avoid: None known.

Materials to avoid: Strong bases

Hazardous decomposition products: none.

Hazardous polymerization: Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin: No effect expected.

Eyes: May be mildly irritating. May cause mechanical irritation.

Inhalation: No effect expected. Prolonged or repeated contact may cause mild irritation.

Ingestion: Swallowing large amounts may be harmful.

Sensitization - skin: Not known to cause allergic reaction.

Chronic Health Hazard

Carcinogenic effects: A component of this product is listed in EC Annex I as a carcinogen category 2.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: May cause harm to the unborn child..

Reproductive toxicity: Possible risk of harm to the unborn child.. Possible risk of impaired fertility.

Component	**LD50 / LC50**
Boric acid	- = 2660 mg/kg (Oral LD50; Rat) > 2000 mg/kg (Dermal LD50; Rabbit) > 0.16 mg/L (Inhalation LC50; Rat) 4 h 2 mg/m³ mg/kg (oral-rat)

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Boric acid

Bioaccumulation: Not applicable

Persistence and degradability: Not applicable

Algae toxicity: 72h EC50= 220 mg/l (Skeletonema costatum)

Freshwater Fish Species Data	LC50 72 h (Carassius auratus) = 1020 mg/L
Water Flea Data	EC50 48 h (water flea) = 115.0 mg/L EC50 48 h (Daphnia magna) = 658 - 875 mg/L

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Dispose of in accordance with local regulations

14. TRANSPORT INFORMATION

UN number: None
Shipping name: Not regulated.

ADR/RID
Class: Not regulated

IMDG/IMO
Class or Div.: Not regulated

ICAO/IATA
Class or Div.: Not regulated

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

contains: Boric acid.

Indication of danger:
- T - Toxic

R-phrase(s):
- R60 - May impair fertility.
- R61 - May cause harm to the unborn child.

S-phrase(s):
- S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
- S53 - Avoid exposure - obtain special instructions before use.

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Text of R phrases mentioned in Section 3

- R61 - May cause harm to the unborn child.
- R60 - May impair fertility.

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 2 *Revision date: 30 April 2012*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **L071 Temporary Clay Stabilizer**

Product Code: **L071**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: For industrial use only. Additive in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger The product is non-dangerous in accordance with Directive 1999/45/EC.

Most important hazards
Health hazards: May be mildly irritating to eyes. May be mildly irritating to skin.

Environmental hazard: None known.

Main physical hazards: None known.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Cholinium chloride	67-48-1	200-655-4	70-75	-

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Consult a physician if necessary.

Skin contact: Wash off immediately with soap and plenty of water. Consult a physician if necessary.

Eye contact: Immediately flush eye(s) with plenty of water. Seek medical attention if irritation occurs.

Ingestion: Do not induce vomiting without medical advice. Seek medical attention.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:	Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Use self-contained breathing apparatus in closed areas. Wear protective fire fighting clothing and avoid breathing vapors.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released. Chlorine, chlorine oxides, hydrogen chloride.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Avoid contact with the skin and the eyes. Use personal protective equipment.
Environmental precautions:	None known.
Methods for cleaning up:	Dam up. Put into suitable containers for disposal.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions:	No special precautions required.
Safe handling advice:	Avoid contact with skin and eyes. Use personal protective equipment.

Storage:

Technical measures/Storage conditions:	Keep containers tightly closed in a dry, cool and well-ventilated place.
Packaging requirements:	High density polyethylene (HDPE) drum or can.
Incompatible products:	Strong acids, Strong bases, Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required.

Hand protection: Impervious gloves made of: Rubber PVC disposable gloves

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Cholinium chloride	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Liquid
Odour: amine-like
Colour: Amber - blue

Important Health, Safety and Environmental Information

pH: 6.5 - 8.5
Boiling point/range: No data available.
Flash point: Does not flash.
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None known
Relative density: 1.1
Solubility:
Water solubility: Soluble
Fat solubility: No information available.
Partition coefficient (n-octanol/water): No information available.
Viscosity: No information available.

Vapour density:	No information available.
Vapour pressure:	No information available.
Evaporation rate:	No information available.

Other information

Melting point/range:	< 0 °C

10. STABILITY AND REACTIVITY

Stability:	Stable under recommended storage conditions.
Conditions to avoid:	None known.
Materials to avoid:	Strong acids and strong bases, Oxidizing agents
Hazardous decomposition products:	When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released. Chlorine, chlorine oxides, hydrogen chloride.
Hazardous polymerization:	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin:	May be mildly irritating.
Eyes:	May be mildly irritating.
Inhalation:	This is an unlikely route of exposure.
Ingestion:	May be mildly irritating.
Sensitization - skin:	Not known to cause allergic reaction.

Chronic Health Hazard

Carcinogenic effects:	None known.
Mutagenic effects:	Not known to cause heritable genetic damage.
Teratogenic effects:	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity:	Not known to adversely affect reproductive functions and organs.

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Cholinium chloride

Bioaccumulation:	No information available
Persistence and degradability:	No information available
Freshwater Fish Species Data	500 mg/L EC50 (Desmodesmus subspicatus) = 72 h
Freshwater Fish Species Data	10000 mg/L LC50 (Leuciscus idus) = 96 h
Water Flea Data	500 mg/L EC50 (Daphnia magna Straus) = 48 h 320 mg/L EC50 (Daphnia magna) = 48 h

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. TRANSPORT INFORMATION

UN number: None
Shipping name: Not regulated.

ADR/RID
Class: Not regulated

IMDG/IMO
Class or Div.: Not regulated

ICAO/IATA
Class or Div.: Not regulated

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

Indication of danger
- The product is non-dangerous in accordance with Directive 1999/45/EC

R-phrase(s):
None

S-phrase(s):
Exercise reasonable care and cleanliness

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Reason for revision:
9. PHYSICAL AND CHEMICAL PROPERTIES

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

Safety Data Sheet

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 05/Feb/2013*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product name: **CAUSTIC SODA M2**

Product code: **M002**

Company Identification:
Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency telephone number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. Hazards Identification

Indication of danger C - Corrosive.

Most Important Hazards
Health hazards: Causes burns to mouth, throat and stomach. Causes severe eye burns. Causes burns to respiratory tract. Causes severe skin burns.

S-phrase(s): S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)

Safety Combination Phrases: S37/39 - Wear suitable gloves and eye/face protection

Environmental hazard: None known.

Main physical hazards: Corrosive to Metals. Water reactive.

3. Composition/information on Ingredients

component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Sodium hydroxide	1310-73-2	215-185-5	60-100	C;R35

4. First aid measures

Inhalation: Move to fresh air. Call a physician immediately. If not breathing, give artificial respiration.

Skin contact:	Take off contaminated clothing and shoes immediately. Rinse immediately with plenty of water for at least 30 minutes. Obtain medical attention.
Eye contact:	Immediately flush eyes with water for 30 minutes while holding eyelids open. Seek medical attention at once.
Ingestion:	Do NOT induce vomiting. Immediately give large quantities of water to drink. Call a physician immediately.

5. Fire-fighting measures

Suitable extinguishing media:	The product itself does not burn. Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	None known.

6. Accidental release measures

Personal Precautions:	Use personal protective equipment. See also section 8.
Environmental Precautions:	Do not allow material to contaminate ground water system.
Methods for cleaning up:	Shovel into suitable container for disposal. After cleaning, flush away traces with water.

7. Handling and Storage

Handling:

Technical measures/Precautions:	No special precautions required.
Safe handling advice:	Keep airborne concentrations below exposure limits.

Storage:

Technical measures/Storage conditions:	Keep material dry. Keep containers tightly closed in a dry, cool and well-ventilated place.

Packaging requirements: Paper bag (minimum 3 ply), or other industrial container designed for powders and granulated materials.

Incompatible products: Aluminium, Water

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: No personal respiratory protective equipment normally required. In case of insufficient ventilation, wear suitable respiratory equipment. Half mask with a particle filter P2 (BS EN 143).

Hand protection: Impervious gloves made of: Neoprene Rubber gloves

Eye protection: Chemical splash goggles and face shield.

Skin and body protection: Chemical resistant suit. Chemical resistant boots.

Environmental exposure controls

Exposure limit(s)

component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Sodium hydroxide	none	none

9. PHYSICAL AND CHEMICAL PROPERTIES

General information

Physical State: flakes
Odour: None
Colour: white

Important health, safety and environmental information

pH: 13
pH Regulating agent 10 g/l
Boiling point/range: Not applicable
Flash Point: Not applicable
Explosive properties:

Explosion data - sensitivity to mechanical impact	Not applicable
Explosion data - sensitivity to static discharge	Not applicable
Flammability Limits in Air:	
lower:	Not applicable
upper:	Not applicable
Oxidizing properties:	None
Relative density:	2.1 (@ 20°C)
Bulk density:	No information available
Solubility:	
Water solubility:	Soluble
Fat solubility:	No information available
Partition coefficient (n-octanol/water):	Not applicable
Viscosity:	Not applicable
Vapor density:	> 1 (air = 1)
Vapor pressure:	0.13 kPa (@ 739°C)
Evaporation Rate:	No data available

Other information

Melting point/range: 318 °C

10. STABILITY AND REACTIVITY

Stability: Stable under recommended storage conditions.

Conditions to Avoid: Keep material dry.

Materials to avoid: Water, Metals, Acids

Hazardous decomposition products: None known.

Hazardous polymerization: Hazardous polymerisation does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin: Corrosive; rapidly causes pain, burns, redness, swelling and damage to tissue.

Eyes: Corrosive. Rapidly causes pain, burns, corneal injury. May cause permanent damage and blindness.

Inhalation: Corrosive. Short exposure can injure lungs, throat, and mucous membranes. Causes pain, burns, choking, and coughing.

Ingestion: Corrosive. Causes pain and severe burns to mouth, throat and stomach.

Sensitization - skin: Not known to cause allergic reaction.

Chronic Health Hazard:

Carcinogenic effects: None known.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

component	LD50 / LC50
Sodium hydroxide	- = 1350 mg/kg (Dermal LD50; Rabbit)

12. ECOLOGICAL INFORMATION

Ecotoxicity

Component Information

Sodium hydroxide

Bioaccumulation: not applicable
Persistence and degradability: not applicable
Freshwater Fish Species Data 45.4 mg/L LC50 (Oncorhynchus mykiss) = 96 h

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: In accordance with local and national regulations

Contaminated packaging: Send empty bags to sanitary landfill. Render other types of containers unuseable by puncturing or crushing and sanitary landfill unless prohibited by local regulations

14. TRANSPORT INFORMATION

UN number: UN 1823
Shipping name: SODIUM HYDROXIDE, SOLID

ADR/RID

Class: 8
Classification Code: C6
14.7 II
ADR/RID-Labels 8
Hazard ID 80

IMDG/IMO:

Class or Div.: 8
Label(s): 8
Packing group: II

EmS: F-A, S-B

ICAO/IATA

Class or Div.: 8

Label(s) 8

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

Contains: Sodium hydroxide.

Indication of danger
• C - Corrosive

R-phrase(s):
• R35 - Causes severe burns

S-phrase(s):
• S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
• S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible)
• S37/39 - Wear suitable gloves and eye/face protection

International Inventories

Australia (AICS): All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Text of R phrases mentioned in Section 3
• R35 - Causes severe burns

Section(s) revised: New

Prepared by: Well Services Safety & Environment

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End of Safety Data Sheet

Material Safety Data Sheet

M275

1 . Identification of the material and supplier

Names

Product name : M275

Product code : M275

ADG : Corrosive solid, acidic, organic, n.o.s. (isothiazolones)

Supplier : Baker Hughes, Australia
5 Walker Street,
Braeside,
Victoria 3195,
Australia

Tel: +613 9580 9004
Fax: +613 9580 6004

Emergency telephone number : CHEMTREC Emergency Telephone Numbers (Australasia Geomarket):
- Australia: (02) 9037 2994
- New Zealand: 9801 0034
- PNG: +(61) 2 9037 2994

- UK: +(44) 870-820-0418
- USA: +(1) 703-527-3887 (CHEMTREC International 24 hour)

Uses

Material uses : Biocide

2 . Hazards identification

Classification : Xn; R20/21/22
C; R34
R43
N; R51/53

Risk phrases : R20/21/22- Harmful by inhalation, in contact with skin and if swallowed.
R34- Causes burns.
R43- May cause sensitisation by skin contact.
R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety phrases : S25- Avoid contact with eyes.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36/37/39- Wear suitable protective clothing, gloves and eye/face protection.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S51- Use only in well-ventilated areas.
S57- Use appropriate containment to avoid environmental contamination.
S61- Avoid release to the environment. Refer to special instructions/safety data sheet.

Statement of hazardous/dangerous nature : HAZARDOUS SUBSTANCE. DANGEROUS GOODS.

3 . Composition/information on ingredients

Ingredient name	CAS number	Concentration
reaction mass of: 5-chloro-2-methyl-4-isothiazolin-3-one [EC no. 247-500-7] and 2-methyl-2H-isothiazol-3-one [EC no. 220-239-6] (3:1)	55965-84-9	5 - 10

Other ingredients, determined not to be hazardous according to Safe Work Australia criteria, and not dangerous according to the ADG Code, make up the product concentration to 100%.

3 . Composition/information on ingredients

There are no additional ingredients present which, within the current knowledge of the supplier and in the concentrations applicable, are classified as hazardous to health or the environment and hence require reporting in this section.

4 . First-aid measures

Inhalation : Move exposed person to fresh air. Keep person warm and at rest. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway. In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

Ingestion : Get medical attention immediately. Wash out mouth with water. If material has been swallowed and the exposed person is conscious, give small quantities of water to drink. If vomiting occurs, the head should be kept low so that vomit does not enter the lungs. Chemical burns must be treated promptly by a physician. If unconscious, place in recovery position and get medical attention immediately. Maintain an open airway.

Skin contact : Get medical attention immediately. Flush contaminated skin with plenty of water. Remove contaminated clothing and shoes. Wash contaminated clothing thoroughly with water before removing it, or wear gloves. Continue to rinse for at least 15 minutes. Chemical burns must be treated promptly by a physician. In the event of any complaints or symptoms, avoid further exposure. Wash clothing before reuse. Clean shoes thoroughly before reuse.

Eye contact : Get medical attention immediately. Immediately flush eyes with plenty of water, occasionally lifting the upper and lower eyelids. Check for and remove any contact lenses. Continue to rinse for at least 15 minutes. Chemical burns must be treated promptly by a physician.

Protection of first-aiders : No action shall be taken involving any personal risk or without suitable training. If it is suspected that fumes are still present, the rescuer should wear an appropriate mask or self-contained breathing apparatus. It may be dangerous to the person providing aid to give mouth-to-mouth resuscitation. Wash contaminated clothing thoroughly with water before removing it, or wear gloves.

Advice to doctor : In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.

5 . Fire-fighting measures

Suitable : Use dry chemical powder.

Not suitable : Do not use water jet.

Special exposure hazards : Promptly isolate the scene by removing all persons from the vicinity of the incident if there is a fire. No action shall be taken involving any personal risk or without suitable training. Move containers from fire area if this can be done without risk. Use water spray to keep fire-exposed containers cool. This material is toxic to aquatic organisms. Fire water contaminated with this material must be contained and prevented from being discharged to any waterway, sewer or drain.

Hazardous thermal decomposition products : Decomposition products may include the following materials:
carbon dioxide
carbon monoxide
nitrogen oxides
sulfur oxides
halogenated compounds
metal oxide/oxides

Special protective equipment for fire-fighters : Fire-fighters should wear appropriate protective equipment and self-contained breathing apparatus (SCBA) with a full face-piece operated in positive pressure mode.

Hazchem code : 2X

6 . Accidental release measures

Personal precautions : No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas. Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilt material. Shut off all ignition sources. No flares, smoking or flames in hazard area. Do not breathe dust. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).

Environmental precautions : Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air). Water polluting material. May be harmful to the environment if released in large quantities.

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labelled waste container. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach the release from upwind. Prevent entry into sewers, water courses, basements or confined areas. Vacuum or sweep up material and place in a designated, labelled waste container. Avoid creating dusty conditions and prevent wind dispersal. Use spark-proof tools and explosion-proof equipment. Dispose of via a licensed waste disposal contractor. Note: see section 1 for emergency contact information and section 13 for waste disposal.

7 . Handling and storage

Storage : Store in accordance with local regulations. Store in a segregated and approved area. Store in original container protected from direct sunlight in a dry, cool and well-ventilated area, away from incompatible materials (see section 10) and food and drink. Eliminate all ignition sources. Separate from oxidizing materials. Keep container tightly closed and sealed until ready for use. Containers that have been opened must be carefully resealed and kept upright to prevent leakage. Do not store in unlabelled containers. Use appropriate containment to avoid environmental contamination.

8 . Exposure controls/personal protection

Occupational exposure limits : **No exposure standard allocated.**

Recommended monitoring procedures : If this product contains ingredients with exposure limits, personal, workplace atmosphere or biological monitoring may be required to determine the effectiveness of the ventilation or other control measures and/or the necessity to use respiratory protective equipment.

Engineering measures : Use only with adequate ventilation. Use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits. Use explosion-proof ventilation equipment.

Hygiene measures : 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. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.

Eyes : Safety eyewear complying with an approved standard should be used when a risk assessment indicates this is necessary to avoid exposure to liquid splashes, mists or dusts. If operating conditions cause high dust concentrations to be produced, use dust goggles.

Hands : 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.

Respiratory : 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 must be based on known or anticipated exposure levels, the hazards of the product and the safe working limits of the selected respirator.

Skin : 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.

8 . Exposure controls/personal protection

Environmental exposure controls : Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

9 . Physical and chemical properties

Physical state : Solid. [Powder.]

Colour : Tan. / Red.

Odour : Faint odour.

Relative density : 0.714 to 0.726 (16°C)

Flash point : Closed cup: >93°C (>199.4°F)

Solubility : Miscible with water.

10 . Stability and reactivity

Chemical stability : The product is stable.

Possibility of hazardous reactions : Under normal conditions of storage and use, hazardous reactions will not occur.

Conditions to avoid : Avoid the creation of dust when handling and avoid all possible sources of ignition (spark or flame). Take precautionary measures against electrostatic discharges. To avoid fire or explosion, dissipate static electricity during transfer by earthing and bonding containers and equipment before transferring material. Prevent dust accumulation. Avoid release to the environment. Refer to special instructions/safety data sheet.

Materials to avoid : Reactive or incompatible with the following materials:
oxidizing materials

Hazardous decomposition products : Under normal conditions of storage and use, hazardous decomposition products should not be produced.

11 . Toxicological information

Potential acute health effects

Inhalation : Harmful by inhalation. May give off gas, vapor or dust that is very irritating or corrosive to the respiratory system. Exposure to decomposition products may cause a health hazard. Serious effects may be delayed following exposure.

Ingestion : Harmful if swallowed. May cause burns to mouth, throat and stomach.

Skin contact : Corrosive to the skin. Causes burns. Harmful in contact with skin. May cause sensitisation by skin contact.

Eye contact : Corrosive to eyes. Causes burns.

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
reaction mass of: 5-chloro-2-methyl-4-isothiazolin-3-one [EC no. 247-500-7] and 2-methyl-2H-isothiazol-3-one [EC no. 220-239-6] (3:1)	LD50 Oral	Rat	53 mg/kg	-

Conclusion/Summary : Not available.

Potential chronic health effects

Chronic toxicity

Conclusion/Summary : Not available.

Irritation/Corrosion

Conclusion/Summary : Not available.

Sensitiser

Conclusion/Summary : Not available.

Carcinogenicity

Conclusion/Summary : Not available.

Mutagenicity

11 . Toxicological information

Conclusion/Summary : Not available.

Teratogenicity

Conclusion/Summary : Not available.

Reproductive toxicity

Conclusion/Summary : Not available.

Chronic effects : Repeated or prolonged inhalation of dust may lead to chronic respiratory irritation. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.

Carcinogenicity : No known significant effects or critical hazards.

Mutagenicity : No known significant effects or critical hazards.

Teratogenicity : No known significant effects or critical hazards.

Developmental effects : No known significant effects or critical hazards.

Fertility effects : No known significant effects or critical hazards.

Inhalation : Adverse symptoms may include the following:
respiratory tract irritation
coughing

Ingestion : Adverse symptoms may include the following: stomach pains Irritation to digestive system

Skin : Adverse symptoms may include the following:
pain or irritation
redness
blistering may occur

Eyes : Adverse symptoms may include the following:
pain
watering
redness

Target organs : Contains material which may cause damage to the following organs: upper respiratory tract, skin, eyes.

12 . Ecological information

Ecotoxicity : Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Aquatic ecotoxicity

Conclusion/Summary : Not available.

Other ecological information

Persistence/degradability

Conclusion/Summary : Not available.

Other adverse effects : No known significant effects or critical hazards.

13 . Disposal considerations

Methods of disposal : This material and its container must be disposed of in a safe way. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Avoid dispersal of spilt material and runoff and contact with soil, waterways, drains and sewers.

14 . Transport information

Regulation	UN number	Proper shipping name	Classes	PG*	Label	Additional information

14 . Transport information

ADG	UN3261	Corrosive solid, acidic, organic, n.o.s. (isothiazolones)	8	II		**Hazchem code** 2X
ADR	UN3261	Corrosive solid, acidic, organic, n.o.s. (isothiazolones)	8	II		**UK Hazchem:** 2X
IMDG	UN3261	Corrosive solid, acidic, organic, n.o.s. (isothiazolones)	8	II		-
IATA	UN3261	Corrosive solid, acidic, organic, n.o.s. (isothiazolones)	8	II		-

PG* : Packing group

15 . Regulatory information

Standard for the Uniform Scheduling of Drugs and Poisons

Not regulated.

Control of Scheduled Carcinogenic Substances

Ingredient name	Schedule
No listed substance	

Australia inventory (AICS) : All components are listed or exempted.

EU Classification : Xn; R20/21/22
C; R34
R43
N; R51/53

Risk phrases : R20/21/22- Harmful by inhalation, in contact with skin and if swallowed.
R34- Causes burns.
R43- May cause sensitisation by skin contact.
R51/53- Toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

Safety phrases : S25- Avoid contact with eyes.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S36/37/39- Wear suitable protective clothing, gloves and eye/face protection.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S51- Use only in well-ventilated areas.
S57- Use appropriate containment to avoid environmental contamination.
S61- Avoid release to the environment. Refer to special instructions/safety data sheet.

15 . Regulatory information

National regulations : **National Code of Practice for the Control of Workplace Hazardous Substances. National Code of Practice for the Labelling of Workplace Substances. National Code of Practice for the Preparation of Material Safety Data Sheets. Approved Criteria for Classifying Hazardous Substances.**

16 . Other information

Date of printing : 17 October 2012.

Date of issue/ Date of revision : 17 October 2012

Date of previous issue : 16 October 2012

Version : 1.01

Indicates information that has changed from previously issued version.

Disclaimer

To the best of our knowledge, the information contained herein is accurate. However, neither the above-named supplier, nor any of its subsidiaries, assumes any liability whatsoever for the accuracy or completeness of the information contained herein.
Final determination of suitability of any material is the sole responsibility of the user. All materials may present unknown hazards and should be used with caution. Although certain hazards are described herein, we cannot guarantee that these are the only hazards that exist.

Schlumberger

Safety Data Sheet

(USA)

(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

Version: 3 *Revision date* 25/Jan/2013

1. Identification of the substance/preparation and the company/undertaking

Product code **S100**

Product name **Sand S100**

Use of the substance/preparation Used as a proppant in oilfield applications.

Company identification

Schlumberger Technology Corporation
110 Schlumberger Drive
Sugar Land, Texas 77478, USA
Telephone: 1-281-285-7873

Emergency telephone number **USA: +1-281-595-3518 (24hr)**

2. Hazards identification

Emergency Overview

Warning

Main physical hazards No classified physical hazards.

Main health hazards: Respirable dust. This product may contain small amounts of repirable crystalline silica. Repeated or prolonged inhalation of crystalline silica dust can cause delayed lung injury, and other diseases, including silicosis and lung cancer.

Precautions Avoid dust formation. Do not breathe dust. Wear suitable protective equipment.

HMIS classification: Health: 0 Flammability 0 Physical hazard: 0

Physical State solid / Powder **Color** Tan **Odor** None

Principle routes of exposure:
Inhalation. Eye contact.

3. Composition/information on ingredients

Component	CAS-No	Weight % - range
Crystalline silica	14808-60-7	60-100

4. First aid measures

Eye contact Rinse with water. Seek medical attention if irritation occurs.

Skin contact	Rinse with water.
Ingestion	Rinse mouth. Never give anything by mouth to an unconscious person. Consult a physician if necessary.
Inhalation	Move to fresh air. Consult a physician if necessary.

5. Fire-fighting measures

Fire hazard	Not combustible.
Flash point	Not applicable
Autoignition temperature	No data available
Flammability limits in air:	
Lower	Not Applicable
Upper	Not Applicable
Oxidizing properties	None.

Suitable extinguishing media
The product itself does not burn. Use extinguishing media appropriate for surrounding material.

Extinguishing media which must not be used for safety reasons
None known.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases
none.

Special protective equipment for firefighters
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

NFPA Rating

Health	**0**
Flammability	**0**
Instability	**0**
Special firefighting procedures	**none**

6. Accidental release measures

Main physical hazards	No classified physical hazards.
Personal precautions	Do not breathe dust. Wear suitable protective equipment.
Methods for cleaning up	Shovel into suitable container for disposal.
Environmental precautions	Prevent product from entering drains.

7. Handling and storage

Handling

Precautions	Avoid dust formation. Do not breathe dust. Wear suitable protective equipment.
Safe handling advice	Provide appropriate exhaust ventilation at places where dust is formed.

Technical measures/ storage conditions No special storage conditions required.

Packaging requirements Paper bag (minimum 3 ply), or other industrial container designed for powders and granulated materials.

Incompatible products None known.

8. Exposure controls/personal protection

All chemical Personal Protective Equipment (PPE) should be selected based on an assessment of both the chemical hazard present and the risk of exposure to those hazards. The PPE recommendations below are based on an assessment of the chemical hazards associated with this product. Where this product is used in a mixture with other products or fluids, additional hazards may be created and as such further assessment of risk may be required. The risk of exposure and need of respiratory protection will vary from workplace to workplace and should be assessed by the user in each situation.

Engineering measures to reduce exposure Ensure adequate ventilation.

Hygiene measures Keep airborne concentrations below exposure limits.

Respiratory protection Use NIOSH approved respirator with dust and mist protection (3M 8210). If dust concentration exceeds 5 times the exposure limit, wear an approved HEPA respirator.

Eye protection Safety glasses with side-shields.

Hand protection Cotton gloves.

Skin and body protection No special precautions required.

Occupational exposure limits

	ACGIH - TLVs			OSHA - PELs		
Component	**TWA / Ceiling**	**STEL**	**Skin Notation**	**TWA / C**	**STEL**	**Final PELs - Skin**
Crystalline silica	0.025 mg/m³	-	-	total dust respirable fraction	-	-

Component	**OSHA - Final PELs - Table Z-3 Mineral Dusts**
Crystalline silica	(30)/(%SiO2 + 2) mg/m³ TWA, total dust; (250)/(%SiO2 + 5) mppcf TWA, respirable fraction; (10)/(%SiO2 + 2) mg/m³ TWA, respirable fraction

Particles Not Otherwise Regulated/Specified [PNOR or PNOS] (insoluble or poorly soluble):
- OSHA PEL's for Inert or Nuisance Dust are covered by PNOR limits: respirable fraction: 5 mg/m³; total dust 15 mg/m³.
- ACGIH PNOS Recommendations: airborne concentrations should be kept below 3 mg/m³, respirable particulate, and 10 mg/m³, inhalable particles.

9. Physical and chemical properties

Chemical characterization	Inorganic mineral. Inert.
Fire hazard	Not combustible.
Physical State	solid / Powder
Color	Tan
Odor	None
Odor threshold	Not applicable
pH	Not applicable
Boiling point/range	Not applicable
Flash point	Not applicable
Flammability limits in air:	
Lower	Not Applicable
Upper	Not Applicable
Bulk density	1100-1600 kg/m^3
Melting point/range	> 1700 °C
Decomposition temperature	No data available
Solubility:	
Water solubility	Insoluble
Fat solubility	Insoluble
Partition coefficient (n-octanol/water)	Not Applicable
Relative density	~ 2.6 (@ 20°C)
Vapor pressure	Not Applicable
Vapor density	Not Applicable
Viscosity	Not Applicable
Evaporation rate	Not Applicable
% Volatile (VOC)	None

10. Stability and reactivity

Stability
Stable.

Conditions to avoid
None known.

Incompatibility with other substances
Strong oxidizing agents.

Hazardous decomposition products
None.

Hazardous polymerization
Hazardous polymerization does not occur.

11. Toxicological information

PRODUCT TOXICOLOGICAL INFORMATION

Acute health hazard

Eye contact May cause mechanical irritation.
Skin contact No effect expected.
Ingestion Accidental ingestion of small amounts is not expected to cause adverse effects.
Inhalation Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough. This product may contain small amounts of respirable crystalline silica. Repeated or prolonged inhalation of crystalline silica dust can cause delayed lung injury, and other diseases, including silicosis and lung cancer.
Sensitization - lung None known.
Sensitization - skin None known.
Toxicologically synergistic products Smoked tobacco.

Chronic health hazard

Carcinogenic effects Crystalline silica dust is listed by IARC in Group 1 as known to cause lung cancer in humans, if inhaled. Risk of cancer depends on duration and level of exposure.
Mutagenic effects None known.
Teratogenic effects None known.
Reproductive toxicity None known.
Target organ effects Lung cancer. silicosis.

COMPONENT TOXICOLOGICAL INFORMATION

Component	Target organ effects	LD50 / LC50
Crystalline silica	eyes, respiratory system (in animals: lung cancer)	= 500 mg/kg (Oral LD50; Rat)

Component	IARC Group 1 or 2	ACGIH - Carcinogens	OSHA listed carcinogens	NTP
Crystalline silica	Group 1; Monograph 100C [in preparation] Group 1; Monograph 68 [1997] Group 1; Supplement 7 [1987]	A2 - Suspected Human Carcinogen	Listed	Listed

12. Ecological information

Product information

Component information

Crystalline silica

Bioaccumulation Not applicable
Persistence / degradability Not applicable.
Other information Listed on PLONOR list of OSPAR

13. Disposal considerations

Waste from residues / unused products

Dispose of by sanitary landfilling or other acceptable method in accordance with local regulations.

Contaminated packaging
Send empty bags to sanitary landfill. Render other types of containers unuseable by puncturing or crushing and sanitary landfill unless prohibited by local regulations.

EPA RCRA Hazardous Waste Code:
None

14. Transport information

DOT:

CERCLA RQ	None
Proper shipping name	Not regulated
Label(s)	None required

IMDG/IMO:

Shipping name	Not regulated
UN number	None

ICAO/IATA:

Shipping name	Not regulated
UN number	None

TDG (Canada):

Shipping name	Not regulated
PIN	None

Note 1:
For the applicable placard selection refer to the appropriate transport regulations; the selection may vary depending on the cargo size and categories of other hazardous materials in the cargo.

15. Regulatory information

International Chemical Inventories

USA, Toxic Substances Control Act inventory (TSCA)
This product complies with TSCA requirements.
Canada, Domestic Substance List (DSL)
This product complies with DSL requirements.

U.S.A. Regulations
OSHA Hazard Communication Standard:
(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

EPA RCRA Hazardous Waste Code:
None

EPA, Sections 311 and 312 - Material Safety Data Sheet Requirements (40 CFR 370):

Immediate (Acute) Health Hazard:	None
Delayed (Chronic) Health Hazard:	Yes
Fire Hazard:	None

Sudden Release or Pressure Hazard: None
Reactive Hazard: None

EPA, Sections 313 - List of Toxic Chemicals (40 CFR 372):
This product contains the following substance(s), which appear(s) on the List of Toxic Chemicals:

Crystalline silica
EPA, CERCLA Section 102a/103 Hazardous Substances (40 CFR 302.4): None
CERCLA/SARA - Hazardous Substances and their RQs: None
EPA, SARA TITLE III Section 304, Extremely Hazardous Substances (40 CFR 355.40): None

Additional Regulatory Information

Crystalline silica
California Proposition 65: carcinogen

International Hazard Class

WHMIS Hazard Class:
D2A (Other Toxic Effects - Very Toxic Material)

16. Other information

Current references
1. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. *American Conference of Governmental Industrial Hygienists, Cincinnati OH.*
2. IARC Monograms on the Evaluation of the Carcinogenic Risk of Chemicals to Man. *World Health Organization, International Agency for Research on Cancer. Geneva, Switzerland.*
3. Annual Report on Carcinogens. National Toxicology Program. *U.S. Department of Heath and Human Services, Public Health Service.*
4. NIOSH Registry of Toxic Effects of Chemical Substances (RTECS). *National Institute for Occupational safety and Health. Cincinnati, OH.*
5. LOLI Database.

Explanation of terms
ACGIH: American Conference of Governmental Industrial Hygienist
ACGIH-TL: Threshold Limit Value
DSL: Domestic Substance List
HMIRC: Hazardous Materials Information Review Commission
IARC: International Agency for Research on Cancer
NFPA: National Fire Protection Association
NTP: National Toxicology Program
NIOSH: National Institute of Occupational Safety & Health
NIOSH-REL: Recommended Exposure Limit
OSHA: Occupational Safety & Health Administration
OSHA-PEL: Permissible Exposure Limit
TSCA: Toxic Substance Control Act (Inventory)

Occupational Exposure Limits indicators: TWA - Time Weighted Average; STEL - Short Term Limit; C - Ceiling Limit;units: [mg/m^3]

ACGIH Notations:
"Skin" refers to the potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors or by direct skin contact with the substance.
"A" notation indicates carcinogenicity as follows:
ACGIH classification: A1 - Confirmed Human Carcinogen; A2 - Suspected Human Carcinogen; A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans; A4 - Not Classifiable as a Human Carcinogen; A5 - Not suspected as a Human Carcinogen.
"SEN" refers to the potential for an agent to product sensitization as confirmed by human and animal data.

Section(s) revised: 8, 11, 16

Prepared by: Global Chemical Regulatory Compliance (GCRC).

Revision date 25/Jan/2013

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End of the Material Safety Data Sheet

Schlumberger

MATERIAL SAFETY DATA SHEET

(USA)

(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

Version: 2 *Revision date:* 23 September 2008

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product code: **S580-2040**

Product name: **Fracturing Additive S580 20/40**

Company identification:

Schlumberger Technology Corporation
110 Schlumberger Drive
Sugar Land, Texas 77478, USA
Telephone: 1-281-285-7873

Emergency telephone number: **USA: +1-281-595-3518 (24hr)**

2. HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Main physical hazards:	No classified physical hazards.
Main health hazards:	May cause mechanical irritation to eyes. Respirable dust. Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough.
Other hazards:	Dust.
Precautions:	Avoid dust formation. Do not breathe dust.
HMIS classification:	Health: **0** Flammability: **0** Physical hazard: **0**

Form: Dry flowable granules **Color:** Light grey **Odor:** None

Principle routes of exposure:
Eye contact. Skin contact. Respiratory system.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	Weight % - Range
Calcined bauxite	66402-68-4	60 - 100

4. FIRST AID MEASURES

General advice:	Consult a physician if necessary.
Eye contact:	Rinse with water.
Skin contact:	Rinse with water.
Ingestion:	Rinse mouth. Never give anything by mouth to an unconscious person.
Inhalation:	Move to fresh air.

5. FIRE-FIGHTING MEASURES

Fire hazard:	Not combustible.
Flash point:	Does not flash.
Autoignition temperature:	Not applicable.
Flammability limits in air:	
Lower:	Not applicable

5. FIRE-FIGHTING MEASURES

Upper: Not applicable
Oxidizing properties: None.

Suitable extinguishing media:
None needed. Use extinguishing media appropriate for surrounding material.

Extinguishing media which must not be used for safety reasons:
None known.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:
None known.

Special protective equipment for firefighters:
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

NFPA rating:

Health:	**0**
Flammability:	**0**
Instability:	**0**
Special:	**None**

6. ACCIDENTAL RELEASE MEASURES

Main physical hazards:	No classified physical hazards.
Other hazards:	Dust.
Personal precautions:	Wear suitable protective equipment. See also Section 8.
Methods for cleaning up:	Sweep up and shovel into suitable containers for disposal.
Environmental precautions:	No special environmental precautions required.

7. HANDLING AND STORAGE

Handling:

Precautions:	Avoid dust formation. Do not breathe dust.
Safe handling advice:	Provide appropriate exhaust ventilation at places where dust is formed.
Technical measures/ storage conditions:	Keep material dry.
Packaging requirements:	Paper bag (minimum 3 ply), or other industrial container designed for powders and granulated materials.
Incompatible products:	None known.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure:	Control the source.
Hygiene measures:	Keep airborne concentrations below exposure limits.
Respiratory protection:	In case of insufficient ventilation, wear suitable respiratory equipment. If dust or mist is generated use NIOSH approved respirator with dust and mist protection (3M 8210).
Eye protection:	Tightly fitting safety goggles.
Hand protection:	Cotton gloves.
Skin and body protection:	Clean, body-covering clothing.

Occupational Exposure Limits

	ACGIH - TLVs	OSHA - PELs

Particles Not Otherwise Regulated/Specified [PNOR or PNOS] (insoluble or poorly soluble):
OSHA PEL's for Inert or Nuisance Dust are covered by PNOR limits: respirable fraction: 5 mg/m³; total dust 15 mg/m³.
ACGIH PNOS Recommendations: airborne concentrations should be kept below 3 mg/m³, respirable particulate, and 10 mg/m³, inhalable particles.

9. PHYSICAL AND CHEMICAL PROPERTIES

Chemical characterization: Inorganic compound. Inert.
Fire hazard: Not combustible.
Form: Dry flowable granules
Color: Light grey
Odor: None
Odor threshold: Not applicable.
pH: Not applicable.
Boiling point/range: Not applicable.
Flash point: Does not flash.
Flammability limits in air:
Lower: Not applicable
Upper: Not applicable
Bulk density: No information available.
Melting point/range: > 2000 °C / 3632 °F
Decomposition temperature: No data available.
Solubility:
Water solubility: Insoluble
Fat solubility: Insoluble.
Partition coefficient (n-octanol/water): Not applicable.
Relative density: 2.7 (@ 20°C)
Vapor pressure: Not applicable.
Vapor density: Not applicable.
Viscosity: Not applicable.
Evaporation rate: Not applicable.
% Volatile (VOC): None.

10. STABILITY AND REACTIVITY

Stability:
Stable.

Conditions to avoid:
None known.

Incompatibility with other substances:
None known.

Hazardous decomposition products:
None reasonably foreseeable.

Hazardous polymerization:
Hazardous polymerization does not occur.

Other hazards:
Dust.

11. TOXICOLOGICAL INFORMATION

PRODUCT TOXICOLOGICAL INFORMATION

Acute Health Hazard

Eye contact: May cause mechanical irritation.
Skin contact: No effect expected.
Ingestion: Accidental ingestion of small amounts is not expected to cause adverse effects.
Inhalation: Inhalation of dust may cause shortness of breath, tightness of the chest, a sore throat and cough.
Sensitization - lung: Not known to cause allergic reaction.
Sensitization - skin: Not known to cause allergic reaction.

Chronic Health Hazard

Carcinogenic effects: None known.
Mutagenic effects: Not known to cause heritable genetic damage.
Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity: Not known to adversely affect reproductive functions and organs.
Target organ effects: None known.

COMPONENT TOXICOLOGICAL INFORMATION

12. ECOLOGICAL INFORMATION

PRODUCT INFORMATION

COMPONENT INFORMATION

Calcined bauxite
Bioaccumulation: Not applicable
Persistence / degradability: The methods for determining biodegradability are not applicable to inorganic substances.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products:
Dispose of by sanitary landfilling or other acceptable method in accordance with local regulations.

Contaminated packaging:
Send empty bags to sanitary landfill. Render other types of containers unuseable by puncturing or crushing and sanitary landfill unless prohibited by local regulations.

EPA RCRA Hazardous Waste Code:
None

14. TRANSPORT INFORMATION

DOT:

CERCLA RQ: None

14. TRANSPORT INFORMATION

Hazard class: Not regulated.
Proper shipping name: Not regulated
Label(s): None required.

IMDG/IMO

Shipping name: Not regulated.

UN number: None

ICAO/IATA

Shipping name: Not regulated.

UN number: None

TDG (Canada):

Shipping name: Not regulated.
PIN: None

Note 1:
For the applicable placard selection refer to the appropriate transport regulations; the selection may vary depending on the cargo size and categories of other hazardous materials in the cargo.

15. REGULATORY INFORMATION

International Chemical Inventories

Inventory - United States TSCA -	This product complies with TSCA requirements.
Canada DSL Inventory List -	This product complies with DSL requirements.
EC-No	This product complies with EINECS/ELINCS requirements.
China inventory of existing chemical substances list -	This product complies with China inventory requirements.
Inventory - Japan - Existing and New Chemicals list -	This product does not comply with JPENCS
Australia (AICS):	All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

U.S.A. Regulations

OSHA Hazard Communication Standard:
(Complies with USA OSHA 29 CFR 1910.1200 and ANSI Z 400.1)

EPA RCRA Hazardous Waste Code:
None

EPA, Sections 311 and 312 - Material Safety Data Sheet Requirements (40 CFR 370):

Immediate (Acute) Health Hazard: None
Delayed (Chronic) Health Hazard: None

Fire Hazard: None
Sudden Release or Pressure Hazard: None
Reactive Hazard: None

EPA, Sections 313 - List of Toxic Chemicals (40 CFR 372):
This product contains the following substance(s), which appear(s) on the List of Toxic Chemicals:

Additional Regulatory Information

Calcined bauxite
EPA, CERCLA Section 102a/103 Hazardous Substances (40 CFR 302.4): None
CERCLA/SARA - Hazardous Substances and their RQs: None
EPA, SARA TITLE III Section 304, Extremely Hazardous Substances (40 CFR 355.40): None
California Proposition 65: None

International Hazard Class

WHMIS Hazard Class:
Non-controlled product.

16. OTHER INFORMATION

Current references:
1. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. *American Conference of Governmental Industrial Hygienists, Cincinnati OH.*
2. IARC Monograms on the Evaluation of the Carcinogenic Risk of Chemicals to Man. *World Health Organization, International Agency for Research on Cancer. Geneva, Switzerland.*
3. Annual Report on Carcinogens. National Toxicology Program. *U.S. Department of Heath and Human Services, Public Health Service.*
4. NIOSH Registry of Toxic Effects of Chemical Substances (RTECS). *National Institute for Occupational safety and Health. Cincinnati, OH.*
5. LOLI Database.

Explanation of terms:
ACGIH: American Conference of Governmental Industrial Hygienist
ACGIH-TL: Threshold Limit Value
DSL: Domestic Substance List
HMIRC: Hazardous Materials Information Review Commission
IARC: International Agency for Research on Cancer
NTP: National Toxicology Program
NIOSH: National Institute of Occupational Safety & Health
NIOSH-REL: Recommended Exposure Limit
OSHA: Occupational Safety & Health Administration
OSHA-PEL: Permissible Exposure Limit
TSCA: Toxic Substance Control Act (Inventory)

Occupational Exposure Limits indicators: TWA - Time Weighted Average; STEL - Short Term Limit; C - Ceiling Limit;units: [mg/m^3]

ACGIH Notations:
"Skin" refers to the potential significant contribution to the overall exposure by the cutaneous route, including mucous membranes and the eyes, either by contact with vapors or by direct skin contact with the substance.
"A" notation indicates carcinogenicity as follows:
ACGIH classification: A1 - Confirmed Human Carcinogen; A2 - Suspected Human Carcinogen; A3 - Confirmed Animal Carcinogen with Unknown Relevance to Humans; A4 - Not Classifiable as a Human Carcinogen; A5 - Not suspected as a Human Carcinogen.
"SEN" refers to the potential for an agent to product sensitization as confirmed by human and animal data.

Section(s) revised: 8

Additional advice:	Consult your supplier if the material is to be used for special applications such as in the food industry or for hygiene, medical or surgical end-use.
Prepared by:	Well Services Safety & Environment (WSSE).
Revision date:	23 September 2008

End of the Material Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 29 March 2012*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Gelling Agent U28 - 30% Active**

Product Code: **U028**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Used as a fracturing additive in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger C - Corrosive.

Most important hazards R-phrase(s): Causes severe burns.

Health hazards: Causes burns to mouth, throat and stomach. Causes severe skin burns. Causes severe eye burns. Causes burns to respiratory tract.

S-phrase(s): S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

Safety Combination Phrases: S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.

Environmental hazard: None known

Main physical hazards: Corrosive to metals.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification (67/548)
Sodium hydroxide	1310-73-2	215-185-5	30	C;R35

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Obtain medical attention.

Skin contact:	Take off contaminated clothing and shoes immediately. Rinse immediately with plenty of water for at least 30 minutes. Seek medical attention at once.
Eye contact:	Immediately flush eyes with water for 30 minutes while holding eyelids open. Seek medical attention at once.
Ingestion:	Do NOT induce vomiting. Immediately give large quantities of water to drink. Seek medical attention at once.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:	The product itself does not burn. Use extinguishing media appropriate for surrounding material.
Extinguishing media which must not be used for safety reasons:	None known.
Special protective equipment for firefighters:	Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.
Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases:	None known.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Do not breathe vapors or spray mist. Use personal protective equipment. See also section 8.
Environmental precautions:	Prevent further leakage or spillage. Keep out of waterways.
Methods for cleaning up:	Dam up. Soak up with inert absorbent material. Shovel into suitable container for disposal. After cleaning, flush away traces with water. Keep people away from and upwind of spill/leak. See also section 13.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions:	Ensure adequate ventilation.
Safe handling advice:	Keep airborne concentrations below exposure limits. Use personal protective equipment. See also section 8.

Storage:

Technical measures/Storage conditions:	Ensure adequate ventilation. Keep containers tightly closed in a dry, cool and well-ventilated place. Do not store in contact with aluminum.
Packaging requirements:	High density polyethylene (HDPE) drum or can.

Incompatible products: Acids, Metals, Aluminium, Zinc

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation, Keep airborne concentrations below exposure limits

Respiratory protection: In case of insufficient ventilation, wear suitable respiratory equipment.

Hand protection: Impervious gloves Neoprene

Eye protection: Chemical splash goggles and face shield.

Skin and body protection: Chemical resistant suit. Chemical resistant boots.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Sodium hydroxide	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Liquid
Odour: None
Colour: Colorless

Important Health, Safety and Environmental Information

pH: > 13
Boiling point/range: 115 °C
Flash point: Not combustible
Explosive properties:
Explosion data - sensitivity to mechanical impact: None
Explosion data - sensitivity to static discharge: None
Flammability Limits in Air:
lower: None
upper: None
Oxidizing properties: None
Relative density: 1.3 (@ 20°C)
Solubility:
Water solubility: Soluble
Fat solubility: No information available.
Partition coefficient (n-octanol/water): Not applicable.
Viscosity: 13 mPa.s (@ 20 °C)
Vapour density: No information available.
Vapour pressure: No information available.
Evaporation rate: No information available.

Other information

Melting point/range: ~ -20 °C

10. STABILITY AND REACTIVITY

Stability: Stable under recommended storage conditions.

Conditions to avoid: None reasonably foreseeable.

Materials to avoid: Acids, Metals, Aluminium, Zinc

Hazardous decomposition products: None known.

Hazardous polymerization: Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin: Corrosive; rapidly causes pain, burns, redness, swelling and damage to tissue.

Eyes: Corrosive. Rapidly causes pain, burns, corneal injury. May cause permanent damage and blindness.

Inhalation: Corrosive. Short exposure can injure lungs, throat, and mucous membranes. Causes pain, burns, choking, and coughing.

Ingestion: Corrosive. Causes pain and severe burns to mouth, throat and stomach.

Sensitization - skin: Not known to cause allergic reaction.

Sensitization - lung: Not known to cause allergic reaction

Chronic Health Hazard

Carcinogenic effects: None known.

Mutagenic effects: Not known to cause heritable genetic damage.

Teratogenic effects: Not known to cause birth defects or have a deleterious effect on a developing fetus.

Reproductive toxicity: Not known to adversely affect reproductive functions and organs.

Component	**LD50 / LC50**
Sodium hydroxide	- = 1350 mg/kg (Dermal LD50; Rabbit)

12. ECOLOGICAL INFORMATION

Ecotoxicity

COMPONENT INFORMATION

Sodium hydroxide

Bioaccumulation:	Not applicable
Persistence and degradability:	Not applicable
Freshwater Fish Species Data	45.4 mg/L LC50 (Oncorhynchus mykiss) = 96 h

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products:	Dispose of as special waste in compliance with local and national regulations
Contaminated packaging:	Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. TRANSPORT INFORMATION

UN number: UN 1824
Shipping name: SODIUM HYDROXIDE SOLUTION

ADR/RID

Class:	8	**Subsidiary risk(s):**	-
Classification Code:	C5		
Packing Group:	II		
ADR/RID-Labels	8		
Hazard ID	80		

IMDG/IMO

Class or Div.:	8	**Subsidiary risk(s):**	-
Label(s):	8		
Packing Group:	II		
EmS:	F-A, S-B		

ICAO/IATA

Class or Div.:	8	**Subsidiary risk(s):**	-
Label(s)	8		
Packing group:	II		

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

contains: Sodium hydroxide .

Indication of danger

- C - Corrosive

R-phrase(s):
- R35 - Causes severe burns.

S-phrase(s):
- S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S45 - In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
- S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection.

International Inventories

Australia (AICS):	All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Text of R phrases mentioned in Section 3
- R35 - Causes severe burns.

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

Schlumberger

SAFETY DATA SHEET

(Australia)

According to the criteria of NOHSC:2011(2003)

Version: 1 *Revision date: 01 April 2011*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: **Chelating Agent U42**

Product Code: **U042**

Company Identification: Schlumberger Oilfield Australia Pty Ltd
ABN: 74 002 459 225
ACN: 002 459 225
256 St. Georges Terrace, Perth WA 6000

Emergency Telephone Number: 1-800-039-008 (24hr)

Use of the Substance/Preparation: Iron control agent in oilfield applications.

2. HAZARDS IDENTIFICATION

Indication of danger: Xi - Irritant.

Most important hazards
Risk Combination Phrases Irritating to eyes, respiratory system and skin.

Health hazards: This product contains small amounts of Nitrilotriacetic acid and/or its trisodium salt. They are listed by IARC in group 2B and by NTP as causing cancer in animals.

S-phrase(s): S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice. S37 - Wear suitable gloves.

Environmental hazard: The organic portion of this material is not biodegradable.

Main physical hazards: Corrosive to aluminum.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Component	CAS-No	EC-No.	Weight % - Range	Classification
Tetrasodium ethylenediaminetetraacetate	64-02-8	200-573-9	30 - 60	Xi;R36/37/38
Sodium hydroxide	1310-73-2	215-185-5	< 5	C;R35
Trisodium nitrilotriacetate (impurity)	5064-31-3		0.1-1.0	Xn;R22 Xi;R36

For the full text of the R phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

Inhalation: Move to fresh air. Consult a physician if necessary.

Skin contact: Take off contaminated clothing and shoes immediately. Wash off immediately with plenty of water for at least 15 minutes. Seek medical attention if irritation occurs.

Eye contact: Immediately flush eyes with water for 30 minutes while holding eyelids open. Seek medical attention at once.

Ingestion: Rinse mouth. Call a physician or poison control centre immediately. If delayed, consider giving activated charcoal in water, or 2 glasses milk or water.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media: Water Fog, Alcohol Foam, CO2, Dry Chemical. Water spray.

Extinguishing media which must not be used for safety reasons: None known.

Special protective equipment for firefighters: Wear protective fire fighting clothing and avoid breathing vapors. Use self-contained breathing apparatus in closed areas.

Special exposure hazards arising from the substance or preparation itself, its combustion products, or released gases: When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions: Avoid contact with the skin and the eyes. Use personal protective equipment. See also section 8.

Environmental precautions: Prevent further leakage or spillage. Prevent entry into sewage. Keep out of waterways.

Methods for cleaning up: Dam up. Soak up with inert absorbent material. Shovel into suitable container for disposal. See also section 13.

7. HANDLING AND STORAGE

Handling:

Technical measures/Precautions: Ensure adequate ventilation.

Safe handling advice: Avoid contact with skin and eyes. Use personal protective equipment. See also section 8.

Storage:

Technical measures/Storage conditions: Do not store in contact with aluminum. Store in well ventilated area out of direct sunlight.

Packaging requirements: Steel or high density polyethylene (HDPE) container.

Incompatible products: Aluminium, Oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure: Ensure adequate ventilation

Respiratory protection: In case of insufficient ventilation, wear suitable respiratory equipment.

Hand protection: Impervious gloves Neoprene

Eye protection: Tightly fitting safety goggles.

Skin and body protection: Clean, body-covering clothing.

Environmental exposure controls

Exposure limit(s)

Component	Australia - Occupational Exposure Standards - TWAs	Australia - Occupational Exposure Standards - STELs
Tetrasodium ethylenediaminetetraacetate	None	None
Sodium hydroxide	None	None
Trisodium nitrilotriacetate (impurity)	None	None

9. PHYSICAL AND CHEMICAL PROPERTIES

General Information

Form: Liquid
Odour: amine-like
Colour: Light yellow, - , Brown

Important Health, Safety and Environmental Information

pH: 11 - 12
pH concentration: @ 10 g/l
Boiling point/range: 106 °C
Flash point: Not applicable.
Explosive properties:
Explosion data - sensitivity to mechanical impact: None known
Explosion data - sensitivity to static discharge: None known
Flammability Limits in Air:
lower: Not applicable
upper: Not applicable
Oxidizing properties: None
Relative density: 1.3 (@ 25°C)
Solubility:
Water solubility: Soluble
Fat solubility: No information available.

Partition coefficient (n-octanol/water):	See also section 12
Viscosity:	20 mPa.s (@ 20 °C)
Vapour density:	No information available.
Vapour pressure:	No information available.
Evaporation rate:	No information available.

Other information

Melting point/range:	-31 °C

10. STABILITY AND REACTIVITY

Stability:	Stable under recommended storage conditions.
Conditions to avoid:	None reasonably foreseeable.
Materials to avoid:	Aluminium, Oxidizing agents
Hazardous decomposition products:	When heated strongly or burned, oxides of carbon, nitrogen oxides, ammonia and harmful organic chemical fumes are released.
Hazardous polymerization:	Hazardous polymerization does not occur.

11. TOXICOLOGICAL INFORMATION

Local effects

Skin:	Irritant; may cause pain, redness, dermatitis.
Eyes:	Irritant. May cause pain, redness, discomfort.
Inhalation:	Irritant; may cause pain and coughing.
Ingestion:	May cause slight irritation.
Sensitization - skin:	Not known to cause allergic reaction.
Sensitization - lung:	Not known to cause allergic reaction

Chronic Health Hazard

Carcinogenic effects:	This product contains small amounts of Nitrilotriacetic acid and/or its trisodium salt. They are listed by IARC in group 2B and by NTP as causing cancer in animals.
Mutagenic effects:	Not known to cause heritable genetic damage.
Teratogenic effects:	Not known to cause birth defects or have a deleterious effect on a developing fetus.
Reproductive toxicity:	Not known to adversely affect reproductive functions and organs.

Component	**LD50 / LC50**
Tetrasodium ethylenediaminetetraacetate	- = 10 g/kg (Oral LD50; Rat)
Sodium hydroxide	- = 1350 mg/kg (Dermal LD50; Rabbit)

12. ECOLOGICAL INFORMATION

Ecotoxicity

Aquatic toxicity: See component information below.

COMPONENT INFORMATION

Tetrasodium ethylenediaminetetraacetate

Bioaccumulation:	log Pow = < -2.4
Persistence and degradability:	0 % (28d; OECD306)
Freshwater Fish Species Data	1.01 mg/L EC50 (Desmodesmus subspicatus) = 72 h
Freshwater Fish Species Data	41 mg/L LC50 (Lepomis macrochirus) = 96 h 59.8 mg/L LC50 (Pimephales promelas) = 96 h
Water Flea Data	610 mg/L EC50 (Daphnia magna) = 24 h

Sodium hydroxide

Bioaccumulation:	Not applicable
Persistence and degradability:	Not applicable
Freshwater Fish Species Data	45.4 mg/L LC50 (Oncorhynchus mykiss) = 96 h

Trisodium nitrilotriacetate (impurity)

Bioaccumulation:	No information available
Persistence and degradability:	No information available
Freshwater Fish Species Data	560 - 1000 mg/L EC50 (Chlorella vulgaris) = 96 h
Freshwater Fish Species Data	252 mg/L LC50 (Lepomis macrochirus) = 96 h 72-133 mg/L LC50 (Oncorhynchus mykiss) = 96 h 560-1000 mg/L LC50 (Poecilia reticulata) = 96 h 470 mg/L LC50 (Pimephales promelas) = 96 h 175-225 mg/L LC50 (Lepomis macrochirus) = 96 h 560-1000 mg/L LC50 (Oryzias latipes) = 96 h 93-170 mg/L LC50 (Pimephales promelas) = 96 h 114 mg/L LC50 (Pimephales promelas) = 96 h
Water Flea Data	560 - 1000 mg/L LC50 (Daphnia magna) = 48 h

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: Dispose of as special waste in compliance with local and national regulations

Contaminated packaging: Empty containers should be transported/delivered using a registered waste carrier for local recycling or waste disposal

14. TRANSPORT INFORMATION

UN number: UN 3267

Shipping name: CORROSIVE LIQUID, BASIC, ORGANIC, N.O.S. (Tetrasodium ethylenediaminetetra acetic acid),

14. TRANSPORT INFORMATION

ADR/RID

Class:	8
Classification Code:	C7
Packing Group:	III
ADR/RID-Labels	8
Hazard ID	80

IMDG/IMO

Class or Div.:	8
Label(s):	8
Packing Group:	III
EmS:	F-A, S-B

ICAO/IATA

Class or Div.:	8	
Label(s):	8	
Packing group:	III	
Packing instruction (passenger aircraft):	852	**Max Net Qty/Pkg:** 5 L
Packing instruction (cargo aircraft):	856	**Max Net Qty/Pkg:** 60 L

15. REGULATORY INFORMATION

In accordance with the criteria of NOHSC

Indication of danger:

- Xi - Irritant

R-phrase(s):

-
- R36/37/38 - Irritating to eyes, respiratory system and skin.

S-phrase(s):

- S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
- S37 - Wear suitable gloves.

International Inventories

Australia (AICS):	All the constituents of this material are listed on the Australian Inventory of Chemical Substances (AICS).

16. OTHER INFORMATION

Text of R phrases mentioned in Section 3

- R35 - Causes severe burns.
- R36/37/38 - Irritating to eyes, respiratory system and skin.

Prepared by: Chemical Regulatory Compliance

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End of Safety Data Sheet

APPENDIX D

Tables

		Mass (kg)	Concentration (mg/L)
Chemical constituient	CAS No.	Slickwater	
Boric acid*	10043-35-3		
2,2',2"-nitrilotriethanol	102-71-6		
Magnesium nitrate*	10377-60-3	26.50	10.00
Fumaric acid	110-17-8		
2-butoxyethanol	111-76-2		
Decyldimethyl amine (impurity)	1120-24-7		
Triethylenetetramine	112-24-3	2649.50	1000.00
Butyl diglycol	112-34-5		
Tetraethylenepentamine	112-57-2		
Silica gel, pptd., cryst.-free	112926-00-8		
Potassium hydroxide	1310-58-3	2.65	1.00
Sodium hydroxide*	1310-73-2		
Sodium tetraborate*	1330-43-4		
Potassium borate	1332-77-0		
Disodium Ethylene Diamine Tetra Acetate (impurity)	139-33-3		
Cristobalite	14464-46-1	2.65	1.00
Magnesium silicate hydrate (talc)	14807-96-6		
Crystalline silica*	14808-60-7	26495.00	10000.00
Erucic amidopropyl dimethyl betaine	149879-98-1		
Trisodium Ethylenediaminetetraacetate (impurity)	150-38-9		
Octadecanoic acid, calcium salt	1592-23-0	26.50	10.00
Vinylidene chloride/methylacrylate copolymer	25038-72-6		
Acetic acid ethenyl ester, polymer with ethenol	25213-24-5		
Benzenesulfonic acid, 4-ethenyl-, sodium salt, homopolymer	25704-18-1		
Decyl-dimethyl amine oxide	2605-79-0		
5-chloro-2-methyl-2h-isothiazolol-3-one	26172-55-4	26.50	10.00
2-methyl-2h-isothiazol-3-one	2682-20-4	2.65	1.00
Sodium Glycolate (impurity)	2836-32-0		
Polyvinyl acetate, partially hydrolyzed	304443-60-5		
Polyethylene glycol monohexyl ether	31726-34-8	2649.50	1000.00
Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	38193-60-1	2649.50	1000.00
Sodium chloroacetate	3926-62-3		
Pentaethylenehexamine	4067-16-7		
Sodium carbonate*	497-19-8		
Trisodium nitrilotriacetate (impurity)	5064-31-3		
Sodium gluconate	527-07-1		
Glycerol	56-81-5		
L-Glutamic acid	56-86-0		
Dicoco dimethyl quaternary ammonium chloride	61789-77-3	26.50	10.00
Tetrasodium ethylenediaminetetraacetate	64-02-8		
Ethanol*	64-17-5		
Acetic acid*	64-19-7		
Ceramic materials*	66402-68-4		
Ceramic materials and wares, chemicals	66402-68-4	397425.00	150000.00
Cholinium chloride*	67-48-1	26495.00	10000.00
Propan-2-ol	67-63-0	2.65	1.00
Sodium carboxylmethylhydroxypropyl guar	68130-15-4		
Ammonium c6-c10 alcohol ethoxysulfate	68187-17-7		
Alkyl(c12-16) dimethylbenzyl ammonium chloride	68424-85-1		
Alcohols, C6-C10, ethoxylated	68439-45-2		
ß-Alanine, N-coco alkyl derivs., sodium salts	68608-68-4		
Tetramethylammonium chloride*	75-57-0		
Carbonic acid, sodium salt (2:3)*	7542-12-3		
Non-crystalline silica	7631-86-9		
Hydrochloric acid*	7647-01-0	264.95	-
Sodium chloride*	7647-14-5		
Zirconium dichloride oxide	7699-43-6		
Hydrogen peroxide (impurity)	7722-84-1		
N2 (liquid)*	7727-37-9		
Diammonium peroxidisulphate*	7727-54-0		
Water*	7732-18-5	2252075.00	-
Sodium thiosulfate*	7772-98-7		
Magnesium chloride	7786-30-3	26.50	10.00
Sodium bromate	7789-38-0		
Cetylethylmorpholinium ethyl sulfate	78-21-7		
Hydroxypropyl cellulose	9004-64-2	26.50	10.00
Polyethylene glycol sorbitan monolaurate	9005-64-5		
Polylactide resin	9051-89-2		
Diatomaceous earth, calcined	91053-39-3	264.95	100.00

*= Chemicals not assessed in this report as have been previously assessed by other consultants. Ref: www.qgc.com.au

Santos Hydraulic Stimulation Chemical Assessment
Appendix D1 - Mass Balance Table
127666004

		Mass (kg)	Concentration (mg/L)	Mass (kg)	Concentration (mg/L)
Chemical constituient	CAS No.	ThermaFrac 40		HCl YF140HTD 30Q N2	
Boric acid*	10043-35-3			228.03	1000.00
2,2',2"-nitrilotriethanol	102-71-6	2649.50	1000.00	2280.27	10000.01
Magnesium nitrate*	10377-60-3	26.50	10.00	2.28	10.00
Fumaric acid	110-17-8	264.95	100.00		
2-butoxyethanol	111-76-2				
Decyldimethyl amine (impurity)	1120-24-7	26.50	10.00		
Triethylenetetramine	112-24-3	264.95	100.00		
Butyl diglycol	112-34-5				
Tetraethylenepentamine	112-57-2	2649.50	1000.00		
Silica gel, pptd., cryst.-free	112926-00-8	26.50	10.00		
Potassium hydroxide	1310-58-3			0.23	1.00
Sodium hydroxide*	1310-73-2	2649.50	1000.00	2280.27	10000.01
Sodium tetraborate*	1330-43-4	2649.50	1000.00		
Potassium borate	1332-77-0				
Disodium Ethylene Diamine Tetra Acetate (impurity)	139-33-3			2.28	10.00
Cristobalite	14464-46-1	2.65	1.00	0.23	1.00
Magnesium silicate hydrate (talc)	14807-96-6	26.50	10.00	2.28	10.00
Crystalline silica*	14808-60-7	26495.00	10000.00	2280.27	10000.01
Erucic amidopropyl dimethyl betaine	149879-98-1				
Trisodium Ethylenediaminetetraacetate (impurity)	150-38-9			2.28	10.00
Octadecanoic acid, calcium salt	1592-23-0				
Vinylidene chloride/methylacrylate copolymer	25038-72-6	2649.50	1000.00	228.03	1000.00
Acetic acid ethenyl ester, polymer with ethenol	25213-24-5				
Benzenesulfonic acid, 4-ethenyl-, sodium salt, homopolymer	25704-18-1				
Decyl-dimethyl amine oxide	2605-79-0	2649.50	1000.00		
5-chloro-2-methyl-2h-isothiazolol-3-one	26172-55-4	26.50	10.00	2.28	10.00
2-methyl-2h-isothiazol-3-one	2682-20-4	2.65	1.00	0.23	1.00
Sodium Glycolate (impurity)	2836-32-0			2.28	10.00
Polyvinyl acetate, partially hydrolyzed	304443-60-5				
Polyethylene glycol monohexyl ether	31726-34-8			22.80	100.00
Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer	38193-60-1				
Sodium chloroacetate	3926-62-3				
Pentaethylenehexamine	4067-16-7	264.95	100.00		
Sodium carbonate*	497-19-8				
Trisodium nitrilotriacetate (impurity)	5064-31-3			0.23	1.00
Sodium gluconate	527-07-1			2280.27	10000.01
Glycerol	56-81-5				
L-Glutamic acid	56-86-0	2649.50	1000.00		
Dicoco dimethyl quaternary ammonium chloride	61789-77-3			2.28	10.00
Tetrasodium ethylenediaminetetraacetate	64-02-8			22.80	100.00
Ethanol*	64-17-5	264.95	100.00		
Acetic acid*	64-19-7				
Ceramic materials*	66402-68-4	317940.00	120000.00	25083.01	110000.16
Ceramic materials and wares, chemicals	66402-68-4				
Cholinium chloride*	67-48-1			2280.27	10000.01
Propan-2-ol	67-63-0			0.23	1.00
Sodium carboxylmethylhydroxypropyl guar	68130-15-4	26495.00	10000.00	2280.27	10000.01
Ammonium c6-c10 alcohol ethoxysulfate	68187-17-7				
Alkyl(c12-16) dimethylbenzyl ammonium chloride	68424-85-1	2649.50	1000.00		
Alcohols, C6-C10, ethoxylated	68439-45-2				
ß-Alanine, N-coco alkyl derivs., sodium salts	68608-68-4				
Tetramethylammonium chloride*	75-57-0	26495.00	10000.00		
Carbonic acid, sodium salt (2:3)*	7542-12-3				
Non-crystalline silica	7631-86-9			2.28	10.00
Hydrochloric acid*	7647-01-0	264.95	-	2280.27	-
Sodium chloride*	7647-14-5				
Zirconium dichloride oxide	7699-43-6	264.95	100.00		
Hydrogen peroxide (impurity)	7722-84-1	26.50	10.00		
N2 (liquid)*	7727-37-9			52446.28	-
Diammonium peroxidisulphate*	7727-54-0				
Water*	7732-18-5	2225580.00	-	148217.76	-
Sodium thiosulfate*	7772-98-7	26495.00	10000.00	228.03	1000.00
Magnesium chloride	7786-30-3	26.50	10.00	2.28	10.00
Sodium bromate	7789-38-0	2649.50	1000.00	228.03	1000.00
Cetylethylmorpholinium ethyl sulfate	78-21-7			0.23	1.00
Hydroxypropyl cellulose	9004-64-2				
Polyethylene glycol sorbitan monolaurate	9005-64-5			22.80	100.00
Polylactide resin	9051-89-2			2280.27	10000.01
Diatomaceous earth, calcined	91053-39-3	264.95		22.80	100.00

*= Chemicals not assessed in this report as have been previously assessed by other consultants. Ref: www.qgc.com.au

Fluid System	WF130 with CBMF (L)	YF120LG	Slickwater	WF120+N2
Typical fluid Volume[1]	~ 368,343L	~ 96,400L	~ 2,649,500L	~ 90,706L
Additives	~ 14,784 kg (~4.1 %)	~ 844 kg (~1 %)	~ 34,875 kg (~1 %)	~ 5,382 kg (~5 %)
Proppant	~ 63,036 kg (~17.4 %)	~ 22,688 kg (~26 %)	~ 424,187 kg (~14 %)	~ 9,886 kg (~10 %)
Water*	~ 283,500 kg (~78.5 %)	~ 63,677 kg (~73 %)	~ 2,252,075 kg (~85 %)	~ 75,439 kg (~85 %)

Fluid System	YF140Flex	Waterfrac	WF130 Linear Gel	ThermaFrac 40
Typical fluid Volume[1]	~ 173,525L	~ 2,270,780L	~ 378,500L	~ 2,649,500L
Additives	~ 5,942 kg (~5 %)	~ 150 kg (<1 %)	~ 150 kg (<1 %)	~ 105,376 kg (~4 %)
Proppant	~ 20,840 kg (~10 %)	~ 71 kg (<1 %)	~ 71 kg (~12 %)	~ 397,425 kg (~15 %)
Water*	~ 150,967 kg (~87 %)	~ 2,270,780 kg (>99 %)	~ 2,270,780 kg (~87 %)	~ 2,225,580 kg (~82 %)

Fluid System	YF120LG 25k	ClearFrac XT	HCl YF140HTD 30Q N2
Typical fluid Volume[1]	~ 96,502L	~ 23,810L	~ 228,027L
Additives	~ 864 kg (~1 %)	~ 1,212 kg (~1 %)	~ 52,446 kg (~23 %)** N2 additive
Proppant	~ 22,688 kg (~26 %)	~ 8,949 kg (~33 %)	~ 27,364 kg (~12 %)
Water*	~ 63,677 kg (~73 %)	~ 18,452 kg (~66 %)	~ 148,218 kg (~65 %)

Human Health and Ecological Risk Assessment - Schlumberger Chemicals
Project No: 127666004

Appendix D
Table 1 - PBT Table

			Persistence									Bioaccumulation		Toxicity								SUMMARY				
Chemical	**Constituent Name**	**CAS Number**	**ORGANIC Solubility in water (mg/L)**	**INORGANIC Solubility in water (mg/L)**	**Solubility Considered in Conjunction with Acute Toxicity**	**Log Koc**	**Henry's Law (atm m3/mole)**	**EPISUITE Ready Biodegradability**	**EPISUITE Biowin 3 Ultimate Survey Biodegradation**	**EPISUITE Biowin 4 Primary Biodegradation**	**EPISUITE Biowin 7 Anaerobic Biodegradation**	**Fish BCF**	**Log Kow / Log Pow**	**FISH Chronic NOEC (mg/L)**	**INVERT Chronic NOEC (mg/L)**	**PLANT Chronic NOEC (mg/L)**	**FISH Chronic LOEC/MATC /EC_{x50} (mg/L)**	**INVERT Chronic LOEC/MATC /EC_{x50} (mg/L)**	**PLANT Chronic LOEC/MATC /EC_{x50} (mg/L)**	**FISH Acute LC/EC50 (mg/L)**	**INVERT Acute LC/EC50 (mg/L)**	**PLANT Acute LC/EC50 (mg/L)**	**Persistence**	**Bioaccumulation**	**Toxicity**	**Overall Score**	**Data Gaps %**
Crystalline Silica, Quartz		14808-60-7																								
Crystalline Silica, Cristobalite		14464-46-1																								
Non-crystalline Silica		7631-86-9																								
Silica Gel, pptd., cryst.-free		112926-00-8																								
Diatomaceous earth, calcined		91053-39-3																								
Guar gum		9000-30-0																								
Sodium carboxymethylhydroxypropyl guar		68130-15-4																								
Cholinium chloride		67-48-1	○			○	●	○	○	○	●	○	○		○	○				○	○		○	○	○	○	28%
2,2',2"-nitrilotriethanol		102-71-6	○			○	●	○	○	○	●	○	○		○				○	○	○	○	○	○	○	○	22%
Polyethylene Glycol Monohexyl Ether		31726-34-8	○			○	●	○	◖	○	●	○	○							●	●		◖	○	●	◖	39%
Polyethylene glycol sorbitan monolaurate		9005-64-5	○			●	●	●	●	○	●	○	○							○			●	○	○	○	44%
Sodium Glycolate (impurity)		2836-32-0	○			○	◖	○	○	○	○	○	○							○	○	○	○	○	○	○	33%
Dicoco Dimethyl Quarternary Ammonium Chloride		61789-77-3	●			●	●	○	◖	○	●	○	●							○	●		◖	◖	●	●	39%
Disodium Ethylene Diamine Tetra Acetate (Impurity)		139-33-3	○			○	●	○	○	○	●	○	○		○	◖		○	○	◖	○	◖	○	○	◖	○	11%
Trisodium Ethylene Diamine Tetra Acetate (Impurity)		150-38-9	○			○	●	○	○	○	●	○	○										○	○	○	○	50%
Tetrasodium ethylene diamine tetra acetate		64-02-8	○			○	●	○	○	○	●	○	○							○	○		○	○	○	○	39%
Trisodium Nitriloacetate (impurity)		5064-31-3	○			○	●	○	○	○	●	○	○		○					○		○	○	○	○	○	33%
Cetylethylmorpholinium Ethyl Sulfate		78-21-7	●			●	●	●	◖	○	●	○	●							○	○		●	◖	○	◖	39%
5-chloro-2-methyl-2h-isothiazolol-3-one		26172-55-4	○			○	◖	●	◖	○	○	○	○	●	◖			○		●	◖	●	○	○	●	◖	17%
2-methyl-2h-isothizolol-3-one		2682-20-4	○			○	◖	●	◖	○	○	○	○							●			○	○	●	◖	44%
Propan-2-ol		67-63-0	○			○	◖	○	○	○	○	○	○							○	○		○	○	○	○	39%
Alkyl(c12-16) dimethylbenzyl ammonium chloride		68424-85-1	●			●	●	●	◖	○	●	○	◖							●		●	●	○	●	●	39%
Butyl diglycol		112-34-5	○			○	◖	○	○	○	●	○	○			○				○	○		○	○	○	○	33%
Decyldimethyl amine (impurity)		1120-24-7	◖			◖	○	○	◖	○	●	○	◖		●	●				●	●	●	◖	○	●	◖	22%
Decyl-dimethyl amine oxide		2605-79-0	◖			◖	●	○	○	○	●	○	◖	◖	◖	●	○				◖	●	◖	○	●	◖	11%
Fumaric acid		110-17-8	○			○	●	○	○	○	○	○	○			○					○		○	○	○	○	39%
L-Glutamic acid		56-86-0	○			○	●	○	○	○	○	○	○			○				○	○		○	○	○	○	33%
Pentaethylenehexamine		4067-16-7	○			○	●	○	◖	○	○	○	○			◖				○	◖	●	○	○	●	◖	28%
Tetraethylenepentamine		112-57-2	○			◖	●	○	◖	○	○	○	○							○	◖	◖	○	○	◖	○	33%
Tetramethylammonium chloride		75-57-0	○			○	●	●	◖	○	●	○	○		●	○				○	◖	○	◖	○	●	◖	22%
Triethylenetetramine		112-24-3	○			○	●	○	◖	○	○	○	○		◖					○	◖	◖	○	○	◖	○	28%
Ethanol		64-17-5	○			○	◖	○	○	○	○	○	○	◖	●			○		◖	○		○	○	●	◖	22%
Hydrochloric Acid		7647-01-0		●	●														○	○			●		○	◖	64%
Sodium Hydroxide		1310-73-2		●	●															○	◖		●		◖	●	64%
Sodium Bromate		7789-38-0		●	●																		●		○	○	82%
Sodium Thiosulphate		7772-98-7		●	●															○	○		●		○	◖	64%
Potassium Hydroxide		1310-58-3		●	●															◖			●		◖	●	73%
Sodium Tetraborate		1330-43-4		●	●															◖	○	◖	●		◖	●	55%
Nitrogen, liquid form		7727-37-9		●	●															○	○	◖	●		◖	●	55%
Boric acid		10043-35-3		●	●									○	○	◖	◖	○	◖	◖	○		●		◖	●	9%
Magnesium nitrate		10377-60-3		●	●																○		●		○	◖	73%
Magnesium silicate hydrate (talc)		14807-96-6		●	●															○			●		◖	●	64%
Magnesium chloride		7786-30-3		●	●															○	◖		●		◖	●	64%
Hydrogen Peroxide (impurity)		7722-84-1		●	●									○	◖	○		○		◖	◖		●		◖	●	27%
Zirconium Dichloride Oxide		7699-43-6		●	●															◖	○		●		◖	●	64%
Surrogates																											
Surrogates for Vinylidene Chloride/Methacrylate Copolymer		75-35-4	○			○	○	●	◖	○	○	○	○			○	○			◖	◖	◖	○	○	◖	○	22%
Surrogate for Ceramic Materials and Wares		1332-58-7																									
Surrogate for Sodium Gluconate		526-95-4	○			○	●	○	○	○	○	○	○										○	○	○	○	50%
Surrogate for Polylactide Resin		50-21-5	○			○	◖	○	○	○	○	○	○							○	○	○	○	○	○	○	33%
Surrogate for Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer		5165-97-9	○			○	●	●	◖	○	●	○	○			○				○	○	○	◖	○	○	○	28%
Surrogate for Octadecanoic acid, calcium salt		57-11-4	●			●	◖	○	○	○	○	○	●							◖			◖	◖	◖	◖	44%
Surrogate for Hydoxypropyl cellulose		9004-65-3	○			○	●	○	○	○	○	○	○										○	○	○	○	50%

Comments

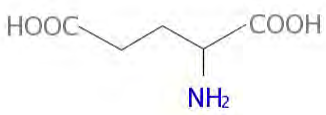
Inorganic
Organic
Surrogate
Not assessed

●	High hazard
◖	Moderate hazard
○	Low hazard

APPENDIX E

Human Health Hazard Summary

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	L-Glutamic acid
Synonyms	alpha.-Aminoglutaric acid; Glutaminic acid
CAS number	56-86-0
Molecular formula	C5H9NO4
Molecular Structure	

Overview	Reference
L-glutamic acid is a major amino acid naturally occurring in living organisms. It acts as neurotransmitters in the brain. In its pure form, it has a powder state. L-glutamic acid is a permitted food additive (E 260). It is also used as plant growth enhancer of specified plant and in pesticide products.). L-glutamic acid is classified *generally recognized as safe (GRAS)* for human consumption.	US EPA, 2004 FDA, 2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as a carcinogenic substance.	ECHA, 2013 IARC, 2013
Mutagenicity/Genotoxicity Not classified as mutagenic.	ECHA, 2013
Reproductive Toxicity Not classified as toxic to reproduction.	ECHA, 2013
Developmental Toxicity/Teratogenicity Not classified as developmental toxicant.	ECHA, 2013
Endocrine Disruption Not listed as an endocrine disruptor	EC, 2000a
Acute Toxicity (oral, dermal, inhalation) Not classified as acute toxic via oral or dermal route. Data lacking regarding acute toxicity via inhalation.	ECHA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as a specific target organ toxicant (based on subchronic studies on rats and dogs with read-across substances administered via oral route).	ECHA, 2013
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser. Data lacking regarding respiratory sensitisation.	ECHA, 2013
Corrosion (irreversible and reversible)/irritation of the skin or eye Not classified as corrosive or irritant to the skin or the eye.	ECHA, 2013

Physical Hazards	Reference
Flammable Potential Not classified as flammable	ECHA, 2013

Explosive Potential Not classified as explosive	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found (NDF)	
	NDF	
High Chronic/Repeat dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	5110 mg/kg	ECHA, 2013
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	> 2000 mg/kg	ECHA, 2013
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL (dog, oral)	1500 mg/kg/day (read-across: monosodium glutamate 90 day study)	ECHA, 2013
NOAEL (rat, oral)	5100-5300 mg/kg/day (male); 4800-4900 mg/kg/day (female) (read-across: monosodium glutamate 90 day study)	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	
Mutagenicity/Genotoxicity	No	
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	
Corrosive (irreversible damage)	No	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	
Irritant (reversible damage)	No	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 0	
Uncertainty analysis /data confidence	12/13	**92 %**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits	No occupational limits established	EC, 2000b
Air (OEL)	NDF	
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	ADWG, 2011
Water, recreational	NDF	NEPM, 1999 - amended
Soil, residential	NDF	NEPM, 1999 - amended
Soil, commercial/industrial	NDF	NEPM, 1999 - amended

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

L-glutamic acid has a low hazard profile to human health. It is not classified as a hazardous substance. Exposure of humans to L-glutamic acid mainly occurs through food intake and no occupational limits were found (within the limits of the search strategy). L-glutamic acid is deemed to be safe for human consumption and risk to humans from the use of L-glutamic acid as pesticides active ingredients are not expected.

References and Notes

Australian Drinking Water Guidelines (ADWG, 2011). National Health and Medical Research Council. Available from http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines.pdf

European Chemicals Agency (ECHA 2013). Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 2 October 2013] (ECHA 2013)

European Commission (EC, 2000a) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

European Commission (EC, 2000b) Joint Research Center. European Commission (EC) Joint Research Centre (JRC) Institute for Health and Consumer Protection - European Chemical Substances Information. IUCLID Data Sheet. Available at http://esis.jrc.ec.europa.eu/doc/IUCLID/data_sheets/56860.pdf.

Food and Drug Administration (FDA, 2013) Generally Recognised As Safe (GRAS) Substances Database. Available at http://www.fda.gov/food/ingredientspackaginglabeling/gras/scogs/ucm260455.htm. [Accessed 9 October 2013].

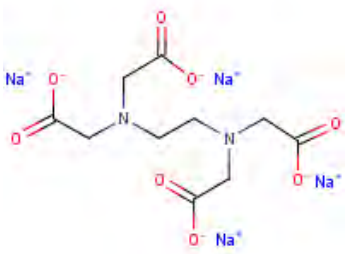
International Agency for Research on Cancer (IARC, 2013) Agents classified by IARC Monographs, Volumes 1-108. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf.

National Environment Protection (Assessment of Site Contamination) Measure 1999 (NEPM 1999 - amended).

United States Environmental Protection Agency (US EPA, 2004). G*amma aminobutyric acid (GABA) & L-Glutamic acid (030802, 374350) Fact Sheet.* Available at http://www.epa.gov/opp00001/chem_search/reg_actions/registration/fs_G-132_19-Oct-04.pdf.

Created by:	JC	Date: 9/10/2013
Reviewed and edited by:	JF	Date 8/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Tetrasodium ethylenediaminetetraacetate
Synonyms	Ethylenediaminetetraacetic acid tetrasodium salt Acetic acid, (ethylenedinitrilo)tetra-, tetrasodium salt N,N'-Ethylenediaminediacetic acid tetrasodium salt EDTA Tetrasodium
CAS number	64-02-8
Molecular formula	$C_{10}H_{12}N_2O_8Na_4$ / $((NaOOCCH_2)_2NCH_2)_2$
Molecular Structure	

Overview	References
Physical properties Tetrasodium EDTA is white powder with solubility of 500g/L at (20°C). Reacts with most divalent and trivalent metallic ions forming soluble metal chelates. Tetrasodium EDTA is highly reactive with oxidizing agents and acids, reactive with metals and slightly reactive to reactive with reducing agents and organic materials. It is highly corrosive in the presence of copper, corrosive in the presence of aluminium and zinc, slightly corrosive in the presence of steel and non-corrosive in the presence of glass. Tetrasodium EDTA has a melting point of > 300°C.	(HSDB, 2013; MSDS 2013; ECHA 2013)
Uses The sodium salt of EDTA is used as an antidote for metal poisoning, an anticoagulant, and an ingredient in a variety of detergents. By forming stable water soluble complexes with multivalent metal ions, chelating agents prevent undesired interaction by blocking normal reactivity of metal ions, such as in the case of the removal of corneal calcium deposits. Other applications include soap, textile dyeing, water softening, metal finishing and plating, pulp and paper, enzyme deactivation, photo chemistry, and bacteriocides.	(HSDB, 2013; ECHA 2013)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as a carcinogen on the ECHA Registered Substances Database.	(IARC, 2010)
The International Agency for Research on Cancer (IARC) has not evaluated the evidence for the carcinogenicity of Tetrasodium EDTA.	(ECHA, 2013)
A lifetime (103 weeks) study in Fischer 344 rats was conducted with trisodium EDTA via the oral	

(feed) route. The chemical was administered to 50 males and 50 females at low (248 mg/kg) and high (495 mg/kg) concentrations, for 103 weeks. Matched-control groups were composed of 20 males and 20 females. Animals were analysed for mortality, clinical signs, histopathological as well as gross pathological changes. The study summary reports that no tumour appeared in a statistically significant positive trend in either dose groups or sexes. A variety of endocrine tumours were found, some types occurring only in treated animals. However, these tumours occurred in low numbers and have frequently been seen in untreated animals in other studies. Thus the study authors judged these to be "probably unrelated to treatment".	
Mutagenicity/Genotoxicity Not classified as a mutagen or genotoxic.	(ECHA, 2013)
Reproductive Toxicity Not classified as reproductive toxicant.	(ECHA, 2013)
Developmental Toxicity/Teratogenicity Not classified as developmental toxicant.	(ECHA, 2013)
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	(EC, 2000)
Neurotoxicity Not classified as toxic to the nervous system.	(ECHA, 2013)
Acute Toxicity (oral, dermal, inhalation) Tetrasodium EDTA has been classified as oral acute toxic 4 H205, harmful if swallowed. Studies on male and female rats show that the LD_{50} for Tetrasodium EDTA is >1780<2000 mg/kg bw. Tetrasodium EDTA has not been classified as acute dermal toxic or inhalation acute toxic.	(ECHA, 2013, ICPS, 2006)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Systemic toxicity/Organ effects A 13 weeks feeding study on rats was performed using 3 different dose groups (500, 2500, 5000 mg/kg) and one control group. After 13 weeks 50% of the animals of each group were sacrificed and tissues examined for gross and histopathologic changes. The remaining animals were placed on control diet for 4 weeks. Thereafter animals were sacrificed and examined for gross and histopathologic changes. No treatment related histopatholigical changes were noted. Decreased weight gain probably due to diarrhea occurred at 2500 and 5000 mg/kg. The clear no observed effect level was 500 mg/kg.	
Sensitisation of the skin or respiratory system Not classified as a respiratory or skin sensitiser by ECHA.	ECHA, 2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Tetrasodium EDTA has been classified as causing serious eye damage, H318 and it is corrosive to eyes on contact. Information from the MSDS indicate that Tetrasodium EDTA is irritating to mucous membranes and upper respiratory tract. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.	(ECHA, 2013; MSDS 2013)

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Physical Hazards	Reference
Flammable Potential Tetrasodium EDTA is not ignited easily but above 350 °C, vapours (substance decomposition) are flammable. ECHA has classified it as not a highly flammable solid but ICPS has indicated that it is combustible and gives off irritating or toxic fumes (or gases) in a fire. Not Classified as Flammable by ECHA.	(ECHA, 2013; ICPS, 2006
Explosive Potential Not classified as an explosive by ECHA but ICPS states that finely dispersed particles can form explosive mixtures in air.	(ECHA, 2013; ICPS 2006)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	>1780<2000 mg/kg bw	(ECHA, 2013)
Rat, oral	>2000 mg/kg bw	(HSDB, 2013)
Rat, oral	3030 mg/kg bw	(MSDS, 2013)
Rat, ip	4000 mg/kg bw	(HSDB, 2013)
Mouse, ip	330 mg/kg	(HSDB, 2013)
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL, Rat	1210-1780 mg/kg bw	ECHA, 2013;
LOAEC, Rat	30 mg/m^3 air 6 hours per day for 5 days	For Disodium ethylene diamine tetraacetic acid (similar structure and formula)ECHA, 2013
NOAEL, Rat	500 mg/kg	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL- NO Observed Adverse Effect Level

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	No found on the IARC carcinogen classification lists.(IARC 2010)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	
Endocrine Disruption[1]	No	Not Classified by European Commission (EC 2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	No found on the IARC carcinogen classification lists.(IARC 2010)
Mutagenicity/Genotoxicity (GHS Category 2)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible effect)	Yes	
Respiratory sensitiser	No	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	LOAEL 1210-1780 mg/kg bw
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	Yes,	LD_{50} >1780<2000 mg/kg bw
Irritant (reversible effect)	Yes, see Band 3	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	NA	

Physical Hazards		
Flammable potential	Potentially, above 350 °C, vapours are flammable.	(IPCS 2006), Not Classified as Flammable by ECHA, 2013
Explosive potential	Potentially, Finely dispersed particles can form explosive mixtures in air.	ICPS (2006) Not Classified as Explosive by ECHA, 2013
Hazard Evaluation (highest band) not including physical hazards	Band 3	
Uncertainty analysis /data confidence (out of 12 parameters)	12/12	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Neurotoxicity based on REACH assessments.

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	NDF	
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
DNEL	25 mg/kg bw/day	ECHA 2013
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Tetrasodium EDTA is a hazardous substance due to its corrosive effects to eyes and irritant effects to skin. It is categorized as hazard band 3.

References and Notes

NDF - No data found within the limits of the search strategy.

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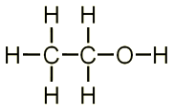
Created by:	AES	Date 28/11/2013
Reviewed by:	JF	Date 11/12/2013

Glossary

ATSDR – US Agency for Toxic Substances and Disease Registry
ECOTOX – ECOTOXicology database
EPI Suite – Estimation Program Interface Suite
ESIS – European chemical Substances Information System
SDS – Safety Data Sheet
HSDB – Hazardous Substances Databank
IRIS – Integrated Risk Information Service
IPCS – International Program on Chemical Safety
NICNAS – National Industrial Chemicals Notification and Assessment Scheme
RAIS – Risk Assessment Information System

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Ethanol
Synonyms	Ethyl Alcohol, ethyl hydrate, ethyl hydroxide, alcohol, bioethanol, grain alcohol, aethanol, aethyl alcohol
CAS number	64-17-5
Molecular formula	C_2H_5OH
Molecular Structure	

Overview	References
The melting point for ethanol is -114 °C, the boiling point is 78.3 °C and the flashpoint is 14 °C. Ethanol is fully water miscible at ambient temperatures.	OECD (2004)
Ethanol use falls into four main categories. These include as a solvent; in the manufacture of chemicals; as a fuel additive; and for the production of alcoholic beverages. Solvent use is mainly in paint and ink manufacture and in pharmaceutical production. Ethanol is widely used in consumer products, mainly cosmetics, but also detergents, winter deicing and cleaning products, including detergents. Ethanol is also used as an additive in petroleum fuels to produce "gasohol".	
There is probably greater exposure to ethanol than to any other solvent with the exception of water, with the general population exposed to ethanol primarily through the consumption of alcoholic beverages containing this chemical.	HSDB (2012)
Ethanol is not accumulated in the body and is readily absorbed by the oral and inhalation routes and subsequently metabolised and excreted in humans.	OECD (2004)
Ethanol is a classified substance according to the Global Harmonised System (GHS) classification.	ECHA (2014)

Human Health Toxicity Summary	Reference
Carcinogenicity Ethanol (in alcoholic beverages) is classified as a Group 1 carcinogen by IARC.	IARC (2011)
Mutagenicity/Genotoxicity The studies provided on ECHA (2014) report that ethanol, when administered at low concentrations, is not reported to be genotoxic or mutagenic, however, when concentrations in studies are well in excess of guideline concentrations, mutagenic and genotoxic effects are observed. This dose-dependent effect requires consideration in view of the extensive use of ethanol in the community and that many exposures are well below concentrations used to generate adverse outcomes.	ECHA (2014)
Reproductive Toxicity Numerous studies have been reported on the effects of ethanol on reproductive toxicity. Studies have reported a threshold for effects in those cases where results have reported adverse outcomes.	ECHA (2014)

In one study in female rats administered 2.5% or 5% ethanol in a liquid diet for periods of 50 to 55 days reported suppression of ovarian function at 5% ethanol manifested by absence of oestrous cycles, a delay in vaginal opening, the absence of several generations of corpora lutea, inhibition of growth of the uteri and vaginae, and a reduction of ovarian and uterine weights. A NOAEL was established of approximately 8 g/kg/d.	
Developmental Toxicity/Teratogenicity Numerous studies are available on the effects of ethanol exposure on developmental toxicity. These studies have concluded that ethanol toxicity is only observed at very high doses. In one study, pregnant mice were fed a liquid diet containing 17%, 25%, or 30% ethanol-derived calories from day 4 to day 9 of gestation. Ethanol treatment did not induce any increase in mortality or change in weight gain with respect to controls but a dose-dependent increase in fetal resoprtions and congenital malformations was observed in groups treated with 25% and 30% ethanol-derived calorie diets. A LOAEL for maternal toxicity and teratogenicity was determined as 25% ethanol derived calories in feed. In humans, ethanol is a developmental toxin, and various effects have been associated with ethanol intake. Excessive consumption of alcoholic beverages during pregnancy is associated with the development of a syndrome of physical and mental manifestations in the offspring - the fetal alcohol syndrome. Ethanol at high blood levels affects the structure of the reproductive organs and causes significant reductions in fetal body weight, increased resorptions and teratogenic effects in a number of species.	ECHA (2014) IARC (1998)
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	BKH (2000)
Neurotoxicity In humans, alcohol may also cause defects in the central nervous system.	IARC (1998)
Acute Toxicity (oral, dermal, inhalation) **Oral** Five female and five male rats (per dose) were orally administered 8 200 mg/kg, 9 840 mg/kg, 11 480 mg/kg and 16 070 mg/kg of ethanol as 5% H_2O in 95% ethanol and observed for a 14 day period following administration. The study determined an LD_{50} of 10 470 mg/kg. A range of other oral toxicity studies have reported LD_{50} values ranging from 8 350 -15 010 mg/kg. Age dependent variability in responses in rat studies has also been observed and reported reflecting differing sensitivities to oral intakes with the following data reported: • LD_{50} (14 day old animals): 6 160mg/kg • LD_{50} (young adults): 17 750mg/kg • LD_{50} (old adults): 11 500mg/kg **Dermal** NDF. **Inhalation** Ten male and ten female rats per dose were exposed to a heated vapour of ethanol for a period of 4 h at concentrations of 62.0 mg/L, 79.1 mg/L, 93.4 mg/L, 115.4 mg/L and 155.0 mg/L and observed for a period of 14 days following administration. The following acute inhalation LC_{50}'s were determined: • Male rat: 116.9 mg/L air (4 h) • Female rat: 133.8 mg/L air (4 h) • Male/female rat: 124.7 mg/L air (4 h)	ECHA (2014)

Another study in ten female and ten male rats exposed to a concentration of 84.2 mg/L, 69.2 mg/L, 58.8 mg/L,53.2 mg/L, 48.6 mg/L and 16.5 mg/L of heated ethanol vapour over a duration of 6 h. The rats were then observed for a period of 14 days. The following acute inhalation LC_{50}'s were determined: • Male/female rat: 52.9 mg/L air (6 h) • Male rat: 51.3 mg/L air (6 h) • Female rat: 54.8 mg/L air (6 h)	
Chronic/repeat dose toxicity (oral, dermal, inhalation) **Oral** In a 90 day sub-chronic repeat dose study, male rats were given a liquid diet containing ethanol at a level of 1% w/v, 2% w/v, 3% w/v, 4% w/v, 5% w/v and 10% w/v. The only significant effect seen in the 1% and 2% dose groups were centrilobular steatosis (a fatty change). This is often associated with ethanol consumption but in its mild form is not considered to be a pathological condition. There was also evidence from glucose dosed animals, used as calorific controls which also showed the effect, that this finding is actually related to the caloric content of ethanol rather than being substance specific. It is not therefore considered an adverse effect. On this basis, the no effect level from this study was 2%, which was approximately equivalent to a dose of 3 900 mg/kg/day. **Dermal** NDF. **Inhalation** In a study to examine the repeat dose toxicity of ethanol, rats were exposed to a single dose of ethanol vapour at 20 mg/L for up to 26 days. Intermediate exposure groups were used to allow changes in clinical chemistry, histopathology and blood ethanol concentrations to be followed with time. The study found a number of transient effects (clinical signs, e.g. lethargy and ataxia, mild hepatic vacuolisation and changes to clinical chemistry parameters) but in animals exposed for the full 26 days, the only significant effect noted was an increase in plasma GPT levels, which, in isolation, was not regarded as biologically significant. It was noticeable that the blood ethanol levels in the animals exposed for 26 days were much lower than those exposed for shorter periods indicating pronounced induction of metabolic tolerance. The NOAEC for the study was determined as >20 mg/L air for male rats.	ECHA (2014)
Sensitisation of the skin or respiratory system **Skin** A study was carried out to evaluate the effect of vehicles (ethanol or diethyl phthalate) for use in the mouse local lymph node assay (LLNA), and their influence on the skin sensitisation potential of four test fragrance materials. Groups of 4 mice were treated with each test fragrance, at one of five concentrations, either in ethanol or diethyl phthalate (and 1:3 or 3:1 mixtures of the two), or with ethanol (or diethyl phthalate) alone. Although there were no true control data for comparison with the ethanol-alone treated animals, the level of induced T-lymphocyte proliferation was low for ethanol when compared with that for fragrance materials known to be mild to moderate skin sensitizers, and comparable to that for the other (negative) control vehicle tested, diethyl phthalate. The review in ECHA (2014) concluded that ethanol was not sensitising to skin. An ear swelling study was undertaken in mice to examine the skin sensitising potential of ethanol. Ethanol was applied twice on the right ear after an induction procedure involving two scapular subcutaneous injection of adjuvant and multiple topical ethanol applications to the abdomen over a period of 14 days. The degree of contact hypersensitivity is deduced from ear swelling measured 24 hours and 48 hours after application. Ethanol was found not to cause any statistical increase in ear swelling, in contrast to 3 positive controls which all caused a statistically significant increase. **Respiratory** NDF.	ECHA (2014)

Corrosion (irreversible)/irritation (reversible) effects on the skin or eye **Skin:** In a guideline and Good Laboratory Practices (GLP) skin irritation study, 0.2 mL of ethanol was applied to an intact skin test site on each of five rabbits for 24 h. After 24 h exposure the test sites were exposed and wiped. The sites were examined for erythema and edema at 1 day, 2 days, 3 days, 4 days, 5 days and 7 days. Alcohol was found to produce no significant irritation and was therefore concluded to be non-irritating to rabbit skin. Closed patch 24 h exposure to 0.2 mL aliquot of undiluted ethanol produced mild erythema responses at the intact skin site in four of five rabbits. Mild erythema was observed in four of five animals that persisted until the end of the observation period on day 7. Based on the observations it was concluded that alcohol, as tested, was a mild skin irritant but that the reaction is not sufficient to warrant classification. A range of studies including those on humans have supported the position that ethanol is a mild skin irritant. **Eye** In a reference handbook of peer reviewed, guideline GLP eye irritation study results in rabbits, ethanol was found to cause reversible eye irritation (Category 2 under EU GHS). This has been supported by other OECD rabbit studies with a US study supporting a position of ethanol's ECHA classification as an eye irritant.	ECHA (2014)

Physical Hazards	Reference
Flammable Potential Classified as highly flammable.	SafeWork (2005)
Explosive Potential NDF.	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	10 470 mg/kg 14 500 mg/kg – 15 010 mg/kg 11 850 mg/kg 9 920 mg/kg 6 160 mg/kg (14 days old) 17 750 mg/kg (young adults) 11 500 mg/kg (old adults)	ECHA (2014)
Mouse, oral	8 350 mg/kg	ECHA (2014)
Rat, dermal	NDF	
Rabbit, dermal 24 h	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat (inhalation)	Male rat: 116.9 mg/L air (4 h) Female rat: 133.8 mg/L air (4 h) Male/female rat: 124.7 mg/L air (4 h) Male/female rat: 52.9 mg/L air (6 h) Male rat: 51.3 mg/L air (6 h) Female rat: 54.8 mg/L air (6 h)	ECHA (2014)
High Chronic/Repeat Dose Toxicity		
LOAEL	3.16 g/kg 4 400 mg/kg 9 700 mg/kg	Oral repeat dose (ECHA, 2014) Female rats – repeat dose (ECHA, 2014) Male mice – repeat dose (ECHA, 2014)
LOAEC	NDF	
NOAEC	>20 mg/L air	Male rats (ECHA, 2014)
NOAEL	NOAEL would appear to be close to 5% ethanol diet, which is estimated to be ~14 g/kg/d ~8 g/kg/d 1.73 g/kg	For persistent effects relating to reproductive toxicity. (ECHA, 2014) Reproductive toxicity (ECHA, 2014) Oral repeat dose (ECHA, 2014)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level
NOAEC – No Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	Yes	Group 1 (IARC, 2011)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2014)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	Yes	'Conclusive but not sufficient for classification' in ECHA (2014) under the Global Harmonised System. However, intake of alcohol in pregnant women is associated with fetal alcohol syndrome and is a known teratogen (IARC ,1998)
Endocrine Disruption[1]	No	BKH (2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC (2011)
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2014)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA (2014)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m[3]) (vapour)	Oral: No Dermal: NDF Inhalation: No	ECHA (2014)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 20 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	Yes	Based on mutagenic and reproductive toxicity at high doses.(ECHA,2014)
Corrosive (irreversible effect)	No	ECHA (2014)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6 h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	Oral: No Dermal: NDF Inhalation: NDF	ECHA (2014)
Skin Sensitiser	No	ECHA (2014)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2,000 mg/kg • dermal LD_{50} >1,000 mg/kg ≤ 2,000 mg/kg;	Oral: No Dermal: NDF Inhalation: No	ECHA (2014)

• inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]		
Irritant (reversible effect)	Yes	Eye irritant ≥ 50% (ECHA, 2014)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	Yes	Highly flammable (ECHA, 2014)
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 4	
Uncertainty analysis /data confidence (out of 12 parameters)	83%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1] Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	1 880 mg/m^3 (1,000 ppm)	SafeWork (2005)
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8-h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Ethanol is a widely used component of beverages that are consumed by a large majority of the population due to its ability to cause intoxication and subsequent euphoria. There has been extensive historical information of the fermentation of fruits and grains to produce products such as wine, beer and distillate spirits and its basic effects

are well recognised. While moderate use has been reported to demonstrate beneficial effects, high level and long term consumption of ethanol-containing beverages has been linked to systemic and organ toxicity, mutagenic, developmental and reproductive effects and cancer at various sites. Ethanol has therefore been assigned a Human Health Toxicity Ranking of Hazard Band 4 based on it being a Group 1 carcinogen. In addition to this, very mild irritation of the skin and irritation of the eyes was reported in several studies following 24 hours of contact, including those on humans. While consumption is not anticipated, the volatile nature and dermal absorption potential of ethanol may present a concern for occupational settings and those involving large-scale spills and these require suitable management. In view of the developmental toxicity potential of ethanol exposure, a particular focus should be female workers in settings where ethanol exposure may exist. The exposure potential for workers would also be heightened should high percentage strengths of ethanol be used in mixture preparations and in settings where elevated temperatures are present. The degradation characteristics of ethanol preclude sustained environmental persistence and distribution and limit the residual exposure potential of this chemical.

References

BKH 2000, BKH Consulting Engineers. *Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption: - preparation of a candidate list of substances as a basis for priority setting*. Final report (incorporating corrigenda to final report dated 21 June 2000), Annex 10: List of 564 substances with their selection criteria. Available at http://ec.europa.eu/environment/archives/docum/pdf/bkh_main.pdf [Accessed 9/01/2014]

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IARC 2011, International Agency for Research on Cancer (IARC). Available at http://monographs.iarc.fr/ENG/Classification/index.php. [Accessed 09/01/2014].

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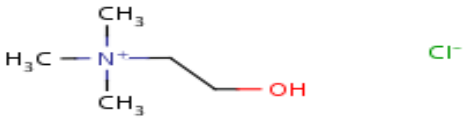
Created by:	CM	13/01/2014
Reviewed:	LT	16/01/2014 Rev1

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Choline Chloride
Synonyms	Ammonium (2-hydroxyethyl) trimethylchloride, biocoline, choline hydrochloride
CAS number	67-48-1
Molecular formula	$C_5H_{14}NOCl$
Molecular Structure	

Overview	References
Choline chloride is a quaternary ammonium salt which appears as a white crystalline solid and is used as a nutrient in food for human and animal consumption. It is generally recognized as safe (GRAS) when used in accordance with good manufacturing practice. Choline has several major metabolic functions in the body including as a precursor for phosphatidylcholine (a structural component of biological membranes) and acetylcholine (a neurotransmitter involved in memory formation) biosynthesis and as methyl donor. It also plays an important function as a precursor for phospholipids. It is largely derived from membrane lecithin or from dietary intake of choline and lecithin. Humans with choline deficiency, Huntington's Disease, or liver disease may be administered choline chloride therapeutically. Cells will die by apoptosis when deprived of adequate choline. Some free choline is excreted with urine, with the remainder metabolized in the intestines, liver or kidney. Metabolic products include betaine and methyamines.	HSDB (2012:, US FDA (2013); OECD (2004)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC A choline-devoid diet has been implicated as cancer-causing in rats.	HSDB (2012); IARC (2013)
Mutagenicity/Genotoxicity No indication of mutagenic or genotoxic effects.	OECD (2004)
Reproductive Toxicity One rat study suggested that prolonged administration of excess choline may prove to be toxic to male reproduction. No adverse fertility effects have been reported from the use of choline chloride as animal feed despite it being used for the purpose for several decades.	HSDB (2012); OECD (2004)

Developmental Toxicity/Teratogenicity No significant developmental toxicity in mice observed at high doses (1250 mg/kg bw/day), with the exception of very high doses (4160 mg/kg bw/day and higher) accompanied with maternal toxicity.	HSDB (2012)
Endocrine Disruption NDF	
Neurotoxicity NDF	
Acute Toxicity (oral, dermal, inhalation) One study reported that single oral doses of 10 g produce no obvious pharmacodynamic response in humans. Another reported a slight hypotensive effect in humans with the same dose. The critical adverse effect from high intake of choline is hypotension. The tolerable upper limit for choline has been set at 3-3.5 g/day. Humans orally dosed with >3000 mg/day choline magnesium trisalicylate did not display acute toxicity effects.	HSDB (2012); OECD (2004)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Humans given choline 9 g/day (week 1) and 12 g/day (week 2) as a chloride or bitartrate, resulted in mild cholinergic toxicity such as lacrimation, blurred vision, anorexia, and diarrhea. Humans fed choline chloride 8 to 20 g/day for 2 to 17 weeks, exhibited fishy body odor and at 250 to 300 mg/kg/day, exhibited lacrimation, anorexia, vomiting, and diarrhea. Humans with and without cirrhosis have been treated with large doses of choline chloride (6 g/day for 4 weeks) with no resultant liver toxicity. 7.5 g of daily choline administered to some patients has resulted in nausea, diarrhea and a small decrease in blood pressure. Sufferers of trimethylaminuria, liver disease, renal disease, depression and Parkinson's disease experienced the highest risk at the upper limit of 3.5 g/day. Long-term memory was affected in another study on young human subjects. When 2 grams of chorine chloride was administered 4 times per day to nine human subjects, choline did not appear to have substantial effects on memory but produced small cognitive effects in some subjects. One rat study was shown to promote short-term memory while inhibiting long-term memory, while another rat study showed no effects on spatial short-term memory. Another rat study indicated improvements in spatial and temporal memory of adult rats exposed to elevated levels of choline chloride perinatally. One rat study concluded that choline diminishes endotoxin shock by preventing macrophage activation. No adverse effects were observed in rats given 500 mg/kg bw/day for 72 weeks.	HSDB (2012)
Sensitisation of the skin or respiratory system NDF for animals Negligible in humans - one case of contact dermatitis reported after dermal exposure to choline chloride (concentration unknown).	OECD (2004)
Corrosion (irreversible and reversible)/irritation of the skin or eye Slightly irritating to rabbit skin and eyes.	OECD (2004)

Physical Hazards	Reference
Flammable Potential When heated to decomposition it emits toxic fumes of chloride, sulfur oxides, and nitrogen oxides.	HSDB (2012)
Explosive Potential NDF	

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	200-400 g for a man (estimated).	HSDB (2012)
High Chronic/Repeat Dose Toxicity		
NOAEL	>500 mg/kg bw/day	OECD (2004)
LOAEL	10 g/day	OECD (2004)
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	6,640 mg/kg	HSDB (2012)
Rat, oral	3,400 mg/kg	HSDB (2012)
Mouse, oral	3,900 mg/kg	HSDB (2012)
LC_{50}		
	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	Not classified by IARC
Mutagenicity/Genotoxicity	No	OECD (2004)
Reproductive Toxicity	No	OECD (2004)
Developmental Toxicity/ Teratogenicity	No	OECD (2004)
Endocrine Disruption[1]	NDF	
Neurotoxicity[2]	NDF	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m[3]) (vapour)	No	HSDB (2012)
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	OECD (2004)
Corrosive (irreversible damage)	NDF	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	OECD (2004)
Skin Sensitiser	No	OECD (2004)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	OECD (2004)
Irritant (reversible damage)	Yes	Slight reaction in rabbits. (OECD, 2004)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NDF	Exists as solid at STP
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	**Band 1**	Limited toxicity with some irritant effect potential
Uncertainty analysis /data confidence	7/14 x 100 =	**50%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*
[3] *milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	NEPM (1999; amended 2013)
Water, recreational	NDF	
Soil, residential	NDF	NEPM (1999; amended 2013)
Soil, commercial/industrial	NDF	NEPM (1999; amended 2013)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Choline (as the chloride) is a dietary intake being found in many foods and exhibits negligible toxicity. It is subsequently assessed as being in Hazard Band 1. This is a consequence of its low acute toxicity and lack of reported genotoxicity, reproductive , developmental and teratogenic effects, however, it may result in minor skin irritation following dermal contact. High (oral) intake in humans has been associated with hypotension and cholinergic effects such as sweating and diarrhoea and fishy body odour.

It is not flammable or explosive and although a solid is usually supplied as a solution. As it degrades readily environmental persistence and distribution is not expected. Its mild irritancy may be readily managed in the occupational setting.

References

IARC (2013) Agents classified by IARC Monographs Volumes 1- 107. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf. [Accessed 11/07/2013].

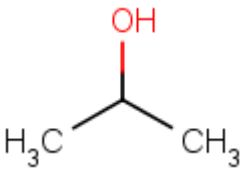
HSDB (2012) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. [Accessed 11 July 2013.]

OECD (2004). Choline Chloride: SIDS initial assessment report. OECD publication. Available at <http://www.inchem.org/documents/sids/sids/67481.pdf>. [Accessed 11/07/2013].

US FDA (2013) Food Additive Status. List. U.S. Food and Drug Administration Available athttp://www.fda.gov/Food/IngredientsPackagingLabeling/FoodAdditivesIngredients/ucm091048.htm, (Accessed 11/07/2013).

Created by:	MER	Date 11/07/2013
Reviewed and edited by:	LT	Date 24 July 2013 Rev0
Updated	JC	Date 21 August 2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Propan-2-ol
Synonyms	2-propanol, Isopropanol, n-Propan-2-ol, i-Propyl alcohol, Isopropyl alcohol, IPA, 2-hydroxypropane
CAS number	67-63-0
Molecular formula	C_3H_8O
Molecular Structure	

Overview	References
Propan-2-ol is an organic mono constituent substance, colourless liquid with a slight alcohol odour. It is miscible in water and is chemically stable.	Oxford University, 2006
It is a high production volume chemical which is used as an industrial solvent, a component of industrial and consumer products and as a disinfectant.	
It is used in the medical profession as a disinfectant, solvent, and preservative. It is applied topically as a disinfectant, astringent, hemostatic, and coolant.	Fisher Scientific, 2008
Toxicological data available from HSIS classifies propan-2-ol as highly flammable and an irritant to the eyes and the respiratory system. Exposure standards are 400 ppm TWA, and 500 ppm STEL. ECHA supports the classification that propan-2-ol can cause eye irritation and also identifies that single target organ toxicity (STOT) exposure through inhalation or oral may cause drowsiness or dizziness with no affects to the organ.	HSIS,2009 ECHA,2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification).	ECHA,2013
IARC has evaluated available evidence for the carcinogenicity of Isopropyl alcohol (Propan-2-ol), classification: group 3 - not classifiable as a human carcinogen.	IARC,2013
Mutagenicity/Genotoxicity Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification).	
A study similar to OECD Guideline 471 (Bacterial Reverse Mutation Assay) was carried out in vitro on test strains S. typhimurium TA 1535, TA 1537, TA 98 and TA 100, all strains/cell types tested. The dose concentrations were between 100 and 10,000 µg/plate. The test substance was not mutagenic in any of the strains tested with or without metabolic activation.	ECHA,2013
A study similar to OECD Guideline 474 (Mammalian Erythrocyte Micronucleus Test) was carried out in vivo on mice, strain ICR. Controls were used. The test species had negative results to genotoxicity.	
Reproductive Toxicity Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification).	

A study equivalent to OECD Guideline 416 (Two-Generation Reproduction Toxicity Study) was carried out on Sprauge-Dawley rats. Oral doses of Isopropanol were 100, 500, 1000 mg/kg bw/day. Exposure periods were 10 weeks before mating until the day prior to euthanasia. Parental test rats, NOAEL 500 mg/kg bw/day, clinical observation of increased organ weights at 1000 mg/kg bw/day. Reproductive test rats, NOAEL 1000 mg/kg bw/day, no clinical effects observed at highest dose. Offspring test rats, NOAEL 500 mg/kg bw/day, clinical observations of reduced body weights and increased mortality at 1000 mg/kg bw/day. A study equivalent to OECD Guideline 415 (One-Generation Reproduction Toxicity Study) was carried out on Wistar rats. Drinking water formulations were prepared with Isopropanol 0.5, 1.0 or 2.0%. Parents and offspring were exposed before mating until euthanasia. Parental test rats NOAEL 853mg/kg bw/day. Clinical observations of increased pre-implantation loss, decreased mean litter weight and decreased mean fetal body weight at the higest exposure (2.0%).	ECHA,2103
Developmental Toxicity/Teratogenicity Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification). A study equivalent to OECD Guideline 414 (Prenatal Developmental Toxicity Study) was carried out on Wistar rats. Drinking water formulations were prepared with Isopropanol 596, 1242, or 1605 mg/kg bw. Test species exposed for 3 weeks. Controls were used. NOAEL for maternal and fetal toxicity, of 596mg/kg bw/day. At higher dose levels maternal clinical observations of decreased food and water consumption and body weight for maternal toxicity and fetal observations of decreased mean body weight. No NOAEL was determined for developmental toxicity.	ECHA,2013
Endocrine Disruption Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification). Not listed as an endocrine disruptor by European Commission.	ECHA,2013 EC, 2000
Neurotoxicity Two studies according to OECD Guideline 426 (Developmental Neurotoxicity Study) were carried out on Sprauge-Dawley rats, via oral administration of test substance. No clinical observations at the highest administered doses. Maternal NOAEL of 700mg/kg bw/day and offspring NOAEL of 1.2E3 mg/kg bw/day.	ECHA via QSAR,2013
Acute Toxicity (oral, dermal, inhalation) Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification). A study that predates toxicity guidelines, similar to OECD Guideline 401 (Acute Oral Toxicity) reliability scoring based on 2001 guideline for Test No. 423. Test was carried out on Sherman rats, via oral administration. No observations are reported, effect level, LD50 of 5840 mg/kg bw. A study similar to OECD Guideline 403 (Acute Inhalation Toxicity) carried out on Fischer 344 rats. Vapour (inhalation) doses of Isopropanol 500, 1500, 5000 and 10,000ppm. Exposure period of 6 hours. LC50 of >10000ppm. Observations of transient concentration-related narcosis and central nervous system sedation effects. Substance classified under STOT single exposure category 3, H336 - may cause drowsiness or dizziness, according to CLP classification criteria A study that predates toxicity guidelines, similar to OECD Guideline 402 (Acute Dermal Toxicity) was carried out on rabbits. Duration of exposure was 24 hours. LD_{50} of 16,400 mg/kg bw.	ECHA,2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification). A study according to OECD Guideline 413 (Subchronic Inhalation Toxicity: 90-Day) was carried	

out on rat and mice. Whole body inhalation doses of Isopropanol 100, 500, 1500 or 5000ppm. Exposure period was 6 hours per day, 5 days per week for 13 weeks. NOAEL of 5000ppm.Clinical observations of increased relative liver weight and motor activity (female only). Toxicity on the central nervous system was observed however as an acute effect. A study of combined repeat dose and carcinogenicity according to guideline OECD 451 was carried out on rats. Whole body inhalation does of Isopropanol 0, 500, 2500, 5000ppm. Exposure period was 6 hours per day, 5 days per week for at least 104 weeks. Clinical observations in the 2500 and 5000ppm groups of toxicity including hypoactivity, lack of startle reflex, and/or narcosis, changes in body weight, and urinalysis and urine chemistry indicative of kidney changes. Toxicology effects NOEC of 500ppm. A number of non-neoplastic histopathological changes were observed, with the most significant being in the kidney for males.Oncogenicity effects NOEC of 500ppm. An oral study was undertaken on male rats via repeat dose of test substance in drinking water. Original value and LOEL was 1280mg/kg bw/day. No dermal dose data found.	ECHA,2013 Rep Dose Tox via QSAR,2013
Sensitisation of the skin or respiratory system Not classified on European Chemical Agency (ECHA) database (conclusive data but not sufficient for classification). A study according to OECD Guideline 406 (Skin Sensitisation) was carried out in vivo on Hartley guinea pigs. Epicutaneous doses of Isopropyl Alcohol 0.4ml for a period of 6 hours weekly over three induction exposures. No skin reactions were observed in the test and control animals, it was concluded that Isopropyl alcohol is not a sensitizer.	ECHA,2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye A study for skin sensitisation predating toxicology guidelines was carried out on guinea pigs. Dermal application (no test substance or dose reported) for 4 hour exposure period. No irritation or tissue destruction was observed concluding that the test substance dose is not irritating. A study similar to OECD Guideline 405 (Acute Eye Irritation / Corrosion) was carried out in vivo on New Zealand white rabbits. A single ocular treatment of neat MRD-86-962, 0.1mL. At 24 hours, clinical observations for the corneal, conjunctival and iridial were not fully reversible. At 14days, study was terminated, results demonstrate a trend in reversibility however it is not conclusive. Substance classified as an eye irritant, category 2, H319: Causes eye irritation according to CLP classification criteria.	ECHA,2013

Physical Hazards	Reference
Flammable Potential Classified by ECHA as a flammable liquid, category 2, H225: highly flammable liquid and vapour. Classified on HSIS database as highly flammable	ECHA,2013 HSIS, 2009
Explosive Potential No data found.	ECHA,2013

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found (NDF)	
LOAEL	(NDF)	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	5,000 - 5,045 mg/kg	Oxford, 2006 Fisher Scientific, 2008
Mouse, oral	3,600 mg/kg	Oxford, 2006
Rabbit, oral	16.4mL/kg bw	ECHA, 2013
Rat, dermal	NDF	
Rabbit, dermal	12,800 mg/kg	Oxford, 2006
Mouse, dermal		
LC_{50}		
Rat, inhalation	>10000ppm	classified under STOT, single exposure - category 3, H336 - may cause drowsiness or dizziness, ECHA, 2013
Mouse, inhalation	53,000 mg/m^3	Fisher Scientific, 2008
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL	5000ppm	ECHA,2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL - No Observed Adverse Effect Level
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No (Group 3)	Not classifiable as a human carcinogen, IARC, 2013
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA, 2013
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	ECHA, 2013
Endocrine Disruption[1]	No	EC, 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No (group 3)	Not classifiable as a human carcinogen, IARC, 2013
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA, 2013
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA, 2013
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m[3]) (vapour)	No	Oral = LD50 of 5.84 g/kg bw. Inhalation = LC50 of >10000ppm Dermal = LD50 of 16.4 mL/kg bw. ECHA, 2013
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	ECHA, 2013
Corrosive (irreversible effect)	No	classified as an eye irritant, category 2, H319: Causes eye irritation
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Oral = LD50 of 5.84 g/kg bw. Inhalation = LC50 of >10000ppm Dermal = LD50 of 16.4 mL/kg bw. ECHA, 2013
Skin Sensitiser	No	ECHA, 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	Oral = LD50 of 5.84 g/kg bw. Inhalation = LC50 of >10000ppm Dermal = LD50 of 16.4 mL/kg bw. ECHA, 2013
Irritant (reversible effect)	Yes	ECHA, 2013

Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	Yes	ECHA, 2013 HSIS, 2009
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	1	
Uncertainty analysis /data confidence (out of 12 parameters)	10/12	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Neurotoxicity based on REACH assessments.*

[3] *milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	NDF	
8-h TWA	400ppm	HSIS, 2009
STEL	500ppm	HSIS, 2009
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

The toxicity associated with propan-2-ol is principally related to the irritation of the eyes and the respiratory tract along with acute toxicity levels, although limited data is available for studies on humans for dermal, oral and inhalation exposure pathways. Propan-2-ol falls into the Hazard Band 1 category. The primary effect of exposure via usual occupational routes is considered to be irritation of the eyes and respiratory tract. Exposure standards are 400 ppm TWA, and 500 ppm STEL. Evidence indicates that propan-2-ol is not classifiable as a human carcinogen due to lack of evidence. Environmental uses should be aware that propan-2-ol is highly flammable as a liquid and a vapour. Occupational use should avoid skin, eye and respiratory system exposure.

References and Notes

European Chemicals Agency (ECHA), 2013. Registered Substances List Dossier for Propan-2-ol Available at: <http://apps.echa.europa.eu/registered/data/dossiers/DISS-9d82bbf7-98d2-11d2-e044-00144f67d249/AGGR-4f139ba1-322b-47ff-adf8-9cf3a86ee9fa_DISS-9d82bbf7-98d2-11d2-e044-00144f67d249.html#AGGR-4f139ba1-322b-47ff-adf8-9cf3a86ee9fa> [Accessed 4 December 2013].

European Commission (EC) (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

Fisher scientific. (2008), MSDS Sheet for Isopropyl Alcohol. <http://fscimage.fishersci.com/msds/89530.htm> [Accessed 4 December 2013].

Hazardous Substances information System (HSIS), Safework SA, Propan-2-ol [Isopropyl alcohol; Isopropanol], Available at: <http://hsis.safeworkaustralia.gov.au/HazardousSubstance/Details?hazardousSubstanceID=5383> [Accessed 4 December 2013].

IARC (International Agency for Research on Cancer). (2011), *Agents Classified by the IARC Monographs, Volumes 1 -102*. < http://www.iarc.fr/> [Accessed 4 December 2013].

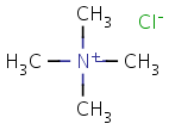
OECD (Organisation for Economic Co-operation & Development). (1997), *2-Propanol SIDS* (Screening Information Data Set). <http://www.inchem.org/documents/sids/sids/67630.pdf > [Accessed 4 December 2013].

Oxford University (2006), *Safety (MSDS) Data for 2-propanol* <http://msds.chem.ox.ac.uk/PR/2-propanol.html> [Accessed 4 December 2013].

NDF - No data found within the limits of the search strategy.

Created by:	C Shem	Date: 4/12/2013
Reviewed by:	JF	Date: 11/12/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Tetramethylammonium chloride
Synonyms	N,N,N-trimethylmethanaminium chloride. Methanaminium, N,N,N-trimethyl-, chloride. Ammonium-, tetramethyl-, chloride. Tetramine chloride
CAS number	75-57-0
Molecular formula	$C_4H_{12}N.Cl$
Molecular Structure	

Overview	Reference
Tetramethylammonium chloride (TMAC) is a white crystalline solid with a molecular weight of 109.598. TMAC has a density of is 1.1690 g/cm^3 (at 20°C) and a melting point of 420°C (decomposes). The substance is soluble in water, very soluble in methanol, slightly soluble in ethanol and insoluble in ether, benzene or chloroform. TMAC reacts with oxidants. When heated to decomposition TMAC produces very toxic fumes including ammonia, carbon monoxide, hydrogen chloride and nitrogen oxides. If released to air, an estimated vapor pressure of 1.2 mm Hg at 25 °C indicating TMAC will exist in both the vapor and particulate phases in the atmosphere. Within industry tetramethylammonium chloride is produced and used as a chemical intermediate, catalyst, and inhibitor. It is also used in hydrofracking fluid as a clay stabiliser. Although most of the human health toxicity summaries are based on studies using TMAC for some of the end-points Tetramethylammonium hydroxide (TMAH) is used as a surrogate to infer toxicity of TMAC.	HSDB (2012) IPCM (2012)

Human Health Toxicity Summary	Reference
Carcinogenicity In the ECHA database data is lacking for a carcinogenicity classification. A search on the International Agency for Research on Cancer (IARC) website did not reveal any information on TMAC.	All proposed data sources
Mutagenicity/Genotoxicity Not classified as a mutagenic/genotoxic chemical. *Notes:* A gene mutation AMES test for TMAC was performed involving a Salmonella typhimurium reverse mutation test and in the Escherichia coli reverse mutation test with and without metabolic activation. All bacterial strains showed negative responses up to 5000 ug/plate, meaning that no significant dose-related increase in the number of revertants with or without metabolic activation was seen. The negative and strain-specific positive control values were within the laboratory historical control data ranges indicating that the test conditions were adequate and that the metabolic activation system functioned properly. Based on the results of this study it is concluded	ECHA (2013)

that TMAC is not mutagenic. In an in-vitro study Tetramethylammonium was used as a surrogate to infer read-across findings for TMAC. The study involved a chromosomal aberration test which showed that Tetramethylammonium was found not to induce polyploidy or other genetic aberrations. Another in-vitro study involving Tetramethylammonium hydroxide (TMAH) was used as a surrogate to infer mutagenicity of TMAC. The study was based on a mouse lymphoma test which concluded that TMAH is not mutagenic in the mouse lymphoma test system under the experimental conditions described in this report.	
Reproductive Toxicity Not classified as having reproductive toxicity effects. No reproductive toxicity studies were available for TMAC. However, a read-across oral study for Tetramethylammonium hydroxide (TMAH) was used as a surrogate to assess the reproductive toxicity of TMAC. *Notes:* A reproductive/developmental toxicity screening test was undertaken on rats where TMAH was administered orally at 0, 1, 5 and 20 mg/kg (10 females and 10 male rats used for each dose group). TMAH showed no effect on any of the following parental reproductive parameters: days required for successful copulation, copulation index, fertility indices of males and females, implantation index, gestation length and delivery index. There was no effect of TMAH on either the numbers of total newborns, sex ratio. No compound-related abnormality was observed either in external features. Based on the rest results, the NOAEL for parental toxicity was determined to be 5 mg/kg. No effects on development were seen at the highest test concentration and therefore for reproduction/developmental toxicity a NOAEL of ≥20 mg/kg was determined.	ECHA (2013)
Developmental Toxicity/Teratogenicity Not classified as having developmental toxicity. This is inferred from the same study as discussed for reproductive toxicity above.	ECHA (2013)
Endocrine Disruption Tetramethylammonium chloride has not been included in the European Commission's Endocrine Disrupters Priority List.	ECD (2013)
Acute Toxicity (oral, dermal, inhalation) Classified as having acute oral and dermal toxic effects. TMAC is fatal if swallowed (GHS Acute Toxicity classification 2 H300) and is toxic when in contact with the skin (GHS Acute Toxicity classification 3 H311). Acute toxicity data via the inhalation pathway is lacking. *Notes:* <u>Oral</u> TMAC (15% aqueous) was administered orally to 7 female rats at doses of 300, 550 or 2000 mg/kg. Deaths occurred within 2 hours of dosing. Prior to death, abnormal physical signs included prostration and lethargy. Necropsy did not reveal any abnormalities in any of the rats. Based on the data, the LD50 (female) of 15% aqueous TMAC was found to be 1146 mg/kg, equivalent to 171.9 mg/kg of pure TMAC. A second oral study, male and female rats were exposed to dilutions of a 50% aqueous solution of TMAC. Deaths occurred between 1 and 18 hours after dosing. Within a few hours after treatment the rats showed sedation, clonic convulsions and dacryorrhoea. Coma was frequently observed. The LD50 (male/female) of the 50% aqueous TMAC was found to be 0.094 ml/kg, equivalent to an LD50 of 47 mg/kg for pure TMAC. A third oral toxicity study involved exposing female rats to TMAC doses of 17.5 91 female), 55 (2 females) or 175 mg/kg (2 females). The deaths occurred within 24 hours of dosing. Pre-death signs included convulsions, tremors, sagging eyelids, nose/mouth area wet, flaccid muscle tone, prostration, lethargy, spasms, ataxia and eyes closed. Two survivors appeared normal at necropsy, but necropsy of one surviving animal revealed abnormalities of the pancreas, kidneys and ovaries. Based on the data, the LD50 (female) of TMAC was determined to be 55mg/kg.	ECHA (2013)

Dermal An acute dermal toxicity study was performed on ten rabbits at doses of 200 or 500 mg/kg and observed for 14 days. All of the rabbits survived at the 200 mg/kg dose while 6/10 died after exposure of 500 mg/kg. Lethargy, instances of diarrhea, few feces and soiling of the anogenital area were noted during the study. Dermal effects ranged from absent to very slight on Day 1 and were absent on Days 7 and 14. The dermal LD50 (male/female) was determined to be >200 mg/kg but less than 500 mg/kg.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) No chronic data studies were available for TMAC. However, a read-across oral study for Tetramethylammonium hydroxide (TMAH) was used as a surrogate to infer oral chronic toxicity of TMAC. *Notes:* A 28-day oral repeated dose study was conducted with tetramethylammoniumhydroxide (TMAH). Female and male rats received oral doses of 5, 10 and 20 mg TMAH/ kg. No deaths were observed at any of the concentrations tested. A significant decrease in food consumption was observed in the first week of administration in male animals at 10 mg/kg, and male and female animals at 20 mg/kg. A decreased absolute and relative heart weight without dose-response and no correlated histopathological findings was also observed at 10 mg/kg and higher in males only. This effect was not seen at the end of the recovery period. Therefore, this effect was not considered to be toxicologically relevant for the time being, awaiting further data. The NOAEL for repeated dose oral toxicity was considered to be 5 mg/kg for males and 10 mg/kg for females. The LOAEL for male rats was 10 mg/kg based on decreases in food consumption s. For female rats the LOAEL was 20 mg/kg based on decreases in food consumption.	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser. Data is lacking for respiratory sensitisation evaluation. *Notes:* A skin sensitisation study was performed on female mice where TMAC was applied at concentrations of 5, 10 or 25%. Two of the three animals in the highest exposure (25%) group had to be sacrificed due to severe systemic toxicity and therefore data obtained at this concentration were not used for interpretation. In the other groups, no significant body weight loss was noted, and no irritation of the ears was observed. The auricular lymph nodes of animals at 5% test substance concentration were considered normal in size while the auricular lymph nodes of all (surviving) animals treated with a 10% and 25% test substance concentration appeared larger in size when compared to the other treated groups. The Stimulation Index (SI) values calculated for the TMAC concentrations of 5 and 10% were 0.5 and 1.1 respectively. Based on this data, TMAC is considered not to be a skin sensitiser.	ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye TMAC causes skin irritation (GHS Skin Irritation Category 2 H315). It is not classified as an eye irritant. *Notes:* Skin irritation In an in-vitro skin irritation test using a human skin model (EPISKIN Standard Model) TMAC was applied directly to 0.38 cm^2 cultured skin (10.5 to 11.8 mg, in presence of 5 µl Milli-Q water). After 15 minutes, the substance was removed and cells were cultured for 42 hours. As the mean relative tissue viability after exposure to the test substance was below 50%, it was concluded that the test substance is irritating in the in-vitro skin irritation test. In a second in-vitro skin corrosion test using a human skin model (EpiDerm Skin Model) TMAC was applied directly to 0.6 cm2 cultured skin (25mg, in presence of 25 µl Milli-Q water). After 3 minutes or 1 hour, the substance was removed and cells were cultured for 3 hours. Since the mean relative tissue viability after exposure to the test substance was above 50% or 15% after	ECHA (2013)

respective exposures of 3 minutes or 1 hour, it can be concluded that the test substance is not corrosive in the in vitro skin corrosion test. Eye irritation An eye irritation study was performed on 3 male New Zealand White rabbits where approximately 50 mg (a volume of approximately 0.1 mL) was instilled into one eye of each of three rabbits. In one animal on Day 1, the corneal injury consisted of slight dulling of the normal luster. Redness of conjunctivae and chemosis was noted for all animals which had completely resolved after 7 days. No systemic toxicity, changes in body weight gain or mortality occurred. Due to these results, TMAC is not irritating to the eyes and is not classified for eye irritation.	

Physical Hazards	Reference
Flammable Potential Not classified as a flammable/combustible chemical.	ECHA (2013) IPCM (2013)
Explosive Potential Not classified as an explosive chemical.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	171.9 mg/kg (female) 47 mg/kg (female/male) 55 mg/kg (female)	ECHA (2013)
Rat, dermal	No data found.	All proposed data sources
Rabbit, dermal	> 200 < 500 mg/kg (male/female)	ECHA (2013)
LOAEL	No data found.	All proposed data sources
LOAEC	No data found.	All proposed data sources
LC_{50}		
Rat	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
LOAEL	10 mg/kg (male rates) 20 mg/kg (female rats)	ECHA (2013)
NOAEL	5 mg/kg (male rates) 10 mg/kg (female rats)	ECHA (2013)
LOAEC	No data found.	All proposed data sources

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No data found.	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	YES	Fatal if swallowed and toxic when in contact with the skin. No inhalation data found.
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	YES	For male rats an oral LOAEL of 10 mg/kg is inferred.
Corrosive (irreversible damage)	NO	
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	YES	For male rats an oral LOAEL of 20 mg/kg is inferred.
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	NO	
Irritant (reversible damage)	YES	Causes skin irritation.
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Hazard Band 3**	
Uncertainty analysis /data confidence	11/13	**85%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	No data found.	All proposed data sources
STEL	No data found.	All proposed data sources
Peak Limitation	No data found.	All proposed data sources
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources
Air, indoor	No data found.	All proposed data sources
Water, potable	No data found.	All proposed data sources
Water, recreational	No data found.	All proposed data sources
Soil, residential	No data found.	All proposed data sources
Soil, commercial/industrial	No data found.	All proposed data sources

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Tetramethylammonium chloride (TMAC) is a white crystalline solid with a molecular weight of 109.598. The substance is soluble in water, very soluble in methanol, slightly soluble in ethanol and insoluble in ether, benzene or chloroform. TMAC reacts with oxidants and when heated to decomposition it produces very toxic fumes including ammonia, carbon monoxide, hydrogen chloride and nitrogen oxides Although most of the human health toxicity summaries are based on studies using TMAC for some of the end-points Tetramethylammonium hydroxide (TMAH) is used as a surrogate to infer toxicity of TMAC.

No information or studies were found on carcinogenicity of TMAC and therefore the carcinogenicity classification is unknown. TMAC is not classified as having mutagenicity/genotoxicity effects, reproductive toxicity effects or developmental toxicity/teratogenicity effects. Based on its exclusion from the endocrine disrupting chemicals list from the European Commission's Endocrine website TMAC is not considered as an endocrine disruptor at this stage. In terms of acute toxicity TMAC is fatal if swallowed and toxic when in contact with the skin. Acute

inhalation data is lacking. Dermal and inhalation chronic/repeat data is lacking for TMAC however based on an oral chronic study a LOAEL of 10 mg/kg and 20 mg/kg was determined for male and female rats respectively. TMAC is not classified as a skin sensitiser with data lacking for the respiratory sensitisation. It is classified as a skin irritant but not as an eye irritant. Due to TMAC being fatal if swallowed it has been categorised as hazard band 3.

References and Notes

ECED (2013) European Commission's Endocrine Disrupters Priority List. Available at http://ec.europa.eu/environment/chemicals/endocrine/strategy/substances_en.htm#priority_list [Accessed 28 October 2013]

ECHA (2013) (European Chemicals Agency) Registered Substances List. Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-dffb4072-e390-47ae-e044-00144f67d031/DISS-dffb4072-e390-47ae-e044-00144f67d031_DISS-dffb4072-e390-47ae-e044-00144f67d031.html [Accessed 28 October 2013]

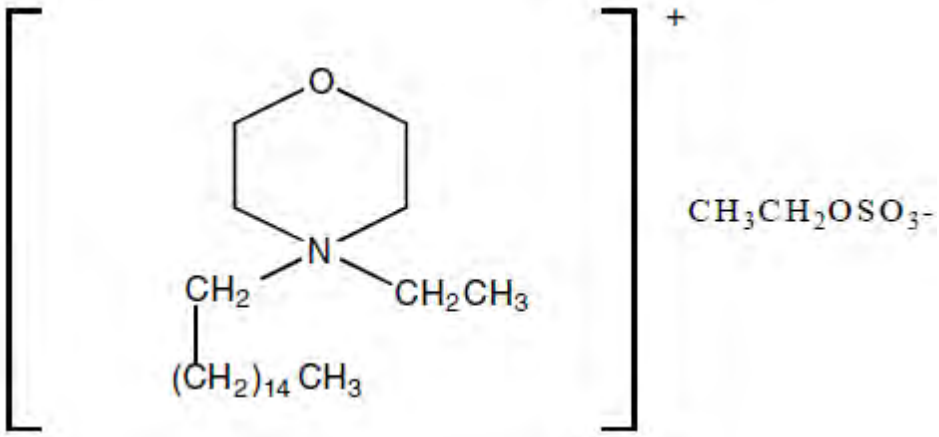
HSDB (2012). 'Tetramethylammonium chloride'. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine. Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search [Accessed 28 October 2013]

IPCM (2012) International Programme on Chemical Safety. INCHEM, 'ICSC 1099 - TETRAMETHYLAMMONIUM CHLORIDE'. Available at Ehttp://www.inchem.org/documents/icsc/icsc/eics1099.htm [Accessed 28 October 2013]

NDF – No data found within the limits of the search strategy

Created by:	JH	Date: 29/10/2013
Reviewed and edited by:	JF	Date: 08/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Cetylethylmorpholinium ethyl sulfate
Synonyms	4-Ethyl-4-hexadecylmorpholinium, ethyl sulphate, Atlas G 263, Barquat cme-A, Morpholinium, 4-ethyl-4-hexadecyl-, ethyl sulfate, sulfuric acid, monoethyl ester, ion(1-), 4-ethyl-4-hexadecylmorpholinium, others
CAS number	78-21-7
Molecular formula	$C_{24}H_{51}NO_5S$
Molecular Structure	

Overview	References
Limited information is available on this compound with the exception of chemical supply and registry databases. Cetylethylmorpholinium ethyl sulfate (CEMES) is amber liquid with a sweet smelling odour. It is water soluble and has a pH of 5-5.5. Structurally it is a quaternary ammonium salt. Reported uses include as a pesticide, surfactant, antistatic and as a combing and detangling agent in hair conditioning. CEMES is a severe eye irritant and is expected to be harmful if swallowed. It is not classified as a skin or respiratory sensitiser No information is available on repeat dose toxicity or other chronic endpoints.	Chemical Book (2010), LookChem (2008), Lonza (2006)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC.	IARC (2013)
Mutagenicity/Genotoxicity No data found.	

Reproductive Toxicity No data found.	
Developmental Toxicity/Teratogenicity No data found.	
Endocrine Disruption No data found.	
Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) Harmful if swallowed.	Lonza (2006)
Chronic/repeat dose toxicity (oral, dermal, inhalation) No data found.	
Sensitisation of the skin or respiratory system No data found.	
Corrosion (irreversible and reversible)/irritation of the skin or eye Risk of serious damage to eyes. In a rabbit eye irritation study the conclusion was that CEMES is an extremely severe eye irritant,	Lonza (2006)

Physical Hazards	Reference
Flammable Potential No classified as a flammable liquid (flash point 93°C).	Lonza (2006)
Explosive Potential Not classified as an explosive.	

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found.	
LOAEL	No data found.	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	1700 mg/kg	Lonza (2006)
Mouse, oral	No data found.	
Rabbit, oral	No data found.	
Rat, dermal	No data found.	
Rabbit, dermal	No data found.	
Mouse, dermal	No data found.	
LOAEL	No data found.	
LOAEC	No data found.	
LC_{50}		
Rat	No data found.	
High Chronic/Repeat Dose Toxicity		
LOAEL	No data found.	
LOAEC	No data found.	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No data found.	
Mutagenicity/Genotoxicity	No data found.	
Reproductive Toxicity	No data found.	
Developmental Toxicity/ Teratogenicity	No data found.	
Endocrine Disruption[1]	No data found.	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	No data found.	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No data found.	
Corrosive (irreversible damage)	YES	Eye
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No data found.	
Skin Sensitiser	No data found.	
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	YES	
Irritant (reversible damage)	YES	skin
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence	4/13 = 31%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).
[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	No data found.	
STEL	No data found.	
Peak Limitation	No data found.	
Environmental Exposure		
Air, ambient	No data found.	
Air, indoor	No data found.	
Water, potable	No data found.	
Water, recreational	No data found.	
Soil, residential	No data found.	
Soil, commercial/industrial	No data found.	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Cetylethylmorpholinium ethyl sulfate (CEMES) is amber liquid with a sweet smelling odour. It is water soluble and has a pH of 5-5.5. Structurally it is a quaternary ammonium salt. Reported uses include as a pesticide, surfactant, antistatic and as a combing and detangling agent in hair conditioning.

CEMES is a severe eye irritant and is expected to be harmful if swallowed. It is not classified as a skin or respiratory sensitiser. No information is available on repeat dose toxicity or other chronic endpoints. Overall it is categorised as hazard band 3 based on severe irritation to the eyes.

References and Notes

Chemical Book (2010). Available at http://www.chemicalbook.com. [Accessed 3 September 2013].

IARC (2013) Agents classified by IARC Monographs Volumes 1- 107. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf. [Accessed 4 August 2013.]

Lonza Group Ltd (2006). Material Safety Data Sheet. Barquat™ CME-35.

LookChem (2008). Available at http://www.lookchem.com. [Accessed 3 September 2013].

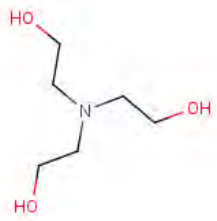
United States Environmental Protection Agency (US EPA, 2013). Aggregated Computational Toxicology Resource (ACToR) database. Available at http://actor.epa.gov/actor/faces/ACToRHome.jsp. [Accessed 3 September 2013]

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

No data found. - No data found within the limits of the search strategy.

Created by:	MER	Date 3/9/2013
Reviewed and edited by:	JF	Date and Revision 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	2,2`,2"-nitrilotriethanol
Synonyms	Trolamine, triethanolamine, sterolamide, nitrilotriethanol
CAS number	102-71-6
Molecular formula	$C_6H_{15}NO_3$
Molecular Structure	

Overview	References
2,2`,2"-nitrilotriethanol is a colourless to slightly liquid which is very hygroscopic and turns brown on exposure to air and light. It is a water-soluble strong base with a pH of 10.3 (concentration 1%) and emits a slight odour of ammonia.  2,2`,2"-nitrilotriethanol is used commercially and industrially in the manufacture of surfactants and detergents, textiles, waxes, polishes, herbicides, petroleum demulsifiers, toilet goods, cement additives, cutting oils and other products. Kinetic studies in rats and mice using radioactive tracers indicate that 2,2`,2"-nitrilotriethanol identified that the compound distributes to the heart, kidney, liver, lung, and spleen with 40% of an intravenously administered dose excreted within 24 hours.  2,2`,2"-nitrilotriethanol has a low order of acute and chronic toxicity. The principal route of exposure causing toxicity is through the skin, with some exposure occurring from inhalation of vapour and aerosols. Potential health effects in humans would be acute in nature and due to alkalinity rather than systemic toxicity. It is not genotoxic, carcinogenic, or toxic to development or the reproductive system.	HSDB (2009) ECHA (2013a) WHO (2012)

Human Health Toxicity Summary	Reference
Carcinogenicity - Not classifiable as to its carcinogenicity to humans (Group 3) based on inadequate evidence in experimental animals and humans. - Conclusive but not sufficient for classification	IARC (2000) ECHA (2013a)
Mutagenicity/Genotoxicity - Not classified as a mutagenic chemical. It is not genotoxic. - Triethanolamine did not induce mutations, DNA damage or other effects on genetic material in a number of non mammalian and mammalian tests both in vitro and in vivo.	IARC (2000) ECHA (2013a)

Reproductive Toxicity - Not classified as a reproductive toxicant. - No reproductive or developmental effects were produced when rats and mice were exposed by topical administration. Other routes of exposure have not been studied.	IARC (2000), WHO (2012), ECHA (2013)
Developmental Toxicity/Teratogenicity - Not classified as a developmental toxicant. Teratogenic at maternally toxic doses. - Maternal effects observed among rat dams given 225 mg/kg/day, however reproductive parameters in exposed rats were unaffected at this or lower dose levels (0-75 mg/kg/day). Maternal effects were observed in another rat study at 450 mg/kg/day. - Not classifiable as to its carcinogenicity to humans (Group 3) based on inadequate evidence in experimental animals and humans.	HSDB (2009) ECHA (2013a)
Endocrine Disruption - Not listed as an endocrine disruptor on the European Commission List of Endocrine Disruptors.	All proposed data sources
Neurotoxicity - NDF	All proposed data sources
Acute Toxicity (oral, dermal, inhalation) - Large doses produced minimal toxicity when administered orally to laboratory animals. - When heated to decomposition it emits toxic and irritating fumes of nitrogen oxides and hydrogen cyanides. - The probably oral lethal dose in humans is 5-15 g/kg bw. Toxicity is low following single exposures.	HSDB (2009) OECD (1997)
Chronic/repeat dose toxicity (oral, dermal, inhalation) - Human data are limited. Based on data from animal studies, chemical is anticipated to have low chronic toxicity under typical human exposure conditions. - Skin irritation and ulceration have been reported following repeated, subchronic, and chronic topical exposure in laboratory animals. - Kidney toxicity is reported in a number of experimental animal studies. Aside from nephrotoxicity (the primary effect), side effects reported in laboratory animals following long-term oral administration include hepatic congestion, and demyelination of peripheral and sciatic nerve fibers. - Classified as causing potential organ damage. - Classified as a potential respiratory irritant.	HSDB(2009) ECHA (2013 b)
Sensitisation of the skin or respiratory system - A skin sensitiser. - Not sensitising in a guinea pig study. - Very low sensitisation potential in humans in a volunteer human study.	SafeWork Australia (2013) ECHA (2013a) ECHA (2013b)
Corrosion (irreversible and reversible)/irritation of the skin or eye - Not irritating to skin in rabbit studies. - Not irritating to eyes in three rabbit studies. Irritating to eyes in two rabbit studies. - Conclusive but not sufficient for classification	ECHA (2013a) ECHA (2013b)
Flammable Potential - Non flammable. Combustible, when exposed to heat or flame.	ECHA (2013a)
Explosive Potential - There are no chemical groups associated with explosive properties in the molecule.	ECHA (2013a)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	All proposed data sources
High Chronic/Repeat Dose Toxicity		
NOAEL, rat (oral), dermal	1000 mg/kg bw	ECHA (2013a)
NOAEL (local effects), mouse	250 mg/kg bw/day	ECHA (2013a)

NOAEC (local effects), rat (inhalation)	0.02 mg/L air	ECHA (2013a)
NOAEC (local effects) male rat (dermal)	125 mg/kg bw/day	ECHA (2013a)
NOAEC (local effects) female rat (dermal)	250 mg/kg bw/day	ECHA (2013a)
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Guinea pig (oral)	2200 mg/kg	TOXNET (2013)
Mouse (intraperitoneal)	1450 mg/kg	TOXNET (2013)
Mouse (oral)	5846 mg/kg	TOXNET (2013)
Rabbit (oral)	2200 mg/kg	TOXNET (2013)
Rabbit (skin)	>20 mL/kg	TOXNET (2013)
Rat (intraperitoneal)	1510 mg/kg	TOXNET (2013)
Rat (oral)	4920 uL/kg	TOXNET (2013)
Rat (skin)	> 16 mL/kg	TOXNET (2013)
Rat (oral)	8,000 mg/kg	HSDB (2009)
Guinea pig (oral)	5,300 mg/kg	HSDB (2009)
Rabbit (dermal)	> 2,000 mg/kg	ECHA (2013a)
Rats (oral)	6400 mg/kg	ECHA (2013a)
LC0		
Rat (inhalation, 8h)	Saturated atmosphere	ECHA (2013a)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	Not classifiable based on inadequate evidence.
Mutagenicity/Genotoxicity	NO	-
Reproductive Toxicity	NO	ECHA (2013), IARC (2000)
Developmental Toxicity/ Teratogenicity	NO	ECHA (2013) IARC (2000)
Endocrine Disruption[1]	NO	-
Neurotoxicity[2]	NDF	-
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	NO	-
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	-
Corrosive (irreversible damage)	NO	Conclusive but not sufficient for classification.
Respiratory sensitiser	NO	-
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	YES	Potential local effects (irritation) in the respiratory tract.
Skin Sensitiser	YES	Reports vary.
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	NO	-
Irritant (reversible damage)	NO	-
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	-
Explosive potential	NO	-
Hazard Evaluation (highest band) not including physical hazards	**Band 2**	
Uncertainty analysis /data confidence	11 parameters, 11/14 x 100 =	**78.5%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
TWA (duration not specified)	5 mg/m^3	Safe Work Australia (2013)
STEL	NDF	All proposed data sources
Peak Limitation	NDF	All proposed data sources
Environmental Exposure		
Air, ambient	NDF	All proposed data sources
Air, indoor	NDF	All proposed data sources
Water, potable	NDF	NEPM (1999; amended 2013)
Water, recreational	NDF	All proposed data sources
Soil, residential	NDF	NEPM (1999; amended 2013)
Soil, commercial/industrial	NDF	NEPM (1999; amended 2013)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

2,2`,2"-nitrilotriethanol is a colourless to slightly liquid which is very hygroscopic and turns brown on exposure to air and light. It is a water-soluble strong base with a pH of 10.3 (concentration 1%) and emits a slight odour of ammonia. 2,2`,2"-nitrilotriethanol is used commercially and industrially in the manufacture of surfactants and detergents, textiles, waxes, polishes, herbicides, petroleum demulsifiers, toilet goods, cement additives, cutting oils and other products. 2,2`,2"-nitrilotriethanol has a low order of acute and chronic toxicity. It is classified as a skin sensitiser. It is not genotoxic, carcinogenic, or toxic to development or the reproductive system. Given the relatively low to moderate hazard it is categorised in Hazard Band 2.

References

HSDB (2009) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. [Accessed 14 August 2013.]

SafeWork Australia. Hazardous Substances Information System (HSIS). Available at http://hsis.safeworkaustralia.gov.au/HazardousSubstance. [Accessed 16 August 2013]

European Chemicals Agency. Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 16 August 2013] (ECHA 2013a)

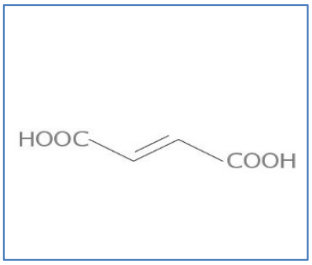
European Chemicals Agency. Classification and Labelling Inventory database Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database. [Accessed 16 August 2013] (ECHA 2013b)

National Industrial Chemicals Notification and Assessment Scheme (NICNAS) (2013). Australian Inventory of Chemical Substances database search. Available at http://www.nicnas.gov.au/regulation-and-compliance/aics/aics-search-page. [Accessed 16 August 2013].

OECD (1997). Triethanolamine.: SIDS initial assessment report. From INCHEM. Available at http://www.inchem.org/documents/sids/sids/102716.html

Created by:	**MER**	Date: **18/08/2013**
Reviewed and edited by:	**JF**	Date: **11/09/2013**

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Fumaric Acid
Synonyms	but-2-enedioic acid, (E)-Butenedionic acid, *trans*-1,2-Ethylenedicarboxylic acid, 2-Butenedioic acid, *trans* butenedioic acid, Allomaleic acid, Boletic acid, Donitic acid, Lichenic acid
CAS number	110-17-8
Molecular formula	C4H4O4
Molecular Structure	

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Overview	Reference
Fumaric acid is a solid, crystalline, colourless organic chemical that is subject to aerobic biodegradation. Fumaric acid is not classified as flammable or explosive. It has been used extensively in a range of products including in the production and manufacture of polishes and wax blends, non-metal-surface treatment products, pH-regulators, flocculants, precipitants, neutralisation agents, leather tanning, in dyes, adhesives, sealants, coatings and paints, thinners, paint removes and ink and toners. It is also an approved food additive in the United States, Europe and Australia. Fumaric acid may result in serious eye irritation following direct contact. A key feature of fumaric acid is the production of maleic anhydride if heated to above 300°C. it rearranges to form maleic (cis-butendioic) acid, which can turn into maleic anhydride. Maleic anhydride is classified as harmful if swallowed, may result in severe skin burns and eye damage form direct contact and is classed as a respiratory sensitiser. Maleic anhydride does however rapidly hydrolyse to form maleic acid in the presence of water.	ECHA (2013); IPCS (2006);

Human Health Toxicity Summary	Reference
Carcinogenicity Not on the IARC International Agency for Research on Cancer Carcinogen list.	IARC (2013)
Mutagenicity/Genotoxicity Not classified as a mutagenic by ECHA.	ECHA (2013)
Reproductive Toxicity Not classified as reproductively toxic by ECHA.	ECHA (2013)
Developmental Toxicity/Teratogenicity No classified as having the ability to induce developmental or teratogenic effects.	ECHA (2013)
Endocrine Disruption Not classified as an endocrine disrupter by the European Commission.	EC (2000)
Acute Toxicity (oral, dermal, inhalation) **Oral** Not classified as exhibiting acute oral toxicity under ECHA guidelines.	ECHA (2013)

Inhalation Not classified as exhibiting acute inhalation toxicity under ECHA guidelines. **Dermal** Not classified as exhibiting acute dermal toxicity under ECHA guidelines.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) **Oral** Not classified as exhibiting chronic oral toxicity under ECHA guidelines. **Inhalation** NDF. **Dermal** NDF.	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser by ECHA. No data found relating to the potential for respiratory sensitisation.	ECHA (2013)
Corrosion (irreversible)/irritation of the skin or eye Not classified as corrosive to the skin by ECHA. Classified as an eye irritant and can cause serious eye irritation. Classified under the GHS as level 2 eye irritant which indicated that effects are reversable.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as flammable.	ECHA (2013)
Explosive Potential Not Classified as explosive.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
NDF		
NDF		
High Chronic/Repeat dose Toxicity		
NOAEL	NDF	
NOAEL	NDF	
LOAEC	**Inhalation** Workers 175 mg/m^3 (respiratory tract irritation)	ECHA (2013)
NOAEL	**Oral** General Population 30 mg/kg bw/day	ECHA (2013)
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	10 700 mg/kg bw (male) 9 300 mg/kg bw (female)	ECHA (2013)
Rat, Inhalation	>1.306 mg/l air	ECHA (2013)
Rabbit, dermal	20 000 mg/kg bw	ECHA (2013)
LC_{50}		
Rat	>1,306 mg/l air	ECHA (2013)

High Chronic/Repeat dose Toxicity		
NOAEL	Rat, oral 600 mg/kg bw/day	ECHA (2013)
LOAEL	Rat, oral 750 mg/kg bw/day	ECHA (2013)
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	Not on the IARC list for causing cancer (IARC 2013)
Mutagenicity/Genotoxicity	No	ECHA, 2013
Reproductive Toxicity	No	ECHA, 2013
Developmental Toxicity/ Teratogenicity	No	ECHA, 2013
Endocrine Disruption[1]	No	ECHA, 2013
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m^3) (vapour)	No	ECHA, 2013
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	ECHA, 2013
Corrosive (irreversible damage)	No	ECHA, 2013
Respiratory sensitiser	NDF	ECHA, 2013
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]	No	ECHA, 2013
Skin Sensitiser	No	ECHA, 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	ECHA, 2013
Irritant (reversible damage)	Yes	Classified under the GHS as level 2 eye irritant which indicated that effects are revisable.
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	ECHA, 2013
Explosive potential	No	ECHA, 2013
Hazard Evaluation (highest band) not including physical hazards	**Band 1**	
Uncertainty analysis /data confidence	11/13	**84.7%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits	NDF	
Air (OEL)	NDF	
8-h TWA	NDF	
STEL	NDF	
Peak Limitation		
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Fumaric acid is a colourless solid that is readily biodegradable under aqueous conditions. Direct contact may result in severe eye irritation but it is not considered harmful if swallowed. It is not classified as a, mutagen or teratogen and has not been shown to produce reproductive or developmental effects. It has not been evaluated for carcinogenicity. It is categorised in Hazard Band 1 on the basis of its reversible but severe irritant action for direct eye contact. Fumaric acid converts to the irritant maleic anhydride, upon partial combustion. Under aqueous conditions dissolution will occur and degradation such that no additional hazards will result. The fate and transport characteristics thus limit potential exposures to direct contact settings with the pure substance or in its concentrated form. This limits human health concerns to occupational exposures and public emergency spill settings.

References

ECHA (2013) European Chemicals Agency Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 31 October 2013]

EC (2000) European Commission Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

HSDB (2009) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~RXFIFI:1. [Accessed 31 October 2013.]

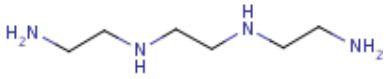
IARC (2013) International Agency for Research on Cancer Agents classified by IARC Monographs, Volumes 1-108. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf.

IPCS (2006) International Program on Chemical Safety. Fumaric acid summary. Available at http://www.inchem.org/documents/icsc/icsc/eics1173.htm [Accessed 31 October 2013)

NDF – No data found within the limits of the search strategy

Created by:	AES	Date: 6/12/2013
Reviewed and edited by:	LT Rev0	Date: 07/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Triethylemetetramine
Synonyms	TETA, 3,6-Diazaoctanethylenediamin
CAS number	112-24-3
Molecular formula	$C_6H_{18}N_4$
Molecular Structure	

Overview	Reference
Triethylemetramine (TETA) is a colourless to yellowish, moderately viscous, hygroscopic liquid which is completely miscible with water. It is the product of the reaction of aqueous ammonia with 1,2-dichloroethane. TETA uses include curing agent for epoxy resin, adhesive, binding agent, hardener for plastic. TETA is also used as intermediate for curing agents, for auxiliary agents (used in paper industry, textile industry and glue), for asphalt emulsifiers. TETA is not readily biodegradable and its target environmental niche is the hydrosphere. TETA is not expected to pass from water to air.	HSDB (2006) IPCS (2009) OECD (1998)

Human Health Toxicity Summary	Reference
Carcinogenicity Not assessed by IARC. The carcinogenic potential of this substance was assessed by applying 0.025 ml of a 5% aqueous solution to the back of 50 mice three times a week until the death of the animals. No treatment-related skin tumors were observed.	IARC (2013) OECD (1998)
Mutagenicity/Genotoxicity The genetic toxicity potential of TETA was assessed with in vivo and in vitro studies. While in vitro Ames test and mammalian cytogenetic tests showed positive genotoxicity, in vivo mouse micronucleus test following intraperitonal injections of 130 to 600 mg/kg bw showed negative genotoxic effects. Futhermore, negative effects were observed in another micronucleus test using oral application where mice received once 1500, 3000 and 6000 mg/kg bw. At the highest dose, a decrease in erythrocytes containing micronucleus was observed. In addition, no mutagenic activity was noted in the SLRL test in Drosophila melanogaster. Based on these findings, TETA is assumed to be not genotoxic.	OECD (1998)
Reproductive Toxicity No animal data on reproductive toxicity is available. However from experience with humans (substance used as a drug in the therapy of Wilsons disease), there are no evidence of reproductive toxic effects of TETA.	OECD (1998)
Developmental Toxicity/Teratogenicity No embryotoxic and teratogenic effects were observed in rabbits study. In a rat study where rats were dosed with 75, 375 and 750 mg/kg orally, no effects on dams and foetuses were observed except a slight increased foetal body weight.	OECD (1998)

Oral administration of TETA to pregnant rats dosed at 830 or 1670 mg/kg bw, resulted in increased foetal abnormalities in the highest dose group. These effects occurred when the copper content of the feed was simultaneously reduced suggesting that the developmental toxicity may have been a secondary consequence of the chelating properties of TETA.	
Endocrine Disruption TETA is not listed in the European Commission's Endocrine Disrupters Priority List.	EC (2000)
Acute Toxicity (oral, dermal, inhalation) TETA showed low acute toxicity via oral route on rats (LD_{50}> 2000 mg/kg) and moderate toxicity via dermal route on rabbits (LD_{50} = 550 - 805 mg/kg). As per the European Commission (EC) classification, TETA is classified as Xn = harmful; R21 = harmful in contact with skin.	OECD (1998) HSIS (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Subchronic (92d) studies in rats and mice received triethylenetetramine in drinking water at target concentrations of 0, 120, 600, 3000 ppm were conducted. Signs of toxicity (inflammation of the lung interstitium, hemapoetic cell proliferation of the spleen, liver periportal fatty infiltration, kidney weight reduction, reduced renal cytoplasmatic vacuolization and body weight gain reduction) were observed in mice at the highest concentration only. The NOAELs of 92 (male) mg/kg bw and 99 (female) mg/kg bw were reported. In a lifetime dermal toxicity study with mice (1.2 mg/mouse/d), no skin or other tumor types were observed.	OECD (1998)
Sensitisation of the skin or respiratory system Guinea Pig Maximization Test (GPMT) and Mouse Ear Swelling Test (MEST) were undertaken to assess the sensitization property of TETA. These studies concluded that TETA is a skin sensitizer for guinea pigs and mice. In addition, positive reactions to TETA were observed in skin tests carried out on workers exposed to epoxy resins. As per the European Commission (EC) classification, TETA is labelled R 43 = may cause an allergic skin reaction. No data found on respiratory sensitisation.	OECD (1998) HSIS (2013) IPCS (2009)
Corrosion (irreversible and reversible)/irritation of the skin or eye TETA is a severe irritant to eyes and skin. As per the EC classification, TETA is labelled C = corrosive and R34 = causes burn.	OECD (1998) HSIS (2013)

Physical Hazards	Reference
Flammable Potential TETA is a combustible liquid which gives off irritating or toxic fumes in a fire	IPCS (2009)
Explosive Potential Potential risk of fire and explosion on contact with oxidants.	IPCS (2009)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	

High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	> 2000 mg/kg bw	OECD (1998)
Rat, dermal	NDF	
Rabbit, dermal	550 – 805 mg/kg bw	OECD (1998)
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
LOAEL	NDF	
NOAEL (mouse, oral)	92 mg/kg bw (male); 99 mg/kg bw (female)	OECD (1998)
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	OECD (1998)
Mutagenicity/Genotoxicity	No	OECD (1998)
Reproductive Toxicity	No	OECD (1998)
Developmental Toxicity/ Teratogenicity	No	OECD (1998)
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	Yes	Dermal LD_{50} (rabbit) 550 – 805 mg/kg bw (OECD, 1998)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	Oral NOAEL (mouse) > 10 mg/kg/day (92-99 mg/kg/day) ((OECD, 1998)
Corrosive (irreversible damage)	Yes	Labelled C = corrosive and R34 = causes burn (HSIS, 2013)
Respiratory sensitiser	NDF	May cause allergy or asthma symptoms or breathing difficulties if inhaled (IPCS 2009)
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	Classified R21 = harmful in contact with skin (HSIS, 2013)
Skin Sensitiser	Yes	Classified R 43 = may cause an allergic skin reaction (HSIS, 2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	
Irritant (reversible damage)	Yes	Severe irritant to the skin and eyes (OECD, 1998)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		

Physical Hazards		
Flammable potential	Yes	Combustible liquid (IPCS, 2009)
Explosive potential	Yes	Risk of fire and explosion in contact with oxidants (IPCS, 2009)
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	1.4 mg/m^3	HSIS (2013)
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	ADWG (2011)
Water, recreational	NDF	NEPM (1999 – amended)
Soil, residential	NDF	NEPM (1999 – amended)
Soil, commercial/industrial	NDF	NEPM (1999 – amended)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Triethylenetetramine (TETA) is is a colourless to yellowish, moderately viscous, hygroscopic liquid which is completely miscible with water.

The carcinogenicity potential of TETA has not been assessed by IARC, but the results of a mouse study suggest that TETA is not a carcinogenic substance. Mutagenic/genotoxic effects were not observed in in-vivo studies however, some positive mutagenic/genotoxic effects were noted in some in-vitro tests. Reproductive toxicity data was not available for animals, but from experience with humans (substance used as a drug) there is no evidence of reproductive toxicity. No embryotoxic and teratogenic effects were observed in a rabbit study. In a rat study, increased foetal abnormalities were observed in the highest dose group (1670 mg/kg bw) when the copper content of the feed was simultaneously reduced. TETA is not listed on the European Commission's Endocrine Disrupters Priority List. Consequently TETA is not considered to be an endocrine disruptor. TETA is harmful in contact with skin. TETA is a skin sensitizer. Based on its dermal acute toxicity, corrosive and skin sensitisation properties, TETA falls in the Hazard Band 3 category.

References and Notes

ADWG (2011) Australian Drinking Water Guidelines. National Health and Medical Research Council. Available from http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines.pdf

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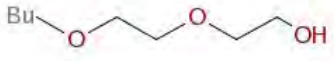
Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

NDF – No data found within the limits of the search strategy

Created by:	JC	Date: 1/11/2013
Reviewed and edited by:	JF	Date: 08/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Butyl diglycol
Synonyms	2-(2-butoxyethoxy)ethanol, Diethylene glycol butyl ether (DEGBE).
CAS number	112-34-5
Molecular formula	$C_8H_{18}O_3$
Molecular Structure	

Overview	Reference
Butyl diglycol is the product of the reaction of ethylene oxide and n-butanol with an alkali catalyst. It is a colourless liquid with a neutral pH and a mild ether odour. It is miscible with oils and in water and evaporates slowly. Butyl diglycol is expected to have a very high mobility in soil as it is not expected to adsorb to solid or sediments. It is expected to exist only as vapour in the atmosphere and is biodegradable in aerobic environments. In 1999, the production of dutyl diglycol in Europe was about 44 000 tonnes per year. The uses of butyl diglycol include as a solvent in coatings and cleaning applications for industrial and consumer markets. Industrial markets include textile and printing industries. Butyl diglycol is also used as diluent in hydraulic brake fluid applications. It is also a chemical intermediate to produce diethylene glycol monobutyl ether acetate (DBA) and some herbicides, insecticides and plasticizers.	HSDB (2009) DEGBE (2010) Dow (2013)

Human Health Toxicity Summary	Reference
Carcinogenicity Not assessed by IARC.	IARC (2013)
Mutagenicity/Genotoxicity In vitro mammalian chromosome aberration test, Ames test, mammalian cell mutation test and in vivo micronucleus assay chromosome aberration test concluded that the substance did not exhibit any mutagenic activity under the conditions of the tests. ECHA has not reported this substance to be mutagenic or genotoxic.	ECHA (2013)
Reproductive Toxicity A two-generation study on mice and a one-generation study with rats concluded that this substance is not toxic to reproduction at the doses used during the tests. ECHA has not reported this substance to be toxic to reproduction.	ECHA (2013)
Developmental Toxicity/Teratogenicity Developmental toxicity studies on rabbits (dermal application), rats (feed) and mice (gavage) concluded that there was no evidence for developmental toxicity at the doses tested. ECHA has not reported this substance to be toxic to development.	ECHA (2013)
Endocrine Disruption	EC (2000a)

Not listed as an endocrine disruptor.	
Acute Toxicity (oral, dermal, inhalation) Acute toxicity data is beyond the thresholds established in Hazard Band 1, as per the GHS classification. ECHA has not reported this substance to be acutely toxic based on their classification methods.	ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Chronic toxicity data is beyond the thresholds established in Hazard Band 2 as per the GHS classification. ECHA has not reported this substance to be chronically toxic based on their classification methods.	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser. Data lacking regarding respiratory sensitisation.	ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye This substance causes reversible irritation of the eye (causes serious eye irritation. GHS classification, Eye Irritation. 2 H319)	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as flammable.	ECHA (2013)
Explosive Potential Not classified as explosive.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found (NDF)	
High Chronic/Repeat dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	3306 mg/kg	ECHA (2013)
Mouse, oral	2410 mg/kg (fasted animals) 5530mg/kg (fed animals)	ECHA (2013)
Rabbit, oral	2500 -3000 mg/kg	ECHA (2013)
Rat, dermal	NDF	
Rabbit, dermal	2764 mg/kg	ECHA (2013)
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
LOAEL (rat, oral)	650 mg/kg/day	ECHA (2013)
LOAEC (rat)	100-117 mg/m^3	EC (2000b)
NOAEL (rat, oral)	250 mg/kg/day	ECHA (2013)
NOAEC (rat)	94 mg/m^3	ECHA (2013)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	IARC (2013)
Mutagenicity/Genotoxicity	No	ECHA (2013)
Reproductive Toxicity	No	ECHA (2013)
Developmental Toxicity/ Teratogenicity	No	ECHA (2013)
Endocrine Disruption[1]	No	EC (2000a)
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	No	ECHA (2013)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 20 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	Yes	ECHA (2013)(NDF regarding carcinogenicity)
Corrosive (irreversible damage)	No	ECHA (2013)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	ECHA (2013)
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	ECHA (2013)
Irritant (reversible damage)	Yes	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	ECHA (2013)
Explosive potential	No	ECHA (2013)
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence	11/13	**85 %**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	up to 100 mg/ m^3	EC (2000b)
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	ADWG (2011)
Water, recreational	NDF	NEPM (1999 – amended)
Soil, residential	NDF	NEPM (1999 – amended)
Soil, commercial/industrial	NDF	NEPM (1999 – amended)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Butyl diglycol is a colourless liquid. It is miscible with water and oils and evaporates slowly. Butyl diglycol can cause severe eye irritation. It has a low order of acute oral toxicity but moderate chronic toxicity following inhalation. Butyl diglycol is not classified as a carcinogen, mutagen or reproductive toxicant. On the basis of chronic inhalation concerns it is categorised as Hazard Band 3. A broad range of toxicological data has been identified providing some confidence to the report of the chronic inhalation toxicity and irritancy properties being the main concern for this chemical. On this basis and taking into account the rapid degradation in the environment under aqueous conditions, the public health concerns are restricted to occupational exposures from direct contact and inhalation to the pure product and emergency spill settings as specific environmental concerns for public health.

References

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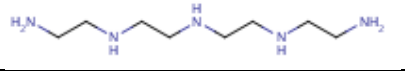
NEPM (1999 - amended) National Environment Protection (Assessment of Site Contamination) Measure 1999

Created by:	JC	Date: 8/10/2013
Reviewed and edited by:	LT	Date 21/10/2013 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Tetraethylenepentamine
Synonyms	1. N-(2-Aminoethyl)-N-(2-((2-aminoethyl)amino)ethyl-1,2-ethanediamine) 2. 1,2-ETHANEDIAMINE, N-(2-AMINOETHYL)-N'-(2-((2-AMINOETHYL)AMINO)ETHYL) 3. 1,4,7,10,13-PENTAAZATRIDECANE 4. 3,6,9-TRIAZAUNDECANE-1,11-DIAMINE
CAS number	112-57-2
Molecular formula	C_8-H_{23}-N_5
Molecular Structure	

Overview	Reference
Tetraethylenepentamine (TEPA) is a polyamine organic compound as it has two or more primary amino groups $–NH_2$. TEPA is a viscous and hygroscopic yellow liquid. It is an alkaline liquid which is soluble in most organic solvents and water. It has a molecular weight of 189.31 and a specific gravity of 0.9980 (at 20°C). TEPA has a boiling temperature of 340.30°C (at 760 mm hg) and a melting temperature of -30°C. TEPA does not occur naturally but is produced only from the ethylene dichloride (EDC) process, which is a reaction of EDC and ammonia. The process involves a reaction of aqueous ammonia with 1,2-dichlotoethane followed by neutralisation (e.g. with aqueous caustic soda) and fractional distillation. TEPA is used primarily as a closed system intermediate in the synthesis of other products which are involved in the manufacturing of lubricating oil additives, fuel additives, paints and asphalt adhesives. In developing hazard classifications for 'Amines, polyethylenepoly-, tetraethylenepentamine fraction' which has a CAS# 90640-66-7 ECHA used hazard data for amine compounds including 'Tetraethylenepentamine' (CAS# 90640-66-7). For some of the human health toxicity summaries below read across interpretations from studies undertaken on triethylenetetramine (TETA) have been considered. TEPA is similar toxicologically to TETA based on its structure and chelation properties and therefore TETA is an appropriate surrogate. TETA (molecular formula C6H15N4), is a yellow, moderately viscous liquid. It is completely soluble in water and is also soluble in alcohols and acids. As TETA has less amino groups it has a slightly smaller molecular weight of 146.24 and a density of 0.9818 at 20°C. Its boiling point is 266-267°C at 760 mm hg and melting point is 12°C.	HSDB (2003) HSDB (2002) SIDS (2001)

Human Health Toxicity Summary	Reference
Carcinogenicity Based on the GHS classification criteria Tetraethylenepentamine is not classifiable as to its carcinogenicity to humans. A search on the International Agency for Research on Cancer (IARC) website did not reveal any information on Tetraethylenepentamine. *Notes:* The GHS carcinogenicity classification for TEPA is based on a read across studies using TETA.	ECHA (2013)

The dermal carcinogenic potential of TETA was assessed by applying 25 µl of a 5% (v/v) solution in deionized water to the backs of 50 male mice three times a week until the death of the animals. No treatment-related skin tumors were observed and therefore TETA was not locally carcinogenic when applied to the skin of mice. In another dermal study TETA was applied to the skin of male mice (50/group) at concentrations of 0, 0.2, or 2% (w/w) in ethanol, 3 times a week for up to 2 years. Although malignant cutaneous tumors were noted in both control and treated groups none were located at the site of application of the test material. Four of the five observed cutaneous tumors were on the ear associated with the metal ear tag, and one fibrosarcoma was present on the tail of a high dose mouse. Therefore none of the tumors were interpreted as related to dermal administration of TETA.	
Mutagenicity/Genotoxicity Not classified as a mutagenic/genotoxic chemical. *Notes:* The genetic toxicity classification for TEPA is based on read across in-vivo studies using TETA. TETA was injected and evaluated for potential clastogenic (chromosome-damaging) activity with the in-vivo micronucleus test system using both female and male mice. Test results showed that TETA was not an active agent in producing treatment-related increases in micronuclei in male and female mice. In another study, fifty chemicals, including TETA, were tested for mutagenic activity in post-meiotic and meiotic germ cells of male Drosophila melanogaster using the sex linked recessive lethal (SLRL) assay. Feeding was chosen as the first route of administration followed by injection. TETA was ambiguous after feeding and negative after injection. In a third study TETA was administered in a single intraperitoneal dose of 150 mg/kg to mice. Results from the micronucleus determination demonstrated that TETA did not produce an increase in the incidence of micronuclei in peripheral blood polychromatic erythrocytes of the test animals at any of the sample periods tested. The absence of positive effects of TETA upon the incidence of micronuclei indicates that TETA does not possess clastogenic activity in vivo under the test conditions. However, some in-vitro studies for both TEOA and TETA have shown mutagenic effects. TEPA was evaluated for potential genotoxic activity using the Sister Chromatid Exchange (SCE) test in Chinese hamster ovary (CHO) cells. Although one of the samples produced dose-related and statistically significant increases in the incidence of SCEs in the CHO cells the increases were small and were seen at concentration levels close to cytotoxicity producing an ambiguous positive genotoxic effect in this test. In an in-vitro study TETA was tested for potential mutagenic activity using the Salmonella/microsome bacterial mutagenicity assay (Ames test). Due to growth inhibition TETA was considered to be mutagenic in this in-vitro bacterial study. Although these two in-vitro studies indicate some potential for positive genetic effects the in-vivo TETA studies did not show any potential for mutagenic effects.	ECHA (2013)
Reproductive Toxicity Not classified as having reproductive toxicity effects. *Notes:* There are no reproductive toxicity studies available for TEPA but there is one study for TETA. TETA which was administered in drinking water to female and male rats and mice. A complete histopathologic examination, including reproductive organs, was conducted. TETA data showed no effects on reproductive organs in rats up to 276 mg/kg/day (males) and 352 mg/kg/day (females) and in mice (up to 500 mg/kg/day) when administered in drinking water.	SIDS (2001)
Developmental Toxicity/Teratogenicity Inferred to have no developmental/teratogenic effects.	

Notes: The developmental/teratogenic classification is based on TETA studies. TETA was orally administered to timed-pregnant rats at at dosages of 75, 325 or 750 mg/kg per day. The test substance was devoid of any embryotoxic activity and did not reveal teratogenic potential in the rat under the present experimental conditions. In another TETA study, timed-pregnant rabbits were treated with TETA by occluded cutaneous application at dosages of 5.0, 50.0 or 125.0 mg/kg per day. TETA produced maternal toxicity at the 125.0 mg/kg dose but no developmental toxicity (including teratogenicity) was observed at any dosages employed. Although no developmental/ teratogenic effects were noted with the above two studies this was not the case with two studies using TETA dihydrochloride and triethylenetetramine tetrachlorhydrate. The effects noted for these two studies are discussed below. Pregnant mice received 3000, 6000 or 12000 ppm to TETA dihydrochloride in the drinking water on days 6-15 of gestation. At levels greater than 3000 ppm, foetal resorptions, reduced foetal and cerebral weight, brain malformations and decreased copper concentration in maternal liver were observed. Sample size was too small to determine whether maternal toxicity occurred. A study using triethylenetetramine tetrachlorhydrate (TETA.4HCl) showed teratogenic effects in rats. TETA.4HCl was fed during pregnancy (day 0 -21) at levels of 0 (control), 0.17, 0.83, or 1.66%. The frequency of resorptions and the frequency of abnormal foetuses at term increased with increasing levels of the substance. Maternal and foetal tissue copper levels were significantly lower in the TETA.4HCl groups than in controls, with levels decreasing in a dose-related manner. Maternal kidney and fetal liver zinc levels increased within the TETA.4HCl groups in a dose-related manner. Maternal liver iron was increased in the high-dose group compared to controls. Fetal iron concentration and maternal and fetal manganese level were not significantly affected by the drug. These results show that TETA.4HCl can be a teratogenic agent in the presence of maternal toxicity..	ECHA (2013) SIDS (2001)
Endocrine Disruption Tetraethylenepentamine has not been included in the European Commission's Endocrine Disrupters Priority List.	ECED (2013)
Acute Toxicity (oral, dermal, inhalation) TEPA is harmful if swallowed (GHS Acute Toxicity 4 H302) and when in contact with the skin (GHS Acute Toxicity 4 H312). *Notes:* <u>Oral</u> TEPA was orally administered via intubation to five male rats per dose group of 2.0, 4.0 and 8.0 mL/kg. The respective death per each group was 0/5, 4/5 and 5/5. The LD50 was determined to be 3.25 mL/kg. Based on using a specific gravity of 0.998 for TEPA this converts to 3244 mg/kg. In another acute oral TEPA study five female rats were administered 1.0, 2.0, 3.98, 7.95 g/kg of a 39.8% solution in water and observed for two weeks. A LD50 of 2140 mg/kg was determined. However it is not considered a reliable study as it was performed pre-GLP and pre-guideline, it had limited reporting and no information on the composition or purity of the test substance. Two read across studies can also be considered using the surrogate TETA. In the first acute oral toxicity study TETA was administered to rats at doses of 800, 1250, 1600 or 2000 mg/kg. The acute oral LD50 for males, females and combined sexes was determined to be 1861.9 mg/kg, 1591.4 mg/kg and 1716.2 mg/kg, respectively. In a second read across rat study using TETA, an LD50 value was estimated to be ca. 1400 mg/kg. <u>Dermal</u> TEPA was applied directly onto the skin of two to four male rabbits at dose levels of 1.0, 2.0, and 4.0 mL/kg. The respective death per group were 1/4, 4/4 and 2/. The acute dermal LD50 was	ECHA (2013) SIDS (2001)

calculated to be 1.26 mL/kg. Based on using a specific gravity of 0.998 for TEPA this converts to 1257mg/kg. In another dermal acute toxicity rabbit study the LD50 was 660 mg/kg. The higher toxicity via the dermal route is most likely due to the corrosive nature of TEPA to the skin whereas TEPA would be neutralized by stomach acid. In a read across dermal study TETA was applied to the skin of New Zealand White rabbits at concentrations of 1000, 2000 and 3000 mg/kg with a 14 day observation period. The acute dermal LD50 in male rabbits and combined sexes was determined to be 1720 mg/kg and 1465.4 mg/kg, respectively. <u>Inhalation</u> In an acute inhalation toxicity rat study with saturated vapor and whole body exposure, the LC50 was calculated to be >9.9 ppm as this was the highest dose tested.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) Repeat dose studies show oral and dermal effects. *Notes:* <u>Oral</u> TEPA was orally administered to 5 male and female rats. At the highest doses given to the rats (3990 mg/kg for males and 3630 mg/kg for females) the following were observed: decrease in food intake, body weight loss, decreased absolute and relative liver weight and decreased relative kidney weight. The NOAEL of this 7-day diet study, based on a limited numbers of parameters was 2800 mg/kg and 3140 mg/kg for males and females, respectively. Due to these effects described the LOAEL for males and females is inferred to be 3990 mg/kg and 3630 mg/kg respectively. In another repeat dose study TETA was administered in drinking water to male and female rats for 90-92 days. The NOEL was 276 mg/kg/day in males and 352 mg/kg/day in females, the highest dose administered in the study. In this same study in mice the NOEL was 487 mg/kg in males and 551 mg/kg in females, the highest dose administered. <u>Dermal</u> TEPA was applied to the skin of 5 male and 5 female rabbits at doses of 50, 100 or 200 mg/kg for approximately 6 hours per day, 5 days a week for a period of 31 days. At 100 and 200 mg/kg the only lesions noted were skin lesions with the degree of irritation being dose-related (i.e. effects in the 200 mg/kg group were generally more severe than in the 100 mg/kg group). Because no changes were observed in the 50 mg/kg group, the NOEL was 50 mg/kg with an inferred LOAEL of 100 mg/kg. A lifetime study was conducted via dermal administration in fifty male mice with a solution of 35% TEPA. There were 20 cases of hyperkeratosis, 13 cases of epidermal necrosis and no evidence of dermal hyperplasia.	ECHA (2013) SIDS (2001)
Sensitisation of the skin or respiratory system May cause an allergic skin reaction (GHS classification Skin Sensitiser 1 H317). *Notes:* A group of nine alkyleneamines were investigated for their potential to induce skin sensitisation and to cross-react with one another to elicit a hypersensitivity response. The sensitising potency was inversely correlated with the number of amine units. Cyclic amines had a lower sensitising potency than the corresponding olefinic amines. The results suggest that there was a direct correlation of the potencies to cause sensitisation and cross-sensitisation in this family of alkyleneamines. From the results of this study it was concluded that Tetraethylenepentamine is a skin sensitiser.	ECHA (2013)

A read across skin sensitisation study involved skin application of the surrogate TETA to guinea pigs at a dose of 0.3 ml/site area. At the first reading (24 hours after), 18/20 animals showed skin reactions and at the second reading (48 hours after), 19/20 animals were positive. It was therefore concluded that TETA is a skin sensitiser. In terms of human studies exposure to low molecular polyamines, including tetraethylenepentamine, during road paving was investigated. Fatty amine wetting agents are used to increase adhesion in bitumen emulsions used in road paving however commercially produced fatty amines are contaminated with low molecular polyamines and alkanol polyamines which are released from the hot bitumen during paving. The highest concentration of TEPA (which is present at low levels in these products) measured during road paving was 0.05 mg/m3 As polyamines and alkanol polyamines are known to cause eye and respiratory tract irritation and skin sensitisation it was concluded they may contribute to the symptoms experienced by the road pavers.	
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes severe skin burns and eye damage (GHS Skin Corrosion 1B H314) Causes serious eye damage (GHS Eye Damage 1 H318) *Notes:* <u>Skin</u> TEPA was applied to the skin of five rabbits at a volume of 0.01 ml and observed for at least up to 24 hour. One rabbit showed moderate erythema, a second rabbit showed marked erythema whereas the other 3 showed moderate necrosis. Due to 3 out of 5 rabbits showing moderate necrosis TEPA has the potential to cause a severe skin burns. Read across studies can also be considered using the surrogate TETA. TETA was applied undiluted directly on the intact and abraded skin sites of 3 male and 3 female New Zealand White rabbits. It was applied at a concentration of 0.5 mL/ site (6 m²) for 3 minutes, 60 minutes, 4hours or 24 hours. Necrosis was observed after a 3 minute exposure. The animals that had been exposed for 60 minutes, 4 hours, or 24 hours scored 4 (necrosis) for erythema and edema immediately after unwrapping. Severe erythema and severe edema remained present in all animals at all observation periods during the study (up to 14 days). In another dermal study TETA was applied to rabbits for 1, 5, 15 minutes and 20 hours. Effects were examined after 10 minutes, 1, 24, 48, 72 hours as well as after 8 days. After a 15 min or 20 h exposure soft necrosis (24 hour evaluation) was observed which turned into a leathery necrosis at the end of the observation period. It was concluded that TETA caused necrosis after a 15 minute exposure. <u>Eye</u> TEPA was applied undiluted at a volume of 0.02 mL to the conjunctival sac of five rabbits. Rabbits showed moderate corneal injury with 1/5 rabbits showing iritis. A volume of 0.005 mL per eye showed minor injury. Because a volume of 0.02 ml was used, it is expected that the amount required according the current OECD guideline (0.1 mL) will induce more severe eye injury and therefore TEPA is considered to be at least 'highly irritating'. Due to lack of information when using a volume of 0.1 mL, and on reversibility, classification in OECD-GHS categories is not possible. <u>Respiratory effects</u> As well as being corrosive to the eyes and the skin TEPA is also irritating to the respiratory tract. Under short-term exposure inhalation of mist may cause severe swelling of the throat.	ECHA (2013) IPCS (2008)

Physical Hazards	Reference
Flammable Potential Combustible. Gives off irritating or toxic fumes (or gases) in a fire.	IPCS (2008)
Explosive Potential	All

No data found.	proposed data sources.

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	3244 mg/kg (male; TEPA) 2140 mg/kg (female; TEPA) 1861.9 mg/kg (male;TETA) 1591.4 mg/kg (female; TETA) 1716.2 (combined sex; TETA) Ca. 1400 mg/kg (TETA)	ECHA (2013)
Rat, dermal		
Rabbit, dermal	1257 mg/kg (male; TEPA) 660 mg/kg (TEPA) 1720 mg/kg (male; TETA) 1465.4 mg/kg (combined sex; TETA)	ECHA (2013) SIDS(2001)
Inhalation	>9.9 ppm (rat)	SIDS (2001)
LOAEL		
LOAEC		
LC_{50}		
Rat	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
LOAEL	3390 mg/kg (male rats, oral; TEPA, 7 day study) 3630 mg/kg (female rats, oral; TEPA 7 day study) 100 mg/kg (dermal; TEPA, 90 day study)	ECHA (2013)
LOAEC	No data found.	All proposed data sources

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	Based on dermal studies using TETA
Mutagenicity/Genotoxicity	NO	Based on in-vivo studies using TETA. Acknowledged that in-vitro PETA and TETA studies show positive mutagenic effects.
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	Based on TETA studies. However, developmental/ teratogenic effects were noted with the two studies using TETA dihydrochloride and triethylenetetramine tetrachlorhydrate
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[2] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L^3 (or mg/m^3) (vapour)	NO	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	NO	
Corrosive (irreversible damage)	YES	Causes severe skin burns and serious eye damage.
Respiratory sensitiser	NO	Short-term exposure can cause respiratory tract irritation as inhalation of mist may cause severe swelling of the throat.
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC	YES	Dermal LOAEL of100 mg/kg

> 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]		
Skin Sensitiser	YES	May cause an allergic skin reaction.
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	YES	
Irritant (reversible damage)	YES	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	YES	
Explosive potential	No data found.	
Hazard Evaluation (highest band) not including physical hazards	**Hazard Band 3**	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	No data found.	All proposed data sources
STEL	No data found.	All proposed data sources
Peak Limitation	No data found.	All proposed data sources
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources
Air, indoor	No data found.	All proposed data sources
Water, potable	No data found.	All proposed data sources
Water, recreational	No data found.	All proposed data sources
Soil, residential	No data found.	All proposed data sources
Soil, commercial/industrial	No data found.	All proposed data sources

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Tetraethylenepentamine (TEPA) is a polyamine organic compound. It is an alkaline, viscous and hygroscopic yellow liquid. For some of the human health toxicity summaries read across interpretations from studies undertaken on triethylenetetramine (TEPA) have been considered. TEPA is similar toxicologically to TETA based on its structure and chelation properties and therefore TETA is an appropriate surrogate. In all of the studies summarised it has been indicated where TETA has been used.

TEPA is not classifiable as to its carcinogenicity to humans. In-vivo studies did not indicate mutagenic/genotoxic effects however mutagenic/genotoxic are noted in some in-vitro tests. Reproductive toxicity testing has been conducted in rats and mice (only one study in each species) in which no effects were noted on reproductive organs. Developmental toxicity/teratogenicity is not noted for the surrogate TETA however, developmental/ teratogenic effects were noted in two studies using TETA dihydrochloride and triethylenetetramine tetrachlorhydrate. Neither TEPA nor TETA are listed on the European Commission's Endocrine Disrupters Priority List and therefore TEPA is not considered an endocrine disrupter. TEPA is harmful if swallowed or when in contact with the skin. Repeat dose studies have shown oral and dermal effects such as decreased body weight, decreased liver and kidney weight and skin lesions. TEPA may cause an allergic skin reaction with an absence of data for the respiratory system sensitisation. Short-term exposure can cause respiratory tract irritation as inhalation of mist may cause severe swelling of the throat. Due to TEPA's ability to cause severe skin burns and serious eye damage it has been categorised as hazard band 3.

References and Notes

ECED (2013) European Commission's Endocrine Disrupters Priority List. Available at http://ec.europa.eu/environment/chemicals/endocrine/strategy/substances_en.htm#priority_list [Accessed 29 October 2013]

ECHA (2013) (European Chemicals Agency) Registered Substances List. Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-97d9b8de-919d-0fc7-e044-00144f67d031/AGGR-9151a308-e978-4f0f-93c0-24147e440982_DISS-97d9b8de-919d-0fc7-e044-00144f67d031.html#L-b05dc300-087c-4b97-8a74-507116721cb4 [Accessed 29 October 2013]

HSDB (2002). 'Triethylenetetramine'. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine. Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~V4ZvQU:1 [Accessed 28 October 2013]

HSDB (2003). 'Tetraethylenepentamine'. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine. Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~f6LyTi:1 [Accessed 29 October 2013]

IPCS (2008). International Programme on Chemical Safety 'ICSC 1718 – TETRAETHYLENEPENTAMINE'. Available at http://www.inchem.org/documents/icsc/icsc/eics1718.htm [Accessed 30 October 2013]

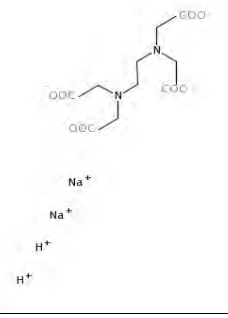
SIDS (2001). OECD SIDS 'Initial Assessment Report For 13th SIAM', Tetraethylenepentamine. Available at

http://www.inchem.org/documents/sids/sids/Tetraethylenepentamine.pdf [Accessed 30 October 2013]

NDF – No data found within the limits of the search strategy

Created by:	JH	Date: 30/10/13
Reviewed and edited by:	JF	Date: 08/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Disodium Ethylene Diamine Tetra Acetate (impurity)
Synonyms	Ethylenediaminetetraacetic acid disodium salt, EDTA disodium salt, Na2 EDTA
CAS number	139-33-3
Molecular formula	C10H16N2O8.2Na
Molecular Structure	

Overview	Reference
Disodium Ethylene Diamine Tetra Acetate (EDTA) is an EDTA salt. EDTA is a binding agent with affinity for metals. Uses of disodium EDTA include food additive and component of sanitizing solutions (for use on food processing equipment). It is also used as a stabilizer for vitamin B12, promoter for color retention, and as a cure accelerator with sodium ascorbate or ascorbic acid. EDTA salts are also used in cosmetics. Disodium EDTA is low order of acute toxicity (harmful if swallowed) and the principal health effect is severe eye irritation Disodium EDTA is soluble in water and doesn't adsorb strongly to soil and sediments. It is biodegradable under certain conditions.	US EPA, 2004

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as carcinogen	ECHA, 2013
Mutagenicity/Genotoxicity Not classified as genotoxic	ECHA, 2013
Reproductive Toxicity Not classified as toxic to reproduction	ECHA, 2013
Developmental Toxicity/Teratogenicity Not classified as toxic to embryo development	ECHA, 2013
Endocrine Disruption Not listed as an Endocrine Disruptor	ECa, 2000

Acute Toxicity (oral, dermal, inhalation) Harmful if swallowed	ECHA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as chronic toxic	ECHA, 2013
Sensitisation of the skin or respiratory system Not classified as sensitiser to skin or respiratory system	ECHA, 2013
Corrosion (irreversible and reversible)/irritation of the skin or eye In general, EDTA and its salts are mild skin irritants but considered severe eye irritants.	US EPA 2004

Physical Hazards	Reference
Flammable Potential Not classified as flammable (in its solid form)	ECHA, 2013
Explosive Potential Not classified as explosive	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found (NDF)	
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	> 2000 mg/kg bw	OECD, 2012
Mouse, oral	2050 mg/kg	US EPA, 2004
Rabbit, oral	2300 mg/kg bw	IPCS, 1974
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat		
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL (mouse, oral)	>= 500 mg/kg bw/day	ECHA, 2013
NOAEL (rat, oral)	692 mg/kg bw/day	OECD, 2012

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	
Corrosive (irreversible damage)	YES	
Respiratory sensitiser	NO	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NO	
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	YES	
Irritant (reversible damage)	NO	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		ECb, 2000
8-h TWA	6 mg/m^3 (MAK value)	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Disodium EDTA fells into the Hazard band category 3. Principal health effects include mild irritation of the skin and severe irritation of the eye. Disodium EDTA is also harmful if swallowed. There are no occupational exposure limits established for this chemical. Disodium EDTA is not readily biodegradable but can biodegrade under certain conditions.

References and Notes

European Chemicals Agency (ECHAa 2013). Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 29 August 2013]

European Chemicals Agency. Classification and Labelling Inventory database Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database [Accessed 29 August 2013] (ECHA 2013b)

European Commission (ECa, 2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

European Commission (ECb, 2000) Joint Research Centre (JRC) Institute for Health and Consumer Protection - European Chemical Substances Information (ESIS). Available at http://esis.jrc.ec.europa.eu/doc/IUCLID/data_sheets/139333.pdf . [Accessed 29 August 2013].

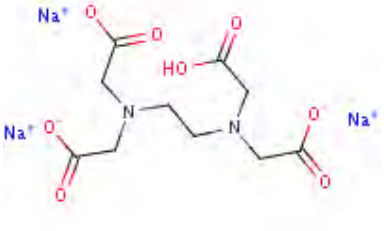
International Program on Chemical Safety (IPCS, 1974) document. Available at http://www.inchem.org/documents/jecfa/jecmono/v05je25.htm. [Accessed 30 August 2013].

Organization for Economic Cooperation and Development (OECD, 2012). Available at http://webnet.oecd.org/Hpv/UI/handler.axd?id=823fc6fd-affd-4610-8e57-87e17b72f9f3. [Accessed 29 August 2013].

United States Environmental Protection Agency (US EPA, 2004). Memorandum: Ethylenediaminetetraacetic acid (EDTA) and the salts of EDTA: Science Assessment Document for Tolerance Reassessment. Available at http://www.epa.gov/opprd001/inerts/edta.pdf. Accessed 29 August 2013].

Created by:	JC	Date: 30/08/2013
Reviewed and edited by:	JF	Date 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Trisodium Ethylenediaminetetraacetate (impurity)
Synonyms	Edetate trisodium, trisodium EDTA, trisodium hydrogen ethylene diaminetetraacetate, N,N'-1,2-Ethanediylbis(N-(carboxymethyl)glycine), trisodium salt, glycine, N,N'-1,2-ethanediylbis(N-(carboxymethyl)-trisodium salt
CAS number	150-38-9
Molecular formula	$C_{10}H_{16}N_2O_8 \cdot 3Na$
Molecular Structure	

Overview	References
Trisodium ethylenediaminetetraacetate is an odourless white solid and is water soluble. It rapidly dissociates in water to ethylenediaminetetraacetate (EDTA). Trisodium EDTA isan organic chelating agent. Chelating agents sequester a variety of polyvalent cations. It is a low production volume (LPV) chemical which is an ingredient in sunscreen and fracking mixtures and is also used in pharmaceutical manufacturing and as a food additive. The toxicity of tri and tetra sodium salts of EDTA are very similar and are dependent on the toxicity of free acid (EDTA). On this basis toxicity information for the acid and tri and tetra sodium salts has been in this profile.	US EPA (2013), US NLM (2013b)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as a carcinogenic substance (Tetra sodium EDTA). Negative in mice and rat carcinogenicity bioassays. Not classified by IARC.	ECHA (2013) US EPA (2013). IARC (2013)
Mutagenicity/Genotoxicity Not classified as a carcinogenic substance (Tetra sodium EDTA). In vitro genetic toxicity assays were negative.	US EPA (2013)
Reproductive Toxicity Not classified as a carcinogenic substance (Tetra sodium EDTA). n al 2 year feeding study on Wistar rats including reproductive and lactation experiments in	ECHA (2013)

four successive generations groups of 25 male and 25 female animals were exposed to $CaNa_2EDTA$ at dietary levels providing daily doses of approximately 50, 125, and 250 mg/kg bw .No treatment related effects on reproduction or fertility were observed (i.e. no observed adverse effect level for reproductive toxicity >250 mg/kg/day)..	
Developmental Toxicity/Teratogenicity EDTA and four of its salts, disodium, trisodium, calcium di-sodium, and tetrasodium edetate, were studied for teratogenic potential in rats. Equimolar doses based on 1000 mg/kg were given by gastric intubation on Days 7 to 14 of gestation. On day 21 of gestation the dams of each group were sacrificed and litter data for each dam collected.No treatment related developmental effects were observed.	
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity Neurotoxicity has been observed in repeat dose toxicity studies. .	
Acute Toxicity (oral, dermal, inhalation) Harmful if swallowed or inhaled. Related compound tetrasodium EDTA is toxic to blood, kidneys, lungs, liver, mucous membranes. Repeated or prolonged exposure to the substance can produce target organs damage.	ECHA (2013), Sciencelab.com, Inc. (2008)
Chronic/repeat dose toxicity (oral, dermal, inhalation) In a range of repeat dose toxicity tests via the oral route (mainly dietary) for a period of one month through to daily exposure effects (such as mortality) and calcium homostatis issues, exhibited increased lethality but no epidemiologic darakidney, ureter and bladder effects (changed in tubules, including acute renal failure and acute tubular necrosis) In a subacute repeated dose toxicity study 10 male Wistar rats per dose were exposed to a respirable dust aerosol of Na_2H_2EDTA for 6 hours per day for 5 consecutive days at concentrations of 0, 30, 300, 1000 mg/m³ air. Exposure in the high dose group (1000 mg/m3) was for one day only due to mortality observed. Inhalation exposure to 1000 mg/m³ disodium EDTA for 6 hours caused lethality in 6 out of 20 male rats. Histological examination of the lung of the dead rats revealed congestion, edema, multifocal hemorraghes and inflammatory cell infiltrates. Inhalation exposure of rats to disodium EDTA for 6 hours per day, 5 consecutive days cause concentration dependant lesions in the larynx and lungs that were fully reversible within 14 days. Due to histopahological changes in the low dose group a no observed effect level could not be determined. The LOAEC was considered to be 30 mg/m³ air.	US EPA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin or respiratory .	
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes serious eye irritation. Causes skin irritation. May cause respiratory irritation. Related compound tetrasodium EDTA can result in skin redness and sensitivity, inhalation (cough, sore throat), eye contact (irritant) and ingestion (burning sensation in the throat and chest, abdominal pain, diarrhoea) as well as corrosive to skin and eyes on contact. Tetrasodium EDTA is irritating to mucous membranes and upper respiratory tract. Liquid or spray mist of tetrasodium EDTA may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract.. Inhalation of the spray mist of tetrasodium EDTA may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.	ECHA (2013), IPCS(2006), Sciencelab.com, Inc. (2008)

Physical Hazards	Reference
Flammable Potential No classified as a flammable solid.	ECHA (2013)
Explosive Potential Not classified as an explosive.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	-
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found.	-
LOAEL	No data found.	-
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	2150 mg/kg	US NLM (2013a)
Mouse, oral	2150 mg/kg	US NLM (2013a)
Rabbit, oral	No data found.	-
Rat, dermal	No data found.	-
Rabbit, dermal	No data found.	-
Mouse, dermal	No data found.	-
LOAEL	No data found.	-
LOAEC	No data found.	-
LC_{50}		
Rat	No data found.	-
High Chronic/Repeat Dose Toxicity		
LOAEL	No data found.	-
LOAEC	30 mg/m3	ECHA (2013)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	Negative in bioassays
Mutagenicity/Genotoxicity	No	Negative in bioassays
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible damage)	Yes	
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No data found.	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	
Irritant (reversible damage)	Yes	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence	12/13 92%%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).
[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	-
8-h TWA	No data found.	-
STEL	No data found.	-
Peak Limitation	No data found.	-
Environmental Exposure		
Air, ambient	No data found.	-
Air, indoor	No data found.	-
Water, potable	0.25 mg/L (for EDTA)	ADWG (2011) – Health Guideline Value
Water, recreational	No data found.	-
Soil, residential	No data found.	-
Soil, commercial/industrial	No data found.	-

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Trisodium ethylenediaminetetraacetate is an odourless white solid and is water soluble. It rapidly dissociates in water to ethylenediaminetetraacetate (EDTA). It is an organic chelating agent. Chelating agents sequester a variety of polyvalent cations. The toxicity of tri and tetra sodium salts of EDTA are very similar and are dependent on the toxicity of free acid (EDTA). On this basis toxicity information for the acid and tri and tetra sodium salts has been in this profile.

EDTA and its salts are organic acids and can cause severe eye irritation, skin and respiratory irritation in the neat form. Trisodium EDTA has a low order of acute toxicity. On repeat dose exposure by inhalation it can cause upper respiratory tract inflammation. Trisodium EDTA is not classified as a carcinogen, mutagen or reproductive toxicant. On the basis of severe eye irritation it is categorised as Hazard Band 3.

References and Notes

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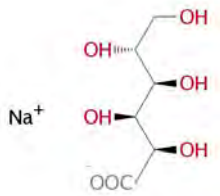
Unites States National Library of Medicine (NLM) Drug Information Portal database. Available at http://druginfo.nlm.nih.gov/drugportal/drugportal.jsp. [Accessed 5 September 2013]. (US NLM (2013b))

No data found. - No data found within the limits of the search strategy.

Created by:	MER	Date 4/9/2013
Reviewed and edited by:	JF	Date 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium gluconate
Synonyms	Sodium D-gluconate,Sodium (2R,3S,4R,5R)-2,3,4,5,6-pentahydroxyhexanoate, sodium pentahydroxy-capronate
CAS number	527-07-1
Molecular formula	$C_6H_{11}NaO_7$
Molecular Structure	

Overview	References
Sodium gluconate is the sodium salt of gluconic acid. Gluconic acid and its mineral salts freely dissociate to the gluconate anion and the respective cations. Glucono-delta-lactone (GDL), the 1,5-inner ester of gluconic acid, is formed from the free acid by the removal of water. On the basis of these spontaneous chemical rearrangements, glucono-delta-lactone, gluconic acid and its sodium, calcium and potassium salts are considered as a category. It is a high solubility in water and occurs as a white or off-white solid. The US FDA considers sodium gluconate to be generally recognized as safe to a limited extent (GRAS/FS). Gluconic acid and its derivatives are naturally occurring substances. Gluconate is a metabolite of glucose oxidation and is excreted in the urine or metabolized. Orally administered gluconate is absorbed rapidly and the majority of it is excreted with the remainder metabolized. Commercially, the gluconates are used as chelating agents in cement set retarding, institutional and household cleaning, personal care products, pharmaceuticals and foodstuffs. Sodium gluconate is an ingredient in some sugar replacement packets and diet soft drinks. Worldwide productions of sodium gluconate is estimated to be 50,000-70,000 tonnes per year.	CHRIP (2008), FDA (2003) OECD (2004).

Human Health Toxicity Summary	Reference
Carcinogenicity - Not classified by IARC	IARC (2013)
Mutagenicity/Genotoxicity - In vitro and in vivo mutagenicity data were negative	OECD (2004)
Reproductive Toxicity - No changes were observed on the reproductive organs in 28 days oral studies with up to 4400 mg/kg bw sodium gluconate (species not specified)	OECD (2004)
Developmental Toxicity/Teratogenicity - NDF	All proposed data sources
Endocrine Disruption - NDF	All proposed data sources
Neurotoxicity - NDF	All proposed data sources

Acute Toxicity (oral, dermal, inhalation) - Although no LD50 data are available for sodium gluconate, similar compound potassium carbonate has an LD50 (oral) of 6,060 mg/kg bw on Wistar rats.	OECD (2004), ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) - Repeated dose toxicity studies of 4 weeks, 6 months, and 24 months were performed. None showed any significant toxicological effects of gluconates.	OECD (2004)
Sensitisation of the skin or respiratory system NDF	All proposed data sources
Corrosion (irreversible and reversible)/irritation of the skin or eye - Not irritating to the eyes or skin.	OECD (2004)
Flammable Potential - Combustible	IPCS (2009)
Explosive Potential - NDF	All proposed data sources

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
LD_{50}	NDF	-
High Chronic/Repeat Dose Toxicity		
NOAEL, rats (female)	2000 mg/kg bw	OECD (2004)
NOAEL, rats (male)	1000 mg/kg bw	OECD (2004)
NOAEL, Dog (beagle)	500 mg/kg bw	OECD (2004)
Animal Toxicity Data		
Acute Toxicity		
LD_{Lo}		
Rat,crj: CD(SD)	>2000 mg/kg bw	OECD (2004)
Dog, beagle	>2000 mg/kg bw	OECD (2004)
LD_{50}		
	>2000 mg/kg bw	-

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	Not classified by IARC.
Mutagenicity/Genotoxicity	NO	-
Reproductive Toxicity	NO	-
Developmental Toxicity/ Teratogenicity	NO	-
Endocrine Disruption[1]	NO	-
Neurotoxicity[2]	NO	-
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	-
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	-
Corrosive (irreversible damage)	NO	-
Respiratory sensitiser	NDF	-
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NO	-
Skin Sensitiser	NO	-
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	NO	-
Irritant (reversible damage)	NO	OECD 2004
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	Combustible. IPCS (2009)
Explosive potential	NO	-
Hazard Evaluation (highest band) not including physical hazards	**Band 0**	
Uncertainty analysis /data confidence	12/13 x 100 =	**92%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	All proposed data sources
STEL	NDF	All proposed data sources
Peak Limitation	NDF	All proposed data sources
Environmental Exposure		
Air, ambient	NDF	All proposed data sources
Air, indoor	NDF	All proposed data sources
Water, potable	NDF	NEPM (1999; amended 2013)
Water, recreational	NDF	All proposed data sources
Soil, residential	NDF	NEPM (1999; amended 2013)
Soil, commercial/industrial	NDF	NEPM (1999; amended 2013)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Qualifying Summary Comments

Gluconic acid and its derivatives are naturally occurring substances. Besides being naturally present at a level up to 1% in wine, honey and other foods and drinks, sodium gluconate,is listed as permitted food additive in Europe and the USA. It is a non hazardous substance either following acute or chronic exposure. It is not classified as a mutagen, carcinogen, reproductive, or developmental toxicant.

Created by:	**MER**	Date: **15/08/2013**
Reviewed and edited by:	**JF**	Date: **1209/2013**

References

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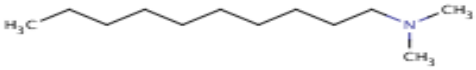
OECD (2004). Gluconic Acid and Its Derivatives.: SIDS initial assessment report. From INCHEM. Available at http://www.inchem.org/documents/sids/sids/gluconates.pdf

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Decyldimethyl amine (impurity)
Synonyms	Decyldimethylamine, Dimethyl-n-decylamine, N,N-Dimethyl-N-decylamine, N,N-Dimethyldecylamine
CAS number	1120-24-7
Molecular formula	C12-H27-N
Molecular Structure	

Overview	Reference
Decyldimethyl amine is a transparent clear liquid at standard temperature and pressure. The boiling point was found to be 237ºC ± 0.5ºC. The liquid is not considered flammable or explosive. It is used in the manufacturing of bulk chemical (including petroleum products) as an intermediate in chemical synthesis. Available data on the manufacture and use of decyldimethyl amine is relatively limited. Acute toxicity studies have found the acute oral median lethal dosage (LD50) of the decyldimethyl amine was greater than 2000 mg/kg. However, research suggests decyldimethyl amine can cause severe skin burns and eye damage (based on New Zealand White rabbit studies).	ECHA 2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as a carcinogen due to lack of data. Not classified by IARC (not currently evaluated by IARC).	ECHA 2013; IARC 2013
Mutagenicity/Genotoxicity Not classified as a germ cell mutagen by ECHA (conclusive data but not sufficient for classification as a germ cell mutagen).Results of a bacterial gene mutation assay which concluded that the substance did not exhibit any mutagenic activity under the conditions of test.	ECHA 2013
Reproductive Toxicity Not classified as reproductively toxic by ECHA (conclusive data but not sufficient for classification as reproductively toxic).	ECHA 2013

Developmental Toxicity/Teratogenicity NDF.	
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC 2000
Acute Toxicity (oral, dermal, inhalation) ECHA lists the chemical as "Harmful is swallowed" (GHS classification listed: Acute Tox 4. H302) Xn; R22 Harmful if swallowed. The acute toxicity of the decyldimethylamine was investigated in a group of five male and five female Sprague-Dawley rats at a dosage of 2000 mg/kg according to OECD guideline 401. The animals were starved overnight prior to dosing. The test material was administered at a constant volume-dosage of 10 ml/kg in maize oil via gavage. Mortality and signs of reaction to treatment were recorded during a subsequent 14 -day observation period; the surviving animals were killed on the following day. All animals were subjected to necropsy. Only one female rat died during the observation period. Under the conditions of this study, the acute oral median lethal dosage (LD50) of the test material was greater than 2000 mg/kg. ECHA states data are lacking for assessment of acute toxicity via dermal and inhalation pathways.	ECHA 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) NDF.	
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser by ECHA due to lack of data.	ECHA 2013
Corrosion (irreversible))/irritation (reversible) of the skin or eye Caused severe skin burns and eye damage as reported in a number of animal studies. (GHS classification: Skin Corr. 1B H314). Six New Zealand rabbits were treated with the test substance in a dermal irritation/corrosion study consistent with OECD 404 and EU B.4 guidelines. The test substance produced erythema with a mean score of 2 and edema with a mean score of 2.2. After 4 h of exposure, severe dermal responses were produced. Under the conditions of this study the test material was considered as corrosive to the skin of rabbits. The potential of the substance to cause inflammatory or corrosive changes upon first contact with skin was also assessed by semi-occluded application of 0.5 mL of the test material to the closely-clipped dorsa of three New Zealand White rabbits for four hours. Dermal reactions were assessed 1, 24, 48 and 72 hours after removal of the dressings and on days 7, 10, 13 and 16. Under the conditions of this test the substance was reported as an irritant to skin. The potential of the substance to cause damage to the conjunctivae, iris or cornea was assessed in the New Zealand White rabbits using the OECD Guideline 405. Rabbits were subjected to a single ocular instillation of 0.1mL of the test material. Ocular reactions were assessed 1, 24, 48 and 72 hours after treatment and on Day 8, 15 and 22. Instillation of the test material caused no initial pain response. Under the conditions of this test and the criteria of the EEC, the substance was classified as having the "*risk of serious damage to eyes"*.	ECHA 2013

Physical Hazards	Reference
Flammable Potential Not classified as a flammable liquid.	ECHA 2013
Explosive Potential Not classified as an explosive.	ECHA 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral (gavage)	> 2000 mg/kg bw	ECHA 2013
Rat, dermal	NDF	
Rabbit, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	IARC 2013;ECHA 2013
Mutagenicity/Genotoxicity	No	ECHA 2013
Reproductive Toxicity	No	ECHA 2013
Developmental Toxicity/ Teratogenicity	NDF	
Endocrine Disruption[1]	No	Not listed as an endocrine disruptor by European Commission, EC 2000
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	No	GHS classification listed: Acute Tox 4. H302, ECHA 2013
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	NDF	
Corrosive (irreversible damage)	Yes	GHS classification listed: Skin Corr. 1B H314, ECHA 2013
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	NDF	
Skin Sensitiser	No	ECHA 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	
Irritant (reversible damage)	Yes	ECHA 2013
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	**3**	

Uncertainty analysis /data confidence	9/13 x 100 = 69%	**69%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	NDF	
8-h TWA		
STEL		
Peak Limitation		
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Across a range of toxicological outcomes decyldimethyl amine exhibits concerns due to skin and eye corrosivity which results in it being placed in Hazard Band 3. Its fate and transport potential is considered similar to dodecyl dimethylamine and subsequently is expected to undergo rapid degradation in agueous systems such that sustained environmental distribution is not expected. Its volatilisation potential suggest the potential for inhalation exposures within confined occupational settings and confined large scale emergency spill settings and these may need to be considered should such settings arise. This is in addition to the dermal and ingestive pathways of exposure for such settings. As this substance is considered an impurity within the fluids the potential for exposures is considered to be substantially reduced provided no concentration processes under any circumstances result during the use of the parent product.

References

European Chemicals Agency (ECHA), 2013. Registered Substances List Dossier for Decyldimethylamine. Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-9eaede3e-ebf6-2909-e044-00144f67d031/DISS-9eaede3e-ebf6-2909-e044-00144f67d031_DISS-9eaede3e-ebf6-2909-e044-00144f67d031.html [Accessed 29 October 2013].

European Commission (EC) (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000). Available at http://www.google.com.au/url?sa=t&rct=j&q=&esrc=s&frm=1&source=web&cd=1&ved=0CCsQFjAA&url=http%3A%2F%2Fec.europa.eu%2Fenvironment%2Farchives%2Fdocum%2Fpdf%2Fbkh_main.pdf&ei=3lGdUuvJHMWAlQWtpoG4Aw&usg=AFQjCNHb22gN8i-m7ibv3ScRCZ205H6X6Q&bvm=bv.57155469,d.dGI [Accessed 29 October 2013].

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Notes

NDF – No data found within the limits of the search strategy

Created by:	MGT	Date: 30/10/2013
Reviewed and edited by:	LT	Date: 08/11/2013 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Potassium hydroxide
Synonyms	Potassium hydroxide, caustic potash, potassium lye, potassium hydrate
CAS number	1310-58-3
Molecular formula	HKO
Molecular Structure	

Overview	References
Anhydrous potassium hydroxide consist of white or slightly yellow lumps. It is very soluble in water and is produced largely in the liquid form. It has many industrial and some domestic uses. Industrial uses include potassium carbonate, chemical manufacturing, potassium chemicals, fertilizers, phosphotes, detergents, agricultural chemicals and alkaline batteries. Principal health effects include severe skins burns and eye damage.	IPCS, 2001 HSDB, 2009 ECHA, 2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as carcinogen.	ECHA, 2013
Mutagenicity/Genotoxicity Not classified as genotoxic based on the Ames test (bacterial reverse mutation assay)	ECHA, 2013
Reproductive Toxicity - Not classified as inducing reproductive toxicity - No studies on reproductive toxicity	ECHA, 2013 IPCS, 2001
Developmental Toxicity/Teratogenicity - Not classified as teratogenic - No studies on developmental toxicity	ECHA, 2013 IPCS, 2001
Endocrine Disruption Not Classified as an Endocrine Disruptor	EC, 2000
Acute Toxicity (oral, dermal, inhalation) - Harmful if swallowed: rat study - on the basis of one week observations - showed that: LD 50 for potassium hydroxide = 333 mg/kg (conventional method) and 388 mg/kg (up-and-down method) - Not classified as acute via dermal exposures or inhalation - Reported for oral rat LD50 values 365 mg/kg bw, 273 mg/kg bw and 1230 mg/kg bw	ECHA, 2013 IPCS, 2001
Chronic/repeat dose toxicity (oral, dermal, inhalation) Under normal handling and use conditions (non-irritating) neither the concentration of potassium in the blood nor the pH of the blood will be increased above normal limits and therefore KOH is not expected to cause systemically toxic levels in the blood. The renal excretion of K+ can be elevated and the OH- ion is neutralised by the bicarbonate buffer system in the blood.	IPCS, 2001
Sensitisation of the skin or respiratory system - Not classified as a skin sensitiser based on a guinea pigs study and extensive human	ECHA, 2013

use experience. - Not classified as a respiratory sensitiser based on extensive human use experience. -	IPCS, 2001
Corrosion (irreversible and reversible)/irritation of the skin or eye - Induces severe skin burns and eye damage based on in vitro studies, in vivo studies on rats and rabbits and supported by clinical cases. - Dust formation is unlikely but if aerosols or mist occur they will lead to irritant effects such as coughing and wheezing	ECHA, 2013 IPCS, 2001

Human Health Toxicity Summary	Reference
Flammable Potential Not classified as flammable	ECHA, 2013
Explosive Potential Not classified as explosive	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	333 mg/kg (conventional method) and 388 mg/kg (up-and-down method) 365 mg/kg, 273 mg/kg and 1230 mg/kg	ECHA, 2013 IPCS, 2001
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NDF	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NDF	
Corrosive (irreversible damage)	YES	
Respiratory sensitiser	NO	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NDF	
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	YES	
Irritant (reversible damage)	YES	If aerosols/mist occur, they will cause direct local effects on respiratory tracts
Hazard Band 0 All indicators outside criteria listed in Hazards 1-4		
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	10/13 x 100	**76.9 %**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mas s(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	2 mg/ m^3	HSDB, 2000
STEL	2 mg/ m^3	HSDB, 2000
Peak Limitation	2 mg/ m^3	HSDB, 2000
Environmental Exposure		
Air, ambient	0.005 mg/ m^3	DK, 2001
Air, indoor	NDF	
Water, potable	12 mg/L (WHO guidelines for drinking water)	IPCS, 2001
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Potassium hydroxide either as a solid or aqueous liquid form is a corrosive substance. It can cause severe burns to the eyes, skin or respiratory tract. Systemic effects are unlikely given its severely corrosive nature. Given it causes adverse effects at the site of contact it is important to protect against direct contact with eyes, skin or respiratory tract. Potassium hydroxide is not persistent or bioccumalative in the environment and is unlikely to cause adverse effects to humans from environmental (low) exposure to soil or water at normal pH.

References

Dk delegation SIAM 13 communication (DK 2001)

European Chemicals Agency (ECHA 2013). Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 20 August 2013]

European Commission (EC) (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

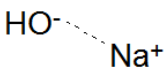
Hazardous Substances Data Bank (HSDB, 2009). Toxicology Data Network (TOXNET) Available at at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~qkNGcU:1. [Accessed 21 August 2013.]

Hazardous Substances Data Bank, Potassium Hydroxide (HSDB, 2000)

International Programme on Chemical Safety (IPCS 2001), Screening Information Data Set (SIDS)available at http://www.inchem.org/documents/sids/sids/POTASSIUMHYD.pdf . [Accessed 21 August 2013.]

Created by:	JC	Date: 22/08/2013
Reviewed and edited by:	JF	Date: 29/08/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium Hydroxide
Synonyms	Caustic Soda, Sodium Hydrate, Soda hydrate, Lye
CAS number	1310-73-2
Molecular formula	NaOH
Molecular Structure	

Overview	References
Sodium hydroxide is a manufactured substance and at room temperature is a white crystalline odourless solid that absorbs moisture from the air. Sodium hydroxide is extensively used in most industries from food preparation to manufacturing. Major uses include in domestic cleaning products, in the manufacturing of soap, rayon, paper, paper, explosives, dyestuffs, and petroleum products according to ATSDR (2002). In addition, the ASTDR states that sodium hydroxide is also used in 'processing cotton fabric, laundering and bleaching, metal cleaning and processing, oxide coating, electroplating, and electrolytic extracting'. Sodium hydroxide is very corrosive. When dissolved in water or neutralized with acid it liberates substantial heat, which may be sufficient to ignite combustible materials. It is generally used as a solid or a 50% solution.	HSDB (2012) ATSDR (2002)

Human Health Toxicity Summary	Reference
Carcinogenicity IARC and the US EPA have not classified sodium hydroxide for carcinogenicity in humans.	ATSDR (2002)
Mutagenicity/Genotoxicity There are no reliable in vitro and in vivo studies to suggest that NaOH is genotoxic or mutagenic.	OECD (2002)
Reproductive Toxicity OECD (2002) (page 3) states that 'sodium hydroxide will neither reach the foetus nor reach male and female reproductive organs, which shows that there is no risk for toxicity to reproduction'.	OECD (2002)
Developmental Toxicity/Teratogenicity OECD (2002) (page 3) states that 'sodium hydroxide will neither reach the foetus nor reach male and female reproductive organs, which shows that there is no risk for developmental toxicity'.	OECD (2002)
Endocrine Disruption Chemical not listed on the European Commission list of identified possible endocrine disruptors.	BKH (2000)
Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) No studies using international/national guidelines in animals are available. OECD (2002) (page 3) reports that 'lethality has been reported for animals at oral doses of 240 mg/kg and 400 mg/kg', however, no reference is made to the type of animal effected. Intentional and accidental ingestion of sodium hydroxide by humans has been reported frequently in the literature with OECD (2002) stating that 'fatal ingestion and fatal dermal exposure has been reported for humans'.	OECD (2002)

In the HSDB a dermal LD_{50} for a rabbit of 1 350 mg/kg and an oral LD_{50} for a rat of 140 mg/kg to 340 mg/kg were stated, although the conditions of the studies in which the results were obtained were not stated.	HSDB (2012)
Chronic/repeat dose toxicity (oral, dermal, inhalation) No studies on animals using international/national guidelines are available on repeated dose toxicity by oral, dermal, inhalation or by other routes. Sodium hydroxide is readily soluble in water and dissociates into ionic parts (i.e. Na^+ and Cl^-). Consequently, sodium hydroxide itself is not considered to be systemically available (OECD,2002). These ions are an important component of biological fluids. Major hazard associated with chronic exposure to sodium hydroxide is development of alkalosis. Dust and vapour exposure are not expected as sodium hydroxide has a negligible vapour pressure, rapidly neutralising in air by carbon dioxide.	OECD (2002)
Sensitisation of the skin or respiratory system In one study sodium hydroxide was applied to the back of male volunteers (human) over a 24 h period (50 µL of solutions containing sodium hydroxide at concentrations of, 0.063%, 0.125%, 0.25%, 0.5% and 1.0%) followed by a further application seven days later (0.125%). The study concluded that sodium hydroxide was not sensitising.	ECHA (2013)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Liquid or solid sodium hydroxide is a severe skin irritant. It causes second and third degree burns on short contact and is very injurious to the eyes.	HSDB (2012)
ATSDR states that 'inhalation of low levels of sodium hydroxide as dusts, mists or aerosols may cause irritation of the nose, throat, and respiratory airways', with higher concentrations resulting in swelling or spasms of the upper airway. Inhalation at higher concentrations may also cause inflammation of the lungs and accumulation of fluid in the lungs.	ATSDR (2002)
Long-term exposure to sodium hydroxide via the inhalation pathway may also lead to ulceration of the nasal passage and chronic skin irritation.	ATSDR (2002)
Classified as 'corrosive' and 'causes severe burns'	SafeWork Australia (2013)
Based on human data, concentrations of 0.5% to 4.0% were irritating to the skin, while a concentration of 8.0% was corrosive for the skin of animals.	OECD (2002)

Physical Hazards	Reference
Flammable Potential Not combustible.	HSDB (2012)
Explosive Potential Not explosive.	HSDB (2012)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	140 mg/kg to 340 mg/kg	HSDB (2012)
Mouse, oral	NDF	
Rabbit, oral	NDF	
Oral (animal not specified)	240 mg/kg	OECD (2002)
Oral (animal not specified)	400 mg/kg	OECD (2002)
Rat, dermal	NDF	
Rabbit, dermal	1 350 mg/kg	HSDB (2012)
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	
Mutagenicity/Genotoxicity (GHS Category 2)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg [3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L [4] (vapour)	140 mg/kg o 340 mg/kg 240 mg/kg and 400 mg/kg	Rat, oral LD_{50} (HSDB, 2012) Animal not specified (OECD, 2002)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [4]	No	Not systemically available OECD (2002)
Corrosive (irreversible effect)	Yes	SafeWork Australia (2013)
Respiratory sensitiser	No	ECHA (2013)
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [4]	No	Not systemically available OECD (2002)
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours) [4]	1,350 mg/kg	Rabbit, dermal LD_{50} (HSDB, 2012)
Irritant (reversible effect)	Yes	OECD (2002)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1 - 4**	No	
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	3	Based on acute toxicity and corrosive
Uncertainty analysis /data confidence (out of 12 parameters)	100%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA		
STEL	NDF	
Peak Limitation	2 mg/m^3	SafeWork Australia (2011)
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	pH 6.5-8.5	pH aesthetic, no health value (ADWG, 2011)
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:
OEL = Occupational Exposure Limit
TWA= 8-h Time-Weighted Average
STEL = (15 min) Short-term Exposure Limit
NDF – no data found within the limits of the search strategy

Summary Concluding Comments

Sodium hydroxide has been assigned to a Hazard Band 3. It is a highly corrosive substance and very dangerous to humans in high concentrations. From an environmental perspective, effects on water alkalinity and direct effects on plants and animal tissues are a concern. These factors are important with respect to acute occupational exposure and acute environmental exposures where exposure to dusts and concentrated solutions may result.

References

ADWG 2011, National Water Quality Management Strategy, *Australian Drinking Water Guidelines 6*, Australian Government, National Health and Medical Research Council, National Resource Management Ministerial Council.

ATSDR 2002, ToxFAQs™ for *Sodium Hydroxide*. Agency for Toxic Substances and Disease Registry. US Department of Health and Human Services, Public Health Service. Available at: http://www.atsdr.cdc.gov/toxfaqs/tf.asp?id=248&tid=45. [Accessed 20 December 2013]

BKH 2000, BKH Consulting Engineers. *Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption: - preparation of a candidate list of substances as a basis for priority setting*. Final report

(incorporating corrigenda to final report dated 21 June 2000), Annex 10: List of 564 substances with their selection criteria. Available at http://ec.europa.eu/environment/archives/docum/pdf/bkh_main.pdf [Accessed 11/12/2013]

ECHA 2013, European Chemical Agency, 2007 – 2013.

Available at: http://apps.echa.europa.eu/registered/data/dossiers/DISS-9ea1ebb9-dbf1-0959-e044-00144f67d031/AGGR-c93b3c36-0c13-4475-a356-cede4a7e7c1e_DISS-9ea1ebb9-dbf1-0959-e044-00144f67d031.html#section_1.1. [Accessed 11/12/2013]

HSDB 2012, Hazardous Substances Database (HSDB). *Sodium Hydroxide*. Hazardous Substances Data Bank Number 229, reviewed 19/01/2012. Toxicology Data Network (TOXNET). Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~JKlwbL:1. [Accessed 11/12/2013].

IARC 2011, International Agency for Research on Cancer (IARC). Available at: http://monographs.iarc.fr/ENG/Classification/index.php. [(database accessed on 5 May 2011].

IPCS (INCHEM) 2005, International Programme on Chemical Safety (IPCS). Joint FAO/WHO Expert Commission on Food Additives (JECFA), (last updated 2005) [Accessed 11/12/2013].

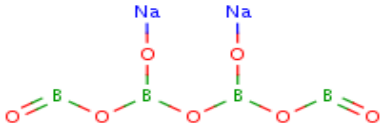
OECD 2002, *OECD SIDS Initial Assessment Report for SIAM 14: Sodium Hydroxide*, March 2002. Available at: http://www.inchem.org/documents/sids/sids/NAHYDROX.pdf [Accessed 11/12/2013]

SafeWork Australia 2011, Hazardous Substance Information System (HSIS). Available at: http://hsis.safeworkaustralia.gov.au/. [Accessed June 2011].

SafeWork Australia 2013, Hazardous Substance Information System (HSIS): *Sodium Hydroxide*. Available at: http://hsis.safeworkaustralia.gov.au/HazardousSubstance/Details?hazardousSubstanceID=876 [Accessed 12/12/2013]

Created by:	JB	23/06/2011
	CM	11/12/2013 (Rev3)
Reviewed and edited by:	LT	02/07/2011 (Rev0) 09/08/2012 (Rev1)
	PDM	09/01/2014 (Rev3)

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Borax (SURROGATE FOR Sodium tetraborate 1330-43-4)
Synonyms	Borax, sodium tetraborate decahydrate, sodium pyroborate
CAS number	1303-96-4 (surrogate for 1330-43-4)
Molecular formula	$B_4Na_2O_7.10H_20$
Molecular Structure	

Overview	References
Sodium tetraborate is a naturally occurring mineral distributed widely in the environment. Commonly known as borax, it occurs in arid regions and was deposited by evaporation of salt lakes in the Tertiary Period. Sodium tetraborate is a white crystalline solid with no odour and an alkaline taste. It is differentiated by the crystal water content and ranges from the anhydrous form to the decahydrate which is referred to as borax.	HSDB (2010)
Industrial uses of sodium tetraborate in the United States of America include glass and ceramics (70%), soaps, bleaches, and detergents (4%), fire retardants (2%), and agriculture (2%). Other uses, including metallurgy, nuclear applications, as an addition to enamels and glazes, and in ingredients for cosmetics or medical preparations which make up the remaining 19%.	ATSDR (2010)
Borates are relatively soluble in water, and readily hydrolysed to form boric acid. Boron in aqueous solution may also be adsorbed by soils and sediments, with adsorption-desorption reactions expected to be the only significant mechanism that influences the fate of boron in water. The extent of boron adsorption depends on the pH of the water and the chemical composition of the soil, with the greatest adsorption generally observed at pH 7.5–9.0.	ATSDR (2010); Rai et al. (1986); Keren & Mezuman (1981); Keren et al. (1981)
Human exposure to sodium tetraborate may occur through ingestion of boron in food and water, or through use of pesticides containing boron compounds; inhalation of boron-containing powders or dusts, or the use of boron in cosmetics or medical preparations.	ATSDR (2010)
Boron concentrations in ambient non-occupational air samples in the United States of America have been reported to range from $<5x10^{-7}$ to $8x10^{-5}$ mg boron/m^3, with an average concentration of $2x10^{-5}$ mg boron/m^3. Workers in other industries, including manufacture of fiberglass and other glass products, cleaning and laundry products, fertilizers, pesticides, and cosmetics, may also be exposed to boron compounds. Mean dust concentrations ranging from 3.3 to 18 mg particulates/m^3 were measured in air samples from U.S. facilities where borax was packaged and shipped.	ATSDR (2010)

The primary health effect associated with inhalation exposure of humans to boron is acute respiratory irritation. Acute-duration exposures of mining and processing workers to 0.44–3.1 mg boron/m^3 (5.7–14.6 mg particulates/m^3) as sodium borate dusts have been associated with mild irritation of the eyes, throat, and nose, as well as with cough and breathlessness.	ATSDR (2010)
Oral exposure animal studies have clearly identified the reproductive system and developing	ATSDR

fetus as the most sensitive targets of boron toxicity. Adverse developmental effects have been identified for acute-and intermediate-duration exposures. Human case reports have reported that boron can be lethal following short-term oral exposure at high doses, although the dose estimation can be quite imprecise and variability in human responses to acute exposure is quite large.	(2010)
The primary health effects associated with dermal exposure are irritation of the eyes and reversible skin changes. Case reports of human occupational exposures have suggested that acute dermal exposure to boron as borax may cause localized hair loss from the scalp.	ATSDR (2010)
No epidemiology studies have identified an association between boron exposure and the development of cancer. The International Agency for Research on Cancer (IARC) has not assessed the carcinogenic potential of boron, sodium tetraborate or other borates. The United States Environment Protection Agency (USEPA) has stated that boron and associated compounds are not classifiable as to their carcinogenic potential on the basis of inadequate data.	IARC (2013); IRIS (2004)

Human Health Toxicity Summary	Reference
Carcinogenicity Inadequate data for classification ('Boron and compounds') (USEPA). Not classified (IARC).	IRIS (2004); IARC(2013)
Mutagenicity/Genotoxicity Negative results have been reported from studies in bacteria, mammalian cells and mice *in vivo*.	IRIS (2004)
Reproductive Toxicity Disodium tetraborate is classified as a presumed human reproductive toxicant based on animal studies (Repr. 1B H360). Oral exposure to the substance may damage fertility. Testes are a sensitive target of boron toxicity in rats and mice (oral studies). Testicular effects from these studies have included reduced organ weight and organ:body weight ratio, atrophy, degeneration of the spermatogenic epithelium, impaired spermatogenesis, reduced fertility, and sterility.	ECHA (2013) Weir and Fisher, 1972; Seal and Weeth, 1980; NTP, 1987; Fail et al., 1991 (in IRIS, 2004)
Developmental Toxicity/Teratogenicity Disodium tetraborate is classified as a presumed human reproductive toxicant based on animal studies (Repr. 1B H360). Oral exposure to the substance may damage the unborn child. Foetuses from rats (Sprague Dawley) exposed to boric acid in their feed had reduced foetal body weight, short and wavy ribs; effects disappeared during the postnatal period. A LOAEL for developmental toxicity of 76 mg/kg/day was determined. Boric acid administered to rabbits (New Zealand White) by gavage was found to be toxic to dams and cause foetal resorption and cardiac or great vessel malformations in surviving foetuses. A LOAEL for maternal and developmental toxicity of 250 mg/kg/day was determined.	ECHA (2013)
Endocrine Disruption Changes in testicular characteristics following exposure to boric-acid have suggested the involvement of an endocrine mechanism, however, boron and borates are not listed as priority Endocrine Disrupting substances by the European Commission.	EC (2000), Weir and Fisher, 1972 (in HSDB, 2013)
Neurotoxicity	

NDF	
Acute Toxicity (oral, dermal, inhalation) Acute *oral* exposure of humans to boron and its soluble salts (including sodium tetraborate) have been lethal at sufficiently high doses. The minimal lethal dose of ingested boron (as boric acid) was reported to be 2–3 g in infants, 5–6 g in children, and 15–20 g in adults. Adverse developmental effects have been identified for acute-duration oral exposures in mice and rats. Acute *dermal* exposure of humans to sodium tetraborate may cause localized hair loss from the scalp. In animals, exposure to boron dust and aqueous solution applied to the eyes has resulted in conjunctivitis, mild irritancy of the epithelium and superficial stroma. Acute *inhalational* exposure of humans to boron can cause acute respiratory irritation and increased nasal secretions.	ATSDR (2010)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Chronic *oral* exposure of humans to borate salts in drinking water (9–25 mg boron/L) found no evidence of reproductive effects. Testicular atrophy has been observed in rats exposed to 81 mg boron/kg/day and mice exposed to 201 mg boron/kg/day for 2 years. Several systemic effects have also been observed in chronic animal studies, including haematological effects, desquamated skin and chronic inflammation of the liver. Chronic *dermal* exposure of industrial workers to sodium tetraborate dust has been documented to cause chronic eczema. Chronic *inhalational* exposure of humans to sodium tetraborate dust has been documented to cause symptoms of persistent respiratory irritation meeting the definition of chronic simple bronchitis.	ATSDR (2010); Garabrant et al. (1984); International Labour Office (1983)
Sensitisation of the skin or respiratory system Not classified as a skin or respiratory sensitiser by ECHA. *In vivo* Buehler tests (OECD guideline 406) carried out on male/female guinea pigs (Hartley) concluded boric acid was not a skin sensitiser. The dose applied epicutaneously (occlusive) was 0.4 g 95% w/w. Chronic *dermal* exposure of industrial workers to sodium tetraborate dust has been documented to cause chronic eczema.	ECHA (2013) ATSDR (2010)
Corrosion (irreversible and reversible)/irritation of the skin or eye Not classified as corrosive/irritating to the skin by ECHA. Disodium tetraborate (anhydrous, pentahydrate, decahydrate) is classified as an eye irritant (Eye Irrit. 2 H319). Eye irritation is caused by the glassy nature of the crystals of substance and not a chemical effect of irritation. Disodium tetraborate decahydrate is used as a buffer in eyewashes. Not corrosive. Irritant to the skin and mucous membranes of the eyes, nose and other parts of the respiratory tract.	ECHA (2013) ACGIH (2001); in HSDB (2013)

Human Health Toxicity Summary	Reference
Flammable Potential No.	HSDB (2013)
Explosive Potential No.	HSDB (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
LD_{50}	NDF	-
LC_{50}	NDF	-
High Chronic/Repeat Dose Toxicity		
LOAEC	1.8 mg/m^3	Garabrant et al. (1984)
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	396 – 5,660 mg/kg	USEPA (1988); O'Neill (ed) (2001)
Rat, dermal	NDF	-
Rabbit, dermal	>10,000 mg/kg	Tomlin (ed) (2003-2004)
LC_{50}		
Rat	>2 mg/m^3/4 hrs	Bingham et al. (2001)
High Chronic/Repeat Dose Toxicity		
LOAEL	28.5 mg B/kg	Heindel et al. (1992); Price et al.(1990)
LOAEL	13.6 – 25.3 mg B/kg	Heindel et al. (1992); Price et al.(1996)
LOAEL	76 mg/kg/day	Oral, developmental toxicity, rats ECHA (2013)
NOAEL	55 mg/kg/day	Oral, developmental toxicity, rats ECHA (2013)
LOAEL	250 mg/kg/day	Oral, developmental and maternal toxicity, rabbits ECHA (2013)
NOAEL	125 mg/kg/day	Oral, developmental and maternal toxicity, rabbits ECHA (2013)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	NDF	
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2013); IRIS (2004)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	Yes	ECHA (2013), category 1B
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	NDF	
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2013); IRIS (2004)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA (2013)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg [3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L [4] (or mg/m^3) (vapour)	No	ATSDR (2010)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [3]; • dermal LOAEL ≤ 20 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [4]	No	ECHA (2013); ATSDR (2010); Garabrant et al. (1984); International Labour Office (1983)
Corrosive (irreversible effect)	No	ECHA (2013)
Respiratory sensitiser	No	ECHA (2013)
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6 h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [4]	Yes	Based on decreased fetal body weight (Heindel et al., 1992; Price et al., 1996) Occupational exposure to sodium borate dust (Garabrant et al., 1984)
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2,000 mg/kg • dermal LD_{50} >1,000 mg/kg ≤ 2,000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours) [4]	No	USEPA (1988); O'Neill (ed) (2001)
Irritant (reversible effect)	Yes	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	HSDB (2013)
Explosive potential	No	HSDB (2013)

Hazard Evaluation (highest band) not including physical hazards	Band 4	Based on reproductive and developmental toxicity
Uncertainty analysis /data confidence (out of 12 parameters)	11/12	**91%**

*Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	5 mg/m^3 (sodium tetraborate)	HSIS (2005)
STEL	6 mg/m^3 (sodium tetraborate)	ACGIH (2006) (in ATSDR, 2010)
Peak Limitation	NDF	All proposed data sources
Environmental Exposure		
Air, ambient	NDF	All proposed data sources
Air, indoor	0.021 mg/m^3 (boron and borates) – **residential** air 0.088 mg/m^3 (boron and borates) – **industrial** air	USEPA Region 9 RSLs (2012)
Water, potable	4 mg/L (boron)	NEPM (1999; amended 2013)
Water, recreational	NDF	All proposed data sources
Soil, residential	4,500 mg/kg (boron); Setting A – low density residential 40,000 mg/kg (boron); Setting B – high density residential	NEPM (1999; amended 2013)
Soil, commercial/industrial	300,000 mg/kg (boron); Setting D – commercial/industrial	NEPM (1999; amended 2013)

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

QualifyingSummary Comments

Boric acid is an inorganic, white, odourless, crystalline solid. Its primary uses (along with sodium salts of boron (primarily borax, or disodium tetraborate decahydrate)) are in industrial processes such as the manufacture of glass, as a fire retardant, in laundry additives, in fertilisers and in herbicides. Low concentrations of simple inorganic borates (e.g. boric acid, disodium tetraborate pentahydrate, boric oxide and disodium octaborate tetrahydrate) will predominately exist as un-dissociated boric acid in aqueous solutions at physiological and acidic pH. Sodium tetraborate exhibits a Hazard Band Rating of 4 based on its reproductive toxicity potential in animal studies. In addition, anhydrous boric acid and aqueous solutions have been reported as being irritating to the eye. It is not flammable and explosive but as a powder it may result in contact and inhalation exposures in occupational settings which can lead to adverse respiratory,dermal and ocular effects. In the environmental setting its solubility and resultant persistence as the metal in various forms combined with its identified toxicity warrants closer evaluation of frequency of use, masses of chemical used and potential distribution in water, soils and sediments.

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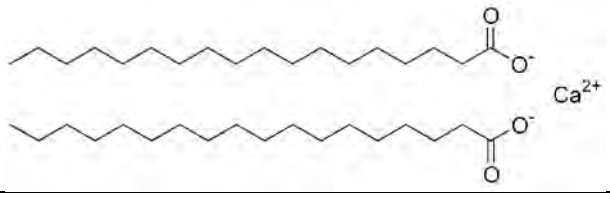
Created by:	MH	Date: 9/01/2014
Reviewed:	LT	Date: 16/01/2014

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Octadecanoic acid calcium salt
Synonyms	Calcium stearate, calcium distearate, stearic acid calcium salt
CAS number	1592-23-0
Molecular formula	C18H36O2.1/2Ca
Molecular Structure	

Overview	Reference
Octadecanoic acid calcium salt is a salt of the stearic acid. Stearic acid salts (stearates) are white to yellow powder or wax-like substances. Stearic acid and its salts are fatty acids with natural occurrence in some animals and vegetable fats and oils. Steric acid is produced by hydrogenating vegetable oils. Stearic acid and its salts are used in cosmetics, pharmaceuticals, food additives, waterproofing agents, plastic stabilizers, emulsifiers, and rubber lubricants and dusting agents. Octadecanoic acid calcium salt is classified *generally recognized as safe* (GRAS) for human consumption by the Food and Drug Administration. The properties and toxicity data for stearic acid have been utilised in this profile when no information was available for its calcium salt.	SIDS, 2012 US NLM, 2013 FDA, 2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not as a carcinogenic substance.	IARC, 2013
Mutagenicity/Genotoxicity Not classified as mutagenic.	ECHA, 2013
Reproductive Toxicity Not classified as toxic to reproduction.	ECHA, 2013
Developmental Toxicity/Teratogenicity Not classified as toxic to development	ECHA, 2013
Endocrine Disruption Not listed as an endocrine disruptor	EC, 2000
Acute Toxicity (oral, dermal, inhalation) Not classified as acute toxicity hazard.	ECHA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as specific target organ toxicant.	ECHA, 2013
Sensitisation of the skin or respiratory system Not classified as a skin sensitizer. Data lacking regarding respiratory sensitization.	ECHA, 2013
Corrosion (irreversible and reversible)/irritation of the skin or eye Not classified as corrosive or irritant to the skin or eye.	ECHA, 2013

Physical Hazards	Reference
Flammable Potential Not classified as flammable	ECHA, 2013
Explosive Potential Not classified as explosive	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found (NDF)	
High Chronic/Repeat dose Toxicity		
	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	> 5000 mg/kg	ECHA, 2013
Rat, dermal	NDF	
Rabbit, dermal	> 2000 mg/kg	ECHA, 2013
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	0.1621 mg/L air (read across: octanoic acid)	ECHA, 2013
High Chronic/Repeat dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL	1000 mg/kg bw/day (read across: docosanoic acid)	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	
Mutagenicity/Genotoxicity	No	
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	
Corrosive (irreversible damage)	No	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	
Irritant (reversible damage)	No	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 0	
Uncertainty analysis /data confidence	12/13	**92%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	10 mg/m^3 (octadecanoic acid calcium salt)	IPCS, 2003
STEL (Excursion limit recommendation)	>30 mg/m^3 (for no more than 30min through work day)	HSDB, 2011
Peak Limitation	50 mg/m^3 (for no more than 30min through work day)	HSDB, 2011
Environmental Exposure		
Air, ambient	35 µg/m^3	Ontario's AAQC, 2012
Air, indoor	NDF	
Water, potable	NDF	ADWG, 2011
Water, recreational	NDF	NEPM, 1999 - amended
Soil, residential	NDF	NEPM, 1999 - amended
Soil, commercial/industrial	NDF	NEPM, 1999 - amended

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Octadecanoic acid calcium salt has a low hazard profile to human health. It is not classified as a hazardous substance and deemed to be safe for human consumption.

References and Notes

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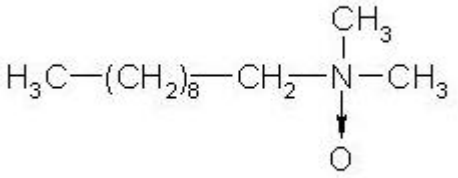
United States National Library of Medicine (US NLM, 2013) Haz-Map Database. Available at http://hazmap.nlm.nih.gov/search?search_query=calcium+stearate. [Accessed 10 October 2013].

NDF – No data found within the limits of the search strategy

Created by:	JC	Date: 10/10/2013
Reviewed and edited by:	JF	Date 08/11/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Decyl-dimethyl amine oxide
Synonyms	N,N-Dimethyl-1-decanamine-N-oxide N,N-Dimethyldecylamine oxide 1-Decanamine,N,N-dimethyl-,N-oxide Capric dimethyl amine oxide DDOA Decylamine oxide
CAS number	2605-79-0
Molecular formula	C12H27NO
Molecular Structure	

Overview	Reference
Decyl-dimethyl amine oxide is a mono constituent organic surfactant that has been used in washing and cleaning products (including solvent-based products), cosmetics and personal care products. It is also used in laboratory chemicals, metal working fluids, polishes and wax blends, water treatment chemicals and pesticides. It is most often found in a mixture in solid (powder) or liquid form. It is a solid at 20°C, is readily biodegradable and very soluble in water (>10000 mg/L) In Europe, annual use has been reported as 100 - 1,000 tonnes. It is recognised as resulting in serious eye damage (Eye Damage 1 H318: serious eye damage/ eye irritation) following contact and is harmful if swallowed (Acute Toxicity 4 H302). Protective gloves/clothing/face/eye protection is required when handling decyl-dimethyl amine oxide. Decyl-dimethyl amine oxide has been reported as being hazardous to the aquatic environment for both acute and long term exposures and release into the environment should be avoided. Based on its rapid aqueous degradation potential exposures to humans following environmental introduction will be limited.	ECHA (2013); HSDB (2009)

Human Health Toxicity Summary	Reference
Carcinogenicity Not on the IARC International Agency for Research on Cancer Carcinogen list.	IARC (2013)
Mutagenicity/Genotoxicity Not classified as mutagenic. ECHA has not reported this substance to be a mutagen.	ECHA (2013)
Reproductive Toxicity Not classified as reproductively toxic.	ECHA (2013)
Developmental Toxicity/Teratogenicity	ECHA

Not classified as a developmentally toxic by ECHA.	(2013)
Endocrine Disruption Not classified as an endocrine disrupter by ECHA.	ECHA (2013)
Acute Toxicity (oral, dermal, inhalation) **Oral** Acute Toxicity 4 (GHS Acute toxicity cat. 4 LD 50 = >300 <2000 mg/kg for oral pathways) H302- Harmful if swallowed. **Dermal** Not classified as dermally acutely toxic, category 5 GHS. **Inhalation** NDF.	ECHA (2013) ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) No classed as chronically toxic. Conclusive but not sufficient for classification as chronic toxic under GHS.	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser. NDF for respiratory sensitiser.	ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye Eye Damage 1 H318: Causes serious irreversible eye damage.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as a flammable substance.	ECHA (2013)
Explosive Potential Not classified as an explosive substance.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat dose Toxicity		
NOAEL	**Dermal** Workers-1100 mg/kg bw/day General Population- 1100 mg/kg bw/day **Oral** Workers- 88 mg/kg	ECHA, 2013
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	>300 <2000 mg/kg bw	ECHA 2013
Rat, dermal	>2000 mg/kg bw	ECHA 2013
Rabbit, dermal	>2000 mg/kg bw	ECHA 2013
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
NOAEL (Oral, rat)	40 mg/kg bw/day (study based on using amines, C_{12-18} (even numbered)-alkyldimethyl, N-	ECHA (2013)

	oxides)	
LOAEL	NDF	ECHA (2013)
LOAEC	NDF	
NOAEL (Dermal, mouse)	NDF	ECHA (2013)
LOAEL(Dermal, mouse)	0.27mg per application (2 cm X 3 cm patch on skin), per day, 5 applications per week	ECHA (2013)
LOAEC (Dermal, mouse)	NDF	
LOAEC	NDF	

Footnotes:
NDF- No data found within the limits of this search/study
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	
Mutagenicity/Genotoxicity	No	
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	NDF	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m[3]) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	
Corrosive (irreversible damage)	Yes	Serious Eye Damage (ECHA (2013))
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	Yes	ECHA (2013)
Irritant (reversible damage)	NDF	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	8/13	**62%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	NDF	
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Decyl-dimethyl amine oxide is a colourless liquid at standard temperature and pressure. It is not classified as a, mutagen or reproductive toxicant but exhibits corrosive action to the eyes with moderate oral acute toxicity. On the basis of the corrosivity it is placed in Hazard Band 3. A broad range of toxicological data has been investigated for this substance providing some confidence in the hazard assessment undertaken. When diluted in water and distributed in the subsurface it will degrade rapidly. It has limited volatility to present as an inhalation hazard. On this basis the main concern relates to direct contact with skin and eyes with the management focus restricted to occupational exposures from direct contact with pure product and public emergency spill settings.

References and Notes

ECHA (2013), European Chemicals Agency, Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 29 October 2013]

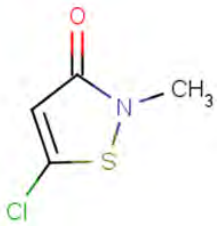
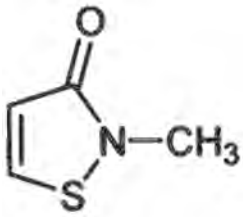
EC (2000), European Commission. Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

HSDB (2013) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) available at http://toxnet.nlm.nih.gov/ [Accessed 30 October 2013]

IARC (2013), International Agency for Research on Cancer, agents classified by IARC Monographs, Volumes 1-108. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf.

Created by:	AES	Date: 30/10/2013
Reviewed and edited by:	LT	Date: 11/06/2013 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	5-chloro-2-methyl-4-isothiazin-3-one & 2-methyl-4-isothiazin-3-one	
Synonyms	CMIT, 3(2H)-Isothiazolone, 5-chloro-2-methyl, Methylchloroisothiazolinone	MIT, 3-Isothiazolone, 2-methyl,Methylisothiazolinone, N-Methylisothiazolin-3-one.
CAS number	26172-55-4	2682-20-4
Molecular formula	C_4H_4ClNOS (5-chloro-2-methyl-4-isothiazin-3-one)	C4H5NOS (2-methyl-4-isothiazin-3-one)
Molecular Structure		

Overview	References
NOTE THAT BOTH OF THE ABOVE HAVE BEEN CONSIDERED COLLECTIVELY. CMIT/MIT are liquid chemicals that are clear to yellow in colour. Freezing point is -5℃, and boiling point is >100℃. Isothiazoline derivatives are effective biocides (antiseptic agents, preservatives, bactericides, slimicides, and fungicides). The biggest application is in the paint industry especially marine antifouling agent. 5-chloro-2-methyl-4-isothiazolin-3-one (CMIT), is used as a biodiesel biocide and is a high performance, broad spectrum antimicrobial agent based on isothiazolone chemistry. CMIT/MIT is very effective at very low concentrations in controlling microorganisms causing microbial induced spoilage. No other preservatives control a wider range of microorganisms over a wide range of pH at such low levels. CMIT/MIT are also used in adhesives, cutting oils, water systems, cosmetics, household goods and wound protectant for pruning cuts. They are also used as pulp and wood impregnating agents as well as in leather, fur and polymer process. CMIT/MIT is rapidly absorbed and metabolised following ingestion and do not bioaccumulate in tissues. CMI/MI are eliminated as metabolites which are rapidly eliminated in urine.	SHP 2013, SPE 2013, EU SCCS 2009

Human Health Toxicity Summary	Reference
Carcinogenicity IARC has not evaluated the evidence for the carcinogenicity of 5-chloro-2-methyl-4-isothiazin-3-one 2-myl-4-isothiazin-3-one.	IARC, 2013
Mutagenicity/Genotoxicity MIT was mutagenic when evaluated in some in vitro test systems (bacterial mutagenicity assay (Ames test), mouse lymphoma gene mutation assay with or without metabolic activation) but not in in vivo (sex-linked recessive lethal test, unscheduled DNA synthesis and micronucleus studies).	EU SCCS 2009
Reproductive Toxicity Rats were dosed for two generation with CMI/MI in drinking water at 0 (control), 0 (magnesium salt control), 30, 100 or 300 ppm active ingredient (a.i.). For the P1 generation, this was	

equivalent to 0, 2.8-4.4; 8.5-11.8, and 22.7-28.0 mg a.i./kg bw/day; and in the P2 generation 0, 4.3-5.5, 13.4-16.0, and 35.7-39.1 mg a.i./kg bw/day. There were no treatment related effects on survival, food consumption or overt signs of toxicity. A decrease in bodyweight gain was noted initially in the P1 generation. This was thought to be linked to reduced water consumption since significant dose-related reduction in water consumption was seen at all concentrations in both the P1 and P2 generations, during the premating, gestation and lactation stages. Treatment-related histopathological changes were seen in the stomach in the P1 and P2 generation at the 100 and 300ppm a.i. The oestrus cycle in P1 or P2 females at any treatment level was comparable with the controls, as was the sperm motility, morphology, testicular sperm count or caudal epididymal reserves of P1 or P2 males. All other endpoints (gestation index, gestation length, number of pups per litter or treatment-related gross findings in F1 or F2 pups) were similar to those in the controls in either generation. The study authors considered that rats exposed to CMI/MI in the drinking water through two generations had a No Observed Adverse Effect Level (NOAEL) of 30 ppm a.i. (2.8-4.4 mg/kg/day in the P1 animals; 4.3-5.5 mg/kg/day in the P2 animals) for parental animal toxicity, based on the gastric irritation of stomach at higher doses. The No Observed Effect Level (NOEL) for reproductive toxicity was 300 ppm a.i. (22.7-28.0 mg/kg/day in the P1 animals; 35.7-39.1 mg/kg/day in the P2 animals), the highest dose tested. There were no effects on fertility or foetal development at any dose level.	EU SCCS 2009
Developmental Toxicity/Teratogenicity CMIT/MIT did not cause developmental toxicity at doses lower than those required to cause maternal toxicity in four developmental toxicity studies in rats. The NOAEL for developmental toxicity was greater than 15 mg a.i./kg.	SCCS 2009
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC,2000
Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) Ingestion – corrosive, can cause burns to gastro-intestinal tract. Other effects include nausea, vomiting and stomach pain. GHS classification, category 2 (Acute toxicity:oral). A reference supporting this classification is *Nordic Chemicals Group Health effects of selected chemicals 2.* The test species were rabbits, the LD50 30mg/kg. GHS classification, category 2 (Acute toxicity:dermal). A reference supporting this classification is *Nordic Chemicals Group Health effects of selected chemicals 2.* The test species were rabbits, the LD50 87mg/kg. GHS classification, category 2 (Acute toxicity:inhalation). A reference supporting this classification is *Nordic Chemicals Group Health effects of selected chemicals 2.* The test species were rats, the LD50 0.2-1.4mg/l.	AET, 2011 NZEPA - HSNO CCID,2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Test species were rats. Original administered dose was 17.2mg/kg/day. Resulted in neoplastic and non-neoplastic proliferative liver lesions. LOEL of 17.2mg/kg/day. No further information found to support the study. A 90 day dietary study was undertaken on dogs. Dose concentration, 840ppm isothiazoline. Resulted in irritation, however no pathological findings were observed. A 30 month skin painting study was undertaken on mice. Dose concentration, 400ppm isothiazoline three times per week. No increased tumour frequency over control.	USEPA from QSAR AET, 2011

A 90 day dermal study was undertaken on rabbits. Dose concentration, 0.4 mg/kg isothiazoline. Resulted in irritation, however no pathological effects were observed.	
Sensitisation of the skin or respiratory system GHS classification, category 1 (skin sensitisation). The test species were guinea pigs and the result was sensitising.	NZEPA - HSNO CCID,2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Skin and eye contact - causes burns. GHS classification, category 1B (skin corrosion/irritation). The test species were rabbits, test substance CAS Number was 55965-84-9. The result was corrosive at 0.6% and greater. Irritation cut off for the test was at 0.06% and greater (GHS category 2). GHS classification, category 1 (serious eye damage/eye irritation). The test species were rabbits, test substance Cas. Number was 55965-84-9. The result was corrosive at 0.6% and greater. Irritation cut off for the test was at 0.06% and greater (GHS category 2B). Inhalation – corrosive to respiratory system. No further information provided.	AET, 2011 NZEPA - HSNO CCID,2013

Physical Hazards	Reference
Flammable Potential No data found	
Explosive Potential No data found	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found	
LOAEL	No data found	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Quail, oral	85mg/kg	Bobwhite quail, 21-day oral, Accepta MSDS (2011)
Rabbit, oral	30mg/kg	NZEPA - HSNO CCID,2013
Rat, dermal	87mg/kg	NZEPA - HSNO CCID,2013
Rat, inhalation	0.2-1.4mg/L	NZEPA - HSNO CCID,2013
Mouse, dermal	No data found	
LC_{50}		
Quail/Duck, oral	>560ppm	Bobwhite Quail and Pekin Duck, 8-day dietary, Aceepta MSDS (2011)
High Chronic/Repeat Dose Toxicity		
LOAEL	No data found	
LOAEC	No data found	
LOEL, rats	17.2 mg/kg/day	Exposure pathway unknown, EU SCCS 2009
NOAEL, rats, oral	30ppm	Parental toxicity, EU SCCS 2009
NOAEL, rats,	>15 mg a.i./kg.	Development toxicity, EU SCCS 2009
NOEL, rats, oral	300ppm	Reproductive toxicity, EU SCCS 2009

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL - No Observed Adverse Effect Level
NOEL - No Observed Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	EU SCCS 2009
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	
Endocrine Disruption[1]	No	Not listed as an endocrine disruptor by European Commission.EC,2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	EU SCCS 2009
Mutagenicity/Genotoxicity (GHS Category 2)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m[3]) (vapour)	Yes	Rabbit, oral = 30mg/kg Rat, dermal = 87mg/kg Rat, inhalation = 0.2-1.4mg/kg NZEPA - HSNO CCID,2013
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible effect)	Yes	GHS classification, category 1B (skin corrosion/irritation). GHS classification, category 1 (serious eye damage/eye irritation). NZEPA - HSNO CCID,2013
Respiratory sensitiser	No	Not classified by Aceepta MSDS, 2011
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	yes	LOEL of 17.2mg/kg/day, USEPA from QSAR
Skin Sensitiser	Yes	GHS classification, category 1 (skin sensitisation). NZEPA - HSNO CCID,2013
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg	No	Rabbit, oral = 30mg/kg

• dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]		Rat, dermal = 87mg/kg Rat, inhalation = 0.2-1.4mg/kg NZEPA - HSNO CCID,2013
Irritant (reversible effect)	Yes	Rabbits, GHS category 2 (Skin irritant). Rabbits, GHS category 2B (eye irritant). NZEPA - HSNO CCID,2013
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No data found	
Explosive potential	No data found	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence (out of 12 parameters)	12/12	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Neurotoxicity based on REACH assessments.

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found	
8-h TWA	No data found	
STEL	No data found	
Peak Limitation	No data found	
Environmental Exposure		
Air, ambient	No data found	
Air, indoor	No data found	
Water, potable	No data found	
Water, recreational	No data found	
Soil, residential	No data found	
Soil, commercial/industrial	No data found	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

The Isothiazoline derivatives are highly reactive compounds that are biologically active ans are thus used as biocides. They are categorized as acutely toxic and are skin sensitisers however they are not considered mutagenic, carcinogenic or reproductive toxicants. The moderate toxicity level of concern for this substance is more focused towards acute occupational and large scale environmental accidental releases.

References and Notes

Advanced Environmental Technologies (AET), Accepta 2893, Material Safety Data Sheet, 0.5% isothiazolin – non-oxidising biocide (2011), Available at: <http://www.accepta.com/images/product-safetydata/MSDS_Accepta%20Ltd_Accepta%202893.pdf> [Accessed 28 November 2013].

NDF - No data found within the limits of the search strategy.

European Commission (EC) (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

European Commission, Scientific Committee on Consumer Safety (EU SCCS), Opinion on the mixture of 5-chloro-2-methylisothiazolin-3(2H)-one and 2-methylisothiazolin-3(2H)-one (2009), Available at: <http://ec.europa.eu/health/scientific_committees/consumer_safety/docs/sccs_o_009.pdf>, [Accessed 2 December 2013].

International Agency for Research on Cancer (IARC), 16 June 2013. Agents Classified by the *IARC Monographs*, Volumes 1–108. Available at http://monographs.iarc.fr/ENG/Classification/index.php. [Accessed 26 November 2013].

New Zealand Environment Protection Authority (NZEPA) - New Zealand Hazardous Substances and New Organisms (HSNO) Chemical Classification Information Database (CCID), 4-Isothiazolin-3-one, 5-chloro-2-methyl-. Available at: http://www.epa.govt.nz/search-databases/Pages/ccid-details.aspx?SubstanceID=1973 [Accessed 28 November 2013].

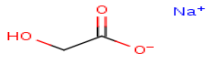
Sino Harvest Products (SHP), *Biocide: CMIT/MIT*, Available at: <http://www.sinoharvest.com/products/CMIT-MIT.shtml> [Accessed 28 November 2013].

SPE Chemicals CO.,Ltd. *Biocides: Biocide CMIT/MIT is antimicrobial agents and effective in controlling microorganisms causing microbial induced spoilage,* Available at: <http://spechemicals.en.alibaba.com/product/478463622212263531/CMIT_MIT_biocide_is_antimicrobial_agents_and_effective_in_controlling_microorganisms_causing_microbial_induced_spoilage.html> [Accessed 28 November 2013].

US EPA (1998) Reregistration Eligibility Decision (RED) Methylisothiazolinone (1998), Available at: <http://www.epa.gov/oppsrrd1/REDs/3092.pdf>, [Accessed 2 December 2013].

Created by:	CS	Date: 28/11/2013
Reviewed by:	JF	Date 02/12/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium Glycolate (Impurity)
Synonyms	Sodium Hydroxyacetic Acid
CAS number	2836-32-0
Molecular formula	$NaOOCCH_2OH$
Molecular Structure	
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Overview	References
Sodium glycolate is a crystalline colourless powder. This chemical belongs to the group of alpha-hydroxy acids (AHAs) and is the sodium salt of glycolic acid. As it readily dissociates to glycolic acid the properties and toxicity data for glycolic acid have been utilised. Glycolic acid is soluble in water or organic solvents like acetone but not lipophilic (fat soluble) and it is stable . AHAs uses include mild exfoliants, pH adjusters and skin-conditioning agents. Glycolic acid is also used in food packaging applications. Glycolic acid is naturally present in a variety of fruits, vegetables, meats, and beverages at concentrations up to 50 mg/kg. Principal health effects of glycolic acid include skin burns and high damage. Moreover, glycolic acid is harmful if inhaled. Sodium glycolate is harmful if swallowed.	Anderson, 1998 ECHA, 2013 EFSA 2008

Human Health Toxicity Summary	Reference
Carcinogenicity A number of carcinogenicity studies in both rats and mice and by both oral and dermal routes have not identified any substance related tumour formation. On this basis it is not classifiable as a carcinogenic substance. One of these studies was conducted for a cosmetic formulation containing 4% or 10% glycolic acid (pH 3.5) or 2% or 4% salicylic acid (pH 4) in combination with ultraviolet light. Only photocarcinogenesis was investigated. Oral feeding studies with the primary metabolite in both rats and mice were negative for carcinogenic effects.	ECHA, 2013
Mutagenicity/Genotoxicity - The genotoxicity potential of glycolic acid has recently been evaluated by the European Food Safety Agency. Glycolic acid was considered non genotoxic based on negative results in mutagenicity and chromosome aberrations in mammaline cells and whole animal mammalian mutagenicity test results (micronucleus assay). - Glycollic acid is not classified as mutagenic	EFSA 2008 ECHA, 2013 Andersen, 1998
Reproductive Toxicity A single generation reproductive toxicity study was conducted in which four groups of rats were dosed at various levels with glycolic acid. Males and females were pair housed for mating and the females observed through gestation and F1 (offspring) and P (parental) generations observed during lactation.	Andersen, 1998 ECHA, 2013

The NOEL for reproductive toxicity was 600 mg/kg bw/day, based on the absence of treatment related effects on reproductive function. The NOEL for reproductive organ pathology in both the P1 generation and the F1 weanlings was 600 mg/kg bw/day, based on the absence of gross pathological changes.	
Developmental Toxicity/Teratogenicity - A developmental toxicity study with rats given 75, 150, 300 and 600 mg/kg bw by oral gavage for 14 days (day 7-21 of gestation) was conducted. Developmental changes were evident in the 300 mg/kg bw/day group as a slight, non-significant, increase in the incidence of skeletal malformations (fused ribs and fused vertebrae in 2 fetuses from 2 litters). There were no indications of developmental toxicity at either the 150 or 75 mg/kg bw/day dose levels. The study authors conclude that the results indicate that glycolic acid is not likely to be uniquely toxic to the rat conceptus, developmental effects were only apparent at maternally toxic doses. On this basis it is not classifiable as a developmental toxicant.	Andersen, 1998 ECHA, 2013
Endocrine Disruption Not listed as an endocrine disruptor.	EC, 2000
Acute Toxicity (oral, dermal, inhalation) - Oral doses greater than 500 mg/kg of a 9.8% buffer solution of sodium glycolate and glycolic acid lead death (cat study). - Based on a rat study, inhalation of glycolic acid can cause death.	Andersen, 1998
Chronic/repeat dose toxicity (oral, dermal, inhalation) - One rat study showed that long term oral administration of high doses of sodium glycolate (2000 mg/kg/day) resulted in deaths caused by calcium oxalate crystals damaging renal and urinary bladder - One rabbit studies showed that long term oral administration of sodium glycolate resulted in increased oxalate content in the kidney.	Andersen, 1998
Sensitisation of the skin or respiratory system Based on a guinea pig study, sodium glycolate is not a skin sensitiser.	Andersen, 1998
Corrosion (irreversible and reversible)/irritation of the skin or eye - Glycollic acid can cause severe skin burns and eye damage	ECHA, 2013
Flammable Potential Non flammable solid. The flammability of the solid form of glycolic acid (glycolic acid >99%) was investigated according to flammable solid test method EC A10. The test substance did not ignite during the full 2 minutes of heating.	ECHA, 2013
Explosive Potential Glycolic acid 70% solution was not found to be sensitive to thermal or impact stimuli (i.e. non explosive) when a 70% glycolic acid solution was tested using EU Method A.14 (Explosive properties).	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	1443 - 2469 mg/kg with a median of 2040 caused renal tubular oxalosis, but cytotoxicity was the cause of renal failure rather than simple mechanical obstruction of the tubular lumina by oxalate crystals.	ECHA, 2013
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat (inhalation)	Glycolic acid 70% solution: >5.2 mg/L (female); 3.6 mg/L (male). Clinical signs included signs of respiratory irritation (gasping, hunched posture, nasal and ocular discharge).	ECHA, 2013
Mice (inhalation)	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL (oral, 90 day male and female rats)	150 mg/kg (males) renal oxalate crystal nephropathy 600 mg/kg (females) (highest dose tested)	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	
Corrosive (irreversible damage)	YES	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NO	
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	YES	
Irritant (reversible damage)	YES	
Hazard Band 0 All indicators outside criteria listed in Hazards 1-4		
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	12/13	**92%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1] *Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mas s(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	10 mg/m^3 (glycolic acid 99% solution)	Anderson, 1998
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Sodium glycolate readily dissociates to glycolic acid thus the health effects of these compounds are equivalent.

The acute toxicity associated with sodium glycolate is principally related to corrosion of skin and eyes and respiratory tract. Sodium glycolate is harmful when swallowed and when inhaled. The systemic, single or repeat dose toxicity of sodium glycolate is due to the formation of oxalate crystals in the kidney resulting in renal tubule inflammation and potential kidney failure . The no observed adverse effect level in 90 day oral rat study was 150 mg/kg/d. Sodium glycolate is not genotoxic, carcinogenic or a reproductive/developmental toxicant.

Sodium glycolate falls into the Hazard Band 3 category. The primary effect of exposure via usual occupational routes is considered to be irritation of the eyes and skin, and inhalation. Therefore, it is import to protect against direct contact with eyes and skin and prevent inhalation.

References

Anderson, F.A. 1998. Final Report On the Safety Assessment of Glycolic Acid, Ammonium, Calcium, Potassium, and Sodium Glycolates, Methyl, Ethyl, Propyl, and Butyl Glycolates, and Lactic Acid, Ammonium, Calcium, Potassium, Sodium, and Tea-Lactates, Methyl, Ethyl, Isopropyl, and Butyl Lactates, and Lauryl, Myristyl, and Cetyl Lactates. *International Journal of Toxicology.*

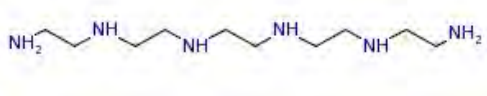
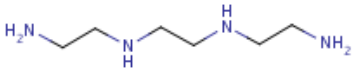
European Chemicals Agency (ECHA, 2013). Registered Chemical Substances Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances. [Accessed 30 August 2013]

European Commission (EC) (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

EFSA (2008). Opinion of the Scientific Panel on food additives, flavourings, processing aids and materials in contact with food (AFC) on a request related to 18th list of substances for food contact materials. The EFSA Journal (2008) 628-633, 1-19 European Food Safety Authority, 2008

Created by:	JC	Date: 30/08/2013
Reviewed and edited by:	JF	05/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Pentaethylenehexamine
Synonyms	PEHA, 3,6,9,12-tetraazatetradecamethylenediamine, 3,6,9,12-Tetraazatetradecane-1,14-diamine, 3,6,9,12-Tetraazatetradecametilendiamina
CAS number	4067-16-7
Molecular formula	$C_{10}H_{28}N_6$ $HN(CH_2CH_2NHCH_2CH_2NHCH_2CH_2NH_2)_2$
Molecular Structure	Pentaethylenehexamine (PEHA):  Triethylenetetramine (TETA; CAS #112-24-3): 

Overview	Reference
Pentaethylenehexamine (PEHA) is a yellow viscous and odourless organic clear liquid with a molecular weight of 232.37. At 20°C the density of Pentaethylenehexamine is 1.003 g/cm^3 and its water solubility > 500 g/l. The flash point of the substance is 183°C and the freezing point is -70°C PEHA has a boiling point of 380 °C and a melting point of -35 to -26 °C. The production of PEHA and other ethyleneamines is via the ethylene dichloride (EDC) process. At high pressure and moderate temperature, EDC is reacted with an excess of ammonia. The resulting ethyleneamine hydrochloride solution is neutralized with caustic soda generating a mixture of ethyleneamines. PEHA is then separated from the other ethyleneamines by distillation. A less common method for the generation of PEHA and other ethyleneamines involves reacting ethylene oxide and ammonia to form monoethanolamine, which is added to ammonia to generate ethylenediamine (EDA) and higher ethyleneamines. PEHA has a wide number of applications across numerous industries. It is a hardener used with epoxy resins that have both industrial and consumer applications including agricultural chemicals, fungicides, bactericides, wood preservatives, chelating agents, surfactants, mineral processing aids, and polymers. It is an intermediate in the synthesis of several substances/products including coatings and auxiliaries, coolants, lubricants, and antifreezes, plastics and auxiliaries, auxiliaries for the recovery and processing of oil, coal, and natural gas, auxiliaries for the construction industry and pharmaceuticals. PEHA has also widespread use in the manufacture of lubricating oil and fuel additives. Studies/data are lacking for the toxicity evaluation of PEHA. Instead most of the human health toxicity summaries below are based upon read across interpretations from studies undertaken on triethylenetetramine. Triethylenetetramine, also known as TETA, (molecular formula $C_6H_{15}N_4$), is a yellow, moderately viscous liquid. It is completely soluble in water and is also soluble in alcohols and acids. TETA has a smaller molecular structure than PEHA with a molecular weight of 146.24 and a density of 0.9818 at 20°C.Its boiling point is 266-267°C at 760 mm HG and melting point is 12°C.	ECHA (2013) NCI (date unknown)

Human Health Toxicity Summary	Reference
Carcinogenicity	

Based on the GHS classification 'Pentaethylenehexamine' is not classifiable as to its carcinogenicity to humans. A search on the International Agency for Research on Cancer (IARC) website did not reveal any information on Pentaethylenehexamine. *Notes:* The carcinogenicity classification for pentaethylenehexamine is based on a read across study using triethylenetetramine (TETA). The dermal carcinogenic potential of TETA was assessed by applying 25 µl of a 5% (v/v) solution in deionized water to the backs of 50 male mice three times a week until the death of the animals. No treatment-related skin tumours were observed and therefore TETA was not carcinogenic when applied to the skin of mice.	ECHA (2013)
Mutagenicity/Genotoxicity Not classified as a mutagenic/genotoxic chemical. *Notes:* The genetic toxicity classification for pentaethylenehexamine is based on a read across key in-vivo study using TETA. TETA was evaluated for potential clastogenic (chromosome-damaging) activity with the in-vivo micronucleus test system using both female and male mice. Test results showed that TETA was not an active agent in producing treatment-related increases in micronuclei in male and female mice. However, in an in-vitro study TETA was tested for potential mutagenic activity using the Salmonella/microsome bacterial mutagenicity assay (Ames test). Due to growth inhibition TETA was considered to be mutagenic in this in-vitro bacterial study but the genetic toxicity classification was based on the above in vivo study in mice.	ECHA (2013)
Reproductive Toxicity Not classified as having reproductive toxicity effects.	ECHA (2013)
Developmental Toxicity/Teratogenicity No information found.	All proposed data sources
Endocrine Disruption Pentaethylenehexamine has not been included in the European Commission's Endocrine Disrupters Priority List.	ECED (2013)
Acute Toxicity (oral, dermal, inhalation) Classified as having acute oral and dermal toxic effects. Pentaethylenehexamine is harmful if swallowed (Oral Acute Toxicity 4 H302) or when in contact with skin (Dermal Acute Toxicity 4 H3120). For the inhalation pathway data is lacking. *Notes:* TETA was used as a surrogate to infer the oral and dermal toxicity of pentaethylenehexamine. TETA was administered orally to 5 female and 5 male rats at doses of 800, 1250, 1600 or 2000 mg/kg with a subsequent observation of 14 days. An acute oral LD50 of 1861.9 (1383.5 - 2505.7) mg/kg was reported for male rats, 1591.4 (1283.5 - 1973.3) mg/kg for female rats and 1716.2 (1446.5 - 2036.1) mg/kg for the combined sexes. TETA was applied to the skin of New Zealand White rabbits at concentrations of 1000, 2000 and 3000 mg/kg with a 14 day observation period. Based on the observations the acute dermal LD50 in males was determined to be 1720 (1082.9-2732.0) mg/kg and for the combined sexes 1465.4 (1074.6-1998.3) mg/kg, respectively. The data generated for the acute dermal LD50 in females did not lend itself to the statistical method employed and therefore an LD50 for female rabbits was not determined.	ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation)	ECHA

Classified as having chronic oral toxic effects. No data available for the chronic dermal and inhalation pathways. *Notes:* The oral repeat dose toxicity is based on the key read across study involving triethylenetetramine dihydrochloride (trientine-2HCl, TJA-250), a copper chelating agent used to treat Wilson's disease. Trientine-2HCl was administered orally to four male and female rats for 4 or 8 weeks at dosages of 0, 100, 350 or 1200 mg/kg/day or to 12 female and male rats for 26 weeks at dosages of 50, 175 or 600 mg/kg/day. Study results showed death and irreversible toxic changes in the lung. Based on this a NOAEL of 50 mg/kg was concluded for the female rats and a LOAEL of 50 mg/kg for the male rats. However, the chronic repeat study was non-GLP compliant as at least 20 animals (ten female and ten male) should have been used instead of 12.	(2013)
Sensitisation of the skin or respiratory system Pentaethylenehexamine may cause an allergic skin reaction (Skin Sensitiser 1 H317). Data is lacking for the respiratory system sensitisation. *Notes:* A group of nine alkyleneamines were investigated for their potential to induce skin sensitisation and to cross-react with one another to elicit a hypersensitivity response. The sensitising potency was inversely correlated with the number of amine units. Cyclic amines had a lower sensitising potency than the corresponding olefinic amines. The results suggest that there was a direct correlation of the potencies to cause sensitisation and cross-sensitisation in this family of alkyleneamines. From the results of this study it was concluded that PEHA is a skin sensitiser. The second skin sensitisation study involved skin application of TETA to guinea pigs at a dose of 0.3 ml/site area. At the first reading (24 hours after), 18/20 animals showed skin reactions and at the second reading (48 hours after), 19/20 animals were positive. It was therefore concluded that TETA is a skin sensitiser. Although specific studies addressing respiratory system sensitisation were lacking it has been noted that ethyleneamines alongside their ability of producing chemical burns and skin rashes, also have the ability to produce asthma-like symptoms.	ECHA (2013) NCI (date unknown)
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes severe skin burns (Skin Corrosion1B H314). Causes serious eye damage (Eye Damage 1 H318). *Notes:* TETA was applied undiluted directly on the intact and abraded skin sites of 3 male and 3 female New Zealand White rabbits. It was applied at a concentration of 0.5 mL/ site (6 m²) for 3 minutes, 60 minutes, 4hours or 24 hours. Necrosis was observed after a 3 minute exposure. The animals that had been exposed for 60 minutes, 4 hours, or 24 hours scored 4 (necrosis) for erythema and oedema immediately after unwrapping. Severe erythema and severe oedema remained present in all animals at all observation periods during the study (up to 14 days). In an eye experiment involving direct contact of undiluted PEHA it was reported that PEHA might be slightly painful and would likely produce considerable conjunctivitis including a possible burn of the soft tissues. However, based on read across with TETA it cannot be excluded that PEHA is corrosive to the eye as well. TETA was applied undiluted to the eye of one female rabbit for 1 second. Vocalisation occurred immediately after test article administration. Due to the extreme ocular scores observed, the study was terminated.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential No information found.	All proposed

	data sources
Explosive Potential No information found.	All proposed data sources

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	1861.9 mg/kg (male; based on TETA study) 1591.4 mg/kg (female; based on TETA study) 1716.2 (combined sexes; based on TETA study)	ECHA (2013)
Rat, dermal	No data found.	All proposed data sources
Rabbit, dermal	1720 mg/kg (male; based on TETA study) 1465.4 (combined sexes; based on TETA study)	ECHA (2013)
LOAEL	No data found.	All proposed data sources
LOAEC	No data found.	All proposed data sources
LC_{50}		
Rat	No data found.	All proposed data sources
High Chronic/Repeat dose Toxicity		
LOAEL	50 mg/kg oral pathway (male rats; based on triethylenetetramine dihydrochloride)	ECHA (2013)
LOAEC	No data found.	All proposed data sources

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	Based on a dermal study using TETA.
Mutagenicity/Genotoxicity	NO	Based on an in-vivo study using TETA. Mutagenic effects noted for an in-vitro Salmonella/microsome bacterial study using TETA.
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	No data found.	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m^3) (vapour)	NO	No data on inhalation.
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	NO	
Corrosive (irreversible damage)	YES	Causes severe skin burns and serious eye damage.
Respiratory sensitiser	No data found.	It has been noted that ethyleneamines have the ability to cause asthma-like symptoms.
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	YES	Oral LOAEL 50mg/kg
Skin Sensitiser	YES	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	YES	
Irritant (reversible damage)	NO	
Hazard Band 0		

All indicators outside criteria listed in Hazards 1-4		
Physical Hazards		
Flammable potential	No data found.	
Explosive potential	No data found.	
Hazard Evaluation (highest band) not including physical hazards	**Hazard Band 3**	
Uncertainty analysis /data confidence	11/13	**85%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	No data found.	All proposed data sources
STEL	No data found.	All proposed data sources
Peak Limitation	No data found.	All proposed data sources
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources
Air, indoor	No data found.	All proposed data sources
Water, potable	No data found.	All proposed data sources
Water, recreational	No data found.	All proposed data sources
Soil, residential	No data found.	All proposed data sources
Soil, commercial/industrial	No data found.	All proposed data sources

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Pentaethylenehexamine (PEHA) is a yellow, viscous and clear liquid with a molecular weight of 232.37. It is an odourless organic substance that is highly soluble in water. As studies on the toxicity evaluation of PEHA are lacking the human health toxicity summaries are mainly based upon read across interpretations from its surrogate triethylenetetramine (TETA).

PEHA is not classifiable as to its carcinogenicity to humans or to its mutagenicity/genotoxicity based upon mice studies using TETA. Furthermore, it is not classified as having reproductive toxicity effects and is not considered an endocrine disrupter. No information was found on developmental toxicity/teratogenicity. In terms of acute toxicity PEHA is harmful if swallowed or when in contact with skin. No data was available for the evaluation of inhalation acute toxicity. Chronic/repeat data was lacking for TETA although irreversible toxic changes in the lung have been noted for an oral repeat dose study using triethylenetetramine dihydrochloride. PEHA may cause an allergic skin reaction with an absence of data for the respiratory system sensitisation, although it has been noted that ethyleneamines have the ability to cause asthma-like symptoms. Due PEHA's corrosion classifications with to its ability to cause severe skin burns and serious eye damage it has been categorised as hazard band 3.

References and Notes

ECED (2013) European Commission's Endocrine Disrupters Priority List. Available at http://ec.europa.eu/environment/chemicals/endocrine/strategy/substances_en.htm#priority_list [Accessed 25 October 2013]

ECHA (2013) (European Chemicals Agency) Registered Substances List. Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-97d78db5-dceb-1601-e044-00144f67d031/AGGR-501d8767-a2fe-4a21-891a-7cc59c5ec4ba_DISS-97d78db5-dceb-1601-e044-00144f67d031.html#L-edc932aa-49bf-4532-a5c1-2cc1d52264ce [Accessed 24 October 2013]

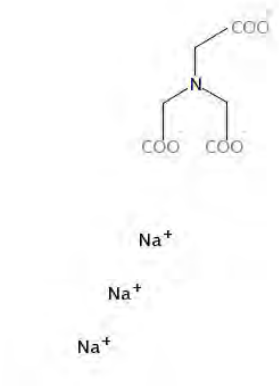
HSDB (2002). 'Triethylenetetramine'. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine. Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~V4ZvQU:1 [Accessed 28 October 2013]

NCI (date unknown) Prepared for NCI to support chemical nomination by Technical Resources International, Inc. under contract no. N02-CB-07007 (10/05; 3/06). Available at http://ntp.niehs.nih.gov/ntp/htdocs/Chem_Background/ExSumPdf/4067-16-7_508.pdf [Accessed 25 October 2013]

NDF – No data found within the limits of the search strategy

Created by:	JH	Date: 28/10/13
Reviewed and edited by:	JF	Date 08/11/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Trisodium nitrilotriacetate (impurity)
Synonyms	Trisodium 2,2',2''-nitrilotriacetate, Nitrilotriacetic acid trisodium salt, NTA trisodium salt, NTA, trisodium salt, trisodium nitrilotriacetate, trisodium NTA
CAS number	5064-31-3
Molecular formula	$C_6H_9NO_6 \cdot 3Na$
Molecular Structure	

Overview	References
Trisodium nitrilotriacetate is a water-soluble, white organic crystalline powder. Parent compound nitrilotriacetic acid is used as a chelating and sequestering agent, a builder in synthetic detergents, an eluting agent, a boiler feedwater additive, in water and textile treatment, in metal plating and cleaning and in pulp and paper processing. Based on the results of animal toxicity studies the toxicity of nitrilotriacetate and its sodium salts is equivalent. Repeated oral administration of nitrilotriacetate results in toxicity of the urinary system (kidney, bladder and ureter). The toxicity is due to its chelating properties resulting in binding to metals within the body.	ECHA (2013a), IARC

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC as a standalone chemical, however nitrilotriacetic acid and its salts are possibly carcinogenic to humans (Group 2B), as there is sufficient evidence in experimental animals for the carcinogenicity of nitrilotriacetic acid and its salts. Suspected of causing cancer from oral route of exposure. Limited evidence of carcinogenic effect. The trisodium salt was tested for carcinogenicity in mice and rats by oral administration. When administered in the diet as the monohydrate, it induced haematopoietic tumours in male mice and benign and malignant tumours of the urinary system (kidney, ureter and bladder) in rats of each sex. When administered in drinking-water to male rats, it induced renal tubular adenomas and adenocarcinomas. The carcinogenicity of nitrilotriacetic acid and its salts is due to chronic inflammation. It is thought to be secondary to its chelating effects.	IARC (1999). ECHA (2013a), ECHA (2013b)
Mutagenicity/Genotoxicity	ECHA (2013a)

Conclusive but not sufficient for classification. Nitrilotriacetic acid and its disodium and trisodium salts were not genotoxic in experimental systems in vivo, except that the acid induced aneuploidy in mouse germ cells. Neither the acid nor its salts were genotoxic in mammalian cells in vitro and they were not mutagenic to bacteria.	IARC (1999)
Reproductive Toxicity Conclusive but not sufficient for classification. One reproductive study indicated no deleterious effects on reproduction in rats. In a second rat study, it caused a slight trend towards post-natal growth retardation but no other effects.	ECHA (2013a)
Developmental Toxicity/Teratogenicity No significant effects on embryonic development of rats at dose levels up to 450 mg/kg/d. No delirious effect on the development of the foetuses was observed in rabbits receiving doses up to 250 mg/kg/d. In a rat study, it was not teratogenic when applied via drinking water in concentrations up to 20 mg/kg/d. In a mice study, there were no observed significant embryotoxic effects and produced no increases in malformations at 300 mg/kg/day.	ECHA (2013a)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) Harmful if swallowed. Toxicity via dermal and inhalation route conclusive but not sufficient for classification. Rats that died during toxicity studies reported gastrointestinal and lung effects. No abnormalities in the organs were detected in the sacrificed rats. In mice and rats, toxic symptoms included ataxia, tremors, hypopnea, hypothermia tremors, muscular incoordination, unthrifty coat, faecal and urinary staining, decreased food consumption, overall weakness and mortality only in first 24 hours upon application. No mortality was observed in rat inhalation studies after treatment with NTA. No symptoms of systemic toxicity were observed in dermal rabbit studies. In a volunteer human study, no clinical signs were observed after consumption of a 10 mg dose. The chemical was poorly absorbed and rapidly excreted by the human subjects.	ECHA (2013a)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Conclusive but not sufficient for classification. In chronic oral rat studies, rats exhibited kidney toxicity, reduced food consumption and significant lower body weight gain. A chronic dermal rabbit study resulted in no observed effects aside from mild skin irritation.	ECHA (2013a)
Sensitisation of the skin or respiratory system Conclusive but not sufficient for classification. Not sensitising to skin in guinea pig studies. Not sensitising to skin in a volunteer human study (three applications per week for three weeks at 40% concentration).	ECHA (2013a)
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes serious eye irritation. Evidence for skin irritation is conclusive but not sufficient for classification. Non-irritating when applied as finely ground powder or as 10 % aqueous solution to intact skin of male and female rabbits. A mild irritant when applied as 25 % aqueous solution to intact skin of male and female rabbits. Non-irritating at 50% in a skin sensitizing study conducted in 20 guinea pigs. Slightly irritating to irritating on rabbit skin at varying concentrations, and non-irritating in two rabbit studies Slightly irritating to highly irritating in rabbit eyes.	ECHA (2013a)

Physical Hazards	Reference
Flammable Potential Not classified as a flammable solid. The self-ignition temperature was determined to be > 200°C. Not highly flammable or easily ignitable. Combustible under specific conditions and decomposes on burning producing toxic and irritating fumes including nitrogen oxides.	ECHA (2013a)
Explosive Potential Not classified as an explosive. Explosive in one experiment and non-explosive in another. When explosive, the ignition temperature of a cloud of the sample dust was 561 °C.	ECHA (2013a)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No data found.	-
High Chronic/Repeat Dose Toxicity		
	No data found.	-
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	1740 mg/kg	ECHA (2013a)
Rat, oral	3500 mg/kg	ECHA (2013a)
Rat, oral (male)	1250 mg/kg	ECHA (2013a)
Rat, oral	3715 mg/kg	ECHA (2013a)
Rat, oral	3900 mg/kg	ECHA (2013a)
Rat, oral (male)	2000 mg/kg	ECHA (2013a)
Rat, oral	2595 mg/kg	ECHA (2013a)
Rat, oral (female)	1000 mg/kg	ECHA (2013a)
Rat, oral	1450 mg/kg	ECHA (2013a)
Rat, oral	2100 mg/kg	ECHA (2013a)
Mouse, oral	300 mg/kg	ECHA (2013a)
Mouse, oral	680 mg/kg	ECHA (2013a)
Rabbit, oral	No data found.	-
Rat, dermal	No data found.	-
Rabbit, dermal	No data found.	-
Mouse, dermal	No data found.	-
LC_{50}		
Rat	No data found.	-
High Chronic/Repeat Dose Toxicity		
LOAEC (monkey, inhalation)	0.34 mg/l	ECHA (2013a)
LOAEL (rat, oral)	0.15 %	ECHA (2013a)
LOAEL (rat, oral)	187 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	200 mg/kg/day	ECHA (2013a)
LOAEL (rat, oral)	1309 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	2%	ECHA (2013a)
LOAEL (rat, oral)	350 mg/kg bw/day	ECHA (2013a)
LOAEL (dog, oral)	90 - 168 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	9 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	500 mg/kg/day	ECHA (2013a)
LOAEL (rat, oral)	150 - 560 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	110 mg/kg bw/day	ECHA (2013a)
LOAEL (rat, oral)	500 mg/kg bw/day	ECHA (2013a)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	-
Mutagenicity/Genotoxicity	No	IARC 1999
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	Yes	Nitrilotriacetic acid and its salts are possibly carcinogenic to humans (Group 2B)
Corrosive (irreversible damage)	Yes	
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	Yes	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	Yes	
Irritant (reversible damage)	Yes	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence	12/13 = 92%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	-
8-h TWA	No data found.	-
STEL	No data found.	-
Peak Limitation	No data found.	-
Environmental Exposure		
Air, ambient	No data found.	-
Air, indoor	No data found.	-
Water, potable	The World Health Organization has established an international drinking-water guideline for parent compound nitrilotriacetic acid of 200 g/L.	-
Water, recreational	No data found.	-
Soil, residential	No data found.	-
Soil, commercial/industrial	No data found.	-

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Trisodium nitrilotriacetate is a water-soluble, white organic crystalline powder. It is a chelating and sequestering agent, a builder in synthetic detergents, an eluting agent, a boiler feedwater additive, in water and textile treatment, in metal plating and cleaning and in pulp and paper processing.

Trisodium nitrilotriacetate can result in severe eye irritation and is harmful if swallowed.

Repeated exposure to high doses in drinking water, feed or bolus administration in rats and mice has resulted in toxicity to the urinary system as well as a range of tumours. These effects are largely attributable to to its chelating properties resulting in interactions with internal zinc and calcium related bodily processes. It is not classifiable a genotoxic, a reproductive or developmental toxicant. Overall a hazard band of 3 was assigned based on possible carcinogenic potential and inhalation repeat dose toxicity.

References and Notes

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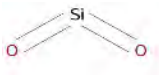
IARC.(1999). Nitrilotriacetic acid and its salts. IARC Monographs on the Evaluation of Carcinogenic Risks to Humans, Volume 73, Some Chemicals that Cause Tumours of the Kidney or Urinary Bladder in Rodents and Some Other Substances. Summary of Data Reported and Evaluation. Iinternational Agency for Research on Cancer (IARC). Lyon France
Available at http://monographs.iarc.fr/ENG/Monographs/vol73/mono73-19.pdf

No data found. - No data found within the limits of the search strategy.

Created by:	MER	Date 4/9/2013
Reviewed and edited by:	JF	Date 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Silica, amorphous - fumed
Synonyms	Silica, amorphous, fumed, crystalline free; Fumed silica, crystalline free; Pyrogenic colloidal silica; Synthetic amorphous silica, fumed; silicon dioxide
CAS number	7631-86-9 (112945-52-5 pyrogenic silica)*
Molecular formula	O_2-Si
Molecular structure	

* Refer to figure 1 at the end of this document.

Overview	References
Silica, amorphous – fumed belongs to a sub-class of silica called synthetic amorphous silica (SAS) which is part of the overarching group of silica (CAS No 7631-86-9); refer to figure 1 at the end of this document for diagram of relationship. Silica amorphous-fumed, also known as pyrogenic silica, is registered under the specific CAS No 112945-52-5.	ECETOC (2006)
SAS (including silica gels) are white, fluffy and/or powdery amorphous forms of silicon dioxide (silica, SiO_2). It has a molecular mass of 60.08 g/mol, a density of 2.2 at 20ºC and a melting point of approximately 1 700 ºC.	
Important quantities of synthetic amorphous silica are produced as pyrogenic (fumed) silica and wet process silica (precipitated silica and silica gels) which are used, notably, for reinforcing elastomers, for thickening resins, paints and toothpaste, and as free-flow additives. Exposure to synthetic amorphous silica may occur during its production and use. Synthetic amorphous silica may also be ingested as a minor constituent (< 2%) of a variety of food products where it serves as an anti-caking agent, and as an excipient in some pharmaceutical preparations. Silica fume (CAS No 69012-64-2) which is a by-product from electrical furnace is another form of amorphous silica.	IARC (1997)
Commercialised since the 1950s, SAS are used in a wide variety of industrial applications and they are usually tailor-made to meet the users' requirements. Main uses of SAS include reinforcement and thickening agent in various systems such as elastomers, resins, inks and water for instance. Due to their high porosity, SAS is also used as an adsorbing agent. Due to their inert nature, SAS are also used in consumers' products such as cosmetics, pharmaceuticals and foods.	ECETOC (2006)
SAS have been studied less than crystalline silica. They are generally less toxic than crystalline silica and are cleared more rapidly from the lung. Furthermore, amorphous silica is chemically and biologically inert when ingested in any of its many physical forms. This explains why overall it is not considered as hazardous to humans.	IARC (1997)
The human health toxicity information discussed below is based on SAS, not specifically on silica, amorphous - fumed.	

Human Health Toxicity Summary	Reference
Carcinogenicity IARC rating for silica, amorphous (CAS No 7631-86-9): Group 3 (Amorphous silica *is not classifiable as to its carcinogenicity to humans)*	IARC (2013)
Mutagenicity/Genotoxicity UNEP reported a study where pyrogenic SAS (Aerosil 200) was used in one sub-chronic inhalation study where rats were exposed to a mean dust concentration of 50 mg/m^3 for 13 wk. The study also included crystalline silica. Alveolar type-II cells were isolated from the bronchoalveolar lavage fluid and subjected to the HPRT gene-mutation assay *in vitro*. The cells were cultured for 14 d to 21 d in	UNEP (2004)

selective medium prior to fixation. No increase in 6TG-resistant mutant vs. control where noted after exposure to the pyrogenic SAS, while the mutant frequency have significantly increased after exposure to crystalline silica.	
Reproductive Toxicity UNEP cited a study where the reproductive toxicity properties of fumed silica were assessed in rats. In this one-generation study, animals were fed pyrogenic SAS (Aerosol) at a dose of 500 mg/kg/d for a premating period of 4.5 months with continued exposure up to 6 months. Five pregnant test females and four pregnant untreated controls females (delivery respectively 45 pups and 37 pups) were included in this study. While no adverse effects were observed, it was reported that the study had some shortcomings regarding the low number of pregnant animals used and that the mating ratio was too low according to current standards.	UNEP (2004)
Developmental Toxicity/Teratogenicity According to UNEP, the potential for developmental effects of SAS were assessed in a comprehensive and reliable testing program where various animal species (rat, mouse, rabbit, and hamster) were administered SAS orally at doses up to 1 600 mg/kg/d. No significant signs of maternal or developmental toxic effects were observed in any species tested. Abnormalities noted in soft or skeletal tissues of the test groups were comparable to the frequencies occurring in the control groups. The types of SAS used were not specified in the UNEP report.	UNEP (2004)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity NDF.	
Acute Toxicity (oral, dermal or inhalation) Oral According to the studies reported in the UNEP report, various forms of SAS administered orally (gavage or in diet) did not cause mortality at the highest doses tested. Oral LD_{50} values by gavage ranged from > 3 100 mg/kg to > 20 000 mg/kg in rats and mice. An oral LD_{50} > 10 000 mg/kg was established for rats given SAS in the diet for 24 h. **Dermal** LD_{50} > 5 000 mg/kg was established for rabbits administered aqueous pastes of precipitated SAS and Na-Al silicates to the intact and abraded skin for 24 h under occlusive conditions. **Inhalation** No adverse effects were observed after 4-h exposure of rats to pyrogenic SAS (Aerosol 200) at an average dust concentration of 139 mg/m^3. In another study, rats survived exposure to an average concentration of 2 080 mg/m^3 pyrogenic SAS (Cab-O-Sil M5). Clinical symptoms included nasal discharge during exposure, crusty eyes and nose in few animals and alopecia post-exposure. It was noted that acute inhalation studies performed with dry dusts were hindered by the inability to achieve the recommended highest test concentration of 5 mg/L. No information about control groups was given. UNEP reports LC_{50} in the range of > 0.14 mg/L to > 2.0 mg/L (maximum concentrations technically feasible) for SAS). It appears that the LC_{50} values are based on the rats study aforementioned.	UNEP (2004)
Chronic/repeat dose toxicity (oral, dermal, inhalation) **Oral** None of the oral repeated dose studies reported by UNEP were performed with a pyrogenic SAS. However, an overall oral NOAEL of 2 500 mg/kg/d was established for rats based on studies carried out with different SAS. **Dermal** According to UNEP, long-term exposure to SAS may produce skin dryness. **Inhalation**	UNEP (2004)

UNEP reports that no evidence of pneumoconiosis or silicosis was observed in occupational exposures to SAS. Other disorders of the respiratory tract could not be correlated with exposure to SAS alone. However, the available epidemiological data base on workers is too limited to be able to draw firm conclusions. UNEP cites a study where rats were exposed to pyrogenic SAS at (1.3, 5.9 and 31) mg/m^3 for 13 wk. The results showed mild reversible pro-inflammatory cell proliferation but no pathologically relevant tissue change. At mid-concentration, adverse effects such as stimulation of collagen production, increase in lung weight, incipient interstitial fibrosis and slight focal atrophy in the olfactory epithelium were observed. All these effects were reversible following discontinuation of exposure. A NOAEL of 1.3 mg/m^3 and a LOAEL of 5.9 mg/m^3 were established. UNEP assessed this study as comprehensive, fully reliable and valid.	
Sensitisation of the skin or respiratory system According to UNEP, there are no experimental data available on sensitisation. There is no evidence of skin sensitisation in workers over decades of practical experience.	UNEP (2004)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye **Effects on skin** UNEP states that based on experimental data, SAS is not irritating to rabbit skin. However, it is noted that cases of dryness or degenerative eczema of the skin in workers with chronic contact have been reported by occupational physicians. When tested on the rabbit eye as a powder, SAS showed no or only weak and non-permanent irritating effects on the conjunctivae but neither the iris nor the cornea were affected.	UNEP (2004)

Physical Hazards	Reference
Flammable Potential Non-flammable	UNEP (2004)
Explosive Potential Non-explosive	UNEP (2004)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral (gavage)	> 3 100 to > 20 000 mg/kg (aqueous suspension and gel SAS)	UNEP (2004)
Mouse, oral	> 3 100 to > 20 000 mg/kg (aqueous suspension and gel SAS)	UNEP (2004)
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	> 5 000 mg/kg (precipitated SAS)	UNEP (2004)
Mouse, dermal	NDF	
LC_{50}		
Rat	> 0.14 - > 2.0 mg/l (pyrogenic and precipitated SAS; maximum concentrations technical feasible)	UNEP (2004)
High Chronic/Repeat Dose Toxicity		
NOAEL (rat, oral)	2 500 mg/kg/d	UNEP (2004)
LOAEC	5.9 mg/m^3 (precipitated and gel SAS)	UNEP (2004)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	IARC Group 3 – not classifiable as to its carcinogenicity to humans) (IARC 2013)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	UNEP, 2004
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	Based on a study with some limitations (UNEP, 2004)
Endocrine Disruption[1]	No	EC, 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC Group 3 – not classifiable as to its carcinogenicity to humans) (IARC 2013)
Mutagenicity/Genotoxicity (GHS Category 2)	No	UNEP, 2004
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	Based on a study with some limitations (UNEP, 2004)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg [3] • dermal LD_{50} ≤ 1 000 mg/kg • inhalation LC_{50} ≤ 10 mg/L [4] (vapour)	No	Oral LD_{50} (rat and mouse,) > 3 100 mg/kg to > 20 000 mg/kg (aqueous suspension and gel SAS) (UNEP 2004) LC_{50} (rat) > 0.14 mg/L- > 2.0 mg/l (pyrogenic and precipitated SAS; maximum concentrations technical feasible)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [4]	No	LOAEC rat = 5.9 mg/m^3 (precipitated and gel SAS) (UNEP 2004)
Corrosive (irreversible effect)	No	UNEP (2004)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d	No	LOAEC (rat) 5.9 mg/m^3 (precipitated and gel SAS)

• inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1.0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [4]		(UNEP 2004)
Skin Sensitiser	NDF	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2 000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2 000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	UNEP (2004)
Irritant (reversible effect)	No	UNEP (2004)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	UNEP (2004)
Explosive potential	No	UNEP (2004)
Hazard Evaluation (highest band) not including physical hazards	**0**	
Uncertainty analysis /data confidence (out of 12 parameters)	**10/12**	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1] *Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	10 mg/m^3	HSIS (2013)
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8-h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

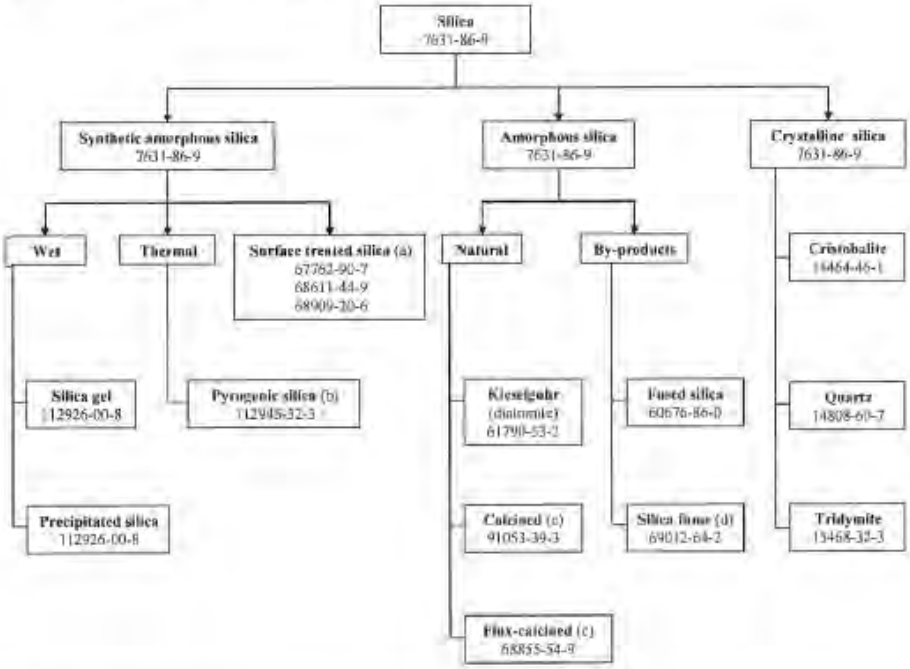
NDF – no data found within the limits of the search strategy

Qualifying Summary Comments

Silica, amorphous-fumed gel is a type of synthetic amorphous silica (SAS). Amorphous silica has been studied less than crystalline silica as it is generally less toxic than crystalline silica and is cleared more rapidly from the lung. Although effects on the lung have been observed at high concentrations these have been reversible following cessation of exposure. Amorphous silica is chemically and biologically inert when ingested in any of its many physical forms such as amorphous siliceous earth (diatomaceous earth, diatomite, kieselguhr) or colloidal silica gels and is not classifiable as to its carcinogenicity to humans. SAS does neither have acute or chronic health effects when administered by oral, dermal and inhalational routes nor have reproductive, development/teratogenicity or mutagenicity/genotoxicity effects. SAS is not classified as a skin sensitiser nor does it cause irritation of the skin or eye. For these reasons it is categorized as Hazard Band 0.

Safe Work Australia has listed amorphous silica as a hazardous substance under the respective legislation and developed an exposure standard for amorphous silica dust which is the generic standard for dusts. Due to its low solubility, amorphous silica in aqueous solution and as introduced during chemical stimulation activities would settle into soils and sediments and become indistinguishable from those materials. The principal hazard is subsequently the generation of dusts under occupational settings which would require management.

Figure 1: Different polymorphs of silica with CAS numbers



(a) All forms of SAS can be surface-treated either physically or chemically; most common treating agents are organosilicon compounds (Appendix B: Table B.2)
(b) Pyrogenic silica is also known as fumed silica in the English speaking countries
(c) Partial transformation into cristobalite
(d) By-product from electrical furnace

2.2 EC classification and labelling

SAS is not classifiable according to the Dangerous Substances Directive 67/548/EEC (EC, 1993).

Surface-treated substances are exempt from notification under the EC Directive (EC, 2002), including the three surface-treated SASs listed in the European Inventory of Existing Commercial Chemical Substances (EINECS): silane, dichlorodimethyl-reaction products with silica (271-893-4), silane, hexamethyldisilazane-reaction product with silica (272-697-1), and silane, octyltrimethoxy-reaction product with silica (296-597-2).

References

EC (European Commission) 2000, *Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption Final Report (Incorporating corrigenda to final report dated 21 June 2000) – Annex 10: List of 564 substances with their selection criteria*, Available at: http://ec.europa.eu/environment/archives/docum/pdf/bkh_annex_10.pdf, Accessed 14 January 2014.

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UNEP (United Nations Environment Programme) 2004, *Synthetic Amorphous Silica and Silicates - SIDS (Screening Information Dataset) Initial Assessment Report*, UNEP Publications, Available at: http://www.chem.unep.ch/irptc/sids/OECDSIDS/Silicates.pdf, Accessed 14 January 2014.

Updated by:	JC	14/01/2014
Reviewed by:	PDM	14/01/2014 Rev 1
Reviewed by:	PDM	15/01/2014 Rev 2

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Hydrochloric acid
Synonyms	Anhydrous hydrochloric acid, Chlorohydric acid, Hydrochloric acid gas, Hydrogen chloride, Muriatic acid
CAS number	7647-01-0
Molecular formula	HCl
Molecular Structure	H-Cl

Overview	References
Hydrogen chloride the gas, and hydrogen chloride the aqueous acid (hydrochloric acid), have the same CAS Registry number. Since the gas becomes the acid in aqueous systems and volatilization of the gas can occur from aqueous systems, it is often difficult to determine which is being considered in a specific item in the literature. If released to water, hydrogen chloride dissociates readily to chloride and hydronium ions, decreasing the pH of the water. There are few detailed studies reported following human exposures. Hydrogen chloride vapour is irritant to mucous membranes and is so severe that workers evacuate from the work place shortly after detecting its odour. A relation between concentrations from accidental exposure and health effects has not been reported in detail.	HSDB (2011)
The solution in water is a strong acid which reacts with bases and is corrosive. It reacts violently with oxidants forming toxic gas (chlorine). Hydrochloric acid attacks many metals in the presence of water forming flammable/explosive gas (hydrogen).	IPCS (2000)
Hydrochloric acid is one of the most widely used industrial chemicals, for example: • Pickling and cleaning steel and other metals. • Production of various inorganic and organic chemicals. • Food processing. • Cleaning of industrial equipment. • Extraction of metals. Hydrochloric acid levels in ambient air usually do not exceed 0.01 mg/m^3. Long-term or repeated exposures may have effects on the lungs, resulting in chronic bronchitis and effects on the teeth, resulting in erosion.	UNEP (2002)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as a carcinogenic substance by ECHA. IARC Group 3, hydrochloric acid is not classifiable as to its carcinogenicity to humans	ECHA (2013) IARC (2013)
Mutagenicity/genotoxicity Not classified as mutagenic by ECHA. In single studies, HCl induced mutation and chromosomal aberrations in mammalian cells and induced chromosomal aberrations in insects and in plants. It did not induce mutation in bacteria. For genetic toxicity, a negative result has been shown in the Ames test. A positive result, which is	ECHA (2013) UNEP(2002)

considered to be an artefact due to the low pH, has been obtained in a chromosome aberration test using Hamster ovary cells. Positive results were obtained in a Sex Linked Recessive Lethal study with *D. melanogaster*. There are no mammalian studies on *in vivo* mutagenicity with hydrogen chloride.	
Reproductive Toxicity According to UNEP, no reliable studies have been reported regarding toxicity to reproduction in animals after oral, dermal or inhalation exposure to hydrogen chloride/hydrochloric acid. Although no reliable studies on reproductive toxicity are reported in the UNEP assessment report, it states that in another study not specifically designed to assess reproductive toxicity (repeated dose inhalation study) no effects on the gonads were observed in mice up to 50 ppm. According to the author, this study was assessed as compliant with FDA-GLP (Food and Drugs Administration – Good Laboratory Practice).	UNEP (2002)
Developmental Toxicity/Teratogenicity UNEP suggests in an assessment report that no reliable studies have been reported regarding developmental toxicity in animals after oral, dermal or inhalation exposure to hydrogen chloride/hydrochloric acid. However, it states that as hydronium ions and chloride ions are normal constituents in the body fluid of animal species, low concentrations of hydrogen chloride gas/mist or solution do not seem to cause adverse effects to animals, provided the gas or acid concentrations do not exceed the capacity for buffering systems in the body to neutralise them. In addition, the UNEP report states that hydrochloric acid plays an important role in digestion, being secreted by the cells of gastric glands in the stomach and that orally administered sulfuric acid, which results in pH change in the stomach as well, did not cause developmental toxicity to laboratory animals. The report concludes that consequently, low concentrations of hydrogen chloride/hydrochloric acid which can be tolerated by the body with respect to irritant and corrosive effects are unlikely to have developmental toxicity.	UNEP (2002)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity No data available.	
Acute toxicity (Oral, Dermal or Inhalation) According to ECHA, data are lacking about the acute toxicity of hydrochloric acid by oral and dermal routes. However, based on the GHS classification ECHA states that hydrochloric acid (> 10% w/w) may cause respiratory irritation of the lungs and respiratory system by inhalation. ECHA reported a study where the acute toxicity of hydrochloric acid by inhalation was assessed in rats exposed to various concentrations of the substance as a gas or aerosol (percentage of HCl not specified), for exposure periods of 5 min or 30 min. For the gas, the LC_{50} was equivalent to 61.1 mg/L and 7.0 mg/L for 5 min and 30 min exposures, respectively. HSIS also classifies hydrochloric acid of concentration > 5% as toxic via inhalation IPCS reports that effects of short-term exposure include pneumonitis and lung oedema caused by inhalation of high concentrations of the gas. This may result in reactive airways dysfunction syndrome (RADS). The effects may be delayed.	ECHA (2013) HSIS (2013) IPCS (2000)
Chronic/repeat dose toxicity (oral, dermal, inhalation) According to UNEP, there are no repeated dose dermal studies available for hydrogen chloride/hydrochloric acid and the oral studies found have low reliability scores. However, it is noted in the report that hydrogen chloride/hydrochloric acid caused adverse effects at the site of	UNEP (2002)

contact at high concentration (actual doses not provided) and that solutions of lower concentration that might not cause skin irritation, are not expected to be absorbed from the skin and not expected to be available systemically in the body. Based on a study cited in the UNEP report, because the cells of the gastric glands secrete hydrochloric acid (with pH as low as 0.87) into the stomach cavity, small volumes or lower concentrations of ingested hydrochloric acid are not known to cause systemic effects. The UNEP report cites another study where the repeat dose toxicity of hydrochloric acid via inhalation was assessed with rats and mice exposed to hydrogen chloride gas at concentrations of (0, 15, 30 and 75) mg/m^3 or (0, 10, 20 and 50) ppm for 90 d, 6 h/d, 5 d/week. At the highest dose, a decrease in body weight gain and food consumption was observed in male and female mice, while a decrease in liver weight was noted in male mice only. Decrease in food consumption and body weight was also noted at the highest dose in rats. Urinalysis, haematology and serum chemistry did not show significant difference between test and control animals. A NOAEL for repeated dose inhalation toxicity of 20 ppm (30 mg/m^3) was established for rats and mice. This NOAEL is assumed to be based on decrease in food consumption and body weight. IPCS states that long-term exposure effects might include chronic bronchitis and teeth erosion.	Ganong (2011) as cited in UNEP (2002) UNEP (2002) IPCS (2000)
Sensitisation of the skin or respiratory system Not classified as a skin sensitizer by ECHA. Data lacking regarding the sensitisation of the respiratory system.	ECHA (2013)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Hydrochloric acid causes severe skin burns and eye damage. ECHA cites a study where the corrosive/irritating properties of hydrochloric acid to the skin were assessed in rabbits. The dorsal and lateral parts of the animals were clipped 15 h to 24 h prior to exposure. Hydrochloric acid aqueous solution (37%) was applied in occluded and semi-occluded patches of 0.5 mL to the areas of the animals for one or four hours. The study concludes that hydrochloric acid aqueous solution at 37% caused corrosion to the rabbit skin under occlusive and semi-occlusive conditions. ECHA deems this study to be reliable with restrictions as it followed the OECD but not the GHS guidelines and no control group was used. To assess the corrosive property of hydrochloric acid to the eye, ECHA cites another rabbit study where a single dose of 0.1 mL of hydrochloric acid aqueous solution at 0% and 10% was instilled in one eye of each rabbit and the vehicle instilled in the other eye (the untreated eye serving as control). The eyes were then observed 4 h, 24 h, 48 h, 72h and 96 h post-treatment. Irreversible damage of the eyes were observed.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Non-flammable. Extreme heat or contact with metals can release explosive hydrogen gas	UNEP (2002)
Explosive Potential Non-explosive. Extreme heat or contact with metals can release explosive hydrogen gas	UNEP (2002)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	NDF	
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat (gas, 5 min exposure)	61.1 mg/L	ECHA (2013)
Rat (gas, 30 min exposure)	7.0 mg/L	ECHA (2013)
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEC (rats and mice)	30 mg/m^3	UNEP (2002)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	IARC Group 3 (IARC 2013)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	NDF	The data found has a low reliability score (UNEP 2002)
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC Group 3 (IARC 2013)
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	NDF	The data found has a low reliability score (UNEP 2002)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg [2] • dermal $LD_{50} \leq 1000$ mg/kg inhalation $LC_{50} \leq 10$ mg/L [3] (vapour)	Yes	LC_{50}: 61.1 mg/L (5 min) and 7.0 mg/L (30 min) (ECHA, 2013). Toxic by inhalation (HSIS)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [2]; • dermal LOAEL ≤ 2 0 mg/kg/d; inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [3]	NDF	NOAEC for rats 30 mg/m^3 (20 ppm) (UNEP 2002) no LOAEC given.
Corrosive (irreversible effect)	Yes	ECHA (2013)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]	NDF	NOAEC for rats 30 mg/m^3 (20 ppm) (UNEP 2002) no LOAEC given.
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours) [3]	No	Aerosol: 46.5 mg/L (5 min) and 8.3 mg/L (30 min) Gas: 40,989 ppm (5 min) and 4,701 ppm (30 min) (ECHA 2013)
Irritant (reversible effect)	No	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No	Reacts violently in contact with metals (UNEP 2002)
Explosive potential	No	Reacts violently in

		contact with metals (UNEP 2002)
Hazard Evaluation (highest band) not including physical hazards	3	
Uncertainty analysis /data confidence (out of 12 parameters)	9/12	**75%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2]*milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d).*

[3] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	7.5 mg/m^3	HSIS (2013)
STEL	7.5 mg/m^3	ACGIH (2001) as cited in UNEP (2002)
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	ADWG (2011)
Water, recreational	NDF	NEPM (1999)
Soil, residential	NDF	NEPM (1999)
Soil, commercial/industrial	NDF	NEPM (1999)

Footnotes:
OEL = Occupational Exposure Limit
TWA= 8-h Time-Weighted Average
STEL = (15 min) Short-term Exposure Limit
NDF – no data found within the limits of the search strategy

Qualifying Summary Comments

Hydrogen chloride gas and hydrochloric acid have the same CAS Registry number. Since the gas becomes the acid in aqueous systems and volatilization of the gas can occur from aqueous systems, it is often difficult to determine which is being considered in a specific item in the literature. Hydrogen chloride in either of its forms exhibits high levels of concern in relation to its irritant, corrosive and necrotic properties on the lung, eyes, skin and mucous membranes. These are acute or short-term effects of exposures to toxic concentrations.

Hydrogen chloride is not classifiable as to its carcinogenicity to humans, mutagenic activity, and reproductive and developmental effects, although the information about these is limited. Based on its acute toxicity via inhalation and its corrosive properties, hydrochloric acid falls in the Hazard Band category 3. In occupational settings, all direct contact with high concentration of hydrochloric acid should be avoided. If released to water, hydrogen chloride dissociates readily to form hydrochloric acid, decreasing the pH of the water. Hydrochloric acid is a strong acid; it reacts violently with oxidants forming toxic gas (chlorine) as well as bases and is corrosive. Hydrochloric acid attacks many metals in the presence of water forming flammable/explosive gas (hydrogen).

It is of concern for occupational settings and in cases where large scale spills may occur of the concentrated form. In the environment it may acidify waters if sufficient discharge occurs. All of these settings require appropriate management measures.

References

ADWG (Australian Drinking Water Guidelines) 2011, National Health and Medical Research Council (NHMRC) Australian Drinking Water Guidelines 6, Available at: http://www.awa.asn.au/uploadedFiles/NHMRC_aust_drinking_water_guidelines.pdf. [Accessed 16 December 2013]

EC (European Commission) 2000, Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption Final Report (Incorporating corrigenda to final report dated 21 June 2000) – Annex 10: List of 564 substances with their selection criteria Available at: http://ec.europa.eu/environment/archives/docum/pdf/bkh_annex_10.pdf. [Accessed 16 December 2013]

ECHA (European Chemical Agency) 2013, Registered Substances List Dossier for hydrochloric acid (CAS no 7647-01-0). Available at: http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances . [Accessed 16 December 2013]

HSDB (Hazardous Substance Data Bank) 2011, Hydrogen Chloride CASRN: 7647-01-0, Toxicology Data Network (TOXNET), Available: at http://toxnet.nlm.nih.gov/ . [Accessed 16 December 2013]

HSIS (Hazardous Substance Information System) 2013, Search Hazardous Substances for Hydrogen Chloride, Available at http://hsis.safeworkaustralia.gov.au/HazardousSubstance . [Accessed 16 December 2013].

IARC (International Agency for Research on Cancer) 2013, Agents Classified by the *IARC Monographs*, Volumes 1–109, Available at: http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf . [Accessed 16 December 2013]

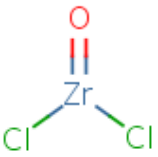
IPCS (International Program on Chemical Safety) 2000, Hydrogen Chloride information card, INCHEM, Available at: http://www.inchem.org/documents/icsc/icsc/eics0163.htm . [Accessed 16 December 2013].

NEPM: (National Environment Protection Measure) 1999, Available at: http://www.comlaw.gov.au/Details/F2013C00288/Download. [Accessed 16 December 2013]

UNEP (United Nations Environment Programme) 2002, Hydrogen Chloride CAS N°: 7647-01-0 SIDS (Screening Information Data Sets) Initial Assessment Report, UNEP Publications, Available at: http://www.inchem.org/documents/sids/sids/7647010.pdf, [Accessed 16 December 2013].

Created by:	JB	07/07/2011
	JC	16/12/2013 (Rev 2)
Reviewed and edited by	LT	09/07/2011 (Rev0) 22/08/2012 (Rev1)
Reviewed and edited by	PDM	13/01/2014 (Rev2)

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Zirconium dichloride oxide
Synonyms	Dichlor(oxo)zirconium, Zirconyl Chloride, zirconium oxychloride, zirconyl chloride, zirconium oxide chloride
CAS number	7699-43-6
Molecular formula	Cl_2OZr
Molecular Structure	

Overview	References
Zirconium dichloride oxide is a crystalline solid at 20 degrees C and 1013 hPa. It is very soluble in water (>10 000mg/L) and instantaneous hydrolysis of zirconium dichloride oxide occurs under neutral condition. It is not possible to determine the melting point of zirconium dichloride oxide solid as the substance decomposes to zirconium dioxide with the loss of water and hydrogen chloride. Decomposition is indicated by a significant weight loss starting at ca 60 °C.	ECHA, 2013
Zirconium dichloride oxide is used in textile (to prepare high quality pigment toner), cosmetic, and grease additive; water repellent; oil field acidizing aid. It is also used to make other zirconium compounds and in preparation of body deodorants and antiperspirant preparation.	HSDB, 2008

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC. Data lacking for classification by ECHA. Not classifiable as a human carcinogen.	IARC 2013 ECHA, 2013 HSDB, 2008
Mutagenicity/Genotoxicity Not classified as a mutagen.	ECHA, 2013
Reproductive Toxicity Not classified as a reproductive toxicant.	ECHA, 2013
Developmental Toxicity/Teratogenicity No data found.	
Endocrine Disruption Not listed as an endocrine disruptor.	EC 2000
Neurotoxicity	

No data found.	
Acute Toxicity (oral, dermal, inhalation) Not classified as acutely toxic via oral exposure Two LD50 studies are presented on ECHA 2013: Rat, oral (gavage) LD50: ~ 3500 mg/kg (data reliability – reliable with restrictions). The time of death varied from a few hours to a few days following the exposure to the test substance. Animals exposed to the test substance showed a progressive depression and decrease in activity until death occurred. Rat, oral (gavage) LD50: 4330 mg/kg (data reliability – not reliable). Some animals died during the 24 hours following administration. For the survivors, the behavior is characterized by poor appetite, progressive weight loss, prostrate animal, dull coat. At autopsy are often found gastrointestinal necrosis and sometimes lung necrosis. Acute poisoning from ingestion of Zr oxychloride resulted in the following symptoms: burning pain in the mouth and throat, vomiting, watery or bloody diarrhea, tenesmus, retching, haemolysis, haematuria, anuria, liver damage with jaundice, convulsions, hypotension, and collapse. Through its hydrolysis to hydrochloric acid, zirconium oxychloride can irritate the respiratory tract and other superficial surfaces of the body on exposure.	ECHA, 2013 HSDB, 2006
Chronic/repeat dose toxicity (oral, dermal, inhalation) Inhalation of 11.3 mg/m^3 zirconium dichloride oxide for 60 days produced no significant changes in animals in mortality rate, growth, biochemistry, hematology values or histopathology. On two animals (cats) among 124 were found testicular atrophy. (data reliability - reliable with restrictions)	ECHA, 2013
Sensitisation of the skin or respiratory system No data found(NDF)	
Corrosion (irreversible and reversible)/irritation of the skin or eye Releases hydrogen chloride in contact with water leading to a pH <2. It is therefore proposed to follow the classification of hydrogen chloride dissolved in water (hydrochloric acid) for corrosion. Therefore classified as skin corrosive category 1 B – H314 – GHS05. Causes severe skin burn and eye damage Eye damage category 1 according to the criteria of the CLP Regulation. Xi; R41 Risk of serious damage to eyes C; R34 Causes burns.	ECHA, 2013
Flammable Potential Not classified as flammable	ECHA, 2013
Explosive Potential Not classified as explosive	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
LD_{50}	NDF	
LC_{50}	NDF	
High Chronic/Repeat Dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral (gavage)	4330 mg/kg bw	ECHA 2013
Rat, oral (gavage)	~ 3500 mg/kg bw	ECHA 2013
Rat, dermal	NDF	
Rabbit, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat		
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL, inhalation, 60 day (6 hours/day, 5 days/week) (cat, dog, guinea pig, rabbit, rat)	11.3 mg/m^3	ECHA 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	
Mutagenicity/Genotoxicity	No	
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	NDF	
Endocrine Disruption[1]	No	
Neurotoxicity[2]	NDF	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible damage)	Yes	Skin corrosive classification: H314
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	
Skin Sensitiser	NDF	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	
Irritant (reversible damage)		
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	3	
Uncertainty analysis /data confidence		

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Zirconium dichloride oxide has a low order of acute toxicity. It is conservatively classified as a skin and eye corrosion hazard on the expectation of release of hydrogen chloride in contact with moisture. The repeat dose toxicity, carcinogenicity, reproductive toxicity and mutagenicity of zirconium dichloride oxide has not been well characterised. Given the possible corrosivity in contact with moisture, zirconium dichloride oxide was categorised in Hazard Band 3.

References and Notes

European Chemicals Agency (ECHA), 2013. Registered Substances List Dossier for zirconium dichloride oxide. Available at http://echa.europa.eu/web/guest/information-on-chemicals/registered-substances [Accessed 1 November 2013].

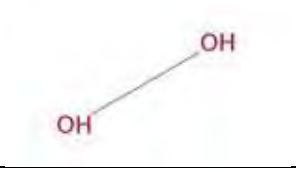
European Commission (EC) (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

Hazardous Substance Data Base (HSDB), 2006. Zirconium Oxychloride. U.S. National Library of Medicine, National Institute of Health, Department of Health and Human Services, U.S. Government. Last date of revision: 14/06/2006.

NDF - No data found within the limits of the search strategy.

Created by:	OH/MGT	Date 1/11/2013
Reviewed and edited by:	JF	Date and Revision 8/11/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Hydroxide peroxide (impurity)
Synonyms	
CAS number	7722-84-1
Molecular formula	H_2O_2
Molecular Structure	

Overview	Reference
Hydrogen peroxide is a colourless and odourless liquid which is exclusively produced and marketed as an aqueous solution of concentrations between 30 to 90 % w/w. It is produced in moderately high volume and is widely used (estimated 670 000 t/annum used in Europe in 1995) The uses of hydrogen peroxide depend on its concentration. Less concentrated solutions of hydrogen peroxide are used in bleaching hair solutions, contact lenses solutions, chlorine free bleaches, fabric stain removers. More concentrated solutions are used as blenching and oxidising agents or as rocket fuel. Hydrogen peroxide is also used as an oxidant in the treatment of drinking water.	ADWG (2011); ECHA (2013); IPCS (2006); SIDS (1999).

Human Health Toxicity Summary	Reference
Carcinogenicity Hydrogen peroxide is not classifiable as to its carcinogenicity (Group 3) to humans.	IARC (2013)
Mutagenicity/Genotoxicity ECHA has not reported this substance to be mutagenic or genotoxic. The genetic toxicity classification of hydrogen peroxide is based on a study of mammalian cell mutagenicity with metabolic activation (S9) which produced negative results. In addition, an *in vivo* study where a hydrogen peroxide solution administered to mice via the intra-peritoneal route prior to micronucleus testing showed that hydrogen peroxide did not have a genotoxic potential under the experimental conditions of this test. However, other mammalian cell studies showed positive results but without metabolic activation. It is inferred that the genetic toxicity classification was based on the aforementioned in vitro and in vivo studies.	ECHA (2013)
Reproductive Toxicity A 90-day drinking water study with mice did not report effects associated with reproductive toxicity.	SIDS (1999)
Developmental Toxicity/Teratogenicity NDF.	ECHA (2013)
Endocrine Disruption Not listed as an endocrine disruptor according to the list of endocrine disrupting chemicals from the European Commission .	EC (2002)
Acute Toxicity (oral, dermal, inhalation)	ECHA

ECHA has reported that this substance is harmful if swallowed (Acute Tox. 4 H302) or inhaled (Acute Tox. 4 H332) (as per the GHS classification) .ECHA has not reported this substance to be as acutely toxic via dermal route. Dermal acute toxicity data exceeds the threshold established in Hazard Band 1. ECHA has also reported that this substance may cause respiratory irritation (STOT Single Exp. 3 H335). This is based on inhalation exposure studies in rats with 50% solution hydrogen peroxide.	(2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as chronic toxic.	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a sensitiser to the skin or respiratory system.	ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye ECHA has reported that this substance causes severe burns and eye damage (Skin Corr. 1A H314 as per the GHS classification) However, the irritation and corrosive potentials of this substance vary with its concentration. Three different concentrations of solution of hydrogen peroxide (10%, 35% and 49.2%) were tested in New Zealand White rabbits. These studies concluded 10% solution of hydrogen peroxide was not irritating to rabbit skin, 35% aqueous solution of hydrogen peroxide was judged to be moderately irritating to the rabbit's skin but non-corrosive within 48h of dosing and 49.2 % solution of hydrogen peroxide is highly irritating to the rabbit's skin. This suggests that the classification reflects higher concentration solutions.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as flammable.	ECHA (2013).
Explosive Potential Not classified as explosive. As a potent oxidising agent it may cause fire and explosion as a result of contact with other substances (incompatibilities).	ECHA (2013).

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat dose Toxicity		
	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	805 mg/kg (70% w/w solution)	ECHA (2013)
Rat, dermal	NDF	
Rabbit, dermal	> 2000 mg/kg	ECHA (2013)
LOAEL	NDF	
LC_{50}		
Rat	> 170 mg/m^3 (50% w/w	ECHA (2013)

	solution)	
High Chronic/Repeat dose Toxicity		
LOAEL (mouse, oral)	300 ppm	ECHA (2013)
LOAEC (rat)	14.6 mg/m^3 6h/day	ECHA (2013)
NOAEC (rat)	2.9 mg/m^3 6h/day	ECHA (2013)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	IARC Group 3
Mutagenicity/Genotoxicity	No	ECHA (2013)
Reproductive Toxicity	No	ECHA (2013)
Developmental Toxicity/ Teratogenicity	No	ECHA (2013)
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m3) (vapour)	No	ECHA (2013)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	ECHA (2013)
Corrosive (irreversible damage)	Yes	ECHA (2013)
Respiratory sensitiser	No	ECHA (2013)
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]	No	ECHA (2013)
Skin Sensitiser		ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	Yes	ECHA (2013)
Irritant (reversible damage)	No	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	ECHA (2013)
Explosive potential	Yes	Based on oxidising potential and incompatibilities
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	12/13	**92.3%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	1.4 mg/m^3	HSIS, 2013
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	NEPM, 2003
Air, indoor	NDF	WHO, 2010
Water, potable	Used as an oxidant in the treatment of drinking water (often in conjunction with ozone)	ADWG, 2011
Water, recreational	NDF	NEPM, 1999 - amended
Soil, residential	NDF	NEPM, 1999 - amended
Soil, commercial/industrial	NDF	NEPM, 1999 - amended

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Hydrogen peroxide is a colourless and odourless liquid but exhibits strong oxidising and thus corrosive properties. These properties result in a potential to cause severe eye irritation and respiratory irritation. The corrosive nature results in severe health effects if swallowed or inhaled. Hydrogen peroxide is not classified as a carcinogen, mutagen or reproductive toxicant but on the basis of severe burns and eye damage it is categorised as Hazard Band 3. The main concern for this chemical thus resides in its corrosive properties, however, hydrogen peroxide breaks down quickly and subsequently the public health issues will be limited to occupational exposures to high concentration solutions of hydrogen peroxide or where large scale spills may result in exposure to members of the public.

References

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NDF – No data found within the limits of the search strategy

Created by:	JC	Date: 16/10/2013
Reviewed and edited by:	LT	Date 23/10/2013 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Nitrogen, liquid form
Synonyms	Numerous synonyms including azote, nitrogen, nitrogen gas, nitrogen-14, nitrogeno, diatomic, diazyne
CAS number	7727-37-9
Molecular formula	N_2
Molecular Structure	

Overview	References
Nitrogen is an inert, odourless, colourless gas, under standard temperature and pressure. At extremely low temperatures, nitrogen gas condenses to form liquid nitrogen. Liquid nitrogen is stored under pressure in cylinders to prevent rapid evaporation back to nitrogen gas. Nitrogen has a melting point of -210°C and a boiling point of –195.8°C. Nitrogen is thermodynamically stable and only reacts under ambient conditions in the presence of a catalyst (e.g. nitrogen fixing bacteria, lightning, etc.). Nitrogen is considered non-flammable, non-explosive and non-oxidising.	ECHA 2008
Nitrogen forms 78.1% v/v of the earth's atmosphere. The majority of Earth's organisms are exposed to this concentration of atmospheric nitrogen for their entire life cycle. Therefore, under standard temperature and pressure nitrogen does not exhibit any adverse toxicological, metabolic or environmental effects. However, when the concentration of atmospheric nitrogen increases (e.g. in confined spaces) it can become asphyxiating (through displacement of ambient oxygen.	ECHA 2008
Nitrogen is widely used and is employed for such uses as an insecticide, medical aid and food additive. As a broad-spectrum insecticide it is used to eradicate wood destroying insects, stored product pests, textile pests and other arthropods. Nitrogen acts as a biocide through inhalation by depleting oxygen which the target insects require for respiration and does not directly affect the insect's physiology.	ECHA 2008

Human Health Toxicity Summary	Reference
Carcinogenicity IARC has not evaluated nitrogen for its carcinogenicity.	IARC
Mutagenicity/Genotoxicity NDF.	
Reproductive Toxicity NDF.	
Developmental Toxicity/Teratogenicity NDF.	
Endocrine Disruption The European Commission in examining endocrine disruptors has not evaluated nitrogen.	EC 2000
Neurotoxicity NDF.	

Acute Toxicity (oral, dermal, inhalation) Increased concentrations of nitrogen in the atmosphere can lead to asphyxiation. This is particularly relevant when used in a confined space. Due to the very cold temperature of liquid nitrogen, it is irritating to the eyes and skin. Contact may cause frostbite and severe burns. Exposure may also produce discomfort in breathing and can provoke an asthma attack in susceptible individuals.	ECHA 2008 NTC 2011, SA 1997
Chronic/repeat dose toxicity (oral, dermal, inhalation) NDF.	
Sensitisation of the skin or respiratory system NDF.	
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Contact with liquid nitrogen may cause frostbite and severe burns.	NTC 2011, SA 1997

Physical Hazards	Reference
Flammable Potential Nitrogen gas is considered non-flammable. Release of nitrogen gas at very low temperatures can lead to the condensation of liquid oxygen, which can increase the combustibility of many materials (e.g. solvents, hydrocarbons).	ECHA 2008 SA 1997
Explosive Potential Nitrogen gas is considered non-explosive.	ECHA 2008

Toxicity Values	Value	Reference
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	NDF.	
LC_{50}		
Rat	NDF.	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF.	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – No data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	NDF	Not currently evaluated by IARC.
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	NDF	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	NDF	
Endocrine Disruption[1]	NDF	Not currently evaluated by EC.
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	NDF	
Mutagenicity/Genotoxicity (GHS Category 2)	NDF	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	NDF	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NDF	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NDF	
Corrosive (irreversible effect)	Yes	Potential to cause frostbite due to extremely low temperatures when in liquid form
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NDF	
Skin Sensitiser	NDF	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	NDF	
Irritant (reversible effect)	NDF	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	Corrosive in liquid form
Uncertainty analysis /data confidence (out of 12	1/12	**8%**

parameters)		

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Neurotoxicity based on REACH assessments.

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Concluding Summary Comments

Nitrogen is an inert gas at standard temperature and pressure, which forms 78.1 % v/v of the Earth's atmosphere. Nitrogen is used as an insecticide and food additive. At extremely low temperatures (–195.8°C) nitrogen gas, will condense to form liquid nitrogen. The risks associated with liquid nitrogen arise from the physical conditions (i.e. extremely low temperature and high pressure) under which it exists. These include the potential for frostbite and burns. In addition, the release of liquid nitrogen to atmosphere can lead to the condensation of oxygen, which presents another physical fire and explosion risk as it creates a localised enrichment of oxygen which may ignite. Nitrogen gas can also act as an asphyxiant by displacing oxygen in confined spaces.While liquid nitrogen has been grouped in Hazard Band 3, the risks are limited to the occupational setting and also to cases of large scale emergency environmental spills or releases. While it is expected that liquid nitrogen would be the dominant form used in stimulation activities it would rapidly convert to gaseous form and be lost to atmosphere with no residual effects apart from the acute effects described above.

References

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Created by:	MGT	Date: 08/01/2014
Reviewed by:	LT	Date: 14/01/2014

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium Thiosulphate
Synonyms	Disodium thiosulphate, sodium thiosulphate, Ametox, sodium hyposulfite, S-Hydril, Sodothiol, sodium thiosulphate pentahydrate, thiosulfuric acid, disodium salt
CAS number	7772-98-7
Molecular formula	$H_2O_3S_2.2Na$
Molecular Structure	

Overview	References
Sodium thiosulphate can be present in an anhydrous or pentahydrate form. It is water soluble solid.	SWA, 2013
Sodium thiosulphate is used as a stabilizer of potassium iodide salt, as a sequestrant in alcoholic beverages, and as an additive in food packaging materials. It is also used to remove chlorine from solution; as "antichlor" in bleaching of paper pulp; fixer in photography; mordant in dyeing & printing textiles; reducer in chrome dyeing, manufacturing of leather; extracting of silver from ores; bleaching bone, straw, ivory; reagent in analytical chemistry; antidote (cyanide poisoning).	ECHA, 2013 HSDB, 2013
Sodium thiosulphate is a normal constituent of human body fluids and is excreted in the urine of mammals. In quantitative studies it has been demonstrated that 2 to 17 milligrams (mg) of thiosulphate sulfur occur in 24-hour urine specimens of healthy young adults. Variations in excretion of thiosulphate are related to the extent of protein metabolism, activity of the intestinal flora, and the sulfur-amino acid content of the diet. The sulfur-containing amino acids of dietary protein are the source of the endogenous thiosulphate pool.	CCOHS, 2013
Orally administered thiosulphate that is absorbed from the gastrointestinal tract is excreted in the urine unchanged or after oxidation to sulfate. Uo to 70% of an oral dose of sodium thiosulphate is considered to be absorbed from the gastrointestinal tract of humans and the remainder to be excreted in the faeces.	
Sodium thiosulphate is not classified as a hazardous substance according to the criteria of the Global Harmonised Scheme (GHS) for classifying hazardous substances and is not listed as a hazardous substance on the Australian Hazardous Substance Information Service.	
High concentrations of dust may result in irritation to eyes and respiratory tract.	

Human Health Toxicity Summary	Reference
Carcinogenicity Not classed as carcinogenic by ACGIH, IARC, OSHA or NTP.	CCOHS, 2013
Mutagenicity/Genotoxicity Not known to cause heritable genetic damage.	Schlumberger, 2013

There was no evidence of chromosomal damage in a bone-marrow assay in rats and mice following single oral doses of 50 to 5000 mg/kg of sodium thiosulphate. In one experiment no statistically significant increases in mutant frequency were observed following treatment with ammonium thiosulphate at any concentration tested.	OECD, 2004 ECHA, 2013
Reproductive Toxicity Not known to adversely affect reproductive functions and organs.	Schlumberger, 2013
Developmental Toxicity/Teratogenicity Not known to cause birth defects or have a deleterious effect on a developing fetus. Up to 550 mg/kg bw/d of sodium thiosulphate to pregnant mice for 10 consecutive days had no clearly discernible effect on nidation or on maternal or foetal survival.	Schlumberger, 2013 ECHA, 2013
Endocrine Disruption Not listed as an endocrine disruptor.	EC, 2000
Acute Toxicity (oral, dermal, inhalation) Considered an inert ingredient by the US EPA. Investigations in which it has been administered to normal and diseased persons, clearly show that very large therapeutic doses cause no adverse effects.	EPA, 2001 FDA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Threshold limit values not established. Acceptable daily intake 0-0.7 mg/kg bw.	IPCS, 2013 IPCS, 2013
Sensitisation of the skin or respiratory system Not known to cause an allergic reaction. Ammonium thiosulphate is not classified as skin sensitizer.	Schlumberger, 2013 ECHA, 2013
Corrosion (irreversible and reversible)/irritation of the skin or eye The results of a draize test was found to be non-irritating to eyes and skin.	ECHA, 2013

Physiochemical Properties	References
Flammable Potential Not combustible. Product does not burn.	IPCS, 2013 ECHA, 2013
Explosive Potential Not explosive.	ESIS, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	No	FDA, 2013, EPA, 2001
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found (NDF)	
LOAEL	Acceptable daily intake 0-0.7 mg/kg bw.	IPCS, 2013
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	>2000 mg/kg (female rat) for calcium thiosulphate >5000 mg/kg (male rat) for potassium thiosulphate >5,000 mg/kg	ECHA, 2013 CCOHS, 2013
Mouse, oral	50-5,000 mg/kg (single dose) gavage, negative result in cytogenetic assay	OECD, 2006
Rabbit, dermal	Acute dermal LD_{50} of potassium thiosulphate was estimated to be >2000 mg/kg Acute dermal LD_{50} of Thio-Sul (Ammonium thiosulphate solution) is estimated to be >2000 mg/kg of body weight	ECHA, 2013 Potassium thiosulphate is not classified as acute toxic by the dermal route.
LC_{50}		
Rat (inhalation)	Four-hour acute inhalation LC_{50} of potassium thiosulphate was estimated to be > 2.60 mg/L Four-hour acute inhalation LC_{50} of sodium sulfite was estimated to be > 5.5 mg/L One-hour acute inhalation LC_{50} of sodium sulfite was estimated to be > 22 mg/L	ECHA, 2013 No concentration values greater than this given value have been examined. For sodium sulfite the test item is not classified as acute toxic via the inhalation route
Mice (inhalation)	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL (Rat)	Oral: Disodium disulfite NOAEL for local effects 108 mg/kg bw/d Na2S2O5. NOAEL for systemic effects can be expected above 955 mg/kg bw/d of Na2S2O5	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	
Mutagenicity/Genotoxicity	No	
Reproductive Toxicity	No	
Developmental Toxicity/ Teratogenicity	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L4 (or mg/m^3) (vapour)	No	For sodium sulfite the test item is not classified as acute toxic via the inhalation route (ECHA, 2013)
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible damage)	No	
Respiratory sensitiser	No	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	
Irritant (reversible damage)	No	ECHA,2013
Hazard Band 0 All indicators outside criteria listed in Hazards 1-4	Yes	
Physical Hazards		
Flammable potential	No	IPCS, 2013, ECHA, 2013
Explosive potential	No	ESIS, 2013
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 0	
Uncertainty analysis /data confidence	14/14	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*
[3] *milligrams per kilogram body mas s(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	10 mg/m^3 (total inhalable dust) (UK) 5 mg/m^3 (respirable dust) (UK) 2 mg/m^3 Maximum workplace concentration (Germany) 10 mg/m^3 (ACGIH) inhalable particulate 3 mg/m3 (ACGIH) respirable particulate 15 mg/m3 (OSHA) total dust 5 mg/m3 (OSHA) respirable fraction	ESIS, 2013 CCOHS, 2013
STEL	None	Schlumberger, 2013
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF Class of danger: 0 – generally not water polluting	ESIS, 2013
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Sodium thiosulphate is a normal constituent of human body fluids, is generally recognised as safe (GRAS) and is a non-hazardous substance. It is used as a direct and indirect food additive. At very high dust concentrations it may cause transient irritation to the respiratory tract. Sodium thiosulphate falls into the Hazard Band 0 category.

There is no evidence to suggest any adverse effects following repeated exposure at low environmental levels. On contact with acid it can liberate sulphur dioxide. Sulphur dioxide can cause irritation of the respiratory tract and is a trigger for asthma in sensitive individuals. Sodium thiosulphate is not expected to be persistent or bioaccumulative in the environment.

References

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International Program on Chemical Safety (IPCS) INCHEM (2013). Sodium Thiosulphate. Available at http://inchemsearch.ccohs.ca/inchem/jsp/search/search.jsp?inchemcasreg=1&Coll=inchemall&serverSpec=charlie.ccohs.ca%3A9900&QueryText1=7772-98-7&QueryText2=&Search.x=39&Search.y=11 [Accessed 13 August 2013]

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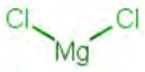
United States Environmental Protection Agency (EPA). Sodium thiosulfate Exemption from the Requirement of a Tolerance 12/01, Dated 21 December 2001. Available at
http://pmep.cce.cornell.edu/profiles/inert/sodium_thiosulfate/sodium_thio_tol_1201.html [Accessed 30 August 2013]

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Created by:	CM	Date 30 August 2013
Reviewed and edited by:	JF	30 August 2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Magnesium Chloride
Synonyms	
CAS number	7786-30-3
Molecular formula	Cl2Mg
Molecular Structure	

Overview	References
Magnesium Chloride is an inorganic, mono constituent substance, colourless to white crystals and thin white to gray coloured granules/flakes at solid at 20°C and 1013 hPa. The melting/freezing point of magnesium chloride is reported by ECHA to be 712°C at 101 kPa. Magnesium chloride substances can accelerate the burning process of a fire. Some substances may decompose explosively when heated, involved in a fire or contaminated. Magnesium chloride is a deliquescent chemical. It also has the ability to react explosively with hydrocarbons (fuel), and ignite combustibles (wood, paper, oil, clothing). Magnesium chloride is a component of fire extinguishers, ceramics, textile and paper manufacturing. It is also used in medication and disinfectants. Magnesium chloride in solution dissociates to magnesium and chloride ions. Magnesium is an essential mineral in all life. It is non hazardous to human health.	ECHA,2013 HSDB,1993

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by ECHA (conclusive data but not sufficient for classification). A lifetime oral mice carcinogenicity study (similar to OECD Guideline 453 (Combined Chronic Toxicity / Carcinogenicity Studies)) was conducted. The dose concentration was 0.5% and 2% magnesium chloride hexahydrate in the test mice diets. Frequency of treatment was daily for a 96 week period. NOAEL for male mice was 2,810 mg/kg bw/day (2% in feed) and female mice 3,930 mg/kg bw/day (2% in feed). IARC has not evaluated the evidence for the carcinogenicity of magnesium chloride.	ECHA,2013 IARC,2013
Mutagenicity/Genotoxicity Not classified by ECHA (conclusive data but not sufficient for classification). Test equivalent or similar to OECD Guideline 476 (In vitro Mammalian Cell Gene Mutation Test) was carried out on target gene, thymidine kinase, species/strain – mouse lymphoma L5178Y cells to see if there was potential to induce mutations. Test concentrations range between 22,000 – 36,000 µg/ml of magnesium chloride hexahydrate. Multiple controls used. The results conclude that the test substance shows no treatment related increase in mutation frequency. A study according to OECD Guideline 473 (In vitro Mammalian Chromosome Aberration Test) was carried out on species/strain: lymphocytes: human peripheral blood lymphocytes. Tests were undertaken with and without metabolic activation at varying concentrations of magnesium chloride hexahydrate. Multiple controls used. Conditions of the study conclude that the test substance is a	ECHA,2013

non-mutagenic agent.	
Reproductive Toxicity Not classified by ECHA (conclusive data but not sufficient for classification). Test according to OECD Guideline 422 (Combined Repeated Dose Toxicity Study with the Reproduction / Developmental Toxicity Screening Test) was carried out on Wistar rats by oral administration. Dose concentrations of magnesium chloride hexahydrate was 250, 500, 1000 mg/kg bw/day orally ingested. Test male rats were exposed for 28-29 days and female rats exposed for maximum 54 days. Controls were used. For both generations, parent and off-springs, NOAEL was >1000mg/kg bw/day.	ECHA,2013
Developmental Toxicity/Teratogenicity Not classified by ECHA (conclusive data but not sufficient for classification). A test equivalent to OECD Guideline 414 (Prenatal Developmental Toxicity Study) was carried out on Wistar rats. The dose concentration of magnesium chloride hexahydrate was 200, 400, 800 mg/kg bw/day orally ingested. Exposure was from day 6 – 15 of pregnancy. No clinical observations for teratogenicity and maternal toxicity effects. The NOAEL for both parent and fetuses was >800 mg/kg bw/day.	ECHA,2013
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC,2000
Neurotoxicity Not classified by ECHA. No data found.	ECHA,2013
Acute Toxicity (oral, dermal, inhalation) Not classified by ECHA (conclusive data but not sufficient for classification) – oral and dermal, (data lacking) – inhalation. A test according to OECD Guideline 423 (Acute Oral toxicity – Acute Toxic Class Method) was carried out on female Wistar rats. The dose concentration of magnesium chloride hexahydrate was 2000mg/kg b/w. No controls were used. No observations of mortality or clinical effects. Test concludes that the LD50 after a single oral administration to female rats, observed over a period of 14 days, is 5000 mg/kg body weight. A test according to OECD Guideline 402 (Acute Dermal Toxicity), was performed on Wistar rats. The dose concentration of magnesium chloride hexahydrate was 2000mg/kg b/w and covered approximately 10% total body surface. Slight dermal irritation observed from 1 of ten test rats and clinical signs of stress; however no control rats to compare with. The dermal LD50 was determined to be > 2000 mg/kg body weight. HSNO Classification 6.1E, acutely toxic (oral) – GHS classification, category 5 (Acute toxicity: oral). The classification comes from reference *Kali und Salz AG Lehrte (21) Journal of Pharmacology and Experimental Theraputics.* The test species were rats, the LD50 was 2800 mg/kg.	ECHA,2013 NZEPA - HSNO CCID,2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified by ECHA (conclusive data but not sufficient for classification) – oral, (data lacking) – inhalation and dermal. A test according to OECD Guideline 422 (Combined Repeated Dose Toxicity Study with the Reproduction / Developmental Toxicity Screening Test) was carried out on Wistar rats. Dose concentrations of magnesium chloride hexahydrate was 250, 500, 1000 mg/kg bw/day orally ingested. Test male rats were exposed for 28-29 days and female rats exposed for maximum 54 days. Controls were used. NOAEL on general toxicity endpoints is >1000 mg/kg bw/day for male and female test rats.	ECHA,2013

Sensitisation of the skin or respiratory system Not classified by ECHA (conclusive data but not sufficient for classification) – skin, (data lacking) – respiratory. A test according to OECD Guideline 406 (Skin Sensitisation) was carried out on female Hartley guinea pigs. Dose concentrations were 5% and 50% suspension w/w of of magnesium chloride hexahydrate. Exposure was intradermal, epicutaneous and occlusive. Under the study conditions, there was no evidence of sensitisation in the test animals. A bibliographic study of multiple clinical case studies was performed by Scientific committee on Food (SCF) to assess the endpoint of repeat dose toxicity for humans when orally ingesting magnesium salts as a food additive. Mild diarrhoea was the most sensitive non-desirable effect of orally administrated easily dissociable magnesium salts occurring at 360/365 mg of magnesium per day (LOAEL). The SCF has set a human NOAEL of 250 mg of magnesium per day. HSNO Classification 6.4A, irritating to the eye – GHS classification, category 2A (Serious damage/eye irritation). A reference supporting this classification is *Kali und SAlz AG Lehrte (27) international Bio Research Forschungs GmbH.* The test spices were rabbits, the result was that the test substance was not irritating.	ECHA,2013 NZEPA - HSNO CCID,2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Not classified by ECHA (conclusive data but not sufficient for classification) A test according to EU method B46 (irritation) was carried out on reconstituted three-dimensional human skin model EPISKIN-SM (Skinethic). The dose concentration of magnesium chloride hexahydrate was approximately 10mg to dermal surface. Controls used. No irritant effects were observed after 15 minutes of treatment and 42 hours post incubation. A test according to OECD Guideline 405 (Acute Eye Irritation / Corrosion) was carried out on New Zealand White rabbits. A dose concentration of 0.1g was applied to the test site for a 72hr exposure period followed by an 8 day observation period. The control was the untreated eye of each rabbit. No observations at 24, 48 and 72 hours for the cornea and iris. Observations of irritation to the chemosis and conjunctivae occurred in some of the test animals, however all effects reversible within 48hrs to 6 days. With the EU criteria, the test substance is not irritating to the eye.	ECHA,2013

Physical Hazards	Reference
Flammable Potential Not classified by ECHA (Data lacking).	ECHA,2013
Explosive Potential Not classified by ECHA (Data lacking).	ECHA,2013

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	5000 mg/kg	LD50 = 5000mg/kg body weight, test species, rat. ECHA, 2013
Rat, oral	2800 mg/kg	LD50 = 2800 mg/kg body weight, test species, rats. NZEPA - HSNO CCID,2013
Rabbit, oral	NDF	
Rat, dermal	>2000 mg/kg b/w	LD50 > 2000 mg/kg body weight, test species, rats. ECHA, 2013.
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	Not classified by ECHA, 2013 Has not be evaluated by IARC,2013
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	Not classified by ECHA, 2013
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	Not classified by ECHA, 2013
Endocrine Disruption[1]	No	Not classified by ECHA, 2013
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	Not classified by ECHA, 2013 Has not be evaluated by IARC,2013
Mutagenicity/Genotoxicity (GHS Category 2)	No	Not classified by ECHA, 2013
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	Not classified by ECHA, 2013
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	Not classified by ECHA, 2013
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	Not classified by ECHA, 2013
Corrosive (irreversible effect)	No	Not classified by ECHA, 2013
Respiratory sensitiser	No	Not classified by ECHA, 2013
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Not classified by ECHA, 2013
Skin Sensitiser		
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	LD50 = 5000mg/kg body weight, test species, rat. ECHA, 2013 LD50 = 2800 mg/kg body weight, test species, rats.

		NZEPA - HSNO CCID,2013 LD50 > 2000 mg/kg body weight, test species, rats. ECHA, 2013.
Irritant (reversible effect)	No	Not classified by ECHA, 2013
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 0	
Uncertainty analysis /data confidence (out of 12 parameters)	12/12 = 100%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Neurotoxicity based on REACH assessments.

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found	
8-h TWA	No data found	
STEL	No data found	
Peak Limitation	No data found	
Environmental Exposure		
Air, ambient	No data found	
Air, indoor	No data found	
Water, potable	>1200 mg/L	>1200 TDS = unacceptable (unpalatable) criteria based on WHO 2004, reference ADWGL, 2011
Water, recreational	No data found	
Soil, residential	No data found	
Soil, commercial/industrial	No data found	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Magnesium is an essential mineral for humans. It is non hazardous to human health. On this basis it is categorised in the lowest hazard band. (Hazard Band 0).

References and Notes

European Chemicals Agency (ECHA), 2013. *Registered Substances List Dossier for magnesium chloride.* Available at: http://apps.echa.europa.eu/registered/data/dossiers/DISS-9eba3f59-f247-5596-e044-00144f67d031/AGGR-0eeb287c-21c3-4ad6-8787-9e9fc114ebf0_DISS-9eba3f59-f247-5596-e044-00144f67d031.html#AGGR-0eeb287c-21c3-4ad6-8787-9e9fc114ebf0 [Accessed 26 November 2013]

European Commission (EC) (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

Hazardous Substance Data Bank (HSDB), *Toxnet, toxicology data network – magnesium chloride* 13 February 2003. Available at: http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~0kpVZo:1 [Accessed 26 November 2013]

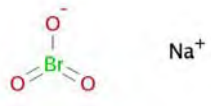
International Agency for Research on Cancer (IARC), 16 June 2013. Agents Classified by the *IARC Monographs*, Volumes 1–108. Available at http://monographs.iarc.fr/ENG/Classification/index.php. [Accessed 26 November 2013].

New Zealand Environment Protection Authority (NZEPA) - New Zealand Hazardous Substances and New Organisms (HSNO) Chemical Classification Information Database (CCID), magnesium chloride, Available at: http://www.epa.govt.nz/search-databases/Pages/ccid-details.aspx?SubstanceID=1983 [Accessed 26 November 2013].

NDF - No data found within the limits of the search strategy.

Created by:	CS	Date: 28/11/2013
Reviewed by:	JF	Date: 11/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium bromate
Synonyms	Sodium bromate(V), Bromic acid, sodium salt, Sodium trioxidobromate, Sodium trioxobromate
CAS number	7789-38-0
Molecular formula	BrHO3.Na
Molecular Structure	

Overview	References
Sodium bromate is an odourless white crystalline substance that is readily soluble in water. It is produced by the introduction of bromine into a solution of sodium carbonate. Sodium bromate readily dissociates in water. Sodium bromate is used as an analytical reagent, in the oxidation of sulfur and vat dyes, and for cleaning boilers. When it is mixed with sodium bromide, it is used for dissolving gold from its ores. The cosmetic industry uses sodium bromate as a neutralizer or oxidizer in hair wave preparations. Following ingestion sodium bromate is rapidly absorbed from the gastrointestinal tract and appears in plasma and urine unchanged and in other tissues as bromide. Most bromate is excreted in the urine, either as bromate or bromide. Given the sodium and potassium salts readily dissociate data for sodium and potassium salts were considered in this profile. Acute toxicity following ingestion of sodium bromate and its surrogate potassium bromate include nausea and vomiting accompanied by abdominal pain and diarrhoea, anaemia, destruction of the red blood cells, decreased blood pressure, convulsions, coma, respiratory depression, and possibly death. Repeat dose toxicity studies with rats, mice and hamsters using the surrogate potassium bromate have identified the kidney as the target organ of bromate. Specific effects include necrosis and degenerative changes in renal tubules and urothelial hyperplasia leading to renal tubular tumours upon oral administration. The relevance of the tumours to humans in unclear (Possible human carcinogen).	US EPA (2001) NCBI (2013) FDA(2013) ECHA (2013)

Human Health Toxicity Summary	Reference
Carcinogenicity -May cause cancer based on demonstrated animal carcinogenicity (The CLP Regulation (which aligns itself with the Globally Harmonised System (GHS) of Classification and Labelling of Chemicals) classifies sodium bromate as a 1B). -IARC (IARC classification of bromate is 2B) has concluded that although there is inadequate evidence of carcinogenicity in humans, there is sufficient evidence for the carcinogenicity of bromate from high- dose studies in experimental animals. This is based on studies where	ECHA (2013) IARC (2013)

potassium bromate was administered orally to rats, mice and hamsters. In rats, it produced renal tubular tumours (adenomas and carcinomas) and thyroid follicular tumours. In mice, it produced a low incidence of renal tubular tumours in males and in hamsters the incidence of renal tubular tumours was marginally increased.	
Mutagenicity/Genotoxicity -Suspected of causing genetic defects (GHS Mutagencity Category 2) based on investigations performed with potassium bromate. In an experiment where V79 Chinese hamster ovary cells were used, bromate increased the frequency of cells with micronuclei, the number of chromosomal aberrations and the number of DNA strand breaks. Potassium bromate also induced gene mutations at the HPRT locus and was mutagenic in Salmonella typhimurium strain TA100 in the presence of S9 activation and produced chromosomal aberrations in cultured Chinese hamster fibroblast cells. Positive results were observed in several in vivo studies.	ECHA (2013)
Reproductive Toxicity -No information on sodium bromate but a one generation reproductive toxicity study with rats was performed on the analogues potassium bromate and a decrease (18%) in epididymal sperm density was observed. Based on this a NOAEL of 7.7 mg /kg/d was obtained (measured as $BrO3^-$).	ECHA (2013)
Developmental Toxicity/Teratogenicity -Not known to cause birth defects or have a deleterious effect on a developing foetus.	SDS (2013)
Endocrine Disruption -Not classified as an endocrine disruptor.	ECED (2013)
Neurotoxicity **-No data found using all proposed data sources.** -	-
Acute Toxicity (oral, dermal, inhalation) -Harmful if swallowed (GHS Acute Toxicity Classification of 4). For rats an oral LD_{50} of 301 mg/kg has been reported for sodium bromate. Sodium bromate was administered orally to women with the lowest toxic dose TD_{LO} of 150mg/kg reported. Behavioural effects included somnolence (general depressed activity), sense organs effects includes changes in ear acuity, and kidney, ureter and bladder effects were observed with a decrease in urine volume. - May cause respiratory irritation (STOT Single Exp. 3) of the respiratory tract via inhalation. -Insufficient data for dermal.	ECHA (2013) ChemIDplus 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) **-**A 13 weeks toxicity study with rats was performed by dosing the animals with potassium bromate in the drinking water. The LOAEL was below 63 mg/kg/d (as BrO_3^-). -Another 15 months toxicity study with male rats was performed by dosing the animals with potassium bromate in the drinking water. The LOAEL was 30 mg/kg/d (as BrO_3^-). -Insufficient data for dermal -Insufficient data for inhalation	ECHA (2013)
Sensitisation of the skin or respiratory system -Not known to cause allergic reaction. **-**May cause respiratory irritation, including pain and coughing.	SDS(2013) ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye -Causes skin irritation (GHS Skin Irritation Category 2) including redness and dermatitis. -Causes serious eye irritation (GHS Eye Irritation Category 2).	ECHA (2013) SDS (2013)

Physical hazards	Reference
Flammable Potential -Not classified as a flammable. -Sodium bromate is a known oxidizing substance (GHS Oxidising. Solid Category 1) which enhances combustion of other substances.	ECHA (2013) IPCS (2013)
Explosive Potential -Not classified as an explosive -There is a risk of explosion on contact with combustible substances or reducing agents.	ECHA (2013) IPCS (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	TDL_0 (oral, women) 150 mg/kg	ChemIDplus 2013
High Chronic/Repeat Dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	301 mg/kg	ECHA 2013
Mouse, oral	140 mg/kg	ChemIDplus 2013
LDL_0		
Rabbit (oral)	250 mg/kg	ChemIDplus 2013
LC_{50}		
	No data found.	All proposed data sources.
High Chronic/Repeat Dose Toxicity		
LOAEL (rats)	< 63 mg/kg/d (based on potassium bromate).	ECHA 2013
LOAEL (rats)	30 mg/kg/d (based on potassium bromate).	ECHA 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
TDL_0 – Lowest toxic dose
LDL_0 – Lowest lethal dose

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	YES	May cause cancer (CLP classification of 1B)
Mutagenicity/Genotoxicity	NO	Insufficient evidence
Reproductive Toxicity	YES	Based on a rats study.
Developmental Toxicity/ Teratogenicity	NO	-
Endocrine Disruption[1]	NO	-
Hazard Band 3		
Acute Toxicity (oral, dermal, inhalation) Very Toxic/Toxic • Oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	NO	-
Carcinogenicity, Mutagencity, Reproductive (Category 2) High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 20 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50ppm/d for gases,≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	YES	Mutagen Category 2 IARC Group 2B
Corrosive (irreversible damage)	NO	
Respiratory sensitiser	NO	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤1.0 mg/L/d for vapours or > 0.02 mg/L ≤0.2 mg/L/d for dust/mists/fumes[4]	YES	Renal tumours in animal studies.
Skin Sensitiser	NO	-
Hazard Band 1		
Acute Toxicity-Harmful • oral$LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal $LD_{50} > 1000$ mg/kg ≤ 2000 mg/kg; • inhalationLC_{50} (6 h/d) > 10 mg/L ≤ 20mg/L for vapours)[4]	YES	For rats an LD_{50} (oral) of 301 mg/kg reported (ECHA 2013)
Irritant (reversible damage)	YES	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	-
Explosive potential	NO	-
Hazard Evaluation (highest band) not including physical hazards	**Band 4**	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4]Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed") (p18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	All proposed data sources.
8-h TWA	No data found.	All proposed data sources.
STEL	No data found.	All proposed data sources.
Peak Limitation	No data found.	All proposed data sources.
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources.
Air, indoor	No data found.	All proposed data sources.
Water, potable	No data found.	All proposed data sources.
Water, recreational	No data found.	All proposed data sources.
Soil, residential	No data found.	All proposed data sources.
Soil, commercial/industrial	No data found.	All proposed data sources.

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Sodium bromate is an odourless white crystalline substance that is readily soluble in water. Following ingestion sodium bromate is rapidly absorbed from the gastrointestinal tract and appears in plasma and urine unchanged and in other tissues as bromide. Given that sodium and potassium salts readily dissociate data for sodium and potassium salts were considered in the human health assessment. Health effects following ingestion of sodium bromate and its surrogate potassium bromate include nausea and vomiting accompanied by abdominal pain and diarrhoea, anaemia, destruction of the red blood cells, decreased blood pressure, convulsions, coma, respiratory depression, and possibly death. Sodium bromate may cause cancer based on demonstrated animal carcinogenicity and is suspected of causing genetic and reproductive defects. Furthermore, sodium bromate causes skin irritation and serious eye irritation. Based on the classifications and data considered sodium bromate is classified as hazard band 4.

References and Notes

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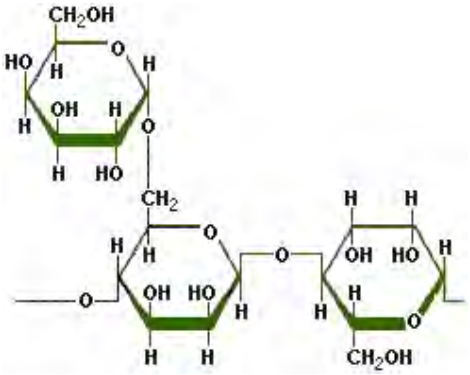
NCBI (2013) US National Library of Medicine, National Institute of Health. Toxicology studies of sodium bromate (CAS No. 7789-38-0) in genetically modified mice (dermal and drinking water studies) and carcinogenicity studies of sodium bromate in genetically modified mice (drinking water studies). Available at http://www.ncbi.nlm.nih.gov/pubmed/18784759 [Accessed 22 August]

US EPA (2001) U.S. Environmental Protection Agency. Toxicological Review of Bromate. In Support of Summary Information on the Integrated Risk. Available at http://www.epa.gov/iris/toxreviews/1002tr.pdf [Accessed 22 August 2013]

Created by:	JH	Date 22/08/13
Reviewed and edited by:	JF	Date 29/08/13
Reviewed and edited by:	PDM	Date 28/08/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Guar Gum
Synonyms:	A-20D, J 2FP, 1212A, Burtonite V-7-E, Cyamopsis gum, Cyanopsis tetragonoloba, Dealca TP1, Dealca TP2, Decorpa, Gendriv 162, Gum cyamopsis Guaran, Guaran, Guar flour, Indalca AG, Jaguar, Jaguar 6000, Jaguar A 20B, Jaguar A 20D, Jaguar A40F, Jaguar Gum A-20-D, Jaguar No 124, Jaguar Plus, Lycoid Dr, NCI-C50395, Regonol, Rein Guarin, Supercol GF, Supercol U Powder, Syngum D 46D, Uni-Gaur
CAS number :	9000-30-0
Molecular formula	Unknown/ Unspecified
Molecular Structure	

Overview	References
Guar gum is a yellowish-white free-flowing powder. It is completely soluble in water and practically insoluble in oils, greases, hydrocarbons, ketones and esters. Water solutions are tasteless, odourless and a pale, translucent grey colour and neutral. The powder has 5 to 8 times the thickening power of starch. Water solution may be converted to a gel by adding a small amount of borox and are stable to heat. Guar gum is extensively used in the community, e.g. typically used as a protective colloid, stabilizer, thickening and film forming agent for cheese, salad dressing, milk products including ice cream and soups; in paper sizing; as a binding and disintegration agent in tablet formulations; in pharmaceutical jelly formulations; in suspension, emulsions, lotions, creams and toothpastes; in bulk laxatives and appetite depressants; in mining industry as a flocculent, for hydraulic fracturing aid in oil well recovery and as a filtering ages; gelling and waterproofing agent in explosive and in water treatment as a coagulant.	HSDB, 2002

Human Health Toxicity Summary	Reference
Carcinogenicity NDF	
Mutagenicity/Genotoxicity Guar gum induced no consistent responses in dominant lethal gene tests to suggest that it was mutagenic to the rat.	HSDB, 2002
Reproductive Toxicity NDF	
Developmental Toxicity/Teratogenicity The developmental effects of guar gum were evaluated in groups of 20 rabbits by daily dermal administration of the test substance for 6 hours/day at dose levels of 0, 2, 10 and 50 mg/kg/day on days 6 through 18 of gestation. The number of early resorptions was significantly increased and the number of viable foetuses was correspondingly decreased at 50 mg/kg/day ($p<0.05$). The NOEL was 2 mg/kg/day. The frequency of foetal malformations and variations in the treated groups was comparable to that of the control group at all dose levels.	HSNO, 2013
Endocrine Disruption NDF	
Neurotoxicity NDF	
Acute Toxicity (oral, dermal, inhalation) Guar gum has been blamed for causing esophageal obstruction. A death has been attributed to the use of one guar gum tablet product, which apparently swelled in the esophagus, indirectly resulting in complications that caused the fatality. Mildly toxic by ingestion.	HSDB, 2002
Chronic/repeat dose toxicity (oral, dermal, inhalation) NDF	
Sensitisation of the skin or respiratory system Occupational asthma has been reported in subjects working with industrial production of guar gum. A respiratory sensitizer.	HSDB, 2002; HSNO, 2013
Corrosion (irreversible and reversible)/irritation of the skin or eye Mildly irritating to the skin. The developmental effects of guar gum were evaluated in groups of 20 rabbits by daily dermal administration of the test substance for 6 hours/day at dose levels of 0, 2, 10 and 50 mg/kg/day on days 6 through 18 of gestation. A dose-related increase in dermal irritation (including erythema, edema, and desquamation) was observed in animals receiving 10 and 50 mg/kg/day.	HSDB, 2002; HSNO, 2013

Physical hazards	Reference
Flammable Potential NDF	
Explosive Potential NDF	

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity	NDF	
High Chronic/Repeat Dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	6770 mg/kg	HSDB, 2002
Rabbit, oral	7000 mg/kg	HSDB, 2002
Mouse, oral	8100 mg/kg	HSDB, 2002
Hamster, oral	6000 mg/kg	HSDB, 2002
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOEL, rabbit, dermal	2 mg/kg/day	HSNO, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOEL – No Observed Effect Limit

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	
Mutagenicity/Genotoxicity	No	HSDB, 2002
Reproductive Toxicity	NDF	
Developmental Toxicity/ Teratogenicity	No	HSNO, 2013
Endocrine Disruption[1]	NDF	
Neurotoxicity[2]	NDF	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	No	HSDB,2002
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NDF	
Corrosive (irreversible damage)	NDF	
Respiratory sensitiser	Yes	HSDB,2002; HSNO, 2013
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]		
Skin Sensitiser	Yes	HSNO, 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	Rat, oral, LD_{50} 6770 mg/kg (HSDB,2002)
Irritant (reversible damage)	Yes	HSNO, 2013
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	NDF	
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	3	Based on respiratory and skin sensitising potential
Uncertainty analysis /data confidence		

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Qualifying Summary Comments

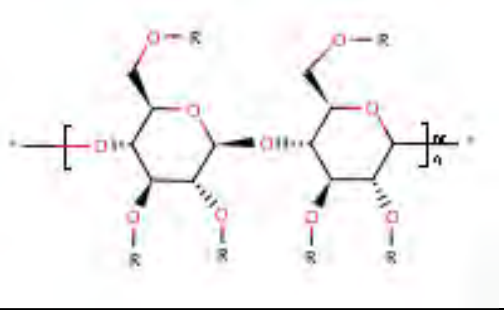
Guar Gum is extensively used in the community and is of limited acute toxicity as reflected in its use as a food additive. The Hazard Band 3 rating is a consequence of its sensitising and irritant properties which are a concern for occupationally-exposed individuals. Such exposure is unlikely following environmental distribution through hydraulic fracturing operations unless there are processes where it results in drying and accumulation of guar gum to the extent that sufficient exposure results.

References

1. HSDB (2002). *Guar Gum*. Hazardous Substances Data Bank, Toxicology Data Network (TOXNET) United States Nation Library of Medicine, 8600 Rockville Pike, Bethesda, MD 2094. [Accessed 10/07/2013].
2. Hazardous Substances and New Organisms (HSNO) 2013, Chemical Classification and Information Database (CCID). *Guar Gum*. New Zealand Environmental Protection Authority, New Zealand Government. [Accessed 10/07/2013].

Created by:	MT	Date 10 July 2013
Reviewed and edited by	LT	Date 23 July 2013 Rev0
Updated	JC	21 August 2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Hydroxypropyl methylcellulose (SURROGATE FOR Hydroxypropyl cellulose 9004-64-2)
Synonyms	2-Hydroxypropyl cellulose methyl ether , 2-Hydroxypropyl methyl cellulose, Cellulose hydroxypropyl methyl ether, Cellulose, 2-hydroxypropyl methyl ether, Hydroxypropyl methyl cellulose, Hydroxypropyl methylcellulose, Hypromellose, Hypromellosum Isopto alkaline, Methocel, Methyl cellulose, propylene glycol ether, Methyl hydroxypropyl cellulose, Methylhydroxypropylcellulosum
CAS number	9004-65-3, surrogate for 9004-64-2
Molecular formula	C3-H8-O2.x-C-H4-O.x-Unspecified
Molecular Structure	

Overview	Reference
Hydroxypropyl cellulose is a derivative of cellulose with both water solubility and organic solubility. It is an organic polymer. It used as an ophthalmic lubricant (component of contact lens wetting solutions), pharmaceutics aid (suspending agent, tablet excipient, viscosity-increasing agent) and food additive (thickening agent, stabilizer and emulsifier).	US NLM (2013); U.S. FDA (2013)
The Joint Food and Agriculture Organization and the World Health Organization (FAO/WHO) Expert Committee for Food Additives (JECFA) has evaluated the food uses of modified celluloses, including hydroxypropyl cellulose, and has concluded that, as a group, modified celluloses are of very low toxicity at the levels of intake necessary to achieve the desired effect and do not pose a hazard to health.	JECFA, 1969
The U.S. Food and Drug Administration's (FDA) Committee on GRAS Substances (SCOGS) considers hydroxypropylmethyl cellulose as Generally Recognized as Safe (GRAS). It is a food additive used as a thickening agent, stabilizer and emulsifier. Hydroxypropylmethyl cellulose is synthesised from methyl cellulose by the action of alkali and propylene oxide. There are no data available to suggest that hydroxypropylmethyl cellulose possesses adverse health effects. However, teratology studies similar to those conducted with methyl cellulose are not available for its hydroxypropyl derivative. Therefore, it is suggested that, in due course, appropriate studies should be conducted with hydroxypropylmethyl cellulose. The Select Committee has weighed the foregoing and concludes that: "*There is no evidence in the available information on hydroxypropylmethyl cellulose that demonstrates, or suggested reasonable grounds to suspect, a hazard to the public when it is used at levels that are now current and in the manner now practiced*".	US FDA (2013)

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC (not currently evaluated by IARC).	IARC 2013
Mutagenicity/Genotoxicity NDF.	
Reproductive Toxicity NDF.	
Developmental Toxicity/Teratogenicity NDF.	
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC 2000
Acute Toxicity (oral, dermal, inhalation) An industrial Bio-test Lab, conducted in 1962 and referenced by JECFA (1969) suggests the LD50 for rat, via oral exposure is10 200 mg/kg.	Industrial Bio-Test Lab, 1962, cited by JECFA (1969)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Groups of five male and five female rats received in their diet 0.2 %, 1.0 % and 5.0 % of hydroxypropyl cellulose for 90 days (concentrations were not provided). Controls received unmodified cellulose at the same levels. There were no differences observed between tests and controls as regards mortality, growth, food utilization, urinalysis, haemotological indices, organ weight, gross pathology and histopathology. At higher dietary levels there were increased food consumption and decreased food utilisation consequential to the inertness of the material.	Industrial Bio-Test Lab, 1963, cited by JECFA (1969)
Sensitisation of the skin or respiratory system NDF.	
Corrosion (irreversible)/irritation (reversible) of the skin or eye NDF.	

Physical Hazards	Reference
Flammable Potential NDF.	
Explosive Potential NDF.	

Toxicity Values	Value	Reference
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	10 200 mg/kg	Industrial Bio-test Lab, 1962 referenced by JECFA, 1969
Rat, dermal	NDF	
Rabbit, dermal	NDF	
LOAEL	NDF	
LOAEC		
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
NOAEL	Estimated to be 2 500 mg/kg	JECFA, 1969
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	
Mutagenicity/Genotoxicity	NDF	
Reproductive Toxicity	NDF	
Developmental Toxicity/ Teratogenicity	NDF	
Endocrine Disruption[1]	No	Not listed as an endocrine disruptor by European Commission, EC 2000
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[2] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L^3 (or mg/m^3) (vapour)	No	See studies listed for Hazard Band 1
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	
Corrosive (irreversible damage)	NDF	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	See studies listed for Hazard Band 1
Skin Sensitiser	NDF	
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	Oral LD_{50} for rat, oral, reported as 10 200 mg/kg
Irritant (reversible damage)	NDF	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	Yes	
Physical Hazards		
Flammable potential	NDF	
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	**0**	
Uncertainty analysis /data confidence	23%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Hydroxypropyl cellulose is an organic polymer which is derivative of cellulose. Based on limited available toxicology data it is considered in Hazard Band 0. However, the JECFA has evaluated the food uses of modified celluloses, including hydroxypropyl cellulose, and has concluded that, as a group, modified celluloses are of very low toxicity at the levels of intake necessary to achieve the desired effect and do not pose a hazard to human health. The SCOGS also reports there are no data available to suggest that hydroxypropylmethyl cellulose possesses adverse health effects. As these cellulose compounds are solids in powder form there is the potential for dust related inhalation hazards. In addition as an organic dust there is the potential for ignition and dust explosions. Taken collectively this hazard profile implies a negligible hazard across most toxicological parameters, however, in the case of dust generation and explosive risk, management of these occupational hazards is required.

References

EC (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, European Commission. Final Report (Incorporating corrigenda to final report dated 21 June 2000).

JECFA (1969) (JECFA), 1969. Hydroxypropyl Cellulose Evaluations of the Joint FAO/WHO Expert Committee on Food Additives Toxicology Monograph 687, FAS 26-JECFA 35/85, 1989. Available at *http://apps.who.int/food-additives-contaminants-jecfa-database/chemical.aspx?chemID=609.* [accessed 18 November 2013].

US NLM (2013) Chem ID Plus Lite Database. Hydroxypropyl methylcellulose. United States National Library of Medicine (NLM) . Available at http://chem.sis.nlm.nih.gov/chemidplus/chemidlite.jsp [Accessed 29 September 2013].

US FDA (2013). Select Committee on GRAS Substances (SCOGS) Opinion: Hydroxypropylmethyl cellulose. U.S. Food and Drug Administration, 10903 New Hampshire Avenue, Silver Spring, MD 20993. U.S. Departments of Health and Human Services. Available at http://www.fda.gov/Food/IngredientsPackagingLabeling/GRAS/SCOGS/ucm260434.htm. [accessed on 18/11/2013].

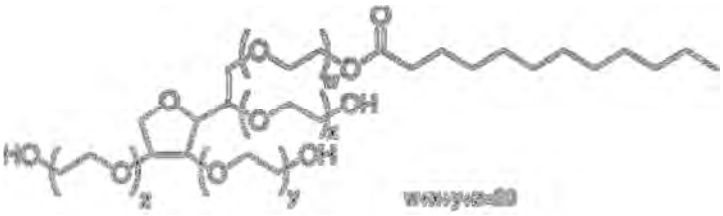
IARC (2013). Agents Classified by the *IARC Monographs*, Volumes 1–108. International Agency for Research on Cancer . Available at http://monographs.iarc.fr/ENG/Classification/index.php. [Accessed 30/10/2013]

Notes

NDF – No data found within the limits of the search strategy

Created by:	MGT	Date: 18/11/2013
Reviewed and edited by:	LT	Date: 11/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sorbitan, monododecanoate, poly(oxy-1,2-ethanediyl) derivatives
Synonyms	Polysorbate 20; PEG(20)sorbitan monolaurate; PEG-10 SORBITAN LAURATE; PEG-40 SORBITAN LAURATE; PEG-44 SORBITAN LAURATE; PEG-75 SORBITAN LAURATE; PEG-80 SORBITAN LAURATE; Polyoxyethylene sorbitan monolaurate; POLYSORBATE 20; POLYSORBATE 21, Commercial brand names: Alkest TW 20 and Tween 20.
CAS number	9005-64-5
Molecular formula	$C_{58}H_{114}O_{26}$
Molecular Structure	

Overview	References
Sorbitan, mono-dodecanoate, poly(oxy-1,2-ethanediyl) derivatives, commonly referred to as Polysorbate 20, belongs to a group of polysorbates which are hydrophilic, non-ionic compounds.	
Polysorbates are widely used in industry, research, pharmacy, and food production. Polysorbate 20 is approved by the US FDA for use as emulsifiers, defoaming agents, synthetic flavorings, stabilizers and thickeners in food, cosmetics, medical products, lubricants and other applications applied up to several times a day to all areas of the skin, hair, nails, and mucous membranes with daily and/or occasional use extending over many years.	HSDB, 2010 US EPA, 2005
It has not been found on a regulatory classification list (Safework Australia).	HSIS, 2013
Sorbitan fatty acid esters and polysorbates show low acute toxicity by the oral and dermal routes and, in general, theirchronic and subchronic toxicity is also low. They show little potential for reproductive or developmental effects, and are generally not considered mutagenic or carcinogenic via oral exposure.	NS, 2008

Human Health Toxicity Summary	Reference
Carcinogenicity	
Not classified on European Chemical Agency (ECHA) database (data lacking).	ECHA,2013
IARC has not evaluated the evidence for the carcinogenicity of Sorbitan, monododecanoate, poly(oxy-1,2-ethanediyl) derivatives.Oral multi-species studies showed no evidence for carcinogenicity. Upon topical application to mice skin, the polysorbates produced benign dermal tumours. Several studies on mouse carcinoma cells have shown that the polysorbates at higher concentrations may inhibit tumour growth in vitro but not in vivo.	IARC,2013 HSDB,2010/ USEPA,2005

Mutagenicity/Genotoxicity Not classified on ECHA database (conclusive but not sufficient for classification). A study according to OECD Guideline 471 (Bacterial Reverse Mutation Assay) was carried out in vitro on test strains S. typhimurium TA 1535, TA 1537, TA 98 and TA 100 and E. coli WP2 uvr A, target genes 'his and trp operon'. The dose concentrations of test substance, PC-2012-412, were between 10 and 5000 µg/plate in the presence and absence of 5-10% S9-mix (metabolic activation system). Multiple tests were ran at varying concentrations and percentages of S9-mix. Cytotoxicity was observed in some test strains at 3330 µg/plate and greater in the presence and absence of the S9-mix. Genotoxicity was not observed in any of the strains tested with or without metabolic activation. A study according to OECD Guideline 473 (In vitro Mammalian Chromosome Aberration Test) was carried out in vitro on peripheral human lymphocytes (isolated from the blood of a healthy adult, non-smoking, male volunteers (26-31 years old)). The dose concentration of test substance, PC-2012-412, were between 10 and 800 µg/mL culture medium in the presence and absence of S9-mix. Multiple tests were run at varying concentrations, and over different exposure/fixation periods. Cytotoxicity was observed in a continuous experiment (48hr exposure and fixation period) at dose of 300 µg/mL. Genotoxicity observations were negative.	ECHA,2013
Reproductive Toxicity Not classified on ECHA database (data lacking). Reproductive toxicity induced in rats and mice by intraperitoneal injections during pregnancy was not observed in rats given the polysorbate 20 either orally or dermally.	BIBRA,1989
Developmental Toxicity/Teratogenicity Not classified on ECHA database (conclusive but not sufficient for classification). A study similar to OECD Guideline 414 (Prenatal Developmental Toxicity Study) was carried out on female Sprauge-Dawley rats. Oral dose concentrations of test substance, Polyoxyethylene sorbitan monolaurate, polysorbate 20, 500 and 5000 mg/kg bw were administered daily for a 20 day period (from gestation day 6-15). Maternal toxic effects observed decrease in weight gain, LOAEL was 5000 mg/kg bw/day and NOAEL >5000 mg/kg bw/day. No teratogenic effects observed, NOAEL >5000 mg/kg bw/day.	ECHA,2013 US EPA, 2005
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC,2000
Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) Not classified on ECHA database (oral and inhalation - conclusive but not sufficient for classification), (dermal – data lacking). The LD50 values for 33 acute oral toxicity studies in rats ranged between 5000 and 38,900 mgkg. A study similar to OECD Guideline 402 (Acute Dermal Toxicity) was carried out on albino guinea pigs exposed to test substance Polysorbate 20 (3000mg/kg) via dermal contact for 24	USEPA, 2005

hours. No controls used. No observations of toxicity and no gross pathology abnormalities at necropsy. LD50 >3000 mg/kg bw. A study according to OECD Guideline 403 (Acute Inhalation Toxicity) carried out on rats via 4 hour inhalation exposure to the nose, test substance, PC-2012-412, concentration 5.1 mg/L. No control animals used. No mortalities occurred, no clinical observations of systemic toxicity over 14 day period and no gross pathology abnormalities at macroscopic examination. LC50 >5.1mg/L air. An intravenous acute toxicity study was undertaken on Wistar rats, predating toxicity classifications. A 50% (w/v) solution of the test substance in propylene glycol was administered via tail vein infusion. Dose concentrations of 795, 1000, 1260, 1410 and 1580 mg/kg bw. No control animals. Toxicity observations of depression, laboured respiration ataxia and convulsions. Gross pathology observations on mortalities of congested lungs, clotted blood in hearts. For test rats who survived, no remarkable gross pathology observations. LD50 1380 mg/kg bw.	ECHA,2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified on ECHA database (conclusive but not sufficient for classification). A study predating toxicity classification was undertaken on rats. Test substance, polyoxyethylene sorbitan monolaurate 21 at 2000 mg/kg bw/day in the diet of male rats for a 2 year period. Controls used. No observations of mortality, systemic toxicology or gross pathology. NOAEL >2000mg/kg bw/day. On repeated intravenous administration, effects on the liver, spleen and kidneys were seen in premature babies (animals) exposed to polysorbate 80:polysorbate 20 mixture and some fatalities occurred. In rats and hamsters, repeated oral exposure to polysorbate 20 produced damage at a range of sites including the gastro-intestinal tract, liver and kidneys. No data found for dermal or inhalation chronic toxicity.	ECHA,2013/ US EPA, 2005 BIBRA,1989
Sensitisation of the skin or respiratory system Not classified on ECHA database (skin - conclusive but not sufficient for classification and respiratory system – data lacking). A study according to OECD Guideline 406 (Skin Sensitisation) was carried out in vivo on female guinea pigs. Controls used. Clinical observations 72 hours after exposure indicate that test substance, PC-2012-412 administered interdermal and on skin surface is not sensitising. No data found for respiratory system.	ECHA,2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Not classified on ECHA database (conclusive but not sufficient for classification). A study according to OECD Guideline 404 (Acute Dermal Irritation / Corrosion) was carried out in vivo on New Zealand White rabbits. Dose concentration of test substance, PC-2012-412, 0.5mL, applied over 4 hr, 14 day observation period. Slight erythema (score of 0.89/4) but not oedema was observed, these slight effects fully reversed within 7 days. A study according to OECD Guideline 405 (Acute Eye Irritation / Corrosion) was carried out in	ECHA,2013

vivo on New Zealand White rabbits. Untreated eyes were the controls. Test material (0.1mL) single application, washed or unwashed after 2 seconds. Observations over 7 days indicate negative results for conjunctivae, iris and cornea, therefore results are non-irritating. Primary rabbit skin irritation studies using the Draize method were performed, with 6 studies showing no signs of irritation, 3 studies showing minimal irritation, and one study showing mild irritation. All of these studies used 100% concentrations of polysorbate, 20, 40, 60, or 80. The polysorbates were non-irritating to mildly irritating in both in-vivo and in-vitro ocular irritation assays (CIR 2000). Twenty-three Draize rabbit eye irritation studies of the polysorbates showed either no irritation or minimal irritation using concentrations ranging between 30% w/v in distilled water and 100% polysorbate 20,2 1,40, 60,61,65, 80, 8 1, or 85	US EPA, 2005

Physical Hazards	Reference
Flammable Potential Flashpoint >149°C. Flashpoint >148.9 °C	NS, 2008 FDA, 2010
Explosive Potential No data found.	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found (NDF)	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rodents, oral	5000mg/kg	EPA,2005
Mouse, oral	NDF	
Rabbit, oral	NDF	
Guinea pig, dermal	>3000 mg/kg bw	ECHA, 2013
Rabbit, dermal	NDF	
Rats, intravenous	1380 mg/kg bw	ECHA, 2013
LC_{50}		
Rat, inhalation	>5.1mg/L	ECHA, 2013
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL, rats, oral	>2000 mg/kg bw/day	ECHA, 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	ECHA, 2013, US EPA, 2005
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA,2013
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	BIBRA,1989
Endocrine Disruption[1]	No	EU, 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	ECHA, 2013, US EPA, 2005
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA,2013
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	BIBRA,1989
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	No	Oral, rats LD50 5000mg/kg USEPA,2005 Dermal, guinea pig LD50 >3000mg/kg bw Intravenous, rat LD50 1380mg/kg bw Inhalation, rat LD50 >5.1mg/L ECHA, 2013
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	Oral study – Maternal toxicity LOAEL 5000 mg/kg bw/day NOAEL >5000 mg/kg bw/day teratogenicity toxicity NOAEL >5000 mg/kg bw/day. ECHA, 2013
Corrosive (irreversible effect)	No	ECHA, 2013 USEPA, 2013
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Oral, rats NOAEL >2000mg/kg bw/day
Skin Sensitiser	No	ECHA, 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	Oral, rats LD50 5000mg/kg USEPA,2005 Dermal, guinea pig LD50 >3000mg/kg bw Intravenous, rat LD50 1380mg/kg bw Inhalation, rat LD50 >5.1mg/L

		ECHA, 2013
Irritant (reversible effect)	Yes	ECHA,2013
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	Yes	NS, 2008 FDA, 2010
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	1	
Uncertainty analysis /data confidence (out of 12 parameters)	11/12	**92%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1] *Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Neurotoxicity based on REACH assessments.*

[3] *milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	NDF	
8-h TWA	NDF	
STEL	NDF	
Peak Limitation		
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational		
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:
OEL = Occupational Exposure Limit
TWA= 8 h Time-Weighted Average
STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Polysorbate 20 is a non hazardous substance with a variety of uses including food, medicine and cosmetics. Polysorbate 20's can result in transient mild irritant effects. as observed in animal studies with some limited human evidence of the potential for sensitisation. The most likely exposure to these chemicals is via the dermal route, however a low concern for human health effects is anticipated based on their low potential for irritation and dermal absorption on intact skin. Polysorbate is categorised as hazard band 1, due to reversible irritation.

The direct use of this substance by workers (or those acutely exposed through emergency spills) presents as the main hazard that could be realised and would be the subject of management controls. It is not anticipated that incorporation at low concentrations into hydraulic fracturing mixtures and environmental dissemination would observe the above adverse outcomes following exposure to hydraulic fracturing fluids. Further evaluation of resultant mixtures is required to support this interpretation.

References and Notes

European Chemicals Agency (ECHA) (2013) Sorbitan monolaurate, ethoxylated. Available at: <http://apps.echa.europa.eu/registered/data/dossiers/DISS-dffb4072-e33d-47ae-e044-00144f67d031/AGGR-cbca8e7d-d960-410d-9a51-57023442a95f_DISS-dffb4072-e33d-47ae-e044-00144f67d031.html#GEN_RESULTS_HD> [Accessed 5 December 2013].

European Commission (EC) (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

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IARC (2012) Agents classified by IARC Monographs Volumes 1- 105. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf. [Accessed 5 December 2013].

Natural Sourcing (NS), Specialists in Cosmeceutical Ingedients, MSDS Polysorbate 20, Avaliable at: <http://www.naturalsourcing.com/msds/MSDS_Polysorbate_20.pdf>[Accessed 5 December 2013].

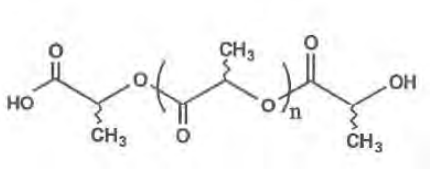
Safework Australia (SWA) (2013) Hazardous Substances Information System (HSIS). Available at: <http://hsis.safeworkaustralia.gov.au/HazardousSubstance> [Accessed 5 December 2013].

United States Environmental Protection Agency (EPA) (2005) Office of Prevention, Pesticides and Toxic Substances: Action Memorandum: Inert Reassessment – Members of the Sorbitan Fatty Acid Esters and the Polysorbates. Available at: <http://www.epa.gov/opprd001/inerts/sorbitan5-20-05.pdf>[Accessed 5 December 2013].

NDF - No data found within the limits of the search strategy.

Created by:	CS	Date: 5/12/2013
Reviewed by:	JF	Date 13/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Polylactide resin
Synonyms	Not Applicable
CAS number	9051-89-2
Molecular formula	(C6H8O4.C6H8O4.C6H8O4)x
Molecular Structure	

Overview	References
Polylactide (PLA), a polymer derived from lactic acid (2-hydroxy propionic acid). PLA is a solid resin (powder or pellets) and is insoluble in water. PLA can hydrolyse in water to form lactic acid. Migrants from PLA may include lactic acid, lactoyl-lactic acid, other small oligomers of PLA and lactide. However, lactic acid is the primary substance of interest as the other species are expected to ultimately hydrolyse to lactic acid in the media commonly found in food systems or in the human digestive track. As a result the human health toxicology data has been predominantly based on lactic acid, with a few inferences made from calcium lactate where lactic acid data was not available.	
PLA offers several technical properties that make it useful in a variety of food and pharmaceutical applications. Particularly, the moisture and oxygen barrier properties of this polymer make it useful in food and pharmaceutical flexible packaging and in certain rigid pack applications.	FDA (2013)
Some of the common food packaging applications of PLA include short shelf life products such as containers, drinking cups, sundae and salad cups, overwrap and lamination films and blister packages. Newer applications include thermoformed PLA containers being used in retail markets for fresh fruit and vegetables.	FDA (2009)
Furthermore, PLA has been widely studied for use in medical applications because of its bioresorbable and biocompatible properties in the human body.	Conn *et al.* (1995)
PLA has been assessed by the US Food and Drug Administration. It is non-hazardous. The Safety assessment of PLA is based on lactic acid which is a raw material in PLA manufacture and a hydrolysis product. Other studies have done safety assessments on the use of PLA for food packaging and concluded that PLA is safe or use for fabricating articles that will hold and/or package food. This is primarily due to the studies finding that the amount of lactic acid and its derivatives that migrate to food simulant solutions from PLA is much lower than the current average dietary lactic acid intake values allowed by several government agencies.	Auras *et al.* (2004)
Lactic acid is produced in varying amounts by most living tissues as a normal metabolic intermediate. The lactate turnover rate in man has been estimated to be of the order of 2g per kg per day. It is generally recognised as safe. When present in the neat form it is a hazardous substance as it can cause severe eye irritation and moderate skin irritation.	

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified as to its carcinogenicity to humans. *Notes:* The long-term toxicity carcinogenicity of calcium lactate, a food additive, was examined in a rat study. Calcium lactate was given in the drinking-water at levels of 0, 2 5 or 5% to groups of 50 male and 50 female rats for two years. No clear toxic lesion was specifically caused by long-term administration of calcium lactate. No significant dose-related increase was found in the incidences of tumours in any organ or tissue The results indicated that calcium lactate had neither toxic nor carcinogenic activity in the rats. Based on this data and lactic acid being a major metabolic species, and a ubiquitous food ingredient, carcinogenicity was considered an irrelevant end point.	ECHA (2013)
Mutagenicity/Genotoxicity Not classified as a mutagenic/genotoxic chemical.	ECHA (2013)
Reproductive Toxicity Not classified as having reproductive toxicity effects.	ECHA (2013)
Developmental Toxicity/Teratogenicity Not classified as having developmental toxic/teratogenic effects	ECHA (2013)
Endocrine Disruption PLA or lactic acid have not been included in the European Commission's Endocrine Disrupters Priority List.	ECED (2013)
Neurotoxicity No information found.	All proposed data sources
Acute Toxicity (oral, dermal, inhalation) Not classified as having acute toxic effects when administered orally, applied to the skin or when inhaled. *Notes:* Lactic acid was administered to rats by oral gavage. The LD_{50} is higher than the upper limit for classification (2000 mg/kg bw). The LD_{50} of 3543 mg/kg was reported for the female rats and an LD_{50} of 4936 mg/kg for the male rats. Acute dermal toxicity was evaluated by applying 2000 mg/kg to the skin (clipped free of hair and abraded) of 5 male and 5 female rabbits for 24 hours of exposure. No abnormal clinical signs were observed during the 14 day study. It was concluded that the application was irritating but otherwise practically non-toxic. Male and female rats were exposed to a concentration of approximately 7.94 mg/L for four hours to determine any acute inhalation toxicity. Rapid breathing and eye tearing were observed during exposure however, most of the animals appeared normal at 24 hours and for the remainder of the 14 day observation period (with the exception of one female rat that died on day nine). The LC_{50} is greater than 7.94 mg/L.	ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as having chronic oral, dermal or inhalation effects. *Notes:* Calcium lactate was administered orally to rats for 13 weeks. All observed effects could be attributed to calcium overload/imbalance. No lactate toxicity was observed.	ECHA (2013)

Lactic acid was applied dermally to rates at a concentration of 886 mg/kg. All animals survived to study termination. No significant gross observations, with the exception of minimal skin irritation throughout the study.	
Sensitisation of the skin or respiratory system Not classified as a skin or respiratory sensitiser.	
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes skin irritation (GHS Skin Irritation Category 2). Causes serious eye irritation (GHS Eye Irritation Category 1). *Notes:* Primary dermal irritation potential was evaluating by the application of the chemical to intact and abraded test sites on the skin of 6 albino rabbits covered with impervious bandages for 24 hours. Severe conditions were observed including severe erythema, severe edema and missing skin. Lactic acid was examined undiluted for eye irritating/corrosive potential in an ex-vivo bioassay, namely the Enucleated Eye Test with chicken eyes (CEET). The results showed that it induced severe corneal effects.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as a flammable liquid. Lacking data for classification in the solids, gases and aerosols forms.	ECHA (2013)
Explosive Potential Not classified as an explosive chemical.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
High Chronic/Repeat Dose Toxicity		
NOEC	Lactic acid is produced in varying amounts by most living tissues as a normal metabolic intermediate. The lactate turnover rate in man has been estimated to be of the order of 2g per kg per day.	FDA (2013)
LOAEL		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	3543 mg/kg (female), 4936 mg/kg (male)	ECHA 2013
Mouse, oral		
Rabbit, oral		
Rat, dermal		
Rabbit, dermal	>2000 mg/kg	ECHA 2013
Mouse, dermal		
LOAEL		

LOAEC		
LC_{50}		
Rat	>7.94 mg/L	ECHA 2013
High Chronic/Repeat Dose Toxicity		
LOAEL		
LOAEC		

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	
Corrosive (irreversible damage)	NO	Lactic acid can cause serious eye damage given its relatively high solubility and low molecular weight. PLA is not expected to cause serious eye damage as it is less soluble and its physical form as a resin prevents intimate contact with the mucous membrane.
Respiratory sensitiser	NO	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NO	
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	NO	
Irritant (reversible damage)	YES	Causes skin irritation (based on lactic acid).

Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NO	Not classified as a flammable liquid. Data lacking for solid, gas and aerosol forms.
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	Band 1	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	All proposed data sources.
8-h TWA	No data found.	All proposed data sources.
STEL	No data found.	All proposed data sources.
Peak Limitation	No data found.	All proposed data sources.
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources.
Air, indoor	No data found.	All proposed data sources.
Water, potable	No data found.	All proposed data sources.
Water, recreational	No data found.	All proposed data sources.
Soil, residential	No data found.	All proposed data sources.
Soil, commercial/industrial	No data found.	All proposed data sources.

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

PLA has been assessed by the US Food and Drug Administration and has been classified as non-hazardous where the safety assessment of PLA was based on lactic acid. It is approved for use in food packaging and for use in some therapeutic product applications. Lactic acid has been used as a surrogate for the hazard profile because it is the raw material in PLA manufacture and a hydrolysis product. Furthermore, the other migrants from PLA are expected to ultimately hydrolyse to lactic acid in the media commonly found in food systems or in the human digestive track. Based on similar approach (i.e. using lactic acid data), other safety assessments on the use of PLA for food packaging and concluded that PLA is safe or use for fabricating articles that will hold and/or package food. Although lactic acid is considered as generally recognised as safe it can cause severe eye irritation and moderate skin irritation when in its neat form. Given that polylactide is relatively less soluble and is present in a resin form with a higher molecular weight it is unlikely to cause the same degree of irritation to the eye or skin. On this basis polylactide was categorised as Hazard Band 1.

References and Notes

Auras R., Harte B. and Selke D (2004). An Overview of Polylactides as Packaging Materials. Macromolecular Bioscience. Vol. 4, pp. 835-864.

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FDA (2009). U.S. Food and Drug Administration, Attachment 9: Environmental Assessment. Available at http://www.fda.gov/downloads/Food/FoodIngredientsPackaging/EnvironmentalDecisions/UCM214608.pdf [Accessed 4 September 2013]

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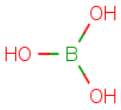
Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Created by:	JH	Date 2/9/13
Reviewed and edited by:	JF	Date 5/9/13

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Boric Acid
Synonyms	Hydrogen borate; boracic acid; acidum boricum; trihydroxidoboron
CAS number	10043-35-3
Molecular formula	H_3BO_3
Molecular Structure	

Overview	References
Boric acid is an inorganic, white, odourless, crystalline solid with a water solubility of approximately 49.2 g/L at 20°C.	ECHA (2013)
The substance decomposes on heating above 100°C, producing water and the irritant boric anhydride. The solution in water is a weak acid.	ICPS (1994)
Low concentrations of simple inorganic borates (e.g. boric acid, disodium tetraborate pentahydrate, boric oxide and disodium octaborate tetrahydrate) will predominately exist as un-dissociated boric acid in aqueous solutions at physiological and acidic pH. At about pH10 the metaborate anion ($B(OH)_4^-$) becomes the main species in solution. This leads to the conclusion that the main species in the plasma of mammals and in the environment is un-dissociated boric acid.	ECHA (2014)/ WHO (1998)
Boric acid is classified as a hazardous substance by Safe Work Australia, within its Hazardous Substances Information System, with associated safety phrases of "*Risk Phase R60 (may impair fertility)*" and "*R61 (may cause harm to the unborn child)*".	SafeWork (2009)
Boric acid is also a classified substance according to the Global Harmonised System (GHS) classification.	ECHA (2014)
The US EPA (2004) states that the main uses of boric acid (and sodium salts of boron (primarily borax, or disodium tetraborate decahydrate)) are: • industrial purposes including manufacture of glass, fiberglass insulation, porcelain enamel, ceramic glazes, and metal alloys • as fire retardants in cellulose insulation • laundry additives • fertilisers (boron is an essential element for plants) • herbicides (at high concentrations, boron is toxic to certain plant species) • insecticides.	US EPA (2004)

Human Health Toxicity Summary	Reference
Carcinogenicity ECHA (2014) states that '*an OECD 451 study in mice consisting of 50 per sex per group treated in diet for 103 weeks with 0 ppm, 2,500 ppm or 5,000 ppm boric acid showed no evidence of carcinogenicity (NTP classification meaning no chemically related increase in benign or malignant neoplasms)*'. IARC have not reviewed the carcinogenicity of boric acid. The US EPA has classified boric acid as Group E – evidence of non-carcinogenicity for humans.	ECHA (2014) IARC (2011), US EPA (2006)
Mutagenicity/Genotoxicity ECHA report a study in male and female mice following oral administration at doses of 0 mg/kg/d, 225 mg/kg/d, 450 mg/kg/d, 900 mg/kg/d, 1 800 mg/kg/d and 3 500 mg/kg/d of boric acid in distilled water over a 2 day period. Boric acid at the concentrations used in the study was not reported as being genotoxic.	ECHA (2014)
Reproductive Toxicity ECHA (2014) reports that boric acid may damage fertility or the unborn child with a subsequent classification of Category 1B. Short- and long-term oral exposures to boric acid or borax in laboratory animals have demonstrated that the male reproductive tract is a consistent target of toxicity. Testicular lesions have been observed in rats, mice, and dogs given boric acid or borax in food or drinking-water. A three-generation study in rats was undertaken at doses of 0 ppm, 670 ppm, 2 000 ppm or 6 700 ppm boric acid in the diet. Rats exposed to the highest dose were sterile and evidence of decreased ovulation was observed in about half of the ovaries examined from the females exposed to the highest dose. There were no adverse effects on reproduction reported at the lower doses with a LOAEL for reproductive toxicity of 336 mg/kg.	ECHA (2014)
Developmental Toxicity/Teratogenicity The teratogenicity of the test substance was assessed according to OECD guideline 414. There was no evidence of developmental toxicity in offspring of rats fed boric acid in diet throughout gestation up to a dose of 0.075 % (55 mg/kg boric acid). At 0.1 % boric acid (76 mg/kg boric acid) effects such as reduced fetal bodyweight and short and wavy ribs were observed with more marked effects at the highest dose of 0.2 % (143 mg/kg boric acid).	ECHA (2014)
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	BKH (2000)
Neurotoxicity NDF.	
Acute Toxicity (oral, dermal, inhalation) **Oral** An acute oral LD_{50} value of >2 600 mg/kg was determined from a study on rats in which the animals were administered doses of anhydrous boric acid at concentrations of 1 540 mg/kg or 2 600 mg/kg. No symptoms were observed for animals dosed at 1,540 mg/kg. Six groups of 5 male and 5 female rats were orally administered boric acid as 50% w/v suspension in 0.5% aqueous methyl cellulose at 2 000 mg/kg, 2 500 mg/kg, 3 160 mg/kg, 3 980 mg/kg, 5 010 mg/kg and 6 310 mg/kg. The rats were then observed at 1 h, 2 h, 4 h, and 24 h intervals and then once a day for a total of 14 days. The LD_{50} for male rats was determined as 3,450 (2,950 – 4,040) mg boric acid/kg, and as 4,080 (3,640 – 4,560) mg boric acid/kg for female rats. A study of 45 rats determined an oral LD_{50} of 2 660 mg/kg. Test conditions such as the number of animals per dose, the doses and the use of control groups was not provided.	ECHA (2014)

Symptoms included signs of central nervous system depression, ataxia and convulsions. **Inhalation:** Five male and five female rats were exposed to an aerosol of boric acid for a duration of 4 h and 9 m at a maximum dose of ~ 2 mg/L. The animals were then observed for a total of 14 days following exposure. An LC_{50} of > 2.03 mg/L air was determined from the results of the study. Five female and five male rats were exposed to boric acid dust at an analytical concentration of 2,120 ± 140 mg/m^3 over a 4 h period. The animals were then observed for a total of 14 days. An LC_{50} of > 2.12 mg/L was determined from the study. **Dermal:** Boric acid at a concentration of 2 000 mg/kg (moistened with 1.5 mL saline) was applied to the skin of five male and five female rabbits and removed following a 24 h period. The rabbits were observed for a 14 day period following administration. An LD_{50} of >2 000 mg/kg was determined from the study with clinical changes observed being erythema, oedema, atonia, desquamation, necrosis and some incidences of skin irritation following 24 h of treatment.	ECHA (2014) ECHA (2014)
Chronic/repeat dose toxicity (oral, dermal, inhalation) A 2 year dietary feeding study in rats at a dose rate of 0 ppm, 670 ppm, 2 000 ppm and 6 690 ppm boric acid, equivalent to 0 mg boric acid/kg/d, 33 mg boric acid/kg/d, 100 mg boric acid/kg/d and 334 mg boric acid/kg/d was undertaken. Testicular atrophy and seminiferous tubule degeneration was observed at 6, 12 and 24 months at the highest dose level only. No treatment related effects were observed in the mid and low dose groups. A NOAEL of 100 mg boric acid/kg/d (nominal) and LOAEL of 334 mg boric acid/kg/d (nominal) were reported.	ECHA (2014)
Sensitisation of the skin or respiratory system A 95 % w/w (400 mg) boric acid moistened with distilled water was applied to the skin of twenty guinea pigs with '*very faint erythema observed in one animal at induction stage and 2 animals at challenge stage and also in one naïve control. No other adverse effects were observed therefore the test substance was considered a non-sensitiser'.* In a supporting study within ECHA (2014) three patients (human) were patch tested with 3% w/v boric acid. No sensitisation was reported.	ECHA (2014)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye **Skin** Boric acid was applied to the skin of ten rabbits at a concentration of 0.5 g (moistened with physiological saline) for a 24 h period with subsequent observations over a 72 h period. No irritancy was observed. Boric acid was applied to six rabbits with intact and 6 rabbits with abraded skin at a concentration of 5 mL as a 10 % solution on a cellulose pad. The study concluded that at 10% boric acid was not considered irritating to skin. The same study was also undertaken on guinea pigs with the same conclusion reached. Anhydrous boric acid 100 mesh (concentration not specified) was applied to the skin of 6 rabbits for a 4 h period with subsequent observations for a 48 h period. The study concluded that the test substance was not considered corrosive to the skin. **Eye** Boric acid (100 mg) was applied to one eye each of 6 rabbits for a period of 24 h with boric acid used at up to 5 % in eye washes. The animals were observed for a 21 day period following application. It was reported that boric acid applied to the eye at this concentration was slightly irritating based on changes in colouration and texture of the eye and blistered appearance of the conjunctiva. These effects were reversed after seven days. Additional studies in rabbits have reported similar results demonstrating reversible eye irritation	ECHA (2014)

with increasing severity in cases where the anhydrous form was retained within the eye.	

Physical Hazards	Reference
Flammable Potential The results of one study classified boric acid as non-flammable based on the boric acid crystals not igniting during the test.	ECHA (2014)
Explosive Potential NDF.	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	>2 600 mg/g 3 450 mg/kg (male) 4 080 mg/kg (female) 2 660 mg/kg	ECHA (2014)
Mouse, oral	3 450 mg/kg	ECHA (2014)
Rat, dermal	NDF	
Rabbit, dermal 24 h	>2 000 mg/kg	
Mouse, dermal	NDF	
LC_{50}		
Rat (inhalation) 2 h aerosol	>2.03 mg/L (4 h) >2.12 mg/L (4 h, dust)	ECHA (2014)
Mouse (inhalation) 2 h aerosol	NDF	
Guinea Pig (inhalation) 2 h aerosol	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	Oral 336 mg/kg/d (reproductive toxicity) 334 mg/kg/d (	ECHA (2014)
LOAEC	NDF	
NOAEL	Oral 100 mg/kg/d (	ECHA (2014)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level
NDF – no data found within the limits of the search strategy

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	ECHA (2014), Not evaluated by IARC (IARC, 2011) US EPA (2006)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2014)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	Yes	Classified as Category 1B, may damage fertility or the unborn child (ECHA, 2014)
Endocrine Disruption[1]	No	Not listed as an endocrine disruptor by European Commission (BKH, 2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	See above
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2014)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA (2014)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	Lowest LD_{50} found during search was 2 660 mg/kg. Lowest dermal LD_{50} found was >2 000 mg/kg (ECHA, 2014)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 20 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	Lowest oral LOAEL for reproductive toxicity (boric acid) found during search was 334 mg/kg/d (ECHA, 2014)
Corrosive (irreversible effect)	No	ECHA (2014)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6 h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Lowest oral LOAEL for reproductive toxicity (boric acid) found during search was 334 mg/kg/d (ECHA, 2014)
Skin Sensitiser	No	ECHA (2014)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2,000 mg/kg • dermal LD_{50} >1,000 mg/kg ≤ 2,000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	Lowest oral LD_{50} found during search was 2 600 mg/kg (ECHA, 2014) Lowest dermal LD_{50} found was >2 000 mg/kg (ECHA, 2014)

Irritant (reversible effect)	Yes	One study concluded that at 100 mg boric acid was considered irritating to the eyes of rabbits (ECHA, 2014)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No	ECHA (2014)
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	4	
Uncertainty analysis /data confidence (out of 12 parameters)	10/12	**83%**

** Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].*

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.
[2] Neurotoxicity based on REACH assessments.
[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)
[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	4 mg boron/L	ADWG (2011)
Water, recreational	As above	NHMRC (2008)
Soil, residential	4,500 mg boron/kg	NEPM, 2013
Soil, commercial/industrial	300,000 mg boron/kg	NEPM, 2013

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Boric acid is an inorganic, white, odourless, crystalline solid. Its primary uses (along with sodium salts of boron (primarily borax, or disodium tetraborate decahydrate)) are in industrial processes such as the manufacture of glass, as a fire retardant, in laundry additives, in fertilisers and in herbicides. Low concentrations of simple inorganic borates (e.g. boric acid, disodium tetraborate pentahydrate, boric oxide and disodium octaborate tetrahydrate) will predominately exist as un-dissociated boric acid in aqueous solutions at physiological and acidic pH. Boric acid was assigned a Human Health Toxicity Ranking of Hazard Band 4 based on research supporting a potential to cause reproductive toxicity. (In addition, anhydrous boric acid and aqueous solutions have been reported as being irritating to the eye. While acute exposures under occupational settings require management, including cases of inadvertent large scale spills (emergency response) boron and inorganic salts of boron should not be allowed to enter surface waters or waters scheduled for human use. Should the latter arise, monitoring and management measures would be required due to the persistence of boron under aqueous conditions and the potential for human exposures.

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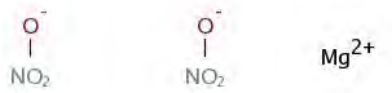
Created by:	CM	09/01/2014
Reviewed::	LT	16/01/2014

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Magnesium nitrate
Synonyms	Nitric acid; magnesium salt; magnesium dinitrate
CAS number	10377-60-3
Molecular formula	$Mg(NO_3)_2$
Molecular Structure	

Overview	References
Magnesium nitrate is a water soluble inorganic salt that appears as colourless or white cubic crystals. It is very hygroscopic and in air quickly forms the hexahydrate with the formula $Mg(NO_3)_2.6H_2O$. Magnesium nitrate is used in fertiliser, as a catalyst in the manufacture of petrochemicals, as a desensitiser for lithographic plates and in pyrotechnics. Magnesium nitrate hexahydrate (CAS number 13446-18-9) is a common commercial form of magnesium nitrate. Magnesium nitrate itself is not flammable or explosive but is classified as an oxidising solid which will react with reducing materials and enhance combustion of other substances. The substance decomposes on heating (at 330 ^{o}C) and in a fire may emit toxic NO_x fumes of oxides of nitrogen. Absorption of the substance may occur through the gastrointestinal system, inhalation and through dermal contact. The substance will readily dissociate into the magnesium cation and nitrate anion. Magnesium cations are integral components of normal human metabolic processes and are metabolised in the human body through well-understood pathways. Nitrate is a naturally occurring ion which is part of the nitrogen cycle. Nitrate is a natural constituent of soil and vegetation and is a normal metabolite in mammals. Methemoglobinemia is the primary adverse health effect associated with human exposure to high levels of nitrate. A nuisance-causing concentration of airborne particles can be reached quickly when dispersed; occupational exposure limits have not been established. Magnesium nitrate solution (with <5% calcium nitrate and <5% nitric acid) is classified as a skin irritant and causes serious eye damage. No LD/LC_{50} values were specifically found for magnesium nitrate. It was considered appropriate to consider information relating to the health effects of nitrates based on dissolution of the inorganic compound and the low hazard properties of magnesium in solution. LD_{50} ratings for sodium nitrate are indicated in the table below	USEPA (2005); ECHA (2013); Ropp, (2013); IPCS (1996)

Human Health Toxicity Summary	Reference
Carcinogenicity Currently not evaluated by IARC.	IARC (2013)
Mutagenicity/genotoxicity ECHA has not reported this substance to be mutagenic or genotoxic. An in vitro Salmonella typhimurium reverse mutation assay and Escherichia coli reverse mutation assay concluded that magnesium nitrate hexahydrate did not exhibit any mutagenic activity under the conditions of the test. An in vitro mammalian chromosome aberration test and mammalian cell gene mutation assay carried out for sodium nitrate (CAS number 7631-99-4) concluded that the substance did not exhibit any mutagenic activity under the conditions of the test.	ECHA (2013)
Reproductive Toxicity ECHA has not reported this substance to be toxic to the reproductive system. No adverse effects were seen on reproductive toxicity endpoints during a reproduction/developmental toxicity screening test carried out for potassium nitrate on male and female rats (gavage). The maximum dose was 1500 mg/kg/day.	ECHA (2013)
Developmental Toxicity/Teratogenicity ECHA has not reported this substance to be toxic to development. No adverse effects were seen on developmental toxicity endpoints during a reproduction/developmental toxicity screening test carried out for potassium nitrate on male and female rats (gavage). The maximum dose was 1500 mg/kg/day.	ECHA (2013)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity No data available.	
Acute toxicity (Oral, Dermal or Inhalation) ECHA has not reported this substance to be acute toxic. *Oral* Classification based on an oral acute toxicity study for magnesium nitrate hexahydrate; the substance does not require classification under the GHS. A single dose of 2000 mg/kg was provided by gavage to six (two subsequent groups of three animals) female rats (Wistar). No mortality occurred and no abnormalities were found at macroscopic post mortem examination of the animals. *Dermal* Classification based on a dermal acute toxicity study for potassium nitrate, the substance does not require classification under the GHS. A maximum dose (dermal, occlusive) of 5000 mg/kg was applied to male/female rats (Sprague-Dawley). All animals survived, gained weight and appeared active and healthy. There were no signs of gross toxicity, adverse pharmacologic effects or abnormal behaviour. *Inhalation* ECHA has reported that this substance does not require classification under the GHS (conclusive data). No further details were found. A nuisance-causing concentration of airborne particles can be reached quickly when dispersed; occupational exposure limits have not been established. Exposure may cause mechanical irritation to the respiratory tract.	ECHA (2013); IPCS (2003)

Chronic/repeat dose toxicity (oral, dermal, inhalation) *Oral* No adverse effects were seen on general toxicity endpoints during a repeated dose toxicity study carried out for potassium nitrate on male and female rats (Sprague-Dawley). Rats were provided daily doses by gavage at concentrations of 0 mg/kg, 250 mg/kg, 750 mg/kg and 1,500 mg/kg for 28 days. *Dermal* NDF *Inhalation* NDF	ECHA (2013)
Sensitisation of the skin or respiratory system Not classified as a skin sensitiser by ECHA. Data lacking regarding respiratory sensitisation. An *in-vivo* mouse local lymph node assay concluded that magnesium nitrate hexahydrate was not a skin sensitisor. The substance was tested at concentrations of 0%, 10%, 25% and 50%.	ECHA (2013)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Magnesium nitrate in its solid form (anhydrous) is not classified as corrosive or irritating to the skin or eyes by ECHA. Magnesium nitrate solution (with <5% calcium nitrate and <5% nitric acid) is classified as a skin irritant (Skin Irrit. 2 H315) and causes serious eye damage (Eye Damage 1 H318). Further information about the study used for this classification was not available. Classified under the GHS as a Category 1 eye irritant which indicated that effects are irreversible.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Non-flammable. Magnesium nitrate is classified as an oxidising solid (Oxid. Solid H272) which may intensity fire.	ECHA (2013)
Explosive Potential Not explosive.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
NOAEL	≥1,500 mg/kg, potassium nitrate	ECHA (2013)
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	3,236 mg/kg, sodium nitrate	WHO JECFA (1996)
Mouse, oral	2,480 to 6250 mg/kg, sodium nitrate	WHO JECFA (1996)
Rabbit, oral	1,600 mg/kg, sodium nitrate	WHO JECFA (1996)
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	

High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEC (rats and mice)	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NDF – no data found within the limits of the search strategy
Conclusive data: means that the study itself was conclusive in its reported finding, but was not sufficient for classifying the material according to ECHA guidelines.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	NDF	IARC (2013)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	ECHA (2013)
Endocrine Disruption[1]	No	ECHA (2013)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	NDF	ECHA (2013)
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	ECHA (2013)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg [3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L [4] (or mg/m^2) (vapour)	No	ECHA (2013)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d [3]; • dermal LOAEL ≤ 2 0 mg/kg/d; inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes [4]	No	ECHA (2013)(NDF regarding carcinogenicity)
Corrosive (irreversible effect)	Yes	ECHA (2013)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [4]	No	ECHA (2013)
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	ECHA (2013)
Irritant (reversible effect)	Yes	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	ECHA (2013)
Explosive potential	No	ECHA (2013)
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence (out of 12 parameters)	10/12	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*
[3] *milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	Nitrate - 50	ADWG (2011)
Water, recreational	Nitrate - 10	ANZECC/ARMCANZ (2000)
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8-h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Magnesium nitrate is a water soluble inorganic salt that appears as colourless or white cubic crystals. In its solid form (anhydrous) it is not classified as corrosive or irritating to the skin or eyes, however, magnesium nitrate solution can cause skin irritation and serious (irreversible) eye damage. It has a low order of acute oral toxicity but in solution the generation of nitrates and their potential reduction to nitrites is the basis for the Australian potable water quality guidelines. These water quality guidelines are established on the basis of protection from the effects of nitrites which may cause methaemoglobinaemia (reduction of haemoglobin), particularly in infants. Magnesium nitrate is not classified as a mutagen or reproductive toxicant. It has not been reviewed for carcinogenicity. On the basis of serious eye damage it is categorised as Hazard Band 3. A broad range of toxicological data have been identified providing some confidence to the hazard profile for magnesium nitrate (as the nitrate). The report of the corrosivity properties are considered the main concern for this chemical. On this basis, the public health concerns are restricted to occupational exposures from direct contact with pure product and emergency spill settings as specific environmental concerns for public health. Environmental concerns may only be realised in cases where magnesium nitrate (and hence the nitrate in solution) enters a potable water source. In such cases determination of the nitrate concentrations would be required.

References

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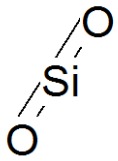
Created by:	MH	13/01/2014
Reviewed and edited by:	LT	16/01/2014

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Cristobalite
Synonyms	Crystalline silica, cristobalite, crystalline silicon dioxide, cristobalite
CAS number	14464-46-1
Molecular formula	SiO_2
Molecular Structure	

Overview	References
Silicon is the second most abundant chemical element, after oxygen, in the earth's crust accounting for 28.15% of its mass and quartz, is by far the most common form of silica in nature, comprising 12% by volume of the Earth's crust. It is a frequently occurring solid component of most natural mineral dusts. Colourless or white crystals which are solid at room temperature and have a melting point of 1713°C – 1728°C. Cristobalite has very similar physio-chemical properties to quartz. Human exposures to crystalline silica occur most often during occupational activities that involve the movement of earth, disturbance of silica-containing products (masonry, concrete, dolomite), or the use in the manufacture of silica containing products. Environmental exposure to ambient quartz dust may occur during natural, industrial and agricultural activities. Silicosis is the critical effect for hazard identification and risk assessment in the occupational environment.	IARC (2011) INCHEM (1997) and OECD (2011)

Human Health Toxicity Summary	Reference
Carcinogenicity There is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica in the form of quartz or cristobalite from occupational sources. There is sufficient evidence in experimental animals for the carcinogenicity of quartz and cristobalite. Crystalline silica inhaled in the form of quartz or cristobalite from occupational sources is carcinogenic to humans (Group 1). US EPA A2, suspected human carcinogen. /Silica, Crystalline - alpha-Quartz (14808-60-7, 1317-95-9); and Cristobalite (14464-46-1). Respirable quartz dust particles can be inhaled and deposited in the deep parts of the lung. There	IARC (2011), ACGIH (2008)

are many epidemiological cohort studies of workers exposed to respirable quartz dust. Silicosis, lung cancer and pulmonary tuberculosis are associated with occupational exposure to quartz dust.	IARC (2011)
Mutagenicity/Genotoxicity Most cellular genotoxicity assays with crystalline silica have been performed with quartz samples. Some studies gave positive results, but most were negative. *Hprt* mutation assays in rat alveolar epithelial cells, both *in vitro* and *in vivo,* were positive in response to quartz. The actual concentrations were 3 and 50 mg/m^3 for crystalline and amorphous silica respectively. The animals were exposed for 13 weeks. Mutation frequency was greatly increased only in the crystalline silica treated rats; no treatment related increase was found in the rats treated with the amorphous form. In an 8-OHdG assay conducted to monitor DNA damage by reactive oxygen species, female rats were exposed to 0, 0.3, 1.5 and 7.5 mg/animal of quartz via intratracheal instillation. Effects were observed 90 days post-exposure. A clear dose-response relationship was identified between quartz exposure and various inflammation markers. Similarly, in another study, 8-OHdG and DNA strand breaks were observed at concentrations of or above 10 µg/m^3 in rat lung epithelial cells.	IARC 1997 OECD (2011)
Reproductive Toxicity No data available.	
Developmental Toxicity/Teratogenicity No data available.	
Endocrine Disruption No data available.	
Neurotoxicity Effects on the nervous system were not reported in either acute or repeat dose toxicity studies.	
Acute Toxicity (oral, dermal, inhalation) No data available	
Chronic/repeat dose toxicity (oral, dermal, inhalation) A study of over 9 days conducted in mice identified a LOAEC of 10 mg/m^3. The conditions of the study are not noted but are said to be similar to the previous study discussed in the paper which exposed rats to 0, 10 or 100 mg/m^3 of cristobalite via inhalation for 6 hours/day during 3 days, with animals observed 3 months after exposure. In a 4-week inhalation study, female rats were exposed to 0, 0.1, 1 or 10 mg/m^3 of quartz 6 hours/day, 5 days/week. A LOAEC of 1 mg/m^3 was identified at 24 weeks. In two separate studies, in which rats or hamsters were exposed to quartz via inhalation for at least 6 months, LOAECs of 2 and 3 mg/m^3 were identified, respectively. All the effects observed were related to inflammation and fibrosis of the lung tissue. Several chronic studies investigated exposure of the respirable forms (i.e. accumulated via inhalation in the lung tissues) of quartz and cristobalite to rats, mice and hamsters. In the study in which the lowest non neoplastic LOAEC was observed, groups of 50 rats/sex were exposed 6 hr/day, 5 days/week for 24 months to filtered air or 1 mg/m^3 of DQ-12 quartz, containing 74% of respirable quartz, through whole-body inhalation. An additional 50 rats/sex were exposed to 5 mg/m^3 of titanium dioxide as positive controls. The mean mass of particle at the end of the exposure period was 0.91 mg/lung. The LOAEC identified was 0.74 mg/m^3 (adjusted for 74% respirable quartz). In studies relating to humans, LOAECs, based on the critical endpoint of radiographic confirmed silicosis were determined at 0.053 mg/m^3 (mean exposure) - study of South African gold miners, and 0.064 mg/m^3 (mean exposure) – study of a mining community population-based random sample survey in Colorado.	OECD (2011)
Sensitisation of the skin or respiratory system No data available.	

Corrosion (irreversible)/irritation (reversible) effects on the skin or eye No data available.	

Physical Hazards	Reference
Flammable Potential Not flammable.	HSDB (2002)
Explosive Potential Not explosive.	HSDB (2002)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	0.053 mg/m^3 (mean exposure)	OECD (2011)
LOAEL	No data found.	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	No data found.	
Mouse, oral	No data found.	
Rabbit, oral	No data found.	
Rat, dermal	No data found.	
Rabbit, dermal	No data found.	
Mouse, dermal	No data found.	
LC_{50}		
Rat	No data found.	
High Chronic/Repeat Dose Toxicity		
LOAEL	No data found.	
LOAEC	0.74 mg/m^3	For rats via the inhalation pathway - adjusted for 74% respirable quartz (OECD, 2011). Lowest value taken from 'Chronic' section above.

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	Yes	Classified as Group 1 carcinogen (IARC, 2011)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	
Endocrine Disruption[1]	No	
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC (2011)
Mutagenicity/Genotoxicity (GHS Category 2)	No	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	Yes	Mean exposure in a study of South African gold miners (OECD, 2011) LOAEC (Lung) at 0.053 mg/m^3
Corrosive (irreversible effect)	No	
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Categorised as Hazard Band 3 for repeat effects,
Skin Sensitiser	No data found	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	
Irritant (reversible effect)	No	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	4	Group 1 carcinogen
Uncertainty analysis /data confidence (out of 12 parameters)	10/12	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.
[2] Neurotoxicity based on REACH assessments.
[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	0.1 mg/m^3	Safe Work Australia (2011)
STEL	No	Safe Work Australia (2011)
Peak Limitation	No	Safe Work Australia (2011)
Environmental Exposure		
Air, ambient	No data found	
Air, indoor	No data found	
Water, potable	No data found	
Water, recreational	No data found	
Soil, residential	No data found	
Soil, commercial/industrial	No data found	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

Respirable crystalline silica is ubiquitous in its global distribution but presents a serious inhalation hazard for sustained exposures to elevated atmospheric concentrations of particulates. In terms of environmental distribution and persistence, silica does not degrade under standard temperature and pressure conditions and thus distribution is widespread. Cristobalite has been given a Hazard Band 4 ranking due to the carcinogenicity of this mineral via the inhalation pathway. The primary concern for human health when using this mineral in hydraulic fracturing operations would be during use of dry material containing the mineral i.e. when being used for the preparation of slurries. The use of relevant respiratory personal protective equipment is therefore recommended. It is not anticipated that subsurface introduction of a slurry will result in extensive surface deposition that exceeds background exposure potentials to crystalline silica (common in sand).

References and Notes

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INCHEM (1997) Cristobalite ICSC 0809. Available at http://www.inchem.org/documents/icsc/icsc/eics0809.htm. [Accessed 21/11/2013]

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ACGIH (2008) American Conference of Governmental Industrial Hygienists TLVs and BEIs. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices. Cincinnati, OHIO, p. 51.

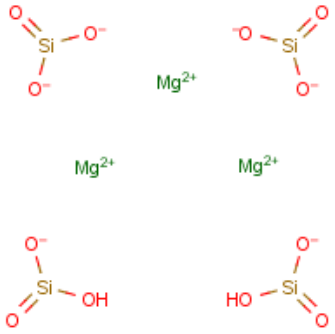
Safe Work Australia (2011) Hazardous Substance Information System (HSIS). WorkSafe Australia, Canberra.

HSDB (2002) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. [Accessed June 2011].

NDF - No data found within the limits of the search strategy.

Created by:	CM	Date 5/12/2013
Reviewed by:	JF	Date: 17/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Magnesium silicate hydrate (not containing asbestos or asbestiform fibres)
Synonyms	agalite, alpine talc usp, asbestine; emtal 596; fibrene c 400; french chalk; hydrous magnesium silicate; mistron 2sc; nonasbestiform talc; nonfibrous talc; snowgoose; soapstone; steatite; steawhite; supreme;
CAS number	14807-96-6
Molecular formula	H_2-O_3-Si 3/4Mg or $Mg_3Si_4O_{10}(OH)_2$
Molecular Structure	

Overview	References
Physical Data Talc is a white to gray-white, fine crystalline powder. It is relatively inert and non-reactive with conventional acids and bases. It is thermally stable up to 930 °C, and loses its crystalline bound water (4.8%) between 930 and 970 °C, leaving an enstatite (dehydrated magnesium silicate residue). Talc is a mineral product. The main component is a crystalline hydrated silicate of magnesium, which is usually in the form of plates but may also be occasionally in the form of fibres. In many talc deposits, amphiboles and serpentines, and other "fibrous minerals", are also present. Therefore, the talc mined and used industrially generally also contains asbestos fibres (notably tremolite). **Uses** Talc is used extensively in industrial products as well as in cosmetics. Only the talc presently used in cosmetics is in the relatively pure platiform. The properties of mineral talc (platyness, softness, hydrophobicity, organophilicity and inertness) govern their specific applications in many industries and processes including production of paint, polymers, paper, ceramics, animal feed, rubber, roofing, fertilizers, cosmetics and pharmaceuticals. The principal technical applications of talc in commercial products are as an anti-sticking and anticaking agent, lubricant, carrier, thickener, strengthening and smoothing filler and absorbent. Talc is a non hazardous substance according to the GHS criteria for classifying hazardous chemicals.	(HSIS, 2013); HSDB, 1993; IARC, 2010) (ECHA, 2013)

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Human Health Toxicity Summary	Reference
Carcinogenicity Talc not containing asbestos or asbestiform fibres is listed as Group 3 (i.e. not classifiable as to its carcinogenicity to humans).	IARC, 2010
Mutagenicity/Genotoxicity **Talc** was not mutagenic to Salmonella typhimurium TA1530, his G46, or Saccharomyces cerevisiae D3 in vitro or in host-mediated assays in mice given 30-5000 mg/kg bw.	HSDB, 2013;
Reproductive Toxicity Not classified as a reproductive toxicant. No animal or human studies were found.	ECHA (2013)
Developmental Toxicity/Teratogenicity No developmental effects were observed in hamsters, rats, mice, or rabbits after oral administration of the following doses of **Talc**:1600 mg/kg bw to rats on days 6-15 of gestation, 1600 mg/kg bw to mice on days 6-15 of gestation, 1200 mg/kg bw to hamsters on days 6-10 of gestation, and 900 mg/kg bw to rabbits on days 6-18 of gestation.	HSDB,2013;
Endocrine Disruption Not listed as an endocrine disruptor by European Commission.	EC, 2000
Neurotoxicity NDF	
Acute Toxicity (oral, dermal, inhalation) Ingestion of large amounts may cause gastrointestinal irritation. May cause respiratory tract irritation. Symptoms may include coughing, laboured breathing, sneezing, cyanosis, and vomiting. It may produce permanent effects in the lungs. No acute toxic effect has been observed; as indicated in the IARC (International Agency for Research on Cancer) monograph on talc: " *no acute mortality was observed in several species of animals following administration of high doses of talc by ingestion, inhalation or intratracheal, intrapleural, intraperitoneal or subcutaneous injection.*"	HSDB, 2013; ECHA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as chronic/repeat does toxic.	ECHA, 2013;
Sensitisation of the skin or respiratory system Not classified as a skin or respiratory sensitiser.	ECHA 2013
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Not classified as a severe skin or eye irritant. May result in mild irritation of skin or eyes.	ECHA 2013

Physical Hazards	Reference
Flammable Potential Non-Flammable	HSDB, 2013, ECHA 2013
Explosive Potential Not classified as a substance with explosion potential**.**	ECHA 2013

Toxicity Values	Value	Reference

Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	NDF	
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)		IARC Group 3 (IARC, 2010)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	HSDB, 1993;
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	
Endocrine Disruption[1]	No	EC, 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC Group 3 (IARC, 2010)
Mutagenicity/Genotoxicity (GHS Category 2)	No	HSDB, 1993;
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	See Hazard Band 1
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	
Corrosive (irreversible effect)	No	See Irritant (reversible effect) Classed as Eye Irritant 2 (ECHA, 2013)
Respiratory sensitiser	No	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	See Hazard Band 1
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	No dose data found but classified on ECHA, 2013 as GHS Harmful if Swallowed Acute Toxic. 4 (H332) Oral Values for which are > 300 ≤ 2000 (UNECE, 2009, Annex 2. page 278)
Irritant (reversible effect)	Yes	Mild skin and eye

		irritation (ECHA 2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Band 1	
Uncertainty analysis /data confidence (out of 12 parameters)	12/12	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Neurotoxicity based on REACH assessments.

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	2.5 mg/m^{3*}	HSIS, 2013
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

* For talc containing less than 1% quartz and no detectable asbestos fibres in the bulk material

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Qualifying Summary Comments

Talc that does not contain asbestiform/asbestos fibres exhibits a low to moderate level of concern as a hazard with the main routes of entry being inhalation or dermal contact, Talc has a low order of toxicity. It can be a mild skin and eye irritant. The toxicity ranking value is principally based on the irritant nature of talc to the skin and the lungs as a fine particulate. These are acute effects limited to occupational settings where exposure to the powder may occur due to dusting and handling.

References and Notes

European Chemicals Agency (ECHA), 2013. Summary of Classification a labelling for CAS Number 14807-96-6 Available at: http://clp-inventory.echa.europa.eu/SummaryOfClassAndLabelling.aspx?SubstanceID=55002&HarmOnly=no?DisclaimerAgr=Agree&Index=14807-96-6&ExecuteSearch=true&fc=true&lang=en [Accessed 28 November 2013].

European Commission (EC), 2000.Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

Hazardous Substances Databank (HSDB), 2013. Toxicology Data Network, U.S. National Library of Medicine Available at: http://toxnet.nlm.nih.gov/cgi-bin/sis/search/r?dbs+hsdb:@term+@na+TALC [Accessed 28 November 2013].

Hazardous Substance Information System (HSIS),2013. Exposure Standard Documentation: Talc, containing no asbestos. Safe Work Australia. Available at: http://hsis.safeworkaustralia.gov.au/HazardousSubstance/Details?hazardousSubstanceID=1057 [accessed on 28 November 2013].

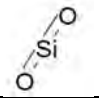
International Agency for Research on Cancer (IARC), 16 June 2013. Agents Classified by the *IARC Monographs*, Volumes 1–108. Available at: http://monographs.iarc.fr/ENG/Classification/index.php. [Accessed 28 November 2013]

United Nations Economic Commission for Europe (UNECE) , 2011. Globally Harmonized System of Classification and Labelling of Chemicals. Available at: http://www.unece.org/fileadmin/DAM/trans/danger/publi/ghs/ghs_rev04/English/ST-SG-AC10-30-Rev4e.pdf [Accessed on 28 November 2013)

NDF - No data found within the limits of the search strategy.

Created by:	AES	Date: 28/11/2013
Reviewed by:	JF	Date 02/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Crystalline silica, quartz
Synonyms	Crystalline silica, crystalline silicon dioxide, cristobalite
CAS number	14808-60-7
Molecular formula	SiO_2
Molecular Structure	

Overview	References
Silicon is the second most abundant chemical element, after oxygen, in the earth's crust accounting for 28.15% of its mass and quartz, is by far the most common form of silica in nature, comprising 12% by volume of the Earth's crust. It is a frequently occurring solid component of most natural mineral dusts. Quartz is a colourless, odourless, non-combustible solid, a component of many mineral dusts and is insoluble in water. Human exposures to crystalline silica occur mainly during occupational activities that involve the movement of earth, disturbance of silica-containing products (masonry, concrete, dolomite), or in the manufacturing of silica-containing products. Environmental exposure to ambient quartz dust may occur during natural, industrial and agricultural activities. Silicosis as a consequence of inhalation exposures to respirable dusts containing crystalline silica is the critical hazard identification in the occupational environment. In this assessment, some information is reported for cristobalite (14464-46-1) which is a polymorph of crystalline silica.	IARC (1997); INCHEM (2010)

Human Health Toxicity Summary	Reference
Carcinogenicity Silica dust, crystalline in the form of quartz or cristobalite is carcinogenic to humans via the respiratory route (Group 1). There is sufficient evidence in humans for the carcinogenicity of inhaled crystalline silica in the form of quartz or cristobalite from occupational sources. There is sufficient evidence in experimental animals for the carcinogenicity of quartz and cristobalite following inhalation exposure. Respirable quartz dust particles can be inhaled and deposited in the deep parts of the lung. There are many (epidemiological) cohort studies of workers exposed to respirable quartz dust. Silicosis, lung cancer and pulmonary tuberculosis are associated with occupational exposure to respirable quartz dust.	IARC (1997; 2013)
Mutagenicity/Genotoxicity Most cellular genotoxicity assays with crystalline silica have been performed with quartz samples and these have produced equivocal results. Mutation assays in rat alveolar epithelial cells, both *in vitro* and *in vivo,* were positive in response to quartz with concentrations of 3 and 50 mg/m^3 for crystalline and amorphous silica respectively.	OECD (2011)

The animals were exposed for 13 weeks. Mutation frequency was greatly increased only in the crystalline silica treated rats; no treatment-related increase was found in the rats treated with the amorphous form. In an 8-hydroxydeoxyguanosine (8-OHdG) assay conducted to monitor DNA damage by reactive oxygen species, female rats were exposed to 0, 0.3, 1.5 and 7.5 mg/animal of quartz via intra-tracheal instillation. Effects were observed 90 days post-exposure. A clear dose-response relationship was identified between quartz exposure and various inflammation markers. Similarly, in another study, 8-OHdG and DNA strand breaks were observed at concentrations of 10 µg/m^3 or above in rat lung epithelial cells.	
Reproductive Toxicity NDF.	
Developmental Toxicity/Teratogenicity NDF.	
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Acute Toxicity (oral, dermal, inhalation) NDF.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) A study of greater than 9 days conducted in mice identified a LOAEC of 10 mg/m^3. The conditions of the study were not reported but are said to be similar to the former study which exposed rats to 0, 10 or 100 mg/m^3 of cristobalite via inhalation for 6 hours/day over 3 days, with animals observed 3 months after exposure. In a 4-week inhalation study, female rats were exposed to 0, 0.1, 1 or 10 mg/m^3 of quartz, 6 hours/day, for 5 days in a week. A LOAEC of 1 mg/m^3 was reported following 24 weeks of exposure. In two separate studies, in which rats or hamsters were exposed to quartz via inhalation for at least 6 months, LOAECs of 2 and 3 mg/m^3 were identified, respectively. All the effects observed were related to inflammation and fibrosis of the lung tissue. Several chronic studies investigated exposure of rats, mice and hamsters to respirable dusts containing quartz and cristobalite. . In the study in which the lowest non-neoplastic LOAEC was observed, groups of 50 rats/sex were exposed 6 hr/day, 5 days/week for 24 months to filtered air or 1 mg/m^3 of DQ-12 quartz, containing 74% of respirable quartz. An additional 50 rats/sex were exposed to 5 mg/m^3 of titanium dioxide as positive controls. The mean mass of particle at the end of the exposure period was 0.91 mg/lung. The LOAEC identified was 0.74 mg/m^3 (adjusted for 74% respirable quartz). In studies relating to humans, LOAECs, based on the critical endpoint of radiographic confirmed silicosis were determined at 0.053 mg/m^3 (mean exposure) from a study of South African gold miners, and 0.064 mg/m^3 (mean exposure) from a study of a mining community in Colorado.	OECD (2011)
Sensitisation of the skin or respiratory system NDF.	
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye NDF.	

Physical Hazards	Reference

Flammable Potential Not flammable.	HSDB (2004)
Explosive Potential Not explosive.	HSDB (2004)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	0.053 mg/m^3 (mean exposure)	OECD (2011)
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	NDF	
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	0.74 mg/m^3	For rats via the inhalation pathway - adjusted for 74% respirable quartz (OECD, 2011).

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level

LOAEC – Lowest Observed Adverse Effect Concentration

NDF - No data found within the limits of the search strategy.

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	Yes	Classified as Group 1 carcinogen via respiratory route (IARC, 2013)
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	OECD (2011) Equivocal results
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	NDF	
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	IARC (2013)
Mutagenicity/Genotoxicity (GHS Category 2)	No	OECD (2011) Equivocal results
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	NDF	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m[3]) (vapour)	NDF	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[2]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	Yes	Mean exposure in a study of South African gold miners (OECD, 2011) LOAEC (Lung) at 0.053 mg/m[3]
Corrosive (irreversible effect)	NDF	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	Categorised as Hazard Band 3 for repeat effects.
Skin Sensitiser	NDF	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	NDF	
Irritant (reversible effect)	NDF	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No	
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	4	Group 1 carcinogen
Uncertainty analysis /data confidence (out of 12 parameters)	6/12	**50%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed)". (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	0.1 mg/m^3	Safe Work Australia (2010)
STEL	No	Safe Work Australia (2010)
Peak Limitation	No	Safe Work Australia (2010)
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Respirable crystalline silica is ubiquitous in its global distribution but presents a serious inhalation hazard for sustained exposures to elevated atmospheric concentrations of particulates. In terms of environmental distribution and persistence, silica does not degrade under standard temperature and pressure conditions and thus distribution is widespread. Crystalline silica, (quartz) has been given a Hazard Band 4 ranking due to the carcinogenicity of this mineral via the inhalation pathway. The primary concern for human health when using this mineral in hydraulic fracturing operations would be during use of dry material containing the mineral, i.e. when being used for the preparation of slurries. The use of relevant respiratory personal protective equipment is therefore recommended. It is not anticipated that subsurface introduction of a slurry will result in extensive surface deposition that exceeds background exposure potentials to crystalline silica (common in sand).

References

EC (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption Final Report (Incorporating corrigenda to final report dated 21 June 2000) – Annex 10: List of 564 substances with their selection criteria - European Commission (EC). Available at: http://ec.europa.eu/environment/archives/docum/pdf/bkh_annex_10.pdf [Accessed 9 January 2014]

IARC (1997) Monographs on the Evaluation of the Carcinogenic Risk to Humans. Volume 68. International Agency for Research on Cancer, World Health Organization, Lyon. Available at: http://monographs.iarc.fr/ENG/Monographs/vol68/mono68-6.pdf. [Accessed 9 January 2014]

IARC (2013) Agents Classified by the *IARC Monographs*, Volumes 1–109. International Agency for Research on Cancer (IARC), 30 October 2013. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsCASOrder.pdf. [Accessed 9 January 2014]

INCHEM (2010) Quartz ICSC 0808. International Program on Chemical Safety (IPCS). Available at http://www.inchem.org/documents/icsc/icsc/eics0808.htm [Accessed 9 January 2014]

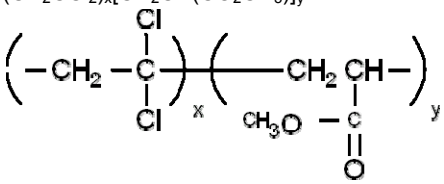
OECD (2011) Organization for Economic Cooperation and Development, SIAM 32, 19-21 April 2011, Initial Targeted Assessment Profile (Human Health) Quartz and Cristobalite. Available at http://webnet.oecd.org/Hpv/UI/handler.axd?id=4bac769f-732c-4136-ba97-3b87246d3b2f. [Accessed 9 January 2014]

Safe Work Australia (2010) Hazardous Substance Information System (HSIS). Available at http://hsis.safeworkaustralia.gov.au/HazardousSubstance. [Accessed 9 January 2014]

HSDB (2004) Hazardous Substances Data Bank. Toxicology Data Network (TOXNET) Available at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB. [Accessed 9 January 2014].

Created by:	JC	9/01/2014
Reviewed by:	LT	16/01/2014 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Poly(vinylidene chloride-co-methyl acrylate)
Synonyms	2-Propenoic acid, methyl ester, polymer with 1,1-dichloroethene 1,1-Dichloroethene, methyl 2-propenoate polymer 1,1-Dichloroethene, polymer with methyl 2-propenoate 2-Propenoic acid, methyl ester, polymer with 1,1-dichloroethene Vinylidene chloride, methyl acrylate polymer 2-Propenoic acid, methyl ester, polymer with 1,1-dichloroethene Acrylic acid methyl ester, polymer with 1,1-Dichlo poly(methyl acrylate-co-vinylidene chloride
CAS number	25038-72-6
Molecular formula	$(CH_2CCl_2)_x[CH_2CH(CO_2CH_3)]_y$
Molecular Structure	

Overview	References
Poly(vinylidene chloride-co-methyl acrylate) (PVCCMA) is polymeric, granular substance, which has a melting point of 152 ºC, a density of 1.78 g/mL at 25 °C and is insoluble in water. I PVCCMA is a high molecular weight polymer. Residual monomers maybe present at low levels. Monomers such as vinylidene chloride, vinyl chloride and methyl acrylate are generally below 0.1%. PVCCMA contains acrylate functionality as well as acid chloride functional groups. PVCCMA is used and approved as an indirect additive used in food contact substances. PVCCMA is classified as a non hazardous polymer. It is unlikely to absorb through skin or be absorb across biological membranes due to its high molecular weight.	Sigma-Aldrich (2010) and Sigma-Aldrich (2011) FDA (2011)

Human Health Toxicity Summary	Reference
Carcinogenicity No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.	Sigma-Aldrich (2013)
Mutagenicity/Genotoxicity Not a hazardous chemical according to GHS although it is noted that the substance has not yet been tested completely.	Sigma-Aldrich (2013)
Reproductive Toxicity No data found.	
Developmental Toxicity/Teratogenicity No data found.	
Endocrine Disruption No data found.	

Neurotoxicity No data found.	
Acute Toxicity (oral, dermal, inhalation) No data found.	
Chronic/repeat dose toxicity (oral, dermal, inhalation) No data found.	
Sensitisation of the skin or respiratory system No data found.	
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye **Not expected to be a moderate or severe skin or eye irritant.**	Sigma-Aldrich (2010)

Physical Hazards	Reference
Flammable Potential No data found.	
Explosive Potential No data found.	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found.	
LOAEL	No data found.	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	No data found.	
Mouse, oral	No data found.	
Rabbit, oral	No data found.	
Rat, dermal	No data found.	
Rabbit, dermal	No data found.	
Mouse, dermal	No data found.	
LC_{50}		
Rat	No data found.	
High Chronic/Repeat Dose Toxicity		
LOAEL	No data found.	
LOAEC	No data found.	
	No data found.	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No data found.	
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No data found.	
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No data found.	
Endocrine Disruption[1]	No data found.	
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No data found.	
Mutagenicity/Genotoxicity (GHS Category 2)	No data found.	
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No data found.	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No data found.	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No data found.	
Corrosive (irreversible effect)	No data found.	
Respiratory sensitiser	No data found.	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No data found.	
Skin Sensitiser	No data found.	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No data found.	
Irritant (reversible effect)	May cause respiratory tract irritation. May cause skin irritation.	Sigma-Aldrich (2010)

	May cause eye irritation.	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	No	
Physical Hazards		
Flammable potential	No data found.	
Explosive potential	No data found.	
Hazard Evaluation (highest band) not including physical hazards	1	Potential irritant
Uncertainty analysis /data confidence (out of 12 parameters)	8%	

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.
[2] Neurotoxicity based on REACH assessments.
[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	
8-h TWA	No data found.	
STEL	No data found.	
Peak Limitation	No data found.	
Environmental Exposure		
Air, ambient	No data found.	
Air, indoor	No data found.	
Water, potable	No data found.	
Water, recreational	No data found.	
Soil, residential	No data found.	
Soil, commercial/industrial	No data found.	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

There is a significant lack of toxicological data related to this polymer and suitable surrogates with similar physic-chemical properties are not readily available. Poly(vinylidene chloride-co-methyl acrylate) has been assigned a Hazard Band 1 ranking based on the potential for the substance to act as an irritant. The general fact that

polymers are relatively stable and inert and unlikely to present health concerns based on chemical considerations suggests that the risk to human health from exposure to this chemical is low. As this product is a granular substance, dusting potential and particulate inhalation (physical hazard) may warrant further investigation for occupational concerns and large-scale environmental release of the powder in close proximity to residential areas.

References and Notes

FDA (US Food and Drug Administration) (2011) List of Indirect Additives Used in Food Contact Substances, dated 14/11/2011. Available at http://www.accessdata.fda.gov/scripts/fcn/fcnNavigation.cfm?rpt=iaListing&displayAll=true [Accessed 5/12/2013]

Sigma-Aldrich Co., (2011) Product Identification: Poly(vinylidene chloride-co-methyl acrylate). Sigma-Aldrich 3050 Spruce St.St. Louis, MO 63103. Available at http://www.sigmaaldrich.com/catalog/ProductDetail.do?D7=0&N5=SEARCH_CONCAT_PNO|BRAND_KEY&N4=430404|ALDRICH&N25=0&QS=ON&F=SPEC [Accessed 6 July 2011].

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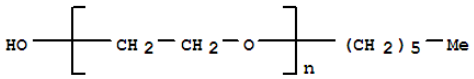
Sigma-Aldrich (2013) Safety Data Sheet: Poly(vinylidene chloride-*co*-methyl acrylate)Version 4.1 Dated 11/04/2013.
Available at http://www.sigmaaldrich.com/MSDS/MSDS/DisplayMSDSPage.do?country=AU&language=en&productNumber=430404&brand=ALDRICH&PageToGoToURL=http%3A%2F%2Fwww.sigmaaldrich.com%2Fcatalog%2Fsearch%3Finterface%3DCAS%2520No.%26term%3D25038-72-6%26lang%3Den%26region%3DAU%26focus%3Dproduct%26N%3D220003048%2B219853060%2B219853286%26mode%3Dpartialmax [Accessed 5/12/2013].

NDF - No data found within the limits of the search strategy.

Created by:	CM	Date 9/12/2013
Reviewed by:	JF	Date 17/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Polyethylene glycol monohexyl ether
Synonyms	Hexan-1-ol, ethoxylated, alpha.-Hexyl,.omega.-hydroxypoly(oxy-1,2-ethanediyl), Hexyl alcohol, ethoxylated, Hexyl poly(oxyethylene) ether, Poly(oxy-1,2-ethanediyl), .alpha.-hexyl-.omega.-hydroxy-, alpha-Hexyl,omega-hydroxypoly(oxy-1,2-ethanediyl), Crissanol A-55, EINECS 500-077-5, Hexyl alcohol, ethoxylated, Hexyl poly(oxyethylene) ether, Poly(oxy-1,2-ethanediyl), .alpha.-hexyl-.omega.-hydroxy-
CAS number	31726-34-8
Molecular formula	$(C_2H_4O)nC_6H_{14}O$
Molecular Structure	

Overview	References
Polyethylene glycol monohexyl ether is the reaction product of hexyl alcohol and ethylene oxide, It is soluble in water. It can be described as belonging to the chemical class known as alcohol ethoxylates.	SWA, 2013
Polyethylene glycol monohexyl ether (PEGMHE) is used as an additive in fracking operations, the manufacture of paper and paper products, architectural and engineering activities, adhesives and binding agents, reprographic agents, paints lacquers and varnishes, cleaning/washing agents, surface treatment, cosmetics, odour agents, impregnation materials, colouring agents, non-agricultural pesticides and preservatives, viscosity adjustors, corrosion inhibitors and aerosol propellants.	ECHA 2013a EPA, 2013
It has not been found on regulatory classification lists (i.e.Safework Australia, ECHA).	
Very little toxicology information is available for PEGMHE. Ethoxylated polyethylene glycols (alcohol ethoxylates) can be harmful if swallowed and via dermal contact irritating to the skin, eyes and respiratory tract. At high oral doses alcohol ethoxylates can cause liver toxicity.	

Human Health Toxicity Summary	Reference
Carcinogenicity Alcohol ethoxylates as a chemical class are not carcinogenic. This assessment is further supported by the absence of any mutagenic or genotoxic activity of this compound class.	HERA (2009)
Mutagenicity/Genotoxicity Not known to cause heritable genetic damage.	Schlumberger, 2012, HERA (2009)
Reproductive Toxicity Not known to adversely affect reproductive functions and organs.	Schlumberger, 2012, HERA (2009)

Developmental Toxicity/Teratogenicity Not known to cause birth defects or have a deleterious effect on a developing fetus.	Schlumberger, 2012, HERA (2009)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Acute Toxicity (oral, dermal, inhalation) No data found, although classification of chemical as irritant on MSDS indicates chemical is non-toxic.	Schlumberger, 2012
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classifiable based on specific target organ toxicity following repeat exposure. Animal toxicity studies indicate that alcohol ethoxylates can cause adaptive changes in the liver when given at high oral doses in repeat dose animal experiments.	HERA, 2009
Sensitisation of the skin or respiratory system Not known to cause allergic reaction.	Schlumberger, 2012
Corrosion (irreversible and reversible)/irritation of the skin or eye Risk of serious damage to eyes (R41). Irritant (Xi) Causes eye and skin irritation and/or dermatitis. May cause corneal inflammation. Irritating to respiratory system. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.	ECHA 2013b Schlumberger, 2012 Sasol, 2010 and Sasol, 2013

Physiochemical Properties	References
Flammable Potential Not classified as a flammable liquid.	Schlumberger, 2012
Explosive Potential Not classified as an explosive hazard.	Schlumberger, 2012

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEC	No data found (NDF)	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	5,100 mg/kg 1.2 – 10 g/kg	Sasol, 2010 Sasol, 2013
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	1,500 – 1,900 mg/kg >2g/kg	Sasol, 2010 Sasol, 2013
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat (inhalation)	1 hour >3.2 mg/l, 4 hours >8.02 mg/l	Sasol 2010
Mice (inhalation)	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL	50 mg/kg (oral rat) for any alcohol ethoxylate	HERA (2009)
LOAEC	NDF	
NOAEL	NDF	

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	HERA, 2009
Mutagenicity/Genotoxicity	No	Schlumberger, 2012
Reproductive Toxicity	No	Schlumberger, 2012
Developmental Toxicity/ Teratogenicity	No	Schlumberger, 2012
Endocrine Disruption[1]	No	EC, 2000
Neurotoxicity[2]	No	HERA 2009
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	No	Schlumberger, 2012 (classified as irritant)
High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	No	Schlumberger, 2012 (classified as irritant)
Corrosive (irreversible damage)	Yes	ECHA 2013b Schlumberger, 2012
Respiratory sensitiser	No	Schlumberger, 2012
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	
Skin Sensitiser	No	Sasol, 2013
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	No	No date found for 6 hr inhalation LC_{50}. Rat inhalation LC_{50}: 1 hour >3.2 mg/l, 4 hours >8.02 mg/l (Sasol 2010)
Irritant (reversible damage)	Yes Eye, skin irritation and respiratory system.	Sasol, 2010 & 2013
Hazard Band 0 All indicators outside criteria listed in Hazards 1-4	No	
Physical Hazards		
Flammable potential	No	Sasol, 2013
Explosive potential	No	
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 3	
Uncertainty analysis /data confidence	14/14	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]*Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mas s(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF There are no exposure limits established for this product.	Sasol, 2010 Sasol, 2013
STEL	NDF There are no exposure limits established for this product.	Sasol, 2010 Sasol, 2013
Peak Limitation	NDF There are no exposure limits established for this product.	Sasol, 2010 Sasol, 2013
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	Readily biodegradable (Sasol, 2013).
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

The toxicity associated with polyethylene glycol monohexyl ether is principally related to the irritation of skin, eyes and the respiratory tract along with the potential to cause serious damage to the eyes, although limited data is available for studies on humans for dermal, oral and inhalation exposure pathways. Polyethylene glycol monohexyl ether falls into the Hazard Band 3category. The primary effect of exposure via usual occupational routes is considered to be irritation of the eyes, skin and respiratory tract. There was no evidence to suggest that polyethylene glycol monohexyl ether is considered carcinogenic. As chronic outcomes are limited and substantial dilution is anticipated, environmental distribution and adverse outcomes would be anticipated to be negligible. Occupational use should avoid skin, eye and respiratory system exposure.

References

United States Environmental Protection Agency (EPA) (2013) ACToR Chemical: Hexan-1-ol, ethoxylated. Available at http://actor.epa.gov/actor/GenericChemical?casrn=31726-34-8 [Accessed 14 August 2013]

European Chemicals Agency (ECHA) (2013a) Polyethylene glycol monohexyl ether. Available at http://echa.europa.eu/information-on-chemicals/registered-substances [Accessed 14 August 2013]

European Chemicals Agency (ECHAb) (2013b) Alkyl polyglycol ether. Available at http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database

European Commission (EC) (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

Human and Environmental Risk Assessment (HERA) (2009) Alcohol Ethoxylates, Human & Environmental Risk Assessment on ingredients of European household cleaning products, Version 2.0, September 2009. Available at http://www.heraproject.com/files/34-F-09%20HERA%20AE%20Report%20Version%202%20-%203%20Sept%2009.pdf [Accessed 16 August 2013]

Schlumberger (2012) Safety Datasheet (Australia), Surfactant F112 (component: polyethylene glycol monohexyl ether), dated March 2012.

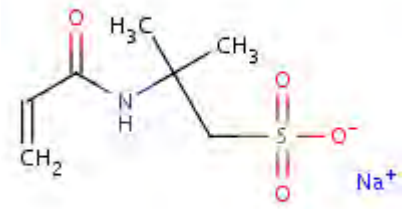
Safework Australia (SWA) (2013) Hazardous Substances Information System (HSIS). Available at http://hsis.safeworkaustralia.gov.au/HazardousSubstance [Accessed 14 August 2013].

Sasol (2010) MSDS for NOVOLFROTH® 234 Ethoxylate, Version 1.3 dated 18 June 2010. Available at http://www.sasoltechdata.com/MSDS/NOVELFROTH234.pdf [Accessed 14 August 2013]

Sasol (2013) MSDS for NOVEL® 6-6 Ethoxylate. Version 2.0 dated 22 July 2013. Available at http://www.sasoltechdata.com/MSDS/NV6-6.pdf [Accessed 14 August 2013]

Created by:	CM	Date 28 August 2013
Reviewed and edited by:	JF	30 August 2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Limited

Name	2-Acrylamido-2-methylpropane sulfonic acid (SURROGATE FOR Acrylamide, 2-acrylamido-2-ethylpropanesulfonic acid, sodium salt polymer 38193-60-1)
Synonyms	
CAS number	5165-97-9, surrogate for 38193-60-1
Molecular formula	$C_7H_{12}NNaO_4S$
Molecular Structure	

Overview	References
2-Acrylamido-2-methylpropane sulfonate, sodium salt (Na-AMPS) is available as a crystalline solid or as an aqueous salt solution. This chemical is the monomer for Poly-AMPS. Poly-AMPS has limited available reference data. AMPSs (comprising sodium and ammonium salts of AMPS as well as the sulfonic acid) are prepared by reacting acrylonitrile, isobutylene, and oleum in the presence of water. The reactive sites on the monomer are the unsaturated vinyl group and the terminal sulfonic acid. The three members of the AMPS category (Na-AMPS, ammonia-AMPS, and AMPS-acid) are virtually homologous, characterized by a 2-acrylamido-2-methylpropanesulfonic parent anion, distinct only by the corresponding H+, Na+ or NH4+ counter-ion (Lubrizol Corp, 2000). While the only use of Na-AMPS as a monomer is, in a derivatised form, as a surfactant in fire-fighting foams, there are several thousand patents and publications involving use of poly-AMPS. These cover many areas including water treatment, oil field, construction chemicals, for medical applications, personal care products, emulsion coatings, adhesives, and rheology modifiers. The sodium and ammonium salts of AMPS monomer are prepared as 50% aqueous solutions. AMPS monomers are highly reactive and hydrophilic. AMPS monomers are primarily used for the preparation of high molecular weight water-soluble polymers. The monomers can be polymerized in solution using conventional vinyl moiety polymerization. No epidemiology studies have identified an association between the three AMPS monomers exposure and development of cancer. The International Agency for Research on Cancer (IARC)	US EPA (2009); IARC (2013); Lubrizol Corp (2000).

has not classified the carcinogenic potential of Na-AMPS or its polymer.	

Human Health Toxicity Summary	Reference
Carcinogenicity Not classified by IARC.	IARC (2013).
Mutagenicity/Genotoxicity Four mutagenic assays on similar compound (ammonium salt of AMPS) were negative. For similar compound (AMPS-acid), two negative results and one inconclusive result were obtained from genetic toxicity tests.	US EPA (2009).
Reproductive Toxicity In a combined reproductive/developmental toxicity screening test, CASRN 58374-69-9 (supporting chemical- ammonium salt) showed no evidence of systemic, reproductive, maternal, or developmental toxicity following oral exposure in rats; the NOAEL was 1000 mg/kg-bw/day (highest dose tested).	US EPA (2009); Lubrizol Corp (2000).
Developmental Toxicity/Teratogenicity In a combined reproductive/developmental toxicity screening test, CASRN 58374-69-9 (supporting chemical – ammonium salt) showed no evidence of systemic, reproductive, maternal, or developmental toxicity following oral exposure in rats; the NOAEL was 1000 mg/kg-bw/day (highest dose tested).	US EPA (2009); Lubrizol Corp (2000).
Endocrine Disruption No data found (NDF).	All proposed data sources.
Neurotoxicity NDF.	All proposed data sources.
Acute Toxicity (oral, dermal, inhalation) When administered to Sprague-Dawley rats in dosages ranging from 1000-8000 mg/kg, no unscheduled deaths were recorded and no unusual clinical or behavioral signs were observed. Animals receiving 16000 mg/kg appeared ruffled and lethargic within 3-4 hours of test material administration. All animals appeared normal by day 5.	US EPA (2013).
Chronic/repeat dose toxicity (oral, dermal, inhalation) No effects were seen in Sprague-Dawley rats exposed to similar compound ammonia-AMPS at up to 1000 mg/kg-bw/day 7 days/week for 28 days.	US EPA (2009).
Sensitisation of the skin or respiratory system NDF.	All proposed data sources.
Corrosion (irreversible and reversible)/irritation of the skin or eye Slight erythema was seen in New Zealand albino rabbits exposed to similar compound ammonia-AMPS at 2000 mg/kg-bw for 24 hours. The dermal irritation subsided after day 11.	All proposed data sources.
Flammable Potential NDF.	All proposed data sources.
Explosive Potential NDF.	All proposed data sources.

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	-
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rats (oral)	> 16000 mg/kg	US EPA 2009
LD_{100}		
	NDF	-
LC_{50}		
	NDF	-
High Chronic/Repeat Dose Toxicity		
LOAEL/NOAEL	1000 mg/kg/day	US EPA 2009

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No-Observed-Adverse-Effect-Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	-
Mutagenicity/Genotoxicity	No	US EPA (2009).
Reproductive Toxicity	No	US EPA (2009; Lubrizol Corp (2000). Based on analogous ammonium salt.
Developmental Toxicity/ Teratogenicity	No	US EPA (2009; Lubrizol Corp (2000). Based on analogous ammonium salt.
Endocrine Disruption[1]	NDF	-
Neurotoxicity[2]	NDF	-
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic oral LD_{50} ≤ 300 mg/kg[3] dermal LD_{50} ≤ 1000 mg/kg inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	No	Oral LD_{50} in rats >16,000 mg/kg body weight. For similar compounds AMPS-acid, oral LD_{50} in rats 1,830 mg/kg body weight. US EPA (2009; Lubrizol Corp (2000).
High Chronic/repeat dose toxicity oral LOAEL ≤ 10 mg/kg/d[3]; dermal LOAEL ≤ 2 0 mg/kg/d; inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NDF	-
Corrosive (irreversible damage)	NDF	-
Respiratory sensitiser	NDF	-
Hazard Band 2		
Harmful chronic/repeat dose toxicity oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	No	Oral NOAEL of 1000 mg/kg/day. US EPA (2009). Based on supporting chemical.
Skin Sensitiser	NDF	-
Hazard Band 1		
Acute Toxicity-Harmful oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg	No	Oral LD_{50} in rats >16,000 mg/kg body weight. For

dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]		similar compounds AMPS-acid, oral LD_{50} in rats 1,830 mg/kg body weight.
Irritant (reversible damage)	Yes	US EPA (2009; Lubrizol Corp (2000).
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NDF	-
Explosive potential	NDF	-
Hazard Evaluation (highest band) not including physical hazards	Hazard Band 1	Low toxicity implied by available data.
Uncertainty analysis /data confidence	14 parameters, 6/14 x 100 =	**43%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1] *Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.*

[2] *Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).*

[3] *milligrams per kilogram body mass (mg/kg) or milligrams per kilogram body mass per day (mg/kg/d)*

[4] *Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).*

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	All proposed data sources
STEL	NDF	All proposed data sources
Peak Limitation	NDF	All proposed data sources
Environmental Exposure		
Air, ambient	NDF	All proposed data sources
Air, indoor	NDF	All proposed data sources
Water, potable	NDF	NEPM (1999; amended 2013)
Water, recreational	NDF	All proposed data sources
Soil, residential	NDF	NEPM (1999; amended 2013)
Soil, commercial/industrial	NDF	NEPM (1999; amended 2013)

Footnotes:
OEL = Occupational Exposure Limit
TWA= 8 h Time-Weighted Average
STEL = (15 min) Short-term Exposure Limit
NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

2-Acrylamido-2-methylpropane sulfonate, sodium salt (Na-AMPS) exhibits a Hazard Band Rating of 1 based on limited data supporting a position of low acute and chronic toxicity in animal studies with some evidence of skin irritancy in rabbits. These data have been based on the monomer as a surrogate for acrylamide, 2-acrylamido-2-ethylpropanesulfonic acid, sodium salt polymer based on structure activity relationships provided in the OECD QSAR Toolkit. Note that the polymer would degrade to its monomeric units which subsequently exhibit a low degree of biodegradation. There are no data on its flammable or explosive potential but this would be expected to be low in aqueous solutions. Based on evidence of skin irritant properties occupational exposures should limit dermal contact through suitable transport and handling management methods.

References

IARC (2013). Agents Classified by the *IARC Monographs*, Volumes 1–107. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf. [Accessed 26 June 2013].
Lubrizol Corporation (2000). Test Plan for AMPS category, August 1, 2000. Available at http://www.epa.gov/oppt/chemrtk/pubs/summaries/amps/c12958.pdf. [Accessed 28 June 2013].
NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra.
SCEW (2013). National Environment Protection (Assessment of Site Contamination) Measure 1999. As Amended. COAG Standing Council on Environment and Water, Canberra.
US EPA (2009). Hazard Characterization Document. Screening-Level Hazard Characterization AMPS® Category. Accessed 28 June 2013. Available at http://www.epa.gov/hpvis/hazchar/Category_AMPS_Sept2009.pdf. [Accessed 28 June 2013].
US EPA (2013) Aggregated Computational Toxicology Resource (ACToR) database. Chemical: sodium 2-methyl-2-[(1-oxoallyl)amino]propanesulphonate. [Accessed 28 June 2013].

Created by:	**MER**	Date: **28/06/2013**
Reviewed and edited by:	**LT**	Date: Rev0 **07/11/2013**

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Dicoco dimethyl quaternary ammonium chloride
Synonyms	Quaternary ammonium compounds, dicoco alkyldimethyl, chlorides, dicocodimethylammonium chloride
CAS number	61789-77-3
Molecular formula	-
Molecular Structure	

Overview	References
Quaternary ammonium compounds are cationic surfactants and their uses include pesticides, detergents (in cleaning products and shampoos), emulsifying agents (in creams and lotions) and wetting agents. Principles health effects include acute, maternal and developmental toxicity, severe skin burns and eyes damage.	US EPA, 2006 ECHA, 2013

Human Health Toxicity Summary	Reference
Carcinogenicity Not carcinogenic	US EPA, 2006
Mutagenicity/Genotoxicity Not classified as genotoxic	ECHA, 2013
Reproductive Toxicity No adverse reproductive effects observed	US EPA, 2006
Developmental Toxicity/Teratogenicity An oral developmental study on rats showed maternal toxicity effects at 20 and 30 mg/kg and developmental toxicity effects (skeletal variations) at 30 mg/kg. The maternal LOAEL was 10 mg/kg/day and the developmental 20mg/kg/day. An oral developmental study on rabbits showed maternal toxicity effects at 3 and 10 mg/kg and developmental toxicity effects (decreased fetal weight and an increased number of dead foetuses) at 10 mg/kg.	US EPA, 2006
Endocrine Disruption Not listed as an endocrine disruptor	EC, 2000
Acute Toxicity (oral, dermal, inhalation) Harmful if swallowed LD50 for rats (gavage) is 960 mg/kg	ECHA, 2013 US EPA, 2013
Chronic/repeat dose toxicity (oral, dermal, inhalation) Oral: no chronic effects observed at 100 mg/kg/day in a dog study using a read-across (Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, chlorides – CAS No 61789-80-8) Derrmal: no chronic effects observed at 140 mg/kg/day in a rabbit study (except for skin irritation) using a read-across (Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, chlorides – CAS No 61789-80-8)	US EPA, 2013
Sensitisation of the skin or respiratory system Data lacking regarding respiratory sensitisation Not classified as a skin sensitiser	ECHA, 2013

Corrosion (irreversible and reversible)/irritation of the skin or eye Causes severe skin burns and eye damage	ECHA, 2013
Physical Hazards	**Reference**
Flammable Potential Flammable liquid and vapour.	ECHA, 2013
Explosive Potential Not classified as explosive.	ECHA, 2013

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	960 mg/kg	US EPA 2013
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEL (dog)	50 mg/kg/day	US EPA 2006
LOAEL (rat)	175 mg/kg/day (male) and 225.5 mg/kg/day (female)	US EPA 2006
LOAEC	NDF	
NOAEL (dog)	Oral NOAEL > 100 mg/kg/day with a read-across	US EPA 2013
NOAEL (rabbit)	Dermal NOAEL > 140 mg/kg/day (except for skin irritation) with a read-across	US EPA 2013

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NDF	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	NO	
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[3] • dermal $LD_{50} \leq 1000$ mg/kg • inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m[3]) (vapour)	YES	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	YES	
Corrosive (irreversible damage)	YES	
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	YES	LOAEL (dog) = 50 mg/kg/day – US EPA, 2006
Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral $LD_{50} > 300$ mg/kg ≤ 2000 mg/kg • dermal $LD_{50} > 1\,000$ mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	YES	
Irritant (reversible damage)	NDF	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	YES	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	10/13	**76.9%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).
[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	Residential exposure (inhalation) not of concern as not expected to occur when used as an inert ingredient in pesticides formulation	US EPA, 2006
Air, indoor		
Water, potable	Measurable concentrations are not expected in drinking water when used as an inert ingredient in pesticides formulation	US EPA, 2006
Water, recreational	NDF	
Soil, residential	Not expected to occur when used as an inert ingredient in pesticides formulation	US EPA, 2006
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Dicoco dimethyl quaternary ammonium chloride is an acute and corrosive substance. It can cause severe skin burns and eye damage. Animal studies (rats and rabbits) showed developmental toxicity effects at maternally toxic doses. Dicoco dimethyl quaternary ammonium chloride falls into the Hazard Band 3 category. Because Dicoco dimethyl quaternary ammonium chloride strongly binds to soil, it is not expected to enter surface and groundwater.

References and Notes

European Chemicals Agency (ECHA, 2013). Classification and Labelling Inventory database Search. Available at http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database [Accessed 23 August 2013]

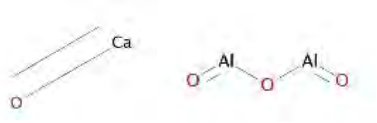
European Commission (EC) (2000) Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

United States Environmental Protection Agency (US EPA 2013). High Production Volume Information System (HPVIS). Available at http://iaspub.epa.gov/oppthpv/public_search.publiclist?wChemicalName=61789-77-3&programFlags= [Accessed 23 August 2013]

United States Environmental Protection Agency (US EPA 2006). Inert Reassessments: Three Exemptions from the Requirement of a Tolerance for Dialkyl (C_8-C_{18}) Dimethyl Ammonium Chloride and Mono and Dialkyl (C_8-C_{18}) Methylated Ammonium Chloride Compounds.

Created by:	JC	Date: 29/08/2013
Reviewed and edited by:	JF	Date 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Ceramic materials and wares, chemicals
Synonyms	
CAS number	66402-68-4 Calcium oxide (CAS number: 1305-78-8) Aluminium oxide (CAS number: 1344-28-1)
Molecular formula	CaO Al_2O_3
Molecular Structure	

Overview	References
'Ceramic materials and wares, chemicals' comprise of numerous chemical substances manufactured in the production of ceramics. For purposes of this category, a ceramic is defined as a crystalline or partially crystalline, inorganic, non-metallic, usually opaque substance consisting principally of combinations of inorganic oxides of aluminum, calcium, chromium, iron, magnesium, silicon, titanium, or zirconium which conventionally is formed first by fusion or sintering at very high temperatures, then by cooling, generally resulting in a rigid, brittle monophase or multiphase structure. Other than by-products or impurities, other chemical substances are formed during the production of various ceramics and therefore incorporated into the ceramic mixture.	
As the composition may contain any one or a combination of the chemical substances mentioned above the human health assessment has been conservatively based on calcium oxide and aluminum oxide.	ECHA (2013)
For reaction product of thermal process between 1000°C and 2000°C aluminum oxide and calcium oxide are the raw materials combined in various proportions which contribute to more than 80% of the multiphase crystalline matrix. However, surrogates of calcium oxide and aluminum oxide have also been used to infer toxicological data from.	IARC (1999)
Calcium oxide is odourless and can take several forms including colourless cubic crystals, white or grayish white lumps, or granular powder. It has a molecular weight of 56.08 g/mol with a melting and boiling point of 2572ºC and 2850 ºC respectively. It is strongly caustic and is soluble in water forming calcium hydroxide and generating large a quantity of heat. Because it can react violently with water it can cause severe irritation when in contact with moist skin or eyes.	HSDB (2013a) HSDB (2013b)
Aluminum oxide is an odourless white crystalline powder. It has a molecular weight of 101.961 g/mol, a specific gravity of 3.4-4 and a melting point of 2030 ºC. Unlike calcium oxide it is insoluble in water but it is soluble in acid and slightly soluble in alkaline solutions. Aluminium oxide is on EPA's Toxics Release Inventory list if it is a fibrous form.	ACS (2013)
Ceramics have an extensive use within the industry, from the very early applications in pottery through to the more advanced medical applications in joint replacements and dental prostheses. Due to the specific mechanical/electrical/ optical/biomedical/chemical properties of ceramic materials its use has found its way in other industries including aerospace, construction, electronics, military, optical materials, sports and transportation.	

Human Health Toxicity Summary	Reference
Carcinogenicity Based on the GHS classification 'Ceramic materials and wares, chemicals' are not classifiable as to its carcinogenicity to humans. A study undertake by IARC has concluded that ceramic implants are *not classifiable as to their carcinogenicity to humans* (Group 3). *Notes:* A human study had investigated the associations between alumina and bauxite dust exposure and circulatory disease mortality, respiratory disease mortality and cancer incidence in a cohort of employees from four bauxite mines and three alumina refineries in. The median, mean and maximum cumulative exposures to bauxite among the bauxite-exposed workers were 5.7, 13.4, and 187 mg/m³-yr, respectively. The median, mean and maximum cumulative exposures to alumina among the alumina-exposed workers were 2.8, 14.5, and 210 mg/m³-yr, respectively. The conclusion of the study was that neither bauxite nor alumina exposure was associated with increased cancer risk. A rat (male/females) study reported no evidence of fibrosis in a repeated dose inhalation study that administered alumina fibres at levels between 2 and 3 mg/m³ for 86 weeks. Exposure to both types of alumina fibres used produced minimal pulmonary reaction and no fibrosis. The authors concluded that the pulmonary reaction to the fibres observed in the study is consistent with their classification as biologically inert materials. Another rat study using calcium lactate did not cause toxicity or carcinogenic activity.	ECHA (2013) IARC (2013)
Mutagenicity/Genotoxicity Not classified as a mutagenic/genotoxic chemical. *Notes:* An in-vitro mutagenicity test was undertaken for calcium oxide. Under the experimental conditions reported, calcium oxide did not induce gene mutations by base pair changes or frameshifts in the genome of the strains used up to and including the highest testable concentration. An in-vivo study involved the administration of aluminium hydroxide to out-bred male rats with the conclusion that aluminium hydroxide did not induce micronuclei in the polychromatic erythrocytes of the bone marrow of male rats treated up to 2000 mg/kg/day (the maximum recommended dose for the study).	ECHA (2013)
Reproductive Toxicity Not classified as having reproductive toxicity effects. *Notes:* A developmental toxicity screening study was undertaken which involved oral administration of aluminium chloride (basic) at short-term and sub-chronic exposure dose levels of 40, 200, and 1000 mg/kg before mating and at a critical period of embryo- , organogenesis and development. No adverse effects on reproductive behavior, mating criteria and histological structure of examined reproductive organs in males and females of rats exposed. The study adds to the weight of evidence for the absence of reproductive/breeding, mating impairment and early postnatal developmental effects due to short-term exposure to high doses of aluminium chloride (basic). No mortality or clinical signs of intoxication were observed in male and female rats due to treatment Suggested NOAEL for reproductive toxicity (lack of reproductive /breeding, mating impairment and early postnatal developmental effects) of 1000 mg/kg.	ECHA (2013)
Developmental Toxicity/Teratogenicity Not classified as having developmental toxic/teratogenic effects. *Notes:* Administration of up to 680 mg/kg of calcium oxide to pregnant rats for 10 consecutive days had no clearly discernible effect on foetal survival. The number of abnormalities seen in either soft or skeletal tissues of test groups did not differ from the number occuring spontaneously in sham-treated controls, resulting in a NOAEL of 680 mg/kg.	ECHA (2013)

Another study assessed the developmental toxicity and embryotoxic/teratogenic potential of high doses of target compound aluminium hydroxide orally administered to rats during the period of active organogenesis. No significant general/maternal toxicity was observed in any Al treated groups that were orally exposed to Al hydroxide at doses 66.5, 133 and 266 mg Al/kg, resulting in a NOAEL of 266 mg/kg.	
Endocrine Disruption Neither 'Ceramic materials and wares, chemicals', calcium oxide or aluminum oxide have been included in the European Commission's Endocrine Disrupters Priority List.	ECED (2013)
Neurotoxicity No information found.	All proposed data sources
Acute Toxicity (oral, dermal, inhalation) Not classified as having acute toxic effects when administered orally, applied to the skin or when inhaled. *Notes:* Calcium oxide was administrated (oral) to female rats and observed over a period of 14 days. No deaths occurred during the study resulting with an LD50 greater than 2000 mg/kg. Aluminium oxide administrated (oral) to female and male rats did not cause mortality after an acute exposure to 10000 mg/kg. At the10000 mg/kg dose no clinical signs of intoxication were observed during the post-administration observation period. Animals appeared healthy through the observation period. Rats (female and males) were exposed to fumed alumina (aluminum oxide) in an inhalation chamber for four hours. No mortality was observed during this study, clinical signs were minor and only one animal showed lung abnormalities on necropsy. A detrimental effect on weight gain was observed in females only. The LC50 for fumed alumina is therefore greater than 2.3 mg/L. Another study conducted on male rats to investigate and compare the acute inhalation toxicity of aluminum flake concluded LC0 and LC50 of 0.888 mg/L air and >0.888 mg/L air respectively A study on female/male rabbits involved dermal application of lime paste for 24 hours resulting in a LD50 (dermal) of > 2500 mg/kg. The available data showed that the tested white lime paste caused no acute toxic effect after dermal application. However, the test did show skin irritating effects from the test sample.	ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Not classified as having chronic oral, dermal or inhalation effects. *Notes:* *Oral Administration* Aluminum hydroxide and basic food grade sodium aluminum phosphate (KASAL and KASAL II) were administered to male rats during a 28-study at daily doses up to approximately 300 mg Al/kg. The results of this study provide no evidence for significant deposition of aluminum in the bone and for toxicity of the substances, resulting in a NOAEL up to 302 mg/kg diet. Treatment with aluminum chloride revealed paternal toxicity (irritation effect on glandular stomach mucosa, local effect) at 1000 mg/kg in both the male and female rats. No Observed Adverse Effect Level (NOAEL) for local toxic effects on stomach was established at 200 mg/kg and LOAEL at level 1000 mg/kg for both male and female rates. Sodium aluminium phosphate was administered to beagle dogs with diet at concentrations 0% (control), 0.3%, 1.0% and 3.0% for 6 months. A the results of this study provided no evidence for toxicity of acidic form of sodium aluminum phosphate during 6-month administration at concentrations up to 3% in the diet n a NOAEL of 90 mg/kg was inferred. *Inhalation* A study had investigated the pulmonary toxicity of two calcined agglomerated aluminium oxyhydroxide (boehmite) nanoparticles in rats exposed by inhalation for 6 hrs/day, 5 days/week	ECHA (2013)

for 4 weeks. In conclusion, an inflammatory pulmonary response was observed only at the end of the 4 week exposure period in the animals receiving the highest dose (28 mg/m³). The NOAEC from this study is 3 mg/m³ and the LOAEC is 28 mg/m³. Another study had exposed rats, guinea pigs and hamsters to three different aluminium powders in the form of Al_2O_3 via intratracheal injection. The aluminium powder caused nodular pulmonary fibrosis in the lungs of the rats only at the highest dose administered (100 mg). All three species developed widespread alveolar proteinosis, rats exhibiting the most severe response. The proteinosis resolved progressively after cessation of exposure. A NOAEC of 70 mg/m³ air for Al_2O_3 was adopted.	
Sensitisation of the skin or respiratory system Not classified as a skin or respiratory sensitiser.	ECHA (2013)
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes serious eye irritation (GHS Eye Irritation Category 1). Classified as a non-irritant to the skin. In a primary dermal irritation study, the skin irritation/corrosion potential of LDSF® LT[1] was tested where 0.5 g of the inferred titanium calcium aluminate was applied on the skin of 3 rabbits. The application of the test item did not induce colouring of the application site and did not interfere with grading of any skin lesion. After the application two animals presented a slight erythema for the 4 -hour exposure time. No other cutaneous lesion was observed. Under the experimental conditions adopted, the test item was found to be a non-skin irritant. In a primary eye irritation study, 0.1 g of LDSF® RG[2], inferred calcium aluminate, was introduced into the conjunctival sac of the left eye of four rabbits. The untreated right eye served as a control. Although chemosis with lacrimation and slight redness of the conjunctivae were observed at all of the animals no ocular lesion persisted in any animal at the end of the exposure period. Under the experimental conditions adopted, the test item was therefore found to be a non-eye irritant. However, in a second eye irritation study, under same experimental conditions 0.1 g of LDSF® LT, inferred titanium calcium aluminate, was introduced into the conjunctival sac of the left eye to one of the rabbits only. As LSDF® LT caused local pain and was probably severely irritating or corrosive. Therefore, exposure of two additional animals was not done. Because ocular lesions and animal pain increased during the reversibility period and under the experimental conditions adopted, LSDF®LT has been classif ed as an eye irritant; hence the Category 1 classification.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Not classified as a flammable/combustible chemical.	ECHA (2013)
Explosive Potential Not classified as an explosive chemical.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		

[1] The ECHA database states that for LDSF® LT there was 'lack of detail on substance' and therefore the chemical composition was not defined. A general search on the internet defined LDSF® LT as low titanium calcium aluminate flux. Website reference: http://www.kerneos.com/content/en/Our-solutions/Products/LDSF-&-OPTIMET/

[2] The ECHA database states that for LDSF® RG there was 'lack of detail on substance' and therefore the chemical composition was not defined. A general search on the internet defined LDSF® RG as calcium aluminate flux. Website reference: http://www.kerneos.com/content/en/Our-solutions/Products/LDSF-&-OPTIMET/

High Chronic/Repeat Dose Toxicity		
LOAEC		
LOAEL		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	>2000 mg/kg (based on calcium oxide)	ECHA (2013)
Mouse, oral		
Rabbit, oral		
Rat, dermal		
Rabbit, dermal	>2500 mg/kg (lime paste, i.e. calcium oxide)	ECHA (2013)
Mouse, dermal		
LOAEL		
LOAEC		
LC_{50}		
Rat	>0.888 mg/L (based on aluminium oxide)	ECHA (2013)
High Chronic/Repeat Dose Toxicity		
LOAEL, rat, inhalation	28 mg/m^3 (based on aluminium oxyhydroxide)	ECHA (2013)
LOAEC		

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NO	
Mutagenicity/Genotoxicity	NO	
Reproductive Toxicity	NO	
Developmental Toxicity/ Teratogenicity	NO	
Endocrine Disruption[1]	-	Not listed on the endocrine disrupting chemicals
Hazard Band 3	NO	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[3] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[4] (or mg/m^3) (vapour)	NO	
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[4]	NO	
Corrosive (irreversible damage)	YES	GHS Eye Damage 1 Classification as it causes serious eye damage. Even though this study was based neither on calcium oxide or aluminum oxide the fact that calcium oxide can react violently with water it can cause severe irritation when in contact with moist skin or eyes. However, the acute toxicity (oral, dermal, inhalation) studies were all based on either calcium oxide or aluminium oxide and these did not classify as having any acute toxic effects.
Respiratory sensitiser	NO	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[4]	NO	

Skin Sensitiser	NO	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[4]	NO	
Irritant (reversible damage)	NO	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**	YES	
Physical Hazards		
Flammable potential	NO	
Explosive potential	NO	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	13/13	**100%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] Based on list of neurotoxic chemicals from US Agency for Toxic Substances and Disease Registry (ATSDR).

[3] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[4] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)	No data found.	All proposed data sources.
8-h TWA	2 mg/m^3 (calcium oxide)	HSIS (2013a)
	10 mg/m^3 (aluminium oxide)	HSIS (2013b)
STEL	No data found.	All proposed data sources.
Peak Limitation	No data found.	All proposed data sources.
Environmental Exposure		
Air, ambient	No data found.	All proposed data sources.
Air, indoor	No data found.	All proposed data sources.
Water, potable	No data found.	All proposed data sources.
Water, recreational	No data found.	All proposed data sources.
Soil, residential	No data found.	All proposed data sources.
Soil, commercial/industrial	No data found.	All proposed data

		sources.

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

Qualifying Summary Comments

'Ceramic materials and wares, chemicals' comprise of numerous chemical substances manufactured in the production of ceramics. For purposes of this category, a ceramic is defined as a crystalline or partially crystalline, inorganic, non-metallic, usually opaque substance consisting principally of combinations of inorganic oxides. As the composition may contain any one or a combination of numerous chemical substances the human health toxicology data has been on calcium oxide and aluminum oxides as they contribute to more than 80% of the multiphase crystalline matrix (for reaction product of thermal process between 1000°C and 2000°C). However, surrogates of calcium oxide and aluminum oxide have also been used to infer toxicological data from.

'Ceramic materials and wares, chemicals' are not classifiable as to its carcinogenicity to humans and is not considered as having acute or chronic health effects when administered via oral, dermal and inhalation exposure pathways. Furthermore it is not classified as having any reproductive, development/teratogenicity and mutagenicity/genotoxicity effects. Amorphous silica is not classified as a skin or respiratoty sensitiser. Although not classified as a non-irritant to the skin it is classified as causing serious eye irritation (GHD Eye Damage 1 Classification). Even though it is inferred that the eye study wasn't based on either calcium oxide or aluminum oxide the fact that calcium oxide can react violently with water means that it can cause severe irritation when in contact with moist skin or eyes. However, the acute toxicity (oral, dermal, inhalation) studies were all based on either calcium oxide or aluminium oxide neither of which is classified as hazardous for acute toxicity. Given the potential for serious eye irritation ceramic materials have been categorised as hazard band 3.

References and Notes

ACS (2013). The American Ceramic Society. Ceramic Resources, Ceramic Science-Engineering'. Available at http://ceramics.org/knowledge-center/learn-about-ceramics [Accessed 6 September 2013]

ECED (2013) European Commission's Endocrine Disrupters Priority List http://ec.europa.eu/environment/endocrine/strategy/substances_en.htm#priority_list/ [Accessed 6 September 2013]

ECHA (2013) European Chemicals Agency) Registered Substances List. Available at http://apps.echa.europa.eu/registered/data/dossiers/DISS-76fd35e0-69c4-29a3-e044-00144f26965e/AGGR-21acd42f-67ed-4528-ac36-6e19c3ca4c37_DISS-76fd35e0-69c4-29a3-e044-00144f26965e.html#L-8329d5cf-ef41-48c1-80a0-c20e9193038e [Accessed 6 September 2013]

HSDB (2013a). *CALCIUM OXIDE*. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine Accessed at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~4SqNvK:1. [Accessed 6 September 2013]

HSDB (2013b). *ALUMINIUM OXIDE*. Hazardous Substance Data Bank (HSDB), U.S. National Library of Medicine Accessed at http://toxnet.nlm.nih.gov/cgi-bin/sis/search/f?./temp/~J7KnB9:1. [Accessed 6 September 2013]

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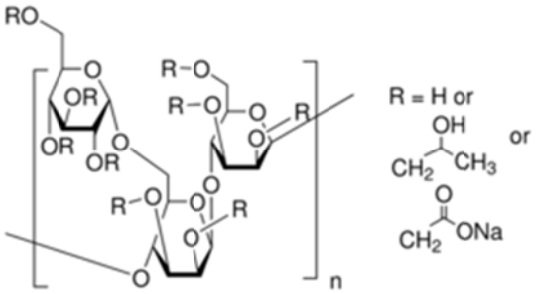
US EPA (2012). *ALUMINIUM OXIDE (FIBROUS FORM) Toxics Release Inventory.* Available at http://yosemite.epa.gov/oswer/lol.nsf/9628f01801ed88d085256ed200780173/d5849529256e136285257abb0064c5b3!OpenDocument [Accessed 6 September 2013]

NDF - No data found within the limits of the search strategy.

Created by:	JH	Date 6/9/13
Reviewed and edited by:	JF	Date 11/09/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Sodium carboxylmethylhydroxylpropyl guar
Synonyms	-
CAS number	68130-15-4
Molecular formula	-
Molecular Structure	 (Gum guar carboxymethyl ether 2-hydroxypropyl ether sodium salt)

Overview	Reference
The Daily Journal of the Unite States Government – Federal Register Information: Exemption This regulation establishes an exemption from the requirement of a tolerance for residues of carboxymethyl guar gum sodium salt (CAS Reg. No. 39346-76-4) and carboxymethyl-hydroxypropyl guar (CAS Reg. No. 68130-15-4); when used as an inert ingredient (thicker/drift reduction agent) in pesticide formulations applied to growing crops. SciReg Inc., on behalf of Rhodia Inc., submitted a petition to EPA under the Federal Food, Drug, and Cosmetic Act (FFDCA), requesting establishment of an exemption from the requirement of a tolerance. This regulation eliminates the need to establish a maximum permissible level for residues of carboxymethyl guar gum sodium salt and carboxymethyl-hydroxypropyl guar. EPA establishes exemptions from the requirement of a tolerance only in those cases where it can be clearly demonstrated that the risks from aggregate exposure to pesticide chemical residues under reasonably foreseeable circumstances will pose no appreciable risks to human health. In order to determine the risks from aggregate exposure to pesticide inert ingredients, the Agency considers the toxicity of the inert in conjunction with possible exposure to residues of the inert ingredient through food, drinking water, and through other exposures that occur as a result of pesticide use in residential settings. If EPA is able to determine that a finite tolerance is not necessary to ensure that there is a reasonable certainty that no harm will result from aggregate exposure to the inert ingredient, an exemption from the requirement of a tolerance may be established. Carboxymethyl guar and carboxymethyl-hydroxypropyl guar are slightly modified forms of guar gum (CAS 9000-30-0), a natural polymer that has been affirmed as generally recognized as safe (GRAS) and a substance of low toxicity. Carboxymethyl guar and carboxymethyl-hydroxypropyl guar are also structurally similar to hydroxypropyl guar, another slightly modified form of guar gum. They all have same toxicity pattern but the exact mode of action is not known. Based upon the structural similarities between carboxymethyl guar gum, carboxymethyl-hydroxypropyl guar, guar gum, and hydroxypropyl guar, the risk assessment for carboxymethyl guar and carboxymethyl-hydroxypropyl guar relies upon available data on all four substances.	FR 2011

Sub-chronic, reproductive and developmental, and carcinogenicity studies with guar gum showed no long term, reproductive/developmental, or carcinogenic effects. Overall, a low toxicity profile is expected with both carboxymethyl guar and carboxymethyl-hydroxypropyl guar because of likelihood of low absorption via any route of exposure due to their high molecular weights.	

Human Health Toxicity Summary	Reference
Carcinogenicity No evidence of carcinogenicity was found in male and female F344 rats and B6C3F1 mice administered diets containing 25,000 or 50,000 ppm (approximately 3,570 or 7,140 mg/kg/day) guar gum for 103 weeks. A reduction in the mean body weight of the higher dose females and of the feed consumption was observed, as compared with the controls. No compound-related clinical signs of adverse effects on survival were observed. There was no increase in the incidence of tumors that could be related to the test substance.	FR 2011
Mutagenicity/Genotoxicity Results of mutagenicity studies performed with guar gum, hydroxypropyl guar, and carboxymethyl-hydroxypropyl guar were all negative.	FR 2011
Reproductive Toxicity The NOAEL for developmental and reproductive toxicity is 7,500 mg/kg/day for Osborne-Mendel rats fed guar gum.	FR 2011
Developmental Toxicity/Teratogenicity Teratogenicity studies with guar gum in mice, rats, and hamsters did not indicate that guar gum is a teratogen; in mice at doses up to 800 mg/kg/day, in rats up to 900 mg/kg/day and in hamsters up to 600 mg/kg/day. Male and female Osborne-Mendel rats were fed guar gum at 0, 1, 2, 4, 5, 7, or 15% (approximately 0, 500, 1,000, 2,000, 3,750 or 7,500 mg/kg/day) in the diet for 13 weeks before mating, during mating, and throughout gestation. No effects on parental fertility, fetal development, sex distribution, and no malformations of the pups were observed.	FR 2011
Endocrine Disruption Not listed as an endocrine disruptor by the European Commission.	EC 2000
Acute Toxicity (oral, dermal, inhalation) Acute oral toxicity studies conducted with guar, hydroxypropyl guar, and carboxymethyl guar resulted in oral LD_{50} values ranging from 7,060 milligrams per kilogram of body weight (mg/kg bw) to 17,800 mg/kg bw.	FR 2011
Chronic/repeat dose toxicity (oral, dermal, inhalation) There are three 90-day toxicity studies available for guar gums. In one study, the LOAEL of guar gum in a diet was 1% (equivalent to 580 mg/kg/day) based on effects on body weight gains, and dose related decrease in kidney weights. The NOAEL was not established in this study. In the second study, no effects were observed in male rats at doses up to 6% (equivalent to 3,000 mg/kg/day). In the third study in rats, decreases in body weight gains, decreases in food efficiency, increases in blood urea nitrogen and thyroid toxicity (males only) were observed at a dietary concentration of 2 and 5%. The NOAEL in this study was 1% (equivalent to 500 mg/kg/day). No adverse effects were reported in dogs that were fed 0, 1, 5, or 10% (approximately 0, 250, 1,250, or 2,500 mg/kg/day) of a precooked mixture of guar and carob bean for 30 weeks. No effects were observed in monkeys that were fed 1 gram (equal to 10 mg/kg/day) of guar flour for 2 months.	FR 2011

Sensitisation of the skin or respiratory system Results of skin sensitization studies performed with guar gum, hydroxypropyl guar, and carboxymethyl-hydroxypropyl guar were all negative. Occupational asthma has been reported in subjects working with industrial production of guar gum.	FR 2011 HSDB 2002
Corrosion (irreversible)/irritation (reversible) of the skin or eye Dermal irritation studies conducted with guar, hydroxypropyl guar, and carboxymethyl guar resulted in no irritation to slight irritation. Eye irritation studies conducted with guar, hydroxypropyl guar, and carboxymethyl-hydroxypropyl guar demonstrated a range of results from non-irritation to severe irritation.	FR 2011

Physical Hazards	Reference
Flammable Potential NDF.	
Explosive Potential NDF.	

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
	NDF	
High Chronic/Repeat dose Toxicity		
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	6770 mg/kg	HSDB, 2002 (Guar Gum)
Mouse, oral	8100 mg/kg	HSDB, 2002 (Guar Gum)
Rabbit, oral	7000 mg/kg	HSDB, 2002 (Guar Gum)
Rat, dermal	NDF	
Rabbit, dermal	NDF	
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	NDF	
High Chronic/Repeat dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL, rats, parental, developmental and reproductive	7,500 mg/kg/day	FR, 2011 (Guar Gum)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	No	FR, 2011
Mutagenicity/Genotoxicity	No	FR, 2011
Reproductive Toxicity	No	FR, 2011
Developmental Toxicity/ Teratogenicity	No	FR, 2011
Endocrine Disruption[1]	No	EC, 2000
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L^3 (or mg/m^3) (vapour)	No	HSDB, 2002
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[3]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	HSDB, 2002
Corrosive (irreversible damage)	No	
Respiratory sensitiser	Yes	Occupational asthma has been reported in subject working with industrial production of guar gum
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	HSDB, 2002
Skin Sensitiser	No	FR, 2011
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	HSDB, 2002
Irritant (reversible damage)	Yes	FR, 2011
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	NDF	
Explosive potential	NDF	

Hazard Evaluation (highest band) not including physical hazards	**3**	
Uncertainty analysis /data confidence	11/13= 87%	**Data based on surrogate compounds**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Sodium carboxymethyl-hydroxypropyl guar and related guar gums exhibit limited human health hazards across a diverse range of toxicological parameters and subsequently have been excepted in the US from the need for tolerance thresholds as additives in pesticides used for crop protection. The Hazard Band 3 rating is a reflection of reported occupational asthma suggestive of Type 1 hypersensitivity responses while dermal and eye irritancy is the other main consideration. The potential for dust generation with such a product may result in both of these adverse outcomes under conditions of occupational exposure and subsequently warrant management measures.

In addition, as the product is an organic dust, ignition and explosion are further concerns related to worker safety during on-site use of this product during chemical stimulation activities.

References

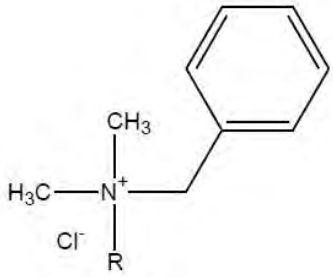
EC (2000). Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000). European Commission.

FR, 2011. Carboxymethyl Guar Gum Sodium Salt and Carboxymethyl-Hydroxypropyl Guar; Exemption From the Requirement of a Tolerance - A Rule by the Environmental Protection Agency on 07/27/2011. The Daily Journal of the United States Government – Federal Register, United States Government. Available at https://www.federalregister.gov/articles/2011/07/27/2011-18588/carboxymethyl-guar-gum-sodium-salt-and-carboxymethyl-hydroxypropyl-guar-exemption-from-the#h-13 [Accessed 20 October 2013]

HSDB, 2002. Guar Gum. Hazardous Substance Data Base , U.S. National Library of Medicine, National Institute of Health, Department of Health and Human Services, U.S. Government. Last date of revision: 12/05/2002.

Created by:	MGT	Date: 31/10/2013
Reviewed and edited by:	LT	Date: 11/12/2013

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Alkyl(C12-16) dimethylbenzyl ammonium chloride
Synonyms	Quaternary ammonium compounds, benzyl-C12-16-alkyldimethyl, chlorides, ADBAC
CAS number	68424-85-1
Molecular formula	$C_9H_{13}NCl^-R$ (R = $C_{12}H_{25}$, $C_{14}H_{29}$ or $C_{16}H_{33}$)
Molecular Structure	

Overview	Reference
Alkyl(C12-16) dimethylbenzyl ammonium chloride (ADBAC) is a quaternary ammonium compound. It is a clear yellow to straw liquid and has an amine odour. It is soluble in water and alcohol. It is used as an antimicrobial, insecticide and fungicide with applications in food handling, medical settings, agriculture, swimming pools, wood preservation, and industrial water systems such as recirculating cooling water, pulp and paper, drilling muds, oil well injection, and saltwater disposal. Principal health effects include acute toxicity (via all routes) and severe skin burns and eye damage.	US EPA(2006) USNLM (2013)

Human Health Toxicity Summary	Reference
Carcinogenicity Not assessed by IARC. Not reported as a carcinogenic substance by the US EPA.	IARC (2013); US EPA (2006).
Mutagenicity/Genotoxicity Not reported as mutagenic or genotoxic (based on the review of the required target database)	US EPA (2006).
Reproductive Toxicity Not reported as a reproductive toxicant (based on a two-generation reproductive study)	US EPA (2006).
Developmental Toxicity/Teratogenicity Not reported as a developmental toxicant (based on *in utero* exposure prenatal development studies review)	US EPA (2006).
Endocrine Disruption Not listed as an endocrine disruptor.	EC(2000).
Acute Toxicity (oral, dermal, inhalation) Toxic in contact with skin, if swallowed or inhaled.	ECHA (2013).
Chronic/repeat dose toxicity (oral, dermal, inhalation) NOAEL has been established at 14 mg/kg/day (chronic dog study))	US (2011).

Sensitisation of the skin or respiratory system Not reported as a dermal sensitiser based on a guinea pig study.	US EPA (2006).
Corrosion (irreversible and reversible)/irritation of the skin or eye Causes severe skin burns and eye damage.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Flammable liquid (flashpoint ≥23°C and initial boiling ≤60°C) and vapour.	ECHA(2013)
Explosive Potential No data found (NDF).	

Toxicity Values	Value	Reference
Human Toxicity Data		
Acute Toxicity		
	NDF	
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	344 mg/kg	US EPA (2011)
Rat, dermal	930 mg/kg	US EPA (2006)
Rabbit, dermal	2848 mg/kg	US EPA (2011)
LOAEL	NDF	
LOAEC	NDF	
LC_{50}		
Rat	0.054 to 0.51 mg/L	US EPA (2006)
High Chronic/Repeat Dose Toxicity		
LOAEL (rat, oral)	88 mg/kg/day	US EPA (2006)
LOAEC	NDF	
NOAEL (rat, oral)	44 mg/kg/day	US EPA (2006)
LOAEL (dog, oral)	48 mg/kg/day	US EPA (2011)
NOAEL (dog, oral)	31 mg/kg/day	US EPA (2011)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration
NOAEL – No Observed Adverse Effect Level

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity	NDF	Not assessed by IARC
Mutagenicity/Genotoxicity	No	US EPA (2006)
Reproductive Toxicity	No	US EPA (2006)
Developmental Toxicity/ Teratogenicity	No	US EPA (2006)
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m[3]) (vapour)	Yes	LC_{50} between 0.054 and 0.51 mg/L (US EPA, 2006)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[2]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	
Corrosive (irreversible damage)	Yes	ECHA (2013)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	Yes	Rat oral LOAEL 88mg/kg/day (US EPA, 2006) Dog oral LOAEL 48 mg/kg/day (US EPA, 2011)
Skin Sensitiser	No	
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	Yes	Rat oral LD_{50} 344 mg/kg (US EPA, 2011)
Irritant (reversible damage)	No	
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	Yes	Flammable liquid (ECHA, 2013)
Explosive potential	NDF	
Hazard Evaluation (highest band) not including physical hazards	**Band 3**	
Uncertainty analysis /data confidence	10/13	**77%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3]Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013).

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	NDF	
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	ADWG, 2011
Water, recreational	NDF	NEPM, 1999 - amended
Soil, residential	NDF	NEPM, 1999 - amended
Soil, commercial/industrial	NDF	NEPM, 1999 - amended

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Alkyl (C12-16) dimethylbenzyl ammonium chloride is an acute inhalation hazard and corrosive substance. It can result in severe skin burns and eye damage and on this basis is considered in Hazard Band 3. This hazard is subsequently a reflection of its concern as a pure product and not reflecting that posed under greatly diluted end-use concentrations. Key hazards are thus those posed within occupational settings and where large scale product spill may impact on public health. The environmental persistence suggests some potential distribution due to limited aqueous microbial degradation and this warrants some further exploration in terms of sustained available concentrations and aqueous degradation pathways.

References

ADWG (2011). Australian Drinking Water Guidelines National Health and Medical Research Council. Available from http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/eh52_aust_drinking_water_guidelines.pdf

ECHA (2013) European Chemicals Agency Classification & Labelling Database. Available at http://echa.europa.eu/web/guest/information-on-chemicals/cl-inventory-database [Accessed 10 October 2013].

EC (2000) European Commission Towards the establishment of a priority list of substances for further evaluation of their role in endocrine disruption, preparation of a candidate list of substances as a basis for priority setting, Final Report (Incorporating corrigenda to final report dated 21 June 2000).

IARC (2013) International Agency for Research on Cancer Agents classified by IARC Monographs, Volumes 1-108. Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsGroupOrder.pdf.

NEPM (1999 – amended) National Environment Protection (Assessment of Site Contamination) Measure 1999

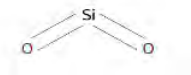
US EPA (2006) United States Environmental Protection Agency. Reregistration Eligibility Decision for Alkyl Dimethyl Benzyl Ammonium Chloride (ADBAC). Available at http://www.epa.gov/oppsrrd1/REDs/adbac_red.pdf

US (2011).Alkyldimethulbenzylammonium Chloride (ADBAC) Category High Production Volume (HPV) Chemicals Challenge Final Test Status and Data Review submitted to United States Environmental Protection Agency Available at http://www.epa.gov/hpv/pubs/summaries/adbac/c16856.pdf

US NLM (2013) United States National Library of Medicine Haz-Map Database. Available at **Error! Hyperlink reference not valid.**http://hazmap.nlm.nih.gov/category-details?id=18780&table=copytblagents [Accessed 10 October 2013].

Created by:	JC	Date: 14/10/13
Reviewed and edited by:	LT	Date 22/10/13 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Diatomaceous earth, calcined
Synonyms	Kieselguhr, calcined; Diatomaceous silica, calcined; calcinated diatomaceous earth
CAS number	91053-39-3
Molecular formula	O_2-Si
Molecular Structure	

Overview	References
Diatomite or diatomaceous earth (DE) is a natural, porous, high surface area form of hydrous silica. DE products are classified based on the manufacturing method. There are three different types: natural or uncalcined DE (Cas No 61790-53-2), flux-calcined DE (CAS No 68855-54-9) and calcined DE (91053-39-3). Calcined diatomaceous earth (DE) is produced by heating natural DE in a rotary furnace to 600°C. At this temperature, the water evaporates and the iron becomes oxidized. Calcined DE consists mostly of oxides of aluminum, iron and silicon. In the process, DE transformed partially into crystalline silica. The crystalline content of calcined DE is typically less than 35% cristobalite and less than 20% quartz. Flux-calcined DE is obtained from heating the natural product in the presence of a fluxing agent (generally soda ash). The flux-calcined product can contain up to 65% cristobalite. Small amounts of quartz and tridymite (quartz polymorph) can also be present in both the calcined and flux-calcined DE. The amount of crystalline silica (cristobalite, quartz and tridymite) in calcined and flux-calcined DE depends on the time and temperature and the calcining method. Flux-calcined DE consists of white crystals, powder or granules while calcined DE consists of pink or yellowish to dark brown powder or granules. Uses for calcined and flux-calcined DE include as filtration agents and functional fillers in paints, plastics, rubber, adhesives, catalysts, agricultural chemicals, pharmaceuticals, toothpastes, polishes and other chemicals. They are also used as thermal insulators and absorbents. Amorphous silica has been studied less than crystalline silica. They are generally less hazardous than crystalline silica and are cleared more rapidly from the lung. Furthermore, amorphous silica is chemically and biologically inert when ingested in any of its many physical forms, such as amorphous siliceous earth (diatomaceous earth, diatomite, kieselguhr) or colloidal silica gels. This explains why overall it is not considered as hazardous to humans. The hazardous potential of calcined DE and flux calcined DE will be dependent on its crystalline fraction. Limited data are available for calcined DE. The human health toxicity information discussed below are primarily based on flux-calcined DE (CAS No 68855-54-9).	ESIS (2000); EPA (2013); CCOHS (2001); Gosselin *et al.*(1984)

Human Health Toxicity Summary	Reference
Carcinogenicity Calcined DE or flux-calcined DE have not been assessed by IARC but the IARC rating for *014808-60-7 Silica dust, crystalline, in the form of quartz or cristobalite* is Group 1 - *carcinogenic to humans*. IARC evaluation for silica, amorphous (CAS No 7631-86-9): Group 3 (Amorphous silica *is not classifiable as to its carcinogenicity to humans).* *Notes:* The evaluations for amorphous silica pertain to inhalation resulting from workplace exposures. Very little epidemiological evidence was available to the Working Group. No association was detected for mesothelioma with biogenic amorphous silica fibres in the three community-based case-control studies. Separate analyses were not performed for cancer risks among a subset of diatomaceous earth industry workers exposed predominantly to amorphous silica. There is *inadequate evidence* in humans for the carcinogenicity of amorphous silica.	IARC (2013)
Mutagenicity/Genotoxicity Flux-calcined DE is not classified as a mutagenic/genotoxic chemical The genotoxic potential of flux-calcined DE (cristoballite content not specified) was assessed in a gene mutation study (Ames test) which produced negative results.	ECHA (2013)
Reproductive Toxicity NDF.	
Developmental Toxicity/Teratogenicity NDF.	
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity NDF.	
Acute Toxicity (oral, dermal, inhalation) Flux-calcined DE is not classified as having acute toxic effects when administered orally, applied to the skin or when inhaled. *Notes:* For rats (male/females) an oral LD_{50} > 2000 mg/kg has been determined. For rats (male/female) an LC_{50} > 2.6 mg/L air has been reported for a four hour exposure duration study.	ECHA (2013)
Chronic/repeat dose toxicity (oral, dermal, inhalation) Flux-calcined DE (cristalline fraction > 10%) is classified as STOT RE (repeated exposure) 1 H372: causes damage to lungs through prolonged or repeated exposure via inhalation, according to CLP (Classification, Labelling and Packaging). This classification is based on a rat study where animals were exposed (nose only) to various concentrations of calcined DE (45% cristobalite) - 0.044 mg/L, 0.207 mg/L and 0.700 mg/L - for 6 hours/exposure, 5 days/week at 24-hour intervals for four consecutive weeks. Following the treatment period there was a 9 week recovery period. Following microscopic examination, the lungs and tracheobronchial lymph nodes were considered as target organs but no NOAEL could be established.	ECHA (2013)

Notes: An oral NOAEL of 3737.9 mg/kg bw/day has been determined for rats (male/female)	
Sensitisation of the skin or respiratory system Flux-calcined DE is not classified as a skin sensitiser. No data found regarding sensitisation of the respiratory system.	ECHA (2013)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye Flux-calcined DE is not classified as irritating or corrosive to the skin or eye.	ECHA (2013)

Physical Hazards	Reference
Flammable Potential Flux-calcined DE is not classified as a flammable substance.	ECHA (2013)
Explosive Potential Flux-calcined DE is not classified as an explosive substance.	ECHA (2013)

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral	> 2000 mg/kg (flux-calcined DE)	ECHA (2013)
Mouse, oral	NDF	
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	NDF	
Mouse, dermal	NDF	
LC_{50}		
Rat	> 2.6 mg/L (flux-calcined DE)	ECHA (2013)
High Chronic/Repeat Dose Toxicity		
LOAEL	NDF	
LOAEC	NDF	
NOAEL (rat, oral)	3738 mg/kg bw/day	ECHA (2013)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	Yes	Not specifically assessed by IARC however, the crystalline fraction (cristobalite and quartz) falls in the Group 1 category: *carcinogenic to humans* (IARC, 2013). Based on an uncertainty of the crystalline fraction the carcinogenicity is recorded as consistent with crystalline silica.
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	NDF	
Endocrine Disruption[1]	No	EC (2000)
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	Not specifically assessed by IARC however, the crystalline fraction (cristobalite and quartz) falls in the Group 1 category: *carcinogenic to humans* (IARC, 2013). Based on an uncertainty of the crystalline fraction the carcinogenicity is recorded as consistent with crystalline silica.
Mutagenicity/Genotoxicity (GHS Category 2)	No	ECHA (2013)
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	NDF	
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral $LD_{50} \leq 300$ mg/kg[2] • dermal $LD_{50} \leq 1000$ mg/kg inhalation $LC_{50} \leq 10$ mg/L[4] (or mg/m^3) (vapour)	No	For rats oral $LD_{50} >$ 2000 mg/kg and $LC_{50} > 2.6$ mg/L (ECHA, 2013)
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[2]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	Classified as STOT RE 1 H372: causes damage to lungs through prolonged or repeated exposure via inhalation (ECHA, 2013) An inhalation NOAEC has not been established.
Corrosive (irreversible effect)	No	ECHA (2013)
Respiratory sensitiser	NDF	
Hazard Band 2		
Harmful chronic/repeat dose toxicity	No	Classified as STOT

• oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes [3]		RE 1 H372: causes damage to lungs through prolonged or repeated exposure via inhalation (ECHA, 2013)
Skin Sensitiser	No	ECHA (2013)
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	For rats oral LD_{50} > 2000 mg/kg and LC_{50} > 2.6 mg/L (ECHA, 2013)
Irritant (reversible effect)	No	ECHA (2013)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	ECHA (2013)
Explosive potential	No	ECHA (2013)
Hazard Evaluation (highest band) not including physical hazards	**4**	
Uncertainty analysis /data confidence (out of 12 parameters)	10/12	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2] milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013)".

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	MAK value: 0.3 mg/m^3 (crystalline fraction not specified) MEL values: 0.10 mg/m^3 (quartz) and 0.05 mg/m^3 (cristobalite)	ESIS (2000)
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF = No data found within the limits of the search strategy

Qualifying Summary Comments

Calcined DE, as flux-calcined DE, is the product of the calcination of naturally occurring DE (diatomite). Flux-calcined DE is differentiated from calcined DE by the addition of a fluxing agent during the heating process. Flux-calcined and calcined DE are often considered as a type of amorphous silica, however during the calcination process, they are partially transformed into cristobalite. Amorphous silica has been studied less than crystalline silica and is considered generally less toxic than crystalline silica being cleared more rapidly from the lung. Amorphous silica is chemically and biologically inert when ingested in any of its many physical forms, such as amorphous siliceous earth (diatomaceous earth**,** diatomite, kieselguhr) or colloidal silica gels. Therefore, the hazardous potential of calcined DE resides in its crystalline fraction. The carcinogenic potential of calcined DE has not been assessed by IARC, however the IARC rating for *014808-60-7 Silica dust, crystalline, in the form of quartz or cristobalite* is Group 1 - *carcinogenic to humans*. Moreover, according to ECHA, mixtures and substances containing cristobalite as an individual constituent, shall be classified as STOT RE 1 H372 (causes damage to lungs through prolonged or repeated exposure via inhalation) if the cristobalite respirable fraction is equal to, or greater than 10%. No information is available regarding the potential effects of calcined DE to reproduction and development but it has a low order of acute toxicity. Based on the classifications and data considered, calcined DE is classified as a Hazard Band 4 substance due to the presence of the crystalline silica fraction. WorkSafe Australia has not listed calcined DE as a hazardous substance under the respective legislation and developed an exposure standard for it. Due to its low solubility, calcined DE in aqueous solution and as introduced during chemical stimulation activities would settle into soils and sediments and become indistinguishable from those materials. The principle hazard is subsequently the generation of dusts under occupational settings which would require management.

References

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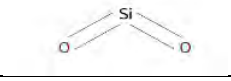
IARC (2013) Agents Classified by the *IARC Monographs*, Volumes 1–109. International Agency for Research on Cancer (IARC), Available at http://monographs.iarc.fr/ENG/Classification/ClassificationsCASOrder.pdf . . [Accessed 11 December 2013].

Created by:	JC	Date: 11/12/13
Reviewed by:	LT/JF	Date: 12/12/2013 Rev0

Project number: 127666004
Project name: Hydraulic Stimulation Chemicals Assessment, Southwest Queensland
Client name: Santos Ltd

Name	Silica gel
Synonyms	Precipitated silica; amorphous silica
CAS number	112926-00-8
Molecular formula	O_2-Si
Molecular structure	

Overview	References
Silica gel is part of a larger group of chemicals referred to as synthetic amorphous silica (SAS) registered under the overarching CAS No 7631-86-9. SAS (including silica gels) are white, fluffy and/or powdery amorphous forms of silicon dioxide (silica, SiO_2). It has a molecular weight of 60.08g/mol, a density of 2.2 at 20ºC and a melting point of approximately 1700 ºC. Commercialised since the 1950s, SAS are used in a wide variety of industrial applications and they are usually tailor-made to meet the users' requirements. Main uses of SAS include reinforcement and thickening agent in various systems such as elastomers, resins, inks and water for instance. Due to their high porosity, SAS is also used as an adsorbing agent. SAS is also used in consumers' products such as cosmetics, pharmaceuticals and foods. SAS have been studied less than crystalline silica. They are generally less toxic than crystalline silica and are cleared more rapidly from the lung. Furthermore, amorphous silica is chemically and biologically inert when ingested in any of its many physical forms such as amorphous siliceous earth (diatomaceous earth**,** diatomite, kieselguhr) or colloidal *silica gels*. This explains why overall it is not considered as hazardous to humans. The human health toxicity information discussed below is based on SAS.	ECETOC (2006); IARC (1997); SIDS (2004); Gosselin *et al.*(1984)

Human Health Toxicity Summary	Reference
Carcinogenicity IARC rating for silica, amorphous (CAS No 7631-86-9): Group 3 (Amorphous silica *is not classifiable as to its carcinogenicity to humans)* *Notes:* The evaluations for amorphous silica pertain to inhalation resulting from workplace exposures. Very little epidemiological evidence was available to the Working Group. No association was detected for mesothelioma with biogenic amorphous silica fibres in the three community-based case-control studies. Separate analyses were not performed for cancer risks among a subset of diatomaceous earth industry workers exposed predominantly to amorphous silica. There is *inadequate evidence* in humans for the carcinogenicity of amorphous silica.	IARC (1997); IARC (2013)
Mutagenicity/Genotoxicity No mutations were observed when SAS was tested in *in vitro* and *in vivo* standard methods. No evidence for mutagenic activity was found in an ex-vivo gene-mutation assays on isolated alveolar	SIDS (2004)

type-II cells after long-term inhalation exposure of rats to a distinctly noxious/inflammatory SAS concentration of 50 mg/m^3 (13 weeks).	
Reproductive Toxicity The reproductive toxicity properties of SAS were assessed with a one-generation on rats where animals were fed SAS at a dose of 500 mg/kg bw/day for a premating period of 4.5 months with continued exposure up to 6 months. While no adverse effects were observed, however, it was reported that the study had some shortcomings regarding the low number of pregnant animals used and that the mating ratio was too low according to current standards.	SIDS (2004)
Developmental Toxicity/Teratogenicity The potential for developmental effects of SAS were assessed in a comprehensive and reliable testing programme where various animal species (rat, mouse, rabbit, and hamster) were administered SAS orally at doses up to 1600 mg/kg bw/day. No significant signs of maternal or developmental toxic effects were observed in any species tested. Abnormalities noted in soft or skeletal tissues of the test groups were comparable to the frequencies occurring in the control groups.	FDA (1972, 1973a,b) as cited in SIDS (2004)
Endocrine Disruption Not listed as an endocrine disruptor.	EC (2000)
Neurotoxicity NDF.	
Acute Toxicity (oral, dermal or inhalation) SAS (aqueous suspension or gel) administered orally (gavage or in diet) and dermally did not cause mortality at the highest doses tested. LD_{50} values ranged from > 3100 to > 20000 mg/kg in rats and mice. One study established an oral LD_{50} for rats to be > 10000 mg/kg bw. Based on a rabbit study, a dermal LD_{50} > 5000 mg/kg bw was established for rabbits. No clinically or pathologically meaningful effects were observed after 4-hour exposure of rats to either pyrogenic or precipitated SAS. However, in the study where animals were exposed to precipitated SAS, signs of some discomfort and stress were observed and body weight of females was retarded for two days post-exposure.	SIDS (2004)
Chronic/repeat dose toxicity (oral, dermal, inhalation) **Oral** The chronic toxic effects of silica gel were assessed in a rat study. In this study, animals received an amorphous silica gel (Syloid 244) at dietary levels of 3.2 and 10% for 6 months, corresponding to average doses of 2170 to 2420 mg/kg bw/day and 7950 to 8980 mg/kg bw/day respectively. No adverse effects were observed. Isolated pathological findings were assessed to be unrelated to dosing and common in untreated rats. The microscopic examination did not show any changes in the kidneys or reproductive organs. **Dermal** No information was found regarding the chronic toxicity of silica gel or SAS via the dermal route. **Inhalation** No evidence of pneumoconiosis or silicosis was observed in occupational exposures to SAS. Other disorders of the respiratory tract could not be correlated to exposure to SAS alone. However, it is noted that the available epidemiological data base on workers is too limited to be able to draw firm conclusions.	Grace (1975) as cited in SIDS (2004); SIDS (2004)
Sensitisation of the skin or respiratory system There are no experimental data available on sensitisation. There is no evidence of skin sensitisation in workers over decades of practical experience.	SIDS (2004)
Corrosion (irreversible)/irritation (reversible) effects on the skin or eye **Effects on skin** Based on experimental data, SAS is not irritating to rabbit skin. However, it is noted that cases of dryness or degenerative eczema of the skin in workers with chronic contact have been reported by occupational physicians.	SIDS (2004)

When tested on the rabbit eye as a powder, SAS showed no or only weak and non-permanent irritating effects on the conjunctivae but neither the iris nor the cornea were affected.	

Physical Hazards	Reference
Flammable Potential Non flammable solid.	
Explosive Potential Not classified as an explosive substance.	

Toxicity Values	Value	Reference
Human Toxicity Data		
High Chronic/Repeat Dose Toxicity		
LOAEC	NDF	
LOAEL	NDF	
Animal Toxicity Data		
Acute Toxicity		
LD_{50}		
Rat, oral (gavage)	> 3100 to > 20000 mg/kg (aqueous suspension and gel SAS)	SIDS (2004)
Mouse, oral	> 3100 to > 20000 mg/kg (aqueous suspension and gel SAS)	SIDS (2004)
Rabbit, oral	NDF	
Rat, dermal	NDF	
Rabbit, dermal	> 5000 mg/kg (precipitated SAS)	SIDS (2004)
Mouse, dermal	NDF	
LC_{50}		
Rat	>0.14 - >2.0 mg/l (pyrogenic and precipitated SAS)	SIDS (2004)
High Chronic/Repeat Dose Toxicity		
LOAEL		
LOAEC	5 mg/m^3 (precipitated and gel SAS)	SIDS (2004)

Footnotes:
LD_{50} – lethal dose for 50% of experimental population
LC_{50} – lethal air concentration for 50% of experimental population
LOAEL – Lowest Observed Adverse Effect Level
LOAEC – Lowest Observed Adverse Effect Concentration

Human Health Toxicity Ranking*		
	Hazard data	**Comment**
Hazard Band 4		
Carcinogenicity (IARC Group 1 or 2A)	No	IARC Group 3 – inadequate evidence to classify
Mutagenicity/Genotoxicity (GHS Category 1A and 1B)	No	SIDS, 2004
Reproductive Toxicity/Developmental toxicity (GHS Category 1, 1A and 1B)	No	Based on a study with some limitations (SIDS, 2004)
Endocrine Disruption[1]	No	EC, 2000
Hazard Band 3		
Carcinogenicity (IARC Group 2B)	No	
Mutagenicity/Genotoxicity (GHS Category 2)	No	SIDS, 2004
Reproductive Toxicity/Developmental toxicity (GHS Category 2)	No	Based on a study with some limitations (SIDS, 2004)
Acute Toxicity (oral, dermal or inhalation) Very Toxic/Toxic • oral LD_{50} ≤ 300 mg/kg[2] • dermal LD_{50} ≤ 1000 mg/kg • inhalation LC_{50} ≤ 10 mg/L[3] (or mg/m^3) (vapour)	No	SIDS, 2004
Possible carcinogenicity, mutagenicity, reproductive or High Chronic/repeat dose toxicity • oral LOAEL ≤ 10 mg/kg/d[2]; • dermal LOAEL ≤ 2 0 mg/kg/d; • inhalation LOAEC (6 h/d) ≤ 50 ppm/d for gases, ≤ 0.2 mg/L/d for vapours or ≤ 0.02 mg/L/d for dust/mists/fumes[3]	No	SIDS (2004)
Corrosive (irreversible effect)	No	SIDS (2004)
Respiratory sensitiser	No	Based on widespread exposure and few reports of allergic responses.
Hazard Band 2		
Harmful chronic/repeat dose toxicity • oral LOAEL > 10 mg/kg and ≤ 100 mg/kg/d • dermal LOAEL > 20 mg/kg/d and ≤ 200 mg/kg/d • inhalation (6-h/d) LOAEC > 50 mg/L ≤ 250 mg/L/d for gases, > 0.2 mg/L ≤ 1 .0 mg/L/d for vapours or > 0.02 mg/L ≤ 0.2 mg/L/d for dust/mists/fumes[3]	No	SIDS (2004)
Skin Sensitiser	No	Based on widespread exposure and few reports of allergic responses.
Hazard Band 1		
Acute Toxicity-Harmful • oral LD_{50} > 300 mg/kg ≤ 2000 mg/kg • dermal LD_{50} >1 000 mg/kg ≤ 2000 mg/kg; • inhalation LC_{50} (6 h/d) > 10 mg/L ≤ 20 mg/L for vapours)[3]	No	SIDS (2004)

Irritant (reversible effect)	No	SIDS (2004)
Hazard Band 0 **All indicators outside criteria listed in Hazards 1-4**		
Physical Hazards		
Flammable potential	No	SIDS (2004)
Explosive potential	No	SIDS (2004)
Hazard Evaluation (highest band) not including physical hazards	**0**	
Uncertainty analysis /data confidence (out of 12 parameters)	**12/12**	**83%**

* Based on IMAP Framework [NICNAS (2013) Inventory Multi-tiered Assessment and Prioritisation (IMAP) Framework. National Industrial Chemicals Notification and Assessment Scheme. Department of Health and Aging, Canberra].

"[1]Based on list of endocrine disrupting chemicals from the European Commission's Endocrine Disrupters website.

[2]milligrams per kilogram body mass(mg/kg) or milligrams per kilogram body mas per day (mg/kg/d)

[3] Based on GHS cut-offs for hazard classification. For chronic/repeat dose toxicity, GHS cut-offs are provided as guidance values (i.e. the dose/concentration at or below which significant health effects are observed"). (p 18, NICNAS 2013)".

Human Health Guidelines		
Media	**Concentration (mg/m^3; mg/L; mg/kg)**	**Reference**
Occupational Exposure Limits		
Air (OEL)		
8-h TWA	10 mg/m^3	HSIS (2013)
STEL	NDF	
Peak Limitation	NDF	
Environmental Exposure		
Air, ambient	NDF	
Air, indoor	NDF	
Water, potable	NDF	
Water, recreational	NDF	
Soil, residential	NDF	
Soil, commercial/industrial	NDF	

Footnotes:

OEL = Occupational Exposure Limit

TWA= 8 h Time-Weighted Average

STEL = (15 min) Short-term Exposure Limit

NDF - No data found within the limits of the search strategy.

Qualifying Summary Comments

Silica gel is a type of synthetic amorphous silica (SAS). Amorphous silica has been studied less than crystalline silica as they are generally less toxic than crystalline silica and are cleared more rapidly removed from the lung. It is noted that although effects on the lung have been observed at high concentrations these have been reversible following cessation of exposure. Amorphous silica is chemically and biologically inert when ingested in any of its many physical forms such as amorphous siliceous earth (diatomaceous earth, diatomite, kieselguhr) or colloidal silica gels and is not classifiable as to its carcinogenicity to humans. SAS is not considered as having

acute or chronic health effects when administered via oral, dermal and inhalation exposure pathways nor as having any reproductive, development/teratogenicity and mutagenicity/genotoxicity effects. SAS is not classified as a skin sensitiser nor does it cause irreversible irritation of the skin or eye. For this reason it is categorized as Hazard Band 0. WorkSafe Australia has listed amorphous silica as a hazardous substance under the respective legislation and developed an exposure standard for amorphous silica dust which is the generic standard for dusts. Due to its low solubility, amorphous silica in aqueous solution and as introduced during chemical stimulation activities would settle into soils and sediments and become indistinguishable from those materials. The principle hazard is subsequently the generation of dusts under occupational settings which would require management.

References

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ECETOC (2005) Report No. 51 Synthetic Amorphous Silica (CAS No. 7631-86-9). ECETOC (European Centre for Ecotoxicology and Toxicology of Chemicals) JACC (Joint Assessment of Commodity Chemicals). Available at http://members.ecetoc.org/Documents/Document/JACC%20051.pdf . [Accessed 11 December 2013].

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Updated by:	JC	11/12/2013
Reviewed by:	LT	12/12/2013 Rev0

APPENDIX F

Chemical Information Sheets

Name	Potassium hydroxide
Synonyms	Caustic potash, Hydroxyde de potassium, Potassium hydrate
CAS Number	1310-58-3
Molecular Formula	KOH

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	56.11	ECHA 2013
Melting Point (°C):	380.00	ECHA 2013
Boiling Point (°C):	1327	ECHA 2013
Solubility (mg/L):	1,120,000.00	ECHA 2013

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Blue gill	Fish LC50	MOR	Mortality	4	80	ECHA 2013

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		273	HSDB 1999	mg/kg

Created By: Naomi Cooper Date: 9/09/2013

Checked By: Kirsten Broadgate Date: 10/09/2013

Name	Sodium Hydroxide
Synonyms	Sodium hydroxide
CAS Number	1310-73-2
Molecular Formula	NaOH

Physical Properties	Value	Reference
PhaseState:	White orthogonal crystals	HSDB 2012
Molecular Weight (g/mol):	40	HSDB 2012
Melting Point (°C):	323.00	HSDB 2012
Boiling Point (°C):	1388	HSDB 2012
Solubility (mg/L):	1,110,000.00	HSDB 2012

Other Relevant Factors	Value	Reference
Reactivity		
Species:	OH-/NaOH	HSDB 2011
Reaction type:	Acid/base	HSDB 2011
pH / Acidity		
acid / alkaline	Alkaline	HSDB 2011
pH (10% solution)	11	HSDB 2011

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Ceriodaphnia dubia	Water flea	Invertebrate EC50	Intoxication	Immobilisation	2	40.38	HSDB 2011
Gambusia affinis	Western mosquitofish	Fish LC50	Mortality	Mortality	1	125	ECOTOX 2012

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		140	HSDB 2012	mg/kg
Rabbit	Mammalian LD50	MOR	Mortality		325	OECD SIDS 200	mg/kg bw

Created By: Lisa Brookes Date: 31/07/2012

Checked By: Kirsten Broadgate Date: 15/07/2013

Name	Sodium tetraborate
Synonyms	Disodium Tetraborate, Sodium Borate, Borax Glass
CAS Number	1330-43-4
Molecular Formula	B4O7.2Na

Physical Properties	Value	Reference
PhaseState:	Colourless glassy solid	HSDB 2007
Molecular Weight (g/mol):		0
Melting Point (°C):	743.00	HSDB 2007
Boiling Point (°C):	1575	HSDB 2007
Solubility (mg/L):	31,000.00	HSDB 2007

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Bluegill	Fish LC50	MOR	Mortality	1	15	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	141	HSDB 2007
Pseudokirchneriella subcapitata	Green algae	Plant EC50	GRO	Growth	4	15.4	ECOTOX 2012

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		2660	HSDB 2007	mg/kg

Created By: Naomi Cooper Date: 8/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Name	Hydrochloric Acid
Synonyms	Anhydrous hydrochloric acid, chlorohydric acid, dilute hydrochloric acid, hydrochloric acid gas, muriatic acid
CAS Number	7647-01-0
Molecular Formula	HCl

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2009
Molecular Weight (g/mol):	36.46	HSDB 2009
Melting Point (°C):	-114.22	HSDB 2009
Boiling Point (°C):	-85.05	HSDB 2009
Solubility (mg/L):	823,000.00	HSDB 2009

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Gambusia affinis	Western Mosquito fish	Fish LC50	Mortality	Mortality	1	282	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lemna minor	Duckweed	Plant EC50	Growth	Weight	10	182.3	ECOTOX 2012

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	Mortality	Mortality		50 mg/kg/bw	INCHEM 2012	

Created By: Chelsea Papadopoulos Date: 16/08/2012

Checked By: Kirsten Broadgate Date: 18/07/2013

Name	Zirconium dichloride oxide (Surrogate for)
Synonyms	zirconyl chloride, chlorozirconyl
CAS Number	7699-43-6
Molecular Formula	Cl2OZr

Physical Properties	Value	Reference
PhaseState:	Solid	HSDB 2006
Molecular Weight (g/mol):		0
Melting Point (°C):	-15.00	HSDB 2006
Boiling Point (°C):		
Solubility (mg/L):	163,000,000.00	ECHA 2013

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Bluegill	Fish LC50	MOR	Mortality	4	15	ECOTOX 2012
Tubifex tubifex	Tubificid Worm	Invertebrate LC50	MOR	Mortality	4	221.2	HSDB 2006

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		2950	ChemIDPlus2013	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		1227	ChemIDPlus2013	mg/kg

Created By: Naomi Cooper Date: 8/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Name	Hydrogen peroxide
Synonyms	Albone, Inibine, Peroxaan
CAS Number	7722-84-1
Molecular Formula	H2O2

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2005
Molecular Weight (g/mol):	34.01	HSDB 2005
Melting Point (°C):	-0.43	HSDB 2005
Boiling Point (°C):	152	HSDB 2005
Solubility (mg/L):	1,000,000.00	HSDB 2005

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Danio rerio	Zebra fish	Fish LC50	MOR	Mortality	4	18.3	USEPA 2009
Gammarus sp	Amphipod	Invertebrate LC50	MOR	Mortality	4	4.32	USEPA 2009

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncoryhynchus mykiss	Rainbow trout	Fish NOEC	REP	Hatching	14	1112	USEPA 2009
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	0.63	USEPA 2009
Ceratophyllum demersum	Coon Tail	Plant NOEC	GRO	Growth	14	34	USEPA 2009
Daphnia magna	Water flea	Invertebrate LOEC	GRO	Growth	21	0.34	USEPA 2009

Project number: 127666004

INORGANIC

Created By: Naomi Cooper Date: 13/11/2013

Checked By: Carolyn Brumley Date: 15/11/2013

Name	Nitrogen, liquid form
Synonyms	Nitrogen elemental,
CAS Number	7727-37-9
Molecular Formula	N2

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2011
Molecular Weight (g/mol):	28.013	HSDB 2011
Melting Point (°C):	-210.01	HSDB 2011
Boiling Point (°C):	-195.79	HSDB 2011
Solubility (mg/L):	18,100.00	HSDB 2011

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Cloeon dipterum	Mayfly	Invertebrate LC50	MOR	Mortality	2	>40	ECOTOX 2012
	Fish	Fish LC50	MOR	Mortality	4	360	ECOSAR 2012
	Daphnid	Invertebrate LC50	MOR	Mortality	2	181	ECOSAR 2012
	Green algae	Plant EC50	MOR	Mortality	4	81	ECOSAR 2012

Project number: 127666004

INORGANIC

Created By: Naomi Cooper Date: 14/01/2014

Checked By: Kirsten Broadgate Date: 14/01/2014

Name	Sodium thiosulfate
Synonyms	Disodium thiosulfate, Sodium hyposulfite
CAS Number	7772-98-7
Molecular Formula	Na2O3S2

Physical Properties	Value	Reference
PhaseState:	Solid - crystals, powder	HSDB 2003
Molecular Weight (g/mol):	158.13	HSDB 2003
Melting Point (°C):		
Boiling Point (°C):		
Solubility (mg/L):	500,000.00	HSDB 2003

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	4.2	805	ECOTOX 2012
Gambusia affinis	Western Mosquitofish	Fish LC50	MOR	Mortality	4	24000	ECOTOX 2012

Project number: 127666004

INORGANIC

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Name	Magnesium chloride
Synonyms	Magnesium dichloride
CAS Number	7786-30-3
Molecular Formula	MgCl2

Physical Properties	Value	Reference
PhaseState:	Granules or flakes	
Molecular Weight (g/mol):	95.21	HSDB 2011
Melting Point (°C):	118.00	HSDB 2011
Boiling Point (°C):	712	HSDB 2011
Solubility (mg/L):	550,000.00	HSDB 2011

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia hyalina	Water flea	Invertebrate LC50	MOR	Mortality	2	32	ECOTOX 2012
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	4	2120	ECOTOX 2012

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		2800	HSDB 2003	mg/kg

Created By: Naomi Cooper Date: 17/12/2013

Checked By: Kirsten Broadgate Date: 17/12/2013

Project number: 127666004

INORGANIC

Name	Sodium bromate
Synonyms	Dyetone
CAS Number	7789-38-0
Molecular Formula	BrH03.Na

Physical Properties	Value	Reference
PhaseState:	Solid - crystals	ChemIDPlus 2012,
Molecular Weight (g/mol):	150.892	ChemIDPlus 2012,
Melting Point (°C):	381.00	ChemIDPlus 2012,
Boiling Point (°C):		
Solubility (mg/L):	364,000.00	ChemIDPlus 2012,

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		301	ECHA 2012	mg/kg/bw

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Name	Boric acid
Synonyms	Orthoboric acid, Boron trihydroxide, Trihydroxyborane
CAS Number	10043-35-3
Molecular Formula	BH3O3

Physical Properties	Value	Reference
PhaseState:	Solid - granules or powder	HSDB 2012
Molecular Weight (g/mol):	61.833	HSDB 2012
Melting Point (°C):	170.90	HSDB 2012
Boiling Point (°C):	300	HSDB 2012
Solubility (mg/L):	50,000.00	HSDB 2012

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus mykiss	Rainbow trout	Fish LC50	MOR	Mortality	4	79	ECOTOX 2012
Ceriodaphnia pulchella	Water flea	Invertebrate LC50	MOR	Mortality	1	101.2	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus mykiss	Rainbow trout	Fish LOEC	MOR	Mortality	32	0.1	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate MATC	GRO	Growth	21	9.33	ECOTOX 2012
Chlorella pyrenoidosa	Green algae	Plant LOEC	POP	Growth	14	0.08	ECOTOX 2012
Micropterus salmoidea	Largemouth bass	Fish NOEC	MOR	Mortality	11	1.390	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	6	ECOTOX 2012

Chlorella pyrenoidosa	Green algae	Plant NOEC	POP	Growth	14	0.4	ECOTOX 2012

Project number: 127666004

INORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		2660	HSDB 2012	mg/kg

Created By: Naomi Cooper Date: 14/01/2014

Checked By: Kirsten Broadgate Date: 14/01/2014

Name	Magnesium nitrate
Synonyms	Magnesium dinitrate
CAS Number	10377-60-3
Molecular Formula	Mg(NO3)2

Physical Properties	Value	Reference
PhaseState:	Solid - white crystals	HSDB 2003
Molecular Weight (g/mol):	148.31	HSDB 2003
Melting Point (°C):	95.00	HSDB 2003
Boiling Point (°C):		
Solubility (mg/L):	712,000.00	HSDB 2003

Other Relevant Factors	Value	Reference
Reactivity		
Species:		
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Caenorhabditis elegans	Nematode	Invertebrate LC50	MOR	Mortality	1	25213	ECOTOX 2012

Project number: 127666004

INORGANIC

Created By: Naomi Cooper Date: 14/01/2014

Checked By: Kirsten Broadgate Date: 14/01/2014

Name	Magnesium silicate hydrate (talc) (Surrogate for Magnesium silicate hydrate (talc))
Synonyms	Magnesium silicate hydrate, talc, talcum
CAS Number	14807-96-6
Molecular Formula	H2O3Si3/4Mg

Physical Properties	Value	Reference
PhaseState:	White to greyish white, very fine crystalline powder	HSDB 2011
Molecular Weight (g/mol):		
Melting Point (°C):	800.00	IUCLID 2000a
Boiling Point (°C):		
Solubility (mg/L):	1,000,000.00	EPISUITE 2011 v4.

Other Relevant Factors	Value	Reference
Reactivity		
Species:	Insoluble and degradable in soil or water	IUCLID 2000a
Reaction type:		
pH / Acidity		
acid / alkaline		
pH (10% solution)		

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Brachydanio rerio	Zebra fish	Fish LC50	MOR	Mortality	1	> 1000	HSDB 2011

Project number: 127666004

INORGANIC

Created By: Lisa Brookes Date: 27/08/2012

Checked By: Kirsten Broadgate Date: 14/06/2013

Project number: 127666004

ORGANIC

Name	L-Glutamic Acid
Synonyms	Glusate, Aciglut
CAS Number	56-86-0
Molecular Formula	C5H9NO4

Physical Properties	Value	Reference
PhaseState:	Solid	ECHA 2012
Molecular Weight (g/mol):	147.13	ECHA 2012
Melting Point (°C):	213.00	ECHA 2012
Boiling Point (°C):		
Density / Specific Gravity (g/L at 20oC	1,540.00	ECHA 2012
Vapour Pressure (mm Hg at 25°C):	1.10E-05	ECHA 2012
Solubility (mg/L):	8.57E+03	ECHA 2012
Henry's Law Constant (atm m^3/mole):	1.47E-14	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	13.40	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.13	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-3.69	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.6277	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.4499	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.273	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.000000482	EPISUITE 2011 v4.1
Fugacity_Water: (%)	27	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	73	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0601	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.0095	

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Cyrpinus carpio	Carp	Fish LC50	MOR	Mortality	4	>100	ECHA 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	>100	ECHA 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pseudokirchnerella subcapitata	Green algae	Plant NOEC	GRO	Growth rate	3	16	QSAR 2013

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		>30000	ChemIDPlus201	mg/kg
Rabbit	Mammalian LD50	MOR	Mortality		>2300	ChemIDPlus201	mg/kg

Created By: Naomi Cooper Date: 10/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Project number: 127666004

ORGANIC

Name	Tetrasodium ethylenediaminetetraacetate
Synonyms	Tetrasodium EDTA
CAS Number	64-02-8
Molecular Formula	C10H16N2O8Na4

Physical Properties	Value	Reference
PhaseState:	White powder	HSDB 2011
Molecular Weight (g/mol):	380.2	HSDB 2011
Melting Point (°C):	300.00	HSDB 2011
Boiling Point (°C):	572.7	EPISUITE 2011 v4.1
Density / Specific Gravity (lb/gal):	6.90	EPISUITE 2011 v4.1
Vapour Pressure (mm Hg at 25°C):	1.49E-12	EPISUITE 2011 v4.1
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	1.18E-23	HSDB 2011
Organic carbon partition coefficient (Koc):	312.70	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	2.50	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-13.17	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.5022	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.3924	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.4106	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00000000000136	EPISUITE 2011 v4.1
Fugacity_Water: (%)	19	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	81	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.198	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.000007617	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis	Bluegill	Fish LC50	MOR	Mortality	4	486	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	1	610	ECOTOX 2012

Created By: Naomi Cooper Date: 17/12/2013

Checked By: Kirsten Broadgate Date: 17/12/2013

Name	Ethanol
Synonyms	Ethyl alcohol, Ethyl hydrate
CAS Number	64-17-5
Molecular Formula	C2H6O

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2012
Molecular Weight (g/mol):	46.07	HSDB 2012
Melting Point (°C):	-114.14	HSDB 2012
Boiling Point (°C):	78.3	HSDB 2012
Density / Specific Gravity (g/cu):	0.79	HSDB 2012
Vapour Pressure (mm Hg at 25°C):	5.93E+01	HSDB 2012
Solubility (mg/L):	1.00E+06	HSDB 2012
Henry's Law Constant (atm m³/mole):	5.00E+06	HSDB 2012
Organic carbon partition coefficient (Koc):	2.75	HSDB 2012
Log organic carbon partition coefficient (log Koc):	0.44	HSDB 2012
Log octanol - water partition coefficient (log Kow):	-0.31	HSDB 2012

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.2573	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.9107	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.9153	EPISUITE 2011 v4.1
Fugacity_Air: (%)	7.4	EPISUITE 2011 v4.1
Fugacity_Water: (%)	41	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	52	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0718	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.02866	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus mykis	Rainbow Trout	Fish LC50	MOR	Mortality	4	42	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	4	100	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Gambusia holbrooki	Eastern Mosquitofish	Fish NOEC	GRO	Growth	84	0.375	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	35	0.008	ECOTOX 2012
Biomarphalaria tenagophila	Snail	Invertebrate LOEC	REP	Hatching	196	19.8	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		6200	HSDB 2012	mg/kg
Guinea pig	Mammalian LD50	MOR	Mortality		5600	HSDB 2012	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	134	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 8/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Project number: 127666004

ORGANIC

Name	Choline Chloride
Synonyms	Hepacholine, Neocolina, Bilineurin chloride, Choline Chlorhydrate
CAS Number	67-48-1
Molecular Formula	C5H14NO.Cl

Physical Properties	Value	Reference
PhaseState:	White Crystals	HSDB 2012
Molecular Weight (g/mol):	139.63	HSDB 2012
Melting Point (°C):	305.00	HSDB 2012
Boiling Point (°C):		
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	4.93E-10	OECD SIDS 2004
Solubility (mg/L):	6.50E+05	OECD SIDS 2004
Henry's Law Constant (atm m^3/mole):	2.08E-13	OECD SIDS 2004
Organic carbon partition coefficient (Koc):	2.34	OECD SIDS 2004
Log organic carbon partition coefficient (log Koc):	0.37	OECD SIDS 2004
Log octanol - water partition coefficient (log Kow):	-3.77	OECD SIDS 2004

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.0506	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7757	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.3444	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.000000659	EPISUITE 2011 v4.1
Fugacity_Water: (%)	37	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	63	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0704	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	HSDB 2012
Biotransformation half - life (Days):		

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate EC50	MOR	MORT	2	349	ECOTOX 2012
Oryzias latipes	Japanese medaka	Fish LC50	MOR	MORT	4	>100	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	MOR	MORT	21	30.2	ECOTOX 2012
Pseudokircheriella subcapitata	Algae	Plant NOEC	GRO	GROWTH	72	32	OECD SIDS 2004

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	MORT		3400	HSDB 2012	
Mouse	Mammalian LD50	MOR	MORT		3900	HSDB 2012	

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	MORT	14	1340	ECOSAR 2012	

Created By: Naomi Cooper Date: 13/07/2013

Checked By: Kirsten Broadgate Date: 15/07/2013

Project number: 127666004

ORGANIC

Name	Propan-2-ol
Synonyms	Isopropyl alcohol; secondary propyl alcohol; dimethyl carbinol; petrohol; IPA
CAS Number	67-63-0
Molecular Formula	C3H8O

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2012
Molecular Weight (g/mol):	60.1	HSDB 2012
Melting Point (°C):	-87.90	HSDB 2012
Boiling Point (°C):	82.3	HSDB 2012
Density / Specific Gravity (Not given):	0.79	HSDB 2012
Vapour Pressure (mm Hg at 25°C):	4.54E+01	HSDB 2012
Solubility (mg/L):	4.02E+05	HSDB 2012
Henry's Law Constant (atm m³/mole):	8.10E-06	EPISUITE 2011 v4.0
Organic carbon partition coefficient (Koc):	1.53	EPISUITE 2011 v4.0
Log organic carbon partition coefficient (log Koc):	0.19	EPISUITE 2011 v4.0
Log octanol - water partition coefficient (log Kow):	0.05	HSDB 2012

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.2263	EPISUITE 2011 v4.0
Biowin 4 (Primary Biodegradation):	3.8905	EPISUITE 2011 v4.0
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	0.6439	EPISUITE 2011 v4.0
Fugacity_Air: (%)	4.6	EPISUITE 2011 v4.0
Fugacity_Water: (%)	45	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	50	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	0.086	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	3	HSDB 2011
Biotransformation half - life (Days):	0.036	EPISUITE 2011 v4.0

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Rasbora heteromorpha	Harlequin Fish	Fish LC50	MOR	Mortality	4	4200	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate EC50	MOR	Mortality	1	1000	HSDB 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Mouse	Mammalian LD50	Mortality	Mortality		3600 mg/kg	HSDB 2012	
Earthworm	QSAR Earthworm LC50	Mortality	Mortality	14	157.684 mg/L	ECOSAR 2012	

Created By: Chelsea Papadopoulos Date: 16/08/2012

Checked By: Carolyn Brumley Date: 31/08/2012

Project number: 127666004

ORGANIC

Name	Tetramethylammonium chloride
Synonyms	N,N,N-trimethylmethanaminium chloride
CAS Number	75-57-0
Molecular Formula	C4H12NCl

Physical Properties	Value	Reference
PhaseState:	Solid	HSDB 2012
Molecular Weight (g/mol):	109.6	HSDB 2012
Melting Point (°C):	420.00	HSDB 2012
Boiling Point (°C):		
Density / Specific Gravity (g/L):	1.17	HSDB 2012
Vapour Pressure (mm Hg at 25°C):	1.20E-08	HSDB 2012
Solubility (mg/L):	5.90E+05	HSDB 2012
Henry's Law Constant (atm m³/mole):	4.20E-12	HSDB 2012
Organic carbon partition coefficient (Koc):	8.00	HSDB 2012
Log organic carbon partition coefficient (log Koc):	0.90	HSDB 2012
Log octanol - water partition coefficient (log Kow):	-4.18	HSDB 2012

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.9570	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.9896	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	0.0801	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00123	EPISUITE 2011 v4.0
Fugacity_Water: (%)	3	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	68	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	0.0687	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	3.2	HSDB 2012
Biotransformation half - life (Days):	0.007535	EPISUITE 2011 v4.0

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	4	462	ECHA 2013
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	3.6	ECHA 2013
Pseudokirchnerella subcapitata	Green algae	Plant EC50	GRO	Growth	3	115	ECHA 2013

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	11	0.03	ECHA 2013
Pseudokirchnerella subcapitata	Green algae	Plant NOEC	GRO	Biomass	3	7.5	ECHA 2013

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	QSAR Earthworm LC50	MOR	Mortality	14	833.78	ECOSAR 2012	mg/L
Rat	Mammalian LD50	MOR	Mortality		50	ChemIDPlus201	mg/kg

Created By: Naomi Cooper Date: 7/11/2013

Checked By: Carolyn Brumley Date: 8/11/2013

Project number: 127666004

ORGANIC

Name	Cetylethylmorpholinium ethyl sulfate
Synonyms	Cetylethylmorpholinium ethosulfate, N-Cetyl-N-ethymorpholinium ethosulfate
CAS Number	78-21-7
Molecular Formula	C24H51N1O5S1

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	465.74	EPISUITE 2011 v4.1
Melting Point (°C):	291.55	EPISUITE 2011 v4.1
Boiling Point (°C):	669.02	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	1.22E-15	EPISUITE 2011 v4.1
Solubility (mg/L):	6.36E-03	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	3.56E-16	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	224,700.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	5.35	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	6.17	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.4596	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.4351	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.4535	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00257	EPISUITE 2011 v4.1
Fugacity_Water: (%)	4	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	54	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	42.1	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	70.79	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	5.1	EPISUITE 2011 v4.1

Project number: 127666004

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Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
	Fish	Fish LC50	MOR	Mortality		269000	ECOSAR 2012
	Daphnid	Invertebrate LC50	MOR	Mortality		117.49	ECOSAR 2012

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	299	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 9/09/2013

Checked By: Kirsten Broadgate Date: 10/09/2013

Name	2,2',2"-nitrilotriethanol
Synonyms	Biafine, Mobisyl, Sterolamide, Triethanolamine
CAS Number	102-71-6
Molecular Formula	C6H15NO3

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2009
Molecular Weight (g/mol):	149.19	HSDB 2009
Melting Point (°C):	20.50	HSDB 2009
Boiling Point (°C):	335.4	HSDB 2009
Density / Specific Gravity (g/L at 20oC	1.12	HSDB 2009
Vapour Pressure (mm Hg at 25°C):	3.59E-06	HSDB 2009
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	7.05E-13	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	7.00	HSDB 2009
Log organic carbon partition coefficient (log Koc):	0.85	HSDB 2009
Log octanol - water partition coefficient (log Kow):	-1	HSDB 2009

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.0946	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7328	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.3155	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0000161	EPISUITE 2011 v4.1
Fugacity_Water: (%)	31	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	69	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0688	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3	HSDB 2009
Biotransformation half - life (Days):	0.0008924	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Scenedesmus subspicatus	Green algae	Plant EC50	GRO	Growth	2	470	ECOTOX 2012
Ceriodaphnia dubia	Water flea	Invertebrate EC50	IMB	Immobilization	2	609.98	ECOTOX 2012
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	4	11800	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Scenedesmus quadricauda	Green algae	Plant LOEC	GRO	Growth		1.8	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	16	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Mouse	Mammalian LD50	MOR	Mortality		5846	ChemIDPlus201	mg/kg
Rat	Mammalian LD50	MOR	Mortality		8000	HSDB 2009	mg/kg
Guinea Pig	Mammalian LD50	MOR	Mortality		2200	ChemIDPlus201	mg/kg

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Name	Fumaric acid
Synonyms	Allmoaleic acid, Butendioic acid, Tumaric acid
CAS Number	110-17-8
Molecular Formula	C4H4O4

Physical Properties	Value	Reference
PhaseState:	Crystalline powder	HSDB 2010
Molecular Weight (g/mol):	116.07	HSDB 2010
Melting Point (°C):	287.00	HSDB 2010
Boiling Point (°C):	522	ChemIDPlus2012
Density / Specific Gravity (g/L at 20oC	1,635.00	HSDB 2010
Vapour Pressure (mm Hg at 25°C):	1.54E-04	HSDB 2010
Solubility (mg/L):	7.00E+03	HSDB 2010
Henry's Law Constant (atm m³/mole):	8.50E-14	HSDB 2010
Organic carbon partition coefficient (Koc):	7.00	HSDB 2010
Log organic carbon partition coefficient (log Koc):	0.87	HSDB 2010
Log octanol - water partition coefficient (log Kow):	0.46	HSDB 2010

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.6719	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.4514	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.0626	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0673	EPISUITE 2011 v4.1
Fugacity_Water: (%)	29	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	70	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.059	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.1841	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	212	QSAR 2013

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pseudokirchnerella subcapitata	Green algae	Plant NOEC	MOR	Mortality	3	100	QSAR 2013

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		9300	HSDB 2010	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	3212	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 13/12/2013

Checked By: Carolyn Brumley Date: 13/12/2013

Project number: 127666004

ORGANIC

Name	Triethylenetetramine
Synonyms	Tecza; Teta; Trien
CAS Number	112-24-3
Molecular Formula	C6H18N4

Physical Properties	Value	Reference
PhaseState:	Moderately viscous yellow liquid	HSDB 2002
Molecular Weight (g/mol):	146.24	HSDB 2002
Melting Point (°C):	12.00	HSDB 2002
Boiling Point (°C):	266	HSDB 2002
Density / Specific Gravity (g/L):	0.98	HSDB 2002
Vapour Pressure (mm Hg at 25°C):	1.00E-02	HSDB 2002
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	6.74E-19	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	76.77	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.89	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-2.65	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.9738	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.8099	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.7012	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0000000000125	EPISUITE 2011 v4.1
Fugacity_Water: (%)	20	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	80	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.1	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.1113	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Poecilia reticulata	Guppy	Fish LC50	MOR	Mortality	4	570	OECD SIDS 1998
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	33.9	ECOTOX 2012
Pseudokirchneriella subcapitata	Green algae	Plant EC50	GRO	Growth	4	3.7	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	IMM	Immobilization	21	1	OECD SIDS 1998

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		2500	ChemIDPlus2013	
Mouse	Mammalian LD50	MOR	Mortality		1600	ChemIDPlus2013	
Rabbit	Mammalian LD50	MOR	Mortality		5500	ChemIDPlus2013	

Created By: Naomi Cooper Date: 7/11/2013

Checked By: Carolyn Brumley Date: 8/11/2013

Project number: 127666004

ORGANIC

Name	Butyl diglycol
Synonyms	Butoxy diethylene glycol, Butyl ethyl, Monobutyl ether
CAS Number	112-34-5
Molecular Formula	C8H18O3

Physical Properties	Value	Reference
PhaseState:	Colourless liquid	HSDB 2007
Molecular Weight (g/mol):	162.23	HSDB 2007
Melting Point (°C):	-68.10	HSDB 2007
Boiling Point (°C):	230.4	HSDB 2007
Density / Specific Gravity (20oC):	0.95	HSDB 2007
Vapour Pressure (mm Hg at 25°C):	2.19E-02	HSDB 2007
Solubility (mg/L):	7.19E+04	HSDB 2007
Henry's Law Constant (atm m^3/mole):	7.20E-09	HSDB 2007
Organic carbon partition coefficient (Koc):	48.00	HSDB 2007
Log organic carbon partition coefficient (log Koc):	1.68	HSDB 2007
Log octanol - water partition coefficient (log Kow):	0.56	HSDB 2007

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.2816	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.9927	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.239	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.172	EPISUITE 2011 v4.1
Fugacity_Water: (%)	31	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	69	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0645	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.03627	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Bluegill	Fish LC50	MOR	Mortality	4	1300	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	1	2850	QSAR 2013

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Scenedesmus subspicatus	Green algae	Plant NOEC	GRO	Biomass	4	100	QSAR 2013

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		4500	HSDB 2007	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		2400	HSDB 2007	mg/kg
Rabbit	Mammalian LD50	MOR	Mortality		2200	HSDB 2007	mg/kg
Guinea pig	Mammalian LD50	MOR	Mortality		2000	HSDB 2007	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	424	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 10/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Name	Tetraethylenepentamine
Synonyms	Tetren; 1,2-ethanediamine, N-(2-aminoethyl)-N'-(2-((2-aminotheyl)amino)ethyl)-
CAS Number	112-57-2
Molecular Formula	C8H23N5

Physical Properties	Value	Reference
PhaseState:	Viscous hygroscopic liquid	HSDB 2003
Molecular Weight (g/mol):	189.31	HSDB 2003
Melting Point (°C):	-30.00	HSDB 2003
Boiling Point (°C):	340.3	HSDB 2003
Density / Specific Gravity (g/L):	1.00	HSDB 2003
Vapour Pressure (mm Hg at 25°C):	8.00E-07	HSDB 2003
Solubility (mg/L):	6.54E+06	HSDB 2003
Henry's Law Constant (atm m³/mole):	3.00E-20	HSDB 2003
Organic carbon partition coefficient (Koc):	1.28	HSDB 2003
Log organic carbon partition coefficient (log Koc):	3.60	HSDB 2003
Log octanol - water partition coefficient (log Kow):	-1.503	HSDB 2003

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.903	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.791	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.9305	EPISUITE 2011 v4.1
Fugacity_Air: (%)	7.45E-16	EPISUITE 2011 v4.1
Fugacity_Water: (%)	18	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	82	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.155	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	4.2	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.1711	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	4	310	OECD SIDS 2001
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	14.6	OECD SIDS 2001
	Green algae	Plant EC50	GRO	Growth	3	2.1	OECD SIDS 2001

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		2100	HSDB 2003	mg/kg

Created By: Naomi Cooper Date: 6/11/2013

Checked By: Carolyn Brumley Date: 8/11/2013

Project number: 127666004

ORGANIC

Name	Disodium ethylene diamine tetra acetate (Surrogate for)
Synonyms	Cheladrate, Disodium EDTA, Sodium versenate
CAS Number	139-33-3
Molecular Formula	C10H14N2Na2O8

Physical Properties	Value	Reference
PhaseState:	Solid - crystals, powder	HSDB 2012
Molecular Weight (g/mol):	336.21	HSDB 2012
Melting Point (°C):	335.19	EPISUITE 2011 v4.1
Boiling Point (°C):	693.42	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	7.57E-17	HSDB 2012
Solubility (mg/L):	1.08E+05	HSDB 2012
Henry's Law Constant (atm m³/mole):	1.18E-23	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	312.70	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	2.50	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-11.7	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.5022	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.3924	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.4106	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00000000355	EPISUITE 2011 v4.1
Fugacity_Water: (%)	19	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	81	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.198	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.0000569	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Blue gill	Fish LC50	MOR	Mortality	4	41	ECHA 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	140	ECHA 2012
Desmodesumus subspicatus	Green algae	Plant EC50	GRO	Growth	3	2.77	ECHA 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	25	ECHA 2012
Daphnia magna	Water flea	Invertebrate LOEC	REP	Reproduction	21	50	ECHA 2012
Desmodesumus subspicatus	Green algae	Plant NOEC	GRO	Growth rate	3	0.39	ECHA 2012
Desmodesumus subspicatus	Green algae	Plant LOEC	GRO	Growth rate	3	0.78	ECHA 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Mouse	Mammalian LD50	MOR	Mortality		400	HSDB 2012	mg/kg
Rat	Mammalian LD50	MOR	Mortality		2000	HSDB 2012	mg/kg

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	Trisodium ethylene diamine tetra acetate (impurity)
Synonyms	Edetate trisodium, Trisodium EDTA, Trisodium versenate
CAS Number	150-38-9
Molecular Formula	C10H13N2O8Na3

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	358.19	EPISUITE 2011 v4.1
Melting Point (°C):	335.12	EPISUITE 2011 v4.1
Boiling Point (°C):	692.95	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	7.81E-17	EPISUITE 2011 v4.1
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	1.18E-23	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	312.70	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	2.50	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-13.15	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.5022	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.3924	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.4106	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00000000345	EPISUITE 2011 v4.1
Fugacity_Water: (%)	19	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	81	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.198	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.00002082	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Terrestrial Ecotoxicological Data

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Rat	Mammalian LD50	MOR	Mortality		2150	ChemIDPlus 201	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		2150	ChemIDPlus 201	mg/kg

Created By: Naomi Cooper Date: 9/09/2013

Checked By: Kirsten Broadgate Date: 10/09/2013

Project number: 127666004

ORGANIC

Name	Decyldimethyl amine
Synonyms	N,N-Dimethyldecylamine
CAS Number	1120-24-7
Molecular Formula	C12H27N

Physical Properties	Value	Reference
PhaseState:	Liquid	ECHA 2013
Molecular Weight (g/mol):	185.36	EPISUITE 2011 v4.0
Melting Point (°C):	-33.00	ECHA 2013
Boiling Point (°C):	237	ECHA 2013
Density / Specific Gravity (mg/L):	0.78	ECHA 2013
Vapour Pressure (mm Hg at 25°C):	8.25E-02	ECHA 2013
Solubility (mg/L):	8.22E+01	EPISUITE 2011 v4.0
Henry's Law Constant (atm m³/mole):	4.68E-04	EPISUITE 2011 v4.0
Organic carbon partition coefficient (Koc):	1,699.00	EPISUITE 2011 v4.0
Log organic carbon partition coefficient (log Koc):	3.23	EPISUITE 2011 v4.0
Log octanol - water partition coefficient (log Kow):	4.46	EPISUITE 2011 v4.0

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.8331	EPISUITE 2011 v4.0
Biowin 4 (Primary Biodegradation):	3.5614	EPISUITE 2011 v4.0
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	-0.5613	EPISUITE 2011 v4.0
Fugacity_Air: (%)	0.623	EPISUITE 2011 v4.0
Fugacity_Water: (%)	19	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	80	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	1.05	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	17.16	
Biotransformation half - life (Days):	0.3648	

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorynchus mykiss	Rainbow trout	Fish LC50	MOR	Mortality	4	0.18	ECHA 2013
Daphnia maga	Water flea	Invertebrate LC50	MOR	Mortality	2	0.0558	ECHA 2013
Scenedesmus subspicatas	Green algae	Plant EC50	MOR	Mortality	3	0.006	ECHA 2013

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	0.036	ECHA 2013
Scenedesmus subspicatas	Green algae	Plant NOEC	GRO	Growth	3	0.0005	ECHA 2013

Created By: Naomi Cooper Date: 13/11/2013

Checked By: Carolyn Brumley Date: 15/11/2013

Project number: 127666004

ORGANIC

Name	Decyl-dimethyl amine oxide
Synonyms	N,N-dimethyldecylamine N-oxide
CAS Number	2605-79-0
Molecular Formula	C12H27NO

Physical Properties	Value	Reference
PhaseState:	Solid	ECHA 2013
Molecular Weight (g/mol):	201.36	EPISUITE 2011 v4.0
Melting Point (°C):	133.00	ECHA 2013
Boiling Point (°C):	403.41	EPISUITE 2011 v4.0
Density / Specific Gravity (g/L at 23oC	0.72	ECHA 2013
Vapour Pressure (mm Hg at 25°C):	5.63E-07	ECHA 2013
Solubility (mg/L):	3.04E+01	EPISUITE 2011 v4.0
Henry's Law Constant (atm m^3/mole):	3.67E-10	EPISUITE 2011 v4.0
Organic carbon partition coefficient (Koc):	2,408.00	EPISUITE 2011 v4.0
Log organic carbon partition coefficient (log Koc):	3.38	EPISUITE 2011 v4.0
Log octanol - water partition coefficient (log Kow):	3.69	EPISUITE 2011 v4.0

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.0525	EPISUITE 2011 v4.0
Biowin 4 (Primary Biodegradation):	3.8263	EPISUITE 2011 v4.0
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	0.0758	EPISUITE 2011 v4.0
Fugacity_Air: (%)	0.00074	EPISUITE 2011 v4.0
Fugacity_Water: (%)	16	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	83	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	1.23	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	126.5	EPISUITE 2011 v4.0
Biotransformation half - life (Days):	1.17	EPISUITE 2011 v4.0

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Danio rerio	Zebra fish	Fish LC50	MOR	Mortality	4	2.4	ECHA 2013
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	2.64	ECHA 2013
Selenastrum capricornutum	Green algae	Plant EC50	MOR	Mortality	3	0.015	ECHA 2013

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pimephales promelas	Fathead minnow	Fish NOEC	GRO	Growth	302	0.42	ECHA 2013
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	0.7	ECHA 2013
Selenastrum capricornutum	Green algae	Plant NOEC	GRO	Growth	72	0.003	ECHA 2013
Pimephales promelas	Fathead minnow	Fish LOEC	GRO	Growth	302	0.88	ECHA 2013

Created By: Naomi Cooper Date: 13/11/2013

Checked By: Carolyn Brumley Date: 15/11/2013

Project number: 127666004

ORGANIC

Name	2-methyl-2h-isothiazol-3-one
Synonyms	2-methyl-4-isothizaolin-3-one
CAS Number	2682-20-4
Molecular Formula	C4H5NOS

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	115.15	ChemIDPlus2012
Melting Point (°C):	47.50	EPISUITE 2011 v4.1
Boiling Point (°C):	237.8	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	3.10E-02	EPISUITE 2011 v4.1
Solubility (mg/L):	5.37E+05	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	4.96E-08	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	12.08	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.08	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-0.83	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.9447	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.6816	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.6095	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.519	EPISUITE 2011 v4.1
Fugacity_Water: (%)	34	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	65	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0797	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.02263	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus mykiss	Rainbow trout	Fish LC50	MOR	Mortality	4	0.07	ECOTOX 2012

Created By: Naomi Cooper Date: 17/12/2013

Checked By: Kirsten Broadgate Date: 17/12/2013

Project number: 127666004

ORGANIC

Name	Sodium glycolate (impurity)
Synonyms	
CAS Number	2836-32-0
Molecular Formula	C2H303Na

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	98.03	EPISUITE 2011 v4.1
Melting Point (°C):	174.37	EPISUITE 2011 v4.1
Boiling Point (°C):	435.8	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	4.58E-10	EPISUITE 2011 v4.1
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	8.58E-08	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	1.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	0.00	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-5.19	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.5557	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.2530	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	1.1816	EPISUITE 2011 v4.1
Fugacity_Air: (%)	2.36	EPISUITE 2011 v4.1
Fugacity_Water: (%)	35	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	63	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0616	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.006808	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
	Fish	Fish LC50	MOR	Mortality	4	3.50E+05	ECOSAR 2012
	Daphnid	Invertebrate LC50	MOR	Mortality	2	1.52E+05	ECOSAR 2012
	Green algae	Plant EC50	MOR	Mortality	4	3.51E+04	ECOSAR 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		7110	ChemIDPlus 201	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		6700	ChemIDPlus 201	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	Mor	Mortality	14	2750	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	Pentaethylenehexamine
Synonyms	3,6,9,12-Tetraazatetradecane-1,14-diamine
CAS Number	4067-16-7
Molecular Formula	C10H28N6

Physical Properties	Value	Reference
PhaseState:	Liquid	ECHA 2012
Molecular Weight (g/mol):	232.38	ECHA 2012
Melting Point (°C):	-70.00	ECHA 2012
Boiling Point (°C):	426	ECHA 2012
Density / Specific Gravity (g/L at 20oC	1,003.00	ECHA 2012
Vapour Pressure (mm Hg at 25°C):	1.26E-05	ECHA 2012
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	8.36E-24	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	396.40	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	2.60	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-3.67	ECHA 2012

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.8323	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7722	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	2.1597	EPISUITE 2011 v4.1
Fugacity_Air: (%)	4.59E-20	EPISUITE 2011 v4.1
Fugacity_Water: (%)	17	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	83	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.275	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.2631	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Poecilia reticulata	Guppy	Fish LC50	MOR	Mortality	4	180	ECHA 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	17.5	ECHA 2012
Selenastrum capricornutum	Green algae	Plant EC50	GRO	Growth rate	3	0.7	ECHA 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Selenastrum capricornutum	Green algae	Plant NOEC	GRO	Growth rate	3	0.25	ECHA 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		1600	ChemIDPlus201	mg/kg

Created By: Naomi Cooper Date: 10/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Project number: 127666004

ORGANIC

Name	Trisodium nitriloacetate (impurity)
Synonyms	Sodium nitriloacetate, Trisodium NTA
CAS Number	5064-31-3
Molecular Formula	C6H6N1O6Na3

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	257.09	EPISUITE 2011 v4.1
Melting Point (°C):	199.47	EPISUITE 2011 v4.1
Boiling Point (°C):	487.76	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	8.08E-10	EPISUITE 2011 v4.1
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	1.21E-16	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	26.27	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.42	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-10.08	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.6158	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.4407	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.3995	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0000000838	EPISUITE 2011 v4.1
Fugacity_Water: (%)	24	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	76	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0653	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.0000837	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Carassius auratus	Goldfish	Fish LC50	MOR	Mortality	4	257	ECOTOX 2012
Navicula seminulum	Diatom	Plant EC50	MOR	Mortality	4	185	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate NOEC	MOR	Mortality	21	100	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		1100	HSDB 2012	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		681	HSDB 2012	mg/kg

Created By: Naomi Cooper Date: 9/09/2013

Checked By: Kirsten Broadgate Date: 10/09/2013

Name	Polyethylene glycol sorbitan monolaurate
Synonyms	Polyethylene glycol sorbitan laurate, Polysorbate 20
CAS Number	9005-64-5
Molecular Formula	C58-H114-O26 (C48-H94O21)

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2012
Molecular Weight (g/mol):	1288	HSDB 2012
Melting Point (°C):	349.84	EPISUITE
Boiling Point (°C):	1001.79	EPISUITE
Density / Specific Gravity (g/mL at 25	1.10	HSDB 2012
Vapour Pressure (mm Hg at 25°C):	8.65E-33	EPISUITE
Solubility (mg/L):	1.10E+06	EPISUITE
Henry's Law Constant (atm m³/mole):	2.19E-40	EPISUITE
Organic carbon partition coefficient (Koc):	239,700,000.00	EPISUITE
Log organic carbon partition coefficient (log Koc):	8.38	EPISUITE
Log octanol - water partition coefficient (log Kow):	-2.03	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	1.753	EPISUITE
Biowin 4 (Primary Biodegradation):	3.125	EPISUITE
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE
Biowin 7 (Anaerobic Model Prediction):	-2.209	EPISUITE
Fugacity_Air: (%)	0.0000000000301	EPISUITE
Fugacity_Water: (%)	1	EPISUITE
Fugacity_Soil: (%)	42	EPISUITE
Fugacity_Sediment: (%)	57.3	EPISUITE
Bioconcentration factor (BCF):	3.162	EPISUITE
Biotransformation half - life (Days):	0.039	EPISUITE

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Poecilia reticula	Guppy	Fish LC50	MOR	MORT	1	350	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Hamster	Mammalian LD50	MOR	MORT		18000 mg/kg	HSDB 2012	
Earthworm	Mammalian LD50	MOR	MORT	14	261000	ECOSAR 2012	

Created By: Naomi Cooper Date: 4/09/2012

Checked By: Kirsten Broadgate Date: 19/09/2012

Project number: 127666004

ORGANIC

Name	5-chloro-2-methyl-2h-isothiazol-3-one
Synonyms	Methylchloroisothiazolinone
CAS Number	26172-55-4
Molecular Formula	C4H4ClNOS

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	149.6	EPISUITE 2011 v4.1
Melting Point (°C):	50.00	IUCLID 2000
Boiling Point (°C):	106.5	IUCLID 2000
Density / Specific Gravity (g/L at 20oC	1.26	IUCLID 2000
Vapour Pressure (mm Hg at 25°C):	1.56E+01	IUCLID 2000
Solubility (mg/L):	1.49E+05	IUCLID 2000
Henry's Law Constant (atm m³/mole):	3.57E-08	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	19.38	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.29	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-0.34	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.6954	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.5313	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.6683	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.251	EPISUITE 2011 v4.1
Fugacity_Water: (%)	32	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	67	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0918	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.04781	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorynchus mykiss	Rainbow trout	Fish LC50	MOR	Mortality	4	0.190	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	2	4.71	IUCLID 2000
Anabaena flos-aquae	Algae	Plant EC50	GRO	Growth	5	0.31	IUCLID 2000

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorynchus mykiss	Rainbow trout	Fish NOEC	GRO	Growth	14	0.05	ECOTOX 2012
Daphnia magna	Water flea	Invertebrate NOEC	REP	Reproduction	21	0.172	IUCLID 2000
Daphnia magna	Water flea	Invertebrate LOEC	REP	Reproduction	21	0.572	IUCLID 2000

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		481	IUCLID 2000	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality		278	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 17/12/2013

Checked By: Kirsten Broadgate Date: 17/12/2013

Project number: 127666004

ORGANIC

Name	Polyethylene glycol monohexyl ether
Synonyms	
CAS Number	31726-34-8
Molecular Formula	C16H34O6

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	322.45	EPISUITE 2011 v4.1
Melting Point (°C):	133.01	EPISUITE 2011 v4.1
Boiling Point (°C):	391.73	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	2.67E-08	EPISUITE 2011 v4.1
Solubility (mg/L):	1.21E+04	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	8.68E-19	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	10.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.00	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	0.45	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.9016	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7323	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.3249	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0000000000718	EPISUITE 2011 v4.1
Fugacity_Water: (%)	31	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	69	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0688	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.02036	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
	Fish	Fish LC50	MOR	Mortality		0.168	EPISUITE 2011 v4.1
	Daphnid	Invertebrate LC50	MOR	Mortality		0.168	EPISUITE 2011 v4.1

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14d	812	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	Dicoco dimethyl quarternary ammonium chloride
Synonyms	Dicocodimonium chloride
CAS Number	61789-77-3
Molecular Formula	C26H56ClN

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	418.2	EPISUITE 2011 v4.1
Melting Point (°C):	250.49	EPISUITE 2011 v4.1
Boiling Point (°C):	581.12	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	8.07E-13	EPISUITE 2011 v4.1
Solubility (mg/L):	4.18E-07	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	2.13E-09	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	5,348,000.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	6.73	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	6.62	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.8717	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7825	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.0164	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.144	EPISUITE 2011 v4.1
Fugacity_Water: (%)	4	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	31	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	65.1	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	70.79	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	10.16	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Aedes nigromaculis	Mosquito	Invertebrate LC50	MOR	Mortality	1	0.2	ECOTOX 2012
	Fish	Fish LC50	MOR	Mortality	4	269000	ECOSAR 2012

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	241	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	Alkyl (C12-C16) dimethylbenzyl ammonium chloride
Synonyms	Alkyl(C12-16)dimethylbenzylammonium chloride, Ammonium, alkyl(C12-C16)dimethylbenzyl-, chlorides, Benzyl-C12-C16-alkyldimethyl ammonium chlorides, C12-16-Alkyldimethylbenzylammonium chloride
CAS Number	68424-85-1
Molecular Formula	C23H42ClN

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	368.05	EPISUITE 2011 v4.1
Melting Point (°C):	241.02	EPISUITE 2011 v4.1
Boiling Point (°C):	560.84	EPISUITE 2011 v4.1
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	3.53E-12	EPISUITE 2011 v4.1
Solubility (mg/L):	2.20E+00	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	1.34E-11	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	903,000.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	5.96	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	3.91	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.7062	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.5907	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	-0.0865	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.0401	EPISUITE 2011 v4.1
Fugacity_Water: (%)	3	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	39	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	58.8	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	70.79	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.5879	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus mykiss	Rainbow Trout	Fish LC50	MOR	Mortality	4	0.064	ECOTOX 2012
Chlorella pyrenoidosa	Green algae	Plant EC50	POP	Population	4	0.67	QSAR 2013

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		426	ChemIDPlus201	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		919	ChemIDPlus201	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	405.5	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 8/11/2013

Checked By: Carolyn Brumley Date: 11/11/2013

Project number: 127666004

ORGANIC

Name	Lactic acid, Surrogate for Polylactide resin (9051-89-2) (Surrogate for)
Synonyms	2-Hydroxypropanoic acid, Lactate, Milk acid, Racemic lactic acid
CAS Number	50-21-5
Molecular Formula	C3H6O3

Physical Properties	Value	Reference
PhaseState:	Crytals or syrupy liquid	HSDB 2006
Molecular Weight (g/mol):	90.09	HSDB 2006
Melting Point (°C):	16.80	HSDB 2006
Boiling Point (°C):	122	HSDB 2006
Density / Specific Gravity (g/L at 25oC	1.20	HSDB 2006
Vapour Pressure (mm Hg at 25°C):	8.13E-02	HSDB 2006
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	8.10E-08	HSDB 2006
Organic carbon partition coefficient (Koc):	5.70	HSDB 2006
Log organic carbon partition coefficient (log Koc):	0.76	HSDB 2006
Log octanol - water partition coefficient (log Kow):	-0.72	HSDB 2006

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.5247	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.2328	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.9102	EPISUITE 2011 v4.1
Fugacity_Air: (%)	1.87	EPISUITE 2011 v4.1
Fugacity_Water: (%)	36	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	62	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0641	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.02417	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
	Fish	Fish LC50	MOR	Mortality		177000	ECOSAR 2012
Meloidogyne arenaria	Peanut root-knot nematode	Invertebrate LC50	MOR	Mortality	1	4504.5	ECOTOX 2012
	Green algae	Plant EC50	GRO	Growth		21338.494	ECOSAR 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		3730	HSDB 2006	mg/kg
Mouse	Mammalian LD50	MOR	Mortality		4875	HSDB 2006	mg/kg
Guinea Pig	Mammalian LD50	MOR	Mortality		1810	HSDB 2006	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14d	2947.999	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	Decanoic acid, Surrogate for Octadecanoic acid, calcium salt (1592-23-0) (Surrogate for)
Synonyms	
CAS Number	57-11-4
Molecular Formula	C18H36O2

Physical Properties	Value	Reference
PhaseState:	Solid	HSDB 2008
Molecular Weight (g/mol):	284.48	HSDB 2008
Melting Point (°C):	69.30	HSDB 2008
Boiling Point (°C):	350	HSDB 2008
Density / Specific Gravity (no units):	0.60	HSDB 2008
Vapour Pressure (mm Hg at 25°C):	4.28E-08	HSDB 2008
Solubility (mg/L):	5.97E-01	
Henry's Law Constant (atm m³/mole):	4.76E-07	HSDB 2008
Organic carbon partition coefficient (Koc):	710,000.00	HSDB 2008
Log organic carbon partition coefficient (log Koc):	5.85	HSDB 2008
Log octanol - water partition coefficient (log Kow):	8.23	HSDB 2008

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.2334	EPISUITE 2011 v4.0
Biowin 4 (Primary Biodegradation):	4.0191	EPISUITE 2011 v4.0
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	1.0414	EPISUITE 2011 v4.0
Fugacity_Air: (%)	0.878	EPISUITE 2011 v4.0
Fugacity_Water: (%)	23	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	75	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	0.867	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	10	EPISUITE 2011 v4.0
Biotransformation half - life (Days):	20.39	EPISUITE 2011 v4.0

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Oncorhynchus kisutch	Silver salmon	Fish LC50	MOR	Mortality	4	12	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Rat	Mammalian LD50	MOR	Mortality		4600	HSDB 2008	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality		1196	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 13/11/2013

Checked By: Carolyn Brumley Date: 15/11/2013

Project number: 127666004

ORGANIC

Name	1,1 DCE (Surrogate for Vinylidene Chloride/Methacrylate Copolymer 25038-72-6)
Synonyms	
CAS Number	75-35-4
Molecular Formula	C2H2Cl2

Physical Properties	Value	Reference
PhaseState:	Liquid	HSDB 2011
Molecular Weight (g/mol):	96.94	HSDB 2011
Melting Point (°C):	-122.50	HSDB 2011
Boiling Point (°C):	31.7	HSDB 2011
Density / Specific Gravity (Enter Unit):	1.21	HSDB 2011
Vapour Pressure (mm Hg at 25°C):	6.00E+02	HSDB 2011
Solubility (mg/L):	2.42E+03	HSDB 2011
Henry's Law Constant (atm m^3/mole):	2.61E-02	HSDB 2011
Organic carbon partition coefficient (Koc):	64.00	HSDB 2011
Log organic carbon partition coefficient (log Koc):	1.81	HSDB 2011
Log octanol - water partition coefficient (log Kow):	2.13	HSDB 2011

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.6386	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.5067	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	EPISUITE 2011 v4.1
Biowin 7 (Anaerobic Model Prediction):	0.6597	EPISUITE 2011 v4.1
Fugacity_Air: (%)	20.8	EPISUITE 2011 v4.1
Fugacity_Water: (%)	75	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	4	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.257	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	11.81	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.614	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Daphnia magna	Water flea	Invertebrate LC50	MOR	Mortality	1	11.6	ECOTOX 2012
Pimephales promelas	Fathead minnow	Fish LC50	MOR	Mortality	7	29	ECOTOX 2012
Chlamydomonas reinhardtii	Green algae	Plant EC50	POP	Biomass	3	9.12	ECOTOX 2012

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Pimephales promelas	Fathead minnow	Fish MATC	GRO	Growth	30	2.8	ECOTOX 2012
	Green algae	Plant NOEC	POP	Biomass	4	56	ECOTOX 2012

Terrestrial Ecotoxicological Data

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Mouse	Mammalian LD50	MOR	Mortality		194	HSDB 2010	mg/kg

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Earthworm	1	MOR	Mortality	14	121	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 17/12/2013

Checked By: Kirsten Broadgate Date: 17/12/2013

Name	Gluconic acid, surrogate for Sodium Gluconate (527-07-1) (Surrogate for)
Synonyms	Dextronic acid, Glycogenic acid, Maltonic acid
CAS Number	526-95-4
Molecular Formula	C6H12O7

Physical Properties	Value	Reference
PhaseState:	Solid - crystals	HSDB 2003
Molecular Weight (g/mol):	196.16	HSDB 2003
Melting Point (°C):	131.00	HSDB 2003
Boiling Point (°C):		
Density / Specific Gravity (g/L at 25oC	1.24	HSDB 2003
Vapour Pressure (mm Hg at 25°C):	8.17E+10	EPISUITE 2011 v4.1
Solubility (mg/L):	3.16E+05	EPISUITE 2011 v4.1
Henry's Law Constant (atm m³/mole):	4.74E-13	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	10.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.00	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-1.87	EPISUITE 2011 v4.1

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.9301	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	4.5975	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Biodegrades fast	
Biowin 7 (Anaerobic Model Prediction):	1.0493	
Fugacity_Air: (%)	0.00257	EPISUITE 2011 v4.1
Fugacity_Water: (%)	24	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	76	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0362	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.1
Biotransformation half - life (Days):	0.0005227	EPISUITE 2011 v4.1

Project number: 127666004

ORGANIC

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Earthworm	1	MOR	Mortality	14	8584.013	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 7/09/2013

Checked By: Kirsten Broadgate Date: 9/09/2013

Project number: 127666004

ORGANIC

Name	2-Acrylamido-2-methylpropanesulfonic acid, sodium salt, surrogate for Acrylamide, 2-acrylamido-2-methylpropanesulfonic acid, sodium salt polymer (38193-60-1)
Synonyms	
CAS Number	5165-97-9
Molecular Formula	C7H12NNaO4S

Physical Properties	Value	Reference
PhaseState:	Solid	USEPA 2009
Molecular Weight (g/mol):	229.23	USEPA 2009
Melting Point (°C):	260.35	USEPA 2009
Boiling Point (°C):		
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	1.72E-13	USEPA 2009
Solubility (mg/L):	1.00E+06	USEPA 2009
Henry's Law Constant (atm m³/mole):	5.20E-20	EPISUITE 2011 v4.1
Organic carbon partition coefficient (Koc):	10.00	EPISUITE 2011 v4.1
Log organic carbon partition coefficient (log Koc):	1.00	EPISUITE 2011 v4.1
Log octanol - water partition coefficient (log Kow):	-4.34	USEPA 2009

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	2.6674	EPISUITE 2011 v4.1
Biowin 4 (Primary Biodegradation):	3.7779	EPISUITE 2011 v4.1
EPISUITE Ready Biodegradability:	Does not biodegrade fast	
Biowin 7 (Anaerobic Model Prediction):	-0.4197	EPISUITE 2011 v4.1
Fugacity_Air: (%)	0.00151	EPISUITE 2011 v4.1
Fugacity_Water: (%)	35	EPISUITE 2011 v4.1
Fugacity_Soil: (%)	65	EPISUITE 2011 v4.1
Fugacity_Sediment: (%)	0.0836	EPISUITE 2011 v4.1
Bioconcentration factor (BCF):	3.162	
Biotransformation half - life (Days):	0.001495	

Project number: 127666004

ORGANIC

Aquatic Ecotoxicological Data

Acute toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Lepomis macrochirus	Bluegill	Fish LC50	Mortality	Mortality	4	>1000	USEPA 2009
Daphnia magna	Cladoceran	Invertebrate EC50	Mortality	Mortality	2	>1000	USEPA 2009
Pseudokirchneriella subcapitata	Green Algae	Plant EC50	GRO	Growth	4	>2000	USEPA 2009

Chronic toxicity data							
SpeciesName	**Common Name**	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc mg/L**	**Reference**
Selenastrum capricornutum	Green Algae	Plant NOEC	GRO	Growth	4	2000	QSAR 2013

Common Name	**Endpoint**	**Effect**	**Effect Measure**	**Test Time (Days)**	**Conc**	**Reference**	**Units**
Sprague-Dawley Rats	2	Mortality	Mortality	14	>16000	USEPA 2009	

Created By: Naomi Cooper Date: 2/07/2013

Checked By: Kirsten Broadgate Date: 2/07/2013

Project number: 127666004

ORGANIC

Name	Hydroxypropyl methylcellulose, surrogate for Hydroxypropyl cellulose (9004-64-2)
Synonyms	2-Hydroxypropyl cellusloe methyl ether; Hypromellose
CAS Number	9004-65-3
Molecular Formula	C20H38O12

Physical Properties	Value	Reference
PhaseState:		
Molecular Weight (g/mol):	470.52	EPISUITE 2011 v4.0
Melting Point (°C):	288.23	EPISUITE 2011 v4.0
Boiling Point (°C):	661.91	EPISUITE 2011 v4.0
Density / Specific Gravity (Enter Unit):		
Vapour Pressure (mm Hg at 25°C):	7.89E-20	EPISUITE 2011 v4.0
Solubility (mg/L):	1.00E+06	EPISUITE 2011 v4.0
Henry's Law Constant (atm m³/mole):	1.83E-24	EPISUITE 2011 v4.0
Organic carbon partition coefficient (Koc):	35.65	EPISUITE 2011 v4.0
Log organic carbon partition coefficient (log Koc):	1.55	EPISUITE 2011 v4.0
Log octanol - water partition coefficient (log Kow):	-5.3	EPISUITE 2011 v4.0

Persistance / Bioaccumulation	Value	Reference
Biowin 3 (Ultimate Survey Biodegradation):	3.2358	EPISUITE 2011 v4.0
Biowin 4 (Primary Biodegradation):	4.0263	EPISUITE 2011 v4.0
EPISUITE Ready Biodegradability:	Biodegrades fast	EPISUITE 2011 v4.0
Biowin 7 (Anaerobic Model Prediction):	0.7306	EPISUITE 2011 v4.0
Fugacity_Air: (%)	0.00000101	EPISUITE 2011 v4.0
Fugacity_Water: (%)	24	EPISUITE 2011 v4.0
Fugacity_Soil: (%)	76	EPISUITE 2011 v4.0
Fugacity_Sediment: (%)	0.0778	EPISUITE 2011 v4.0
Bioconcentration factor (BCF):	3.162	EPISUITE 2011 v4.0
Biotransformation half - life (Days):	0.0000555	EPISUITE 2011 v4.0

Project number: 127666004

ORGANIC

Common Name	Endpoint	Effect	Effect Measure	Test Time (Days)	Conc	Reference	Units
Earthworm	1	MOR	Mortality	14	4675.2	ECOSAR 2012	mg/L

Created By: Naomi Cooper Date: 13/11/2013

Checked By: Carolyn Brumley Date: 15/11/2013

APPENDIX G

Fluid Analytical Results

cash . sale .

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle**: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane**: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville**: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide**: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Schlumberger	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☒ Non Standard or urgent TAT (List due date): ASAP	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE:		Custody Seal Intact?	Yes / No / N/A
PROJECT:	**ALS QUOTE NO.:**	Free ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER:	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt:	13.3 °C
PROJECT MANAGER: Sean McCallum	**CONTACT PH:** 0418 532 890 OF: 1 2 3 4 5 6 7	Other comment:	

SAMPLER:	**SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:**
COC emailed to ALS? (	**EDD FORMAT (or default):**	*Damian Jones*	Greg Vogel
Email Reports to (will default to PM if no other addresses are listed): smccallum2@slb.com		DATE/TIME:	DATE/TIME: 14/8/13 9:30
Email Invoice to (will default to PM if no other addresses are listed): smccallum2@slb.com		**RELINQUISHED BY:** DATE/TIME:	**RECEIVED BY:** DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	BTEX	PAH							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
1	ThermaFRAC Additives	12-Aug-13	Water	40 mL Glass vial with sulphuric acid preservative	2	X	X							Ensure detection limits as per email to SLB Requirements. (< 1 ug/L on all analytes)
2	ThermaFRAC Polymer	12-Aug-13	Water	40 mL Glass vial with sulphuric acid preservative	2	X	X							
3	Slickwater	12-Aug-13	Water	40 mL Glass vial with sulphuric acid preservative	2	X	X							
				TOTAL	6									

Environmental Division
Brisbane
Work Order
EB1319648

Telephone : +61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1319648**	Page	: 1 of 5
Client	: **SCHLUMBERGER WATER SERVICES AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR SEAN McCALLUM	Contact	: Customer Services
Address	: 34 - 38 CARMICHAEL STREET CHINCHILLA QLD, AUSTRALIA 4413	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: cash.sale@alsenviro.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 4669 1364	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: ThermaFRAC Slickwater	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 14-AUG-2013
Sampler	: Damian Jones	Issue Date	: 26-AUG-2013
Site	: ----		
		No. of samples received	: 3
Quote number	: ----	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics
Phalak Inthaksone	Laboratory Manager - Organics	Sydney Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EP132: Insufficient sample has been provided for standard analysis. Where applicable LOR values have been adjusted accordingly.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ThermaFRAC Additives	ThermaFRAC Polymer	Slickwater	----	----
				Client sampling date / time	12-AUG-2013 15:00	12-AUG-2013 15:00	12-AUG-2013 15:00	----	----
Compound	CAS Number	LOR	Unit		EB1319648-001	EB1319648-002	EB1319648-003	----	----
EP125A: Monocyclic Aromatic Hydrocarbons									
Benzene	71-43-2	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Toluene	108-88-3	0.5	µg/L		**3.7**	<0.5	<0.5	----	----
Ethylbenzene	100-41-4	0.05	µg/L		**0.07**	<0.05	<0.05	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Styrene	100-42-5	0.05	µg/L		**0.25**	<0.05	<0.05	----	----
ortho-Xylene	95-47-6	0.05	µg/L		<0.05	<0.05	<0.05	----	----
1.3.5-Trimethylbenzene	108-67-8	0.05	µg/L		<0.05	<0.05	<0.05	----	----
1.2.4-Trimethylbenzene	95-63-6	0.05	µg/L		<0.05	<0.05	<0.05	----	----
Sum of Xylenes	1330-20-7	0.05	µg/L		<0.05	<0.05	<0.05	----	----
EP132B: Polynuclear Aromatic Hydrocarbons									
3-Methylcholanthrene	56-49-5	0.1	µg/L		<0.1	<0.1	<0.2	----	----
2-Methylnaphthalene	91-57-6	0.1	µg/L		<0.1	<0.1	<0.2	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Acenaphthene	83-32-9	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Acenaphthylene	208-96-8	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Anthracene	120-12-7	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Benz(a)anthracene	56-55-3	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Benzo(a)pyrene	50-32-8	0.05	µg/L		<0.07	<0.07	<0.08	----	----
Benzo(b)fluoranthene	205-99-2	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Benzo(e)pyrene	192-97-2	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L		<0.1	**0.2**	<0.2	----	----
Benzo(k)fluoranthene	207-08-9	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Chrysene	218-01-9	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Coronene	191-07-1	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Fluoranthene	206-44-0	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Fluorene	86-73-7	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L		<0.1	<0.1	<0.2	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Naphthalene	91-20-3	0.1	µg/L		<0.1	**0.7**	<0.2	----	----
Perylene	198-55-0	0.1	µg/L		<0.1	<0.1	<0.2	----	----
Phenanthrene	85-01-8	0.1	µg/L		<0.1	**0.3**	<0.2	----	----
Pyrene	129-00-0	0.1	µg/L		<0.1	<0.1	<0.2	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	ThermaFRAC Additives	ThermaFRAC Polymer	Slickwater	----	----
				Client sampling date / time	12-AUG-2013 15:00	12-AUG-2013 15:00	12-AUG-2013 15:00	----	----
Compound	CAS Number	LOR	Unit		EB1319648-001	EB1319648-002	EB1319648-003	----	----
EP132B: Polynuclear Aromatic Hydrocarbons - Continued									
^ **Sum of PAHs**	----	0.05	µg/L		<0.1	**1.2**	<0.2	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.05	µg/L		<0.1	<0.1	<0.2	----	----
EP125S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**113**	**91.4**	**113**	----	----
Toluene-D8	2037-26-5	0.1	%		**105**	**86.5**	**102**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		**97.8**	**79.9**	**104**	----	----
EP132T: Base/Neutral Extractable Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		**68.4**	**84.4**	**87.4**	----	----
Anthracene-d10	1719-06-8	0.1	%		**75.3**	**89.7**	**81.7**	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		**70.2**	**91.1**	**80.9**	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	Recovery Limits (%) High
EP125S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	65	127
4-Bromofluorobenzene	460-00-4	68	124
EP132T: Base/Neutral Extractable Surrogates			
2-Fluorobiphenyl	321-60-8	43	135
Anthracene-d10	1719-06-8	48	138
4-Terphenyl-d14	1718-51-0	48	144

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EB1317643**	Page	: 1 of 5
Client	: **SCHLUMBERGER WATER SERVICES AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: ASHLEY WATLING (COC/SRN)	Contact	: Customer Services
Address	: 34 - 38 CARMICHAEL STREET CHINCHILLA QLD, AUSTRALIA 4413	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: awatling@slb.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: +61 07 4669 1364	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 24-JUL-2013
Sampler	: Damian Jones	Issue Date	: 01-AUG-2013
Site	: ----		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Matt Frost	Senior Organic Chemist	Brisbane Organics
Pabi Subba	Senior Organic Chemist	Sydney Organics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EP125: Sample YF140 HTD has been heated to reduce viscosity of the gel. As such volatile analytes may have been lost through evaporation.**
- **EP125;Particular samples required dilution due to matrix interferences. LOR values have been adjusted accordingly.**
- **PAH: Sample 'YF140 HTD' required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly.**
- **PAH: Samples 'YF120 W/L071 and YF140 HTD' show poor surrogate recovery for Anthracene-d10 due to matrix interference.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	YF120 W/L071	YF140 HTD	----	----	----
			Client sampling date / time	17-JUL-2013 15:00	17-JUL-2013 15:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1317643-001	EB1317643-002	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<5.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<5.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<5.0	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<5.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<5.0	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<5.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<5.0	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<5.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<5.0	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<5.0	----	----	----
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<5.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<5.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<5.0	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<5.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<5.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<5.0	----	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<2.5	----	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L	<0.5	<5.0	----	----	----
EP125A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	0.05	µg/L	----	<0.12	----	----	----
Toluene	108-88-3	0.5	µg/L	----	<0.5	----	----	----
Ethylbenzene	100-41-4	0.05	µg/L	----	<0.12	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.05	µg/L	----	<0.25	----	----	----
Styrene	100-42-5	0.05	µg/L	----	<0.15	----	----	----
ortho-Xylene	95-47-6	0.05	µg/L	----	<0.12	----	----	----
1.3.5-Trimethylbenzene	108-67-8	0.05	µg/L	----	<0.15	----	----	----
1.2.4-Trimethylbenzene	95-63-6	0.05	µg/L	----	<0.15	----	----	----
Sum of Xylenes	1330-20-7	0.05	µg/L	----	<0.25	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**17.9**	**19.2**	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**46.1**	**52.6**	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**72.1**	**79.7**	----	----	----
EP075(SIM)T: PAH Surrogates								

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	YF120 W/L071	YF140 HTD	----	----	----
			Client sampling date / time	17-JUL-2013 15:00	17-JUL-2013 15:00	----	----	----
Compound	CAS Number	LOR	Unit	EB1317643-001	EB1317643-002	----	----	----
EP075(SIM)T: PAH Surrogates - Continued								
2-Fluorobiphenyl	321-60-8	0.1	%	**48.7**	**62.5**	----	----	----
Anthracene-d10	1719-06-8	0.1	%	**26.0**	**22.0**	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**50.5**	**63.8**	----	----	----
EP125S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	----	**99.7**	----	----	----
Toluene-D8	2037-26-5	0.1	%	----	**104**	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	----	**85.5**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	71.9
2-Chlorophenol-D4	93951-73-6	26.8	130.2
2.4.6-Tribromophenol	118-79-6	19.3	180.8
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	13.9	146.1
Anthracene-d10	1719-06-8	34.6	137.4
4-Terphenyl-d14	1718-51-0	36.2	154.2
EP125S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	65	127
4-Bromofluorobenzene	460-00-4	68	124

CASH SALE

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph: 07 4796 0600 E: samples.townsville@alsenviro.com

☐ Melbourne: 24 Westall Rd, Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com

☐ Adelaide: 21 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E: samples@alsenviro.com

☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com

☐ Launceston: 27 Princeton St, Kings Meadows TAS 7249 Ph: 03 6331 2158 E: samples@alsenviro.com

CLIENT: Schlumberger	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	☒ Standard TAT (List due date):	FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes No N/A
OFFICE: Clinch, Tig		☐ Non Standard or urgent TAT (List due date):	Free ice / frozen containers present upon receipt? Yes No N/A
PROJECT:	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
ORDER NUMBER:		OF: 1 2 3 4 5 6 7	Other comments:
PROJECT MANAGER: Sean McCullan	CONTACT PH: 0418 532 890		
SAMPLER: Damian Jones	SAMPLER MOBILE:	RELINQUISHED BY: Ashley	RECEIVED BY:
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 17/7/13	DATE/TIME: 24/07/13 09:40
Email Reports to (will default to PM if no other addresses are listed): awatling@slb.com		RELINQUISHED BY:	RECEIVED BY:
Email Invoice to (will default to PM if no other addresses are listed): awatling@slb.com		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	PAH	BTEX - low level MDT contact Sean McCullam before analysis							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
	~~YF120~~	~~17-7-13~~		~~AG~~	~~2~~									
	~~1400[illegible]~~	~~17-7-13~~			~~2~~									
1	YF120 w/L071	17-7-13	W	AG	2	X								
2	YF140 HTD	17-7-13	W	AG	2	X	X							
				TOTAL	4									

Environmental Division
Brisbane
Work Order
EB1317643

Telephone : +61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

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