Qualitative and Quantitative Tier 3 Assessment

Mixture of 5-Chloro-2-Methyl-2H-Isothiazol-3-One and 2-Methyl-2H-Isothiazol-3-One (3:1)

In accordance with Santos' Gas Field Development (GFD) Project Area Chemical Risk Assessment Framework (CRAF), the assessment for this Tier 3 chemical includes the following components: completing the screening; developing a risk assessment dossier and Predicted No-Effects Concentrations (PNECs) for water and soil; and, completing a qualitative and quantitative assessment of risk. Each of these components is detailed within this attachment.

Background

The mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (3:1) is a component in hydraulic fracturing fluid systems used in stimulation activities. Hydraulic fracturing fluid systems comprise water and chemical additives (including a proppant) blended at the surface of the well lease and injected down the cased well to improve formation permeability, enhancing the gas flow towards the well. The chemical additives are also used to assist well completion by preparing the well or maintain the gas flow to the well (i.e., prevent the swelling of clays within the target hydrocarbon formation).

The purpose and maximum quantity for this chemical in the total fluid system is summarised in **Table 1**. A safety data sheet (SDS) for the stimulation fluid component is included as **Attachment 1**.

Table 1 Hydraulic Fracturing Chemicals

Chemical Name	CAS No.	Use	Quantity[1]
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	bactericide	0.00054%

[1] Volume Percent in Treatment (%)
CAS No = Chemical Abstracts Service Number

CMIT/MIT is also a component in a Water Management Facility (WMF) product (Biomate MBC781) used as a biocide during water treatment. A SDS for the WMF product is included as **Attachment 1**. Process and usage information for this chemical is included in **Attachment 2** and summarised in **Table 2**.

Table 2 Water Management Facility Chemicals

Proprietary Name	Chemical Name	CAS No.	Use	Approximate Quantity Stored On-Site (plant available storage)
Biomate MBC781	Cupric Nitrate	3251-23-8	Biocide	2 x 1000 L (IBC)*
	Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9		
	Water	7732-18-5		

*estimated volume, product is proposed for use
CAS No = Chemical Abstracts Service Number
IBC = intermediate bulk container
L = litre

The assessment of toxicity of this chemical was used to evaluate human health exposure scenarios and is presented in the risk assessment dossier provided in **Attachment 3**. CMIT/MIT is not a carcinogen, and, as a result, only a non-carcinogenic oral reference dose (RfD) was calculated. A detailed discussion of the derivation of the oral RfD and drinking water guideline values is presented in the attachment. **Table 3** provides a summary of the derivation.

Table 3 Oral Reference Doses and Derived Drinking Water Guidelines

Constituent (CAS No.)	Study	Critical Effect/ Target Organ(s)	NOAEL (mg/kg-day)	Uncertainty Factors	Oral Reference Dose (mg/kg-day)	Drinking Water Guideline (mg/L)
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (55965-84-9)	2-year rat drinking water	Gastric irritation of the stomach	17	100	0.17	0.60

CAS = Chemical Abstracts Service
mg/kg-day = milligram per kilogram-day
mg/L = milligram per litre
NOAEL = No observed adverse effect level
Refer to **Attachment 3** for information on the key studies selected for oral reference dose and drinking water level development.

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

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

Table 4 presents the chemical, endpoint, no observed effect concentration (NOEC) (milligrams per litre [mg/L]), assessment factor, and the aquatic PNEC (mg/L). PNECs for sediment and soil are detailed in **Tables 5** and **6,** respectively. Refer to **Attachment 3** for the development of PNECs, or the rational for PNECs that do not have a calculated PNEC.

Table 4 PNECs Water – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/L)	Assessment Factor	$PNEC_{water}$ (mg/L)
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (55965-84-9)	Chronic Algae	0.0014	10	0.00014

EC_{50} = effects concentration – 50%
mg/L = milligram per litre
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

Table 5 PNECs Sediment – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg wet wt)	Assessment Factor	$PNEC_{sed}$ (mg/kg wet wt)
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (55965-84-9)	Chronic Oligochaete	0.27	50	0.0054

EC_{50} = effects concentration – 50%
mg/kg wet wt = milligram per kilogram wet weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

Table 6 PNECs Soil – Tier 3 Chemicals

Constituents	Endpoint	EC_{50} or NOEC (mg/kg dry wt)	Assessment Factor	$PNEC_{soil}$ (mg/kg dry wt)
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (55965-84-9)	Soil Microorganisms	1	50	0.02

EC_{50} = effects concentration – 50%
mg/kg dry wt = milligram per kilogram dry weight
NOEC = no observable effects concentration
PNEC = predicted no effect concentration
Refer to **Attachment 3** for information on the development of PNECs listed above.

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

General Overview

Methylisothiazolinones are made industrially by oxidative cyclisation of the linear organic di-sulfide, N,N'-dimethyl-3,3'-dithiodipropionamide (CAS RN 999-72-4), in a process that uses chlorine as the oxidant. This manufacturing process inevitably produces a mixture of MIT and CMIT, as well as a small amount of the dichloro derivative (DCMIT; CAS RN 26542-23-4). These mixtures are generally not separated into their constituent chemicals and CMIT is not commercially available except as a mixture with MIT (NICNAS, 2020).

The mixture of CMIT and MIT is a powerful biocide and preservative and has a role as an antifouling biocide, an antimicrobial agent, and an antifungal agent. MIT and CMIT use is reported across a wide range of both consumer product uses (e.g. cosmetics, personal care products, baby wipes, automotive and marine sealants and waxes) and industrial uses (e.g. biocides in industrial circulating cooling water systems, preservatives in papermaking, leather treatment and cutting fluids) and are active pharmaceutical ingredients in biological products and prescription medicines (NICNAS, 2000). The molecular structure of the mixture of CMIT and MIT is presented in **Figure 1**.

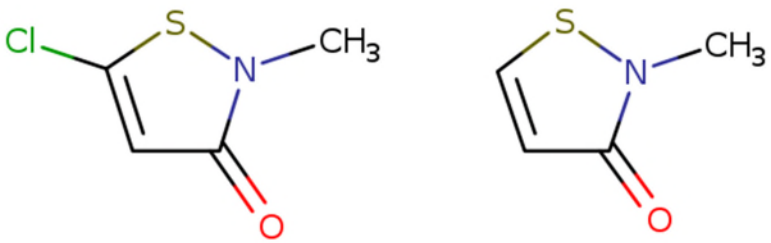

Figure 1 Molecular Structure of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) with 2-methyl-2h-isothiazol-3-one (MIT)[1]

Combined formulations of CMIT and MIT are marketed under several trade names, such as Kathon™ 886 and ACTICIDE LG. Magnesium nitrate and magnesium chloride are present in the commercial

[1] Source https://chem.nlm.nih.gov/chemidview/image/55965-84-9?size=3

CMIT/MIT mixture as an inert ingredient and impurity, respectively. The amount of these two salts vary depending on the formulation (EU SCCS, 2009).

The mixture of CMIT and MIT is readily soluble in water and is stable up to pH 9 where extensive degradation is observed. It is susceptible to photodegradation. The mixture of CMIT and MIT is biodegradable at expected environmental exposure concentrations and would also be removed by common biological wastewater treatment facilities. The mixture is not expected to bioaccumulate and has a low potential to adsorb to soil.

The PBT assessment for the mixture of CMIT and MIT is included in the dossier provided in **Attachment 3**. Based on physico-chemical properties and screening data detailed below, the overall conclusion was that CMIT/MIT is not a PBT substance.

Human Health Hazards

The acute toxicity of CMIT/MIT is moderate to highly toxic by the oral, inhalation and dermal routes. It is corrosive to the skin and eye and is expected to be a skin sensitiser according to a local lymph node assay.

Repeated exposures to rats by the oral, dermal, or inhalation routes have shown no systemic toxicity; however, evidence of localised irritation (site-of-contact) was observed by all routes of exposure. CMIT/MIT may exhibit weak genotoxic effects in some *in vitro* tests, whereas the *in vivo* studies consistently show no genotoxic activity. It has no reported reproductive or developmental effects; and, is not considered carcinogenic.

A 2-year rat drinking water study has been conducted on a product containing the mixture of CMIT and MIT. The no observed adverse effects level (NOAEL) from this study is 17 milligrams per kilogram-day (mg/kg-day) based on gastric irritation of the stomach. The NOAEL was used to derive the oral RfD and the drinking water guidance value (0.60 milligrams per litre [mg/L]) (see **Table 3**). Description of the oral RFD and calculation of the drinking water guideline value is included in the dossier provided in **Attachment 3**.

The lifecycle of chemicals, including the mixture of CMIT and MIT, used during the hydraulic fracturing of wells and water treatment includes the following general categories: transportation of chemicals; hydraulic fracturing activities; treatment, recycling, disposal, and beneficial reuse; produced water transfer, storage and treatment at the (WMF and beneficial reuse of treated water. Without management controls in place, there is the potential for human receptors to be exposed to CMIT and MIT in hydraulic fracturing chemicals during stimulation and completion operations, management of flowback and work-over fluids, and during water treatment, water conveyance and beneficial reuse processes. Based on an assessment of land use and an understanding of the project description provided in the Environmental Impact Statement (EIS) (URS, 2014) and the CRAF conceptual exposure model (CEM), potential human receptors include:

1. Workers at the well lease involved with: blending, injection and recovery of hydraulic fracturing and work-over fluids; recycling, reuse or disposal of recovered fluids including beneficial reuse activities such as land applications of drilling materials and dust suppression; and, mitigating releases from the well lease to an adjacent water body.
2. Workers at the WMF including operators, maintenance staff and supervisors.
3. Agricultural workers/residents at irrigation areas.

Based on the treatment process described in **Attachment 2**, CMIT/MIT would be present in permeate but is not directed to the brine pond. Therefore, exposure pathways associated with the beneficial reuse of treated water would be potentially complete. Beneficial reuse of treated water includes project reuse (dust suppression, construction activities, drilling and completions), irrigation and stock watering.

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

Unlike drilling activities, there are no large volumes of premixed stimulation fluid systems stored on-site. The primary fluid stored on-site is water, and chemicals are blended into the fluid stream as it is used. Exposure of workers to stimulation fluid chemicals is possible via inadvertent spills and leaks during the recycling and beneficial reuse of recovered materials, and during application of the recovered material to land. However, chemical exposures to workers are controlled through engineering, management controls and personal protective equipment, which are focused on elimination and mitigation of the potential for dermal contact and potential for incidental ingestion. In addition, Australia SafeWork Place and Santos Occupational Safety Guidance are used to minimise human health exposure. As a result, petroleum workers, are also excluded from assessment. No potentially complete exposure pathways were identified.

In the unlikely event of a release to ground at the well lease, the potential for exposures (other than workers) is limited. Releases on the well pad would be of limited volumes and the well pad sites are fenced and access is controlled, which limits access to the public. If stimulation fluid chemicals are spilled to the ground, then investigation, remediation and rehabilitation activities would be implemented to address soil impacts.

On-lease storage may utilise tanks, pits or turkey nests and there is the possibility that a containment failure could result in the release of the materials to the well lease and the surrounding environment. Releases on the well pad would be of limited volumes and as such these products would not be anticipated to migrate a significant distance off lease to the surrounding environment, including proximal water bodies. Releases from the gathering pipeline would be of higher potential volumes but the flow back or workover fluid concentrations from an individual well would be potentially diluted with other waters from other wells also flowing in this gathering network.

Exposure of potential receptors (other than workers) is also possible to residual chemicals in areas adjacent to a well lease that have been used for the application of materials for beneficial reuse. The primary land use within the development area is agricultural (grazing on improved or unimproved pastures), and it is sparsely populated. There may be potential for human receptors such as residents and agricultural workers to be exposed to residual chemicals in ponded irrigation water or irrigated soil via direct contact (ingestion and dermal) and inhalation pathways. Relative potential exposure to agricultural workers/residents is considered low due to the remote location of the well leases and the sparse population. In addition, activities are undertaken in operational and controlled areas of the well lease.

However, Environmental Authority (EA) or End of Waste Code/Approval conditions regulate project reuse. A plan for the beneficial reuse of materials has been developed by a Suitably Qualified Person (SQP) in accordance with the EA conditions which require materials of a certain quality and controls the maximum volumes that can be applied to land. In addition, the application techniques and location of application are controlled with specific monitoring required. Irrigation areas are designed to manage the risk of pooling and run-off with a general deficit irrigation strategy employed and are fitted with monitoring bores to manage the risk of vertical and horizontal migration. Additional details regarding mitigation and management controls are discussed in the CRAF.

As a result, potential exposures during stimulation or water treatment activities is considered low due to the employment of mechanical equipment/processes, engineering controls (including secondary containment) and other mitigation and management strategies. Similarly, there is a low potential for human receptors exposed to residual chemicals in areas adjacent to a well lease that have been used for the application of materials for beneficial reuse and to surface water bodies that may receive runoff from beneficial reuse applications. Finally, the probability of any surface related discharge infiltrating subsurface soils and migrating to groundwater is very low.

Environmental Hazards

The mixture of CMIT and MIT exhibits significant acute and chronic aquatic toxicity. The mixture is also toxic to sediment dwelling organisms but less toxic to terrestrial receptors. Under expected environmental conditions, the mixture is readily biodegradable and is not expected to bioaccumulate.

PNECs for the mixture of CMIT and MIT are provided in **Tables 4 – 6**. Toxicity data on water, sediment and soil-dwelling organisms was available to calculate PNECs. Experimental results were available for three trophic levels for water and soil organisms. Experimental results were available for one sediment-dwelling organism. PNEC calculations and assumptions are included in the dossier provided in **Attachment 3**.

During the hydraulic fracturing, water treatment, water conveyance and beneficial reuse processes, there is the potential for environmental receptors to be exposed to stimulation fluid and water treatment chemicals such as the mixture of CMIT and MIT. Pipelines (where produced or treated water containing these chemicals is conveyed) can transect sensitive ecological areas (including MNES). There is the concern of wildlife (terrestrial and aquatic receptors) and livestock in the vicinity of the well leases to have adverse effects from potential exposures. Potential environmental receptors include:

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

The potential for exposure of sensitive receptors (including MNES) is considered low. The hydraulic fracturing activities occur over a short duration and are conducted in controlled/operational areas within a perimeter fence. Further, the activity level, noise, etc. will be a disincentive for wildlife and livestock to access the lease through gaps in the fencing or unsecured gates. Likewise, at the WMF, these facilities are existing and are operational industrial facilities (and thereby provide no habitat value). The industrial activities and operation of equipment do not make it a setting conducive to incursion of fauna. For instance, the WMF is fenced and access is controlled, which precludes entry by livestock.

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

Risk Characterisation

The purpose of the risk characterisation portion of the assessment is to provide a conservative estimate of the potential risk resulting from exposure to the mixture of CMIT and MIT that may occur during hydraulic fracturing and work over activities and water treatment activities. These exposures may include operational activities where planned direct releases to the environment may occur (e.g., land application). The risk characterisation evaluates the toxicity of this chemical and characterises the risk of the chemical assessed for specific exposure pathways identified in the previous sections.

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

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

Exposure Point Concentration Calculations

A quantitative mass balance calculation was undertaken to estimate the potential concentrations of stimulation chemicals containing CMIT/MIT within the flowback water that may be accidently released (e.g., breech of dam or leaking storage tank) to a nearby surface water resource or soils, and the potential concentration of CMIT/MIT within the soil phase from the irrigation of agricultural soils with diluted produced water. Two scenarios were evaluated for the incidental release of

flowback water to surface water: a release from the frac tank at the well pad or from the water feed pond at the WMF. Additionally, releases from the permeate pond at the WMF were also evaluated.

For the mass balance calculation, vendor disclosure forms were used to determine the percentage of CMIT/MIT in the pre-injection fluid. **Table 7** presents the estimated pre-injection fluid concentration.

Table 7 Mass Balance Estimates for CMIT/MIT

Chemical Name	CAS No.	Estimated Pre-injection fluid concentration (mg/L)[1]
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54

1 – Based on volumes provided in Table 1
CAS No = Chemical Abstracts Service Number
mg/L = milligram per litre

The mass balance of CMIT/MIT was then used to estimate the potential EPC for each of the release scenarios (see **Attachment 4, Table 1)**. For the first scenario (frac tank release), the EPC was calculated assuming 20% of the mass returned in the flowback water, which was then conservatively diluted with 150% of the injected volume of return water. This EPC was then adjusted based on biodegradation rates to calculate the theoretical EPCs for two exposure time periods (0 and 150 days) which represent no storage/no degradation (Day 0) and a bounding estimate which considers degradation during storage for prolonged period of time prior to transfer or conveyance to the WMF (Day 150). It is anticipated that the concentration of CMIT/MIT within the stimulation fluids will decrease, where applicable, to account for the biodegradation and photolytic degradation of constituents over time. Chemical-specific biodegradation information presented in the dossier was used for the assessment. **Attachment 4, Table 1** includes the environmental fate information that was used to assess biodegradation of the chemical. The estimated EPC for this scenario assumes that the accidental release of the flowback water to a surface water resource would not be diluted by surface water within the resource, as many of the surface water features in the area are ephemeral with high variations in duration and flow volume.

In the second scenario (water feed pond release), the concentration of stimulation fluid chemicals in flowback water is assumed to be diluted by an additional 90% in the water feed pond due to the aggregation of produced water from other wells within one pond. Therefore, a factor of 10% was applied to the Day 0 and Day 150 flowback concentrations to assess potential accidental releases from the water feed pond at the WMF.

For the third scenario (permeate pond release), the concentrations in the water feed pond were reduced by a factor of 99% to account for efficiencies in the WMF system.

To this permeate concentration, the estimated concentration of CMIT/MIT as a result of water treatment was added. This estimated concentration was based on chemical and physical properties of the chemical as well as the fate and transport of the chemical within the WMF system. Additional detail on the assumptions used for estimation for CMIT/MIT in permeate as a result of water treatment is provided in **Attachment 2**. Permeate is stored in ponds that facilitate further mass reductions of organic constituents via biodegradation prior to conveyance and beneficial use. The permeate ponds have a holding time of greater than 5 days, and often greater than 20 days (based on throughput). As a result, this EPC was adjusted to consider a 5-day holding time.

Release Scenario Assessment

There is no potentially complete exposure pathway to sources of drinking water; however, as a conservative measure, the theoretical concentrations for each of the three release scenarios were compared to human health toxicity-based screening levels to screen for potential effects as a result of a release from the well lease or WMF that may migrate to surface water used as a drinking water source. The results of this comparison, including the ratio of exceedance of screening levels, is presented in **Attachment 4, Table 2**. As detailed in the table, the risk ratio did not exceed the target level of 1 for any of the scenarios.

Theoretical concentrations were also compared to the PNEC for aquatic receptors. **Attachment 4, Table 3** presents the results of this comparison, including the ratio of exceedance of screening levels. As detailed in the table, the risk ratio exceeded the target level for the frac tank release and water feed pond release Day 0 scenarios. The risk ratio did not exceed the target level of 1 for the frac tank release Day 150 scenario, water feed pond release Day 150 scenario or for either of the permeate pond release scenarios. Based on the screening, there is a potential for adverse impacts to surface water resources and associated aquatic flora and fauna, as well as terrestrial ecological receptors from a potential accidental release of CMIT/MIT concentrations within the flowback water at the well lease or produced water in the water feed pond at the WMF. Based on the environmental fate of CMIT/MIT, distances to watercourses, the ephemeral nature of their flows, and the subsequent dilution of any discharge, along with the engineering and management controls previously described, the potential for exposure is low. Further, in the presence of sunlight, CMIT/MIT is susceptible to rapid photodegradation with a half-life of 117 hours, and it is considered rapidly biodegradable in an aerobic aquatic environment with a half-life of 17.3 hours for CMIT and 9.1 hours for MIT in the water/sediment system. Therefore, the biocide is not expected to be a significant risk driver. As a result, further quantitative evaluation of this exposure scenario was not conducted.

There is also the potential for exposure of receptors to CMIT/MIT in residual fluids during a release of flowback water to soil at the well lease or water feed pond (release scenario) or during application of the material to land (irrigation scenario). To calculate the COPC concentrations in soil from an accidental release of flowback water or water feed pond, the flow back or water feed pond concentration was multiplied by the release area (1 hectare) to a depth of 0.15 metre and divided by the mass of soil per hectare. **Attachment 4, Table 4** presents the theoretical estimates of the residual CMIT/MIT concentrations for the incident release scenarios. The EPC for the irrigated agricultural soil is then calculated by assuming a volume of irrigated soil per hectare (1,000 square metre area by 0.15 metre depth), soil density (1,400 kilograms per cubic metre [kg/m^3]), and irrigation rate (8 ML per hectare per year, 20 years). The irrigation rate of 8 ML is a conservative high number. **Attachment 4, Table 5** presents the theoretical estimates of the residual CMIT/MIT concentrations for the irrigation scenario.

The theoretical soil concentrations were compared to PNECs for soils for ecological receptors and are presented in **Attachment 4, Table 6**. The ratio of exceedance of screening levels to the release EPC and irrigation EPC are also presented in the table. As detailed in the table, the ratio of estimated concentrations in soils due to incidental release from the frac tank or water feed pond to $PNEC_{soil}$ exceeded the threshold of 10, indicating the requirement for management controls. There were no unacceptable risks for the irrigation scenario; and, therefore, there are no anticipated adverse effects to releases of permeate during application of the material to land.

Based on the environmental fate of CMIT/MIT along with the engineering and management controls previously described, the potential for exposure is low. CMIT/MIT rapidly biodegrades in soil, with an aerobic soil half-life of 10.4 hours for CMIT and 6.5 hours for MIT, indicating rapid degradation in soil by microbial biotransformation. Therefore, very low persistence exists for the biocide due to biodegradation. As a result, the biocide is not expected to be a significant risk driver. Consequently, further quantitative evaluation of the frac tank release scenario and water feed pond release scenario was not conducted. However, to further evaluate potential risks to non-MNES receptors (mammals and avian) receptors, additional quantitative analysis of the potential beneficial reuse exposure pathway was conducted.

The Northern Quoll and Cattle Egret were selected as ecological endpoints for potential exposure to CMIT/MIT in soils irrigated with produced water. Exposure assumptions, TRVs and total intake calculations are detailed in **Attachment 4, Tables 7 and 8**. **Attachment 4, Table 7** presents the calculated risk estimates for the Northern Quoll. **Attachment 4 Table 8** presents the calculated risk estimates for the Cattle Egret. As indicated in the table, the calculated hazard quotient (HQ) for CMIT/MIT did not exceed the risk threshold level of 1 for any of the irrigation soil scenarios for each of the receptors evaluated.

Terrestrial receptors evaluated for exposure to irrigation water include domesticated livestock, large mammalian wildlife and small mammalian wildlife. Beef cattle were used to evaluate domesticated livestock, kangaroos were evaluated for large mammalian wildlife, and dingos were evaluated for small mammalian wildlife. Exposure assumptions, TRVs and total intake calculations are detailed in **Attachment 4, Tables 9, 10 and 11**. **Attachment 4, Table 9** presents the calculated risk estimates for the kangaroo. **Attachment 4, Table 10** presents the calculated risk estimates for the dingo. **Attachment 4, Table 11** presents the calculated risk estimates for the cattle. As indicated in the tables, the calculated HQ for CMIT/MIT did not exceed the risk threshold level of 1 for any of the scenarios evaluated.

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

For potential human health exposure scenarios, exposure assumptions are detailed in **Attachment 4, Table 12**. As detailed in the table, the resident exposure pathway assumes that a child/adolescent may come in contact with irrigated soils. The agricultural worker exposure pathway includes potential contact with irrigated soils through agricultural activity.

RfDs and total intake calculations are detailed in **Attachment 4, Tables 13 and 14. Attachment 4, Table 13** presents the calculated risk estimates for the resident. **Attachment 4, Table 14** presents the calculated risk estimates for agricultural worker. As indicated in the tables, the calculated HQ for CMIT/MIT did not exceed the risk threshold level of 1 for any of the irrigation soil scenarios for each of the receptors evaluated.

Cumulative Impacts

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

Tier 3 chemicals which trigger persistence and bioacummulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted earlier and discussed in detail in the dossier (**Attachment 3**), CMIT/MIT does meet the criteria for persistence or bioaccumulation. In addition, based on the findings of the quantitative risk assessment, the biocide is not expected to be a significant risk driver. The potential for exposure of sensitive receptors (including MNES) is considered low. In addition, calculated HQs did not exceed the risk threshold of 1 for any of the beneficial reuse scenarios evaluated for non-MNES receptors.

Thus, there is negligible incremental risk posed by the use of this Tier 3 chemical and the existing management and monitoring controls are appropriate to ensure that the risk to MNES (and non MNES) receptors remains low.

Uncertainty Analysis

The procedures and assumptions used to assess potential human health and ecological risks in this Tier 3 assessment are subject to a wide variety of uncertainties. However, the presence of uncertainty is inherent in the risk assessment process, from the sampling and analysis of the chemical in environmental media to the assessment of exposure and toxicity, and risk characterisation. Accordingly, it is important to note that the risks presented within this Tier 3 assessment are based on numerous conservative assumptions in order to be protective of human health and the environment, and to ensure that the risks presented herein are more likely to be overestimated rather than underestimated.

The discussion detailed in **Table 8** below provides an evaluation of uncertainty for this Tier 3 assessment, including elements previously discussed within this assessment.

Table 8 Evaluation of Uncertainty – CMIT/MIT

Risk Characterisation Component	Description of Uncertainty	Magnitude of Uncertainty	Effect on Risk Assessment
Hazard Assessment –COPC concentrations	The concentrations of COPCs in residual stimulation fluids or in the water treatment process were estimated based on previous operations and may not accurately estimate the concentrations of COPCs in the future. Detailed discussions with Santos occurred to identify a conservative estimate of the COPC; however, there is the potential that the empirical concentrations would differ than those presented in the risk assessment.	Low	This assumption may overestimate or underestimate the calculated risks to receptors, dependent on-site-specific conditions.
Exposure Assessment – EPC	The estimated EPC for this scenario assumes that the accidental release of the flowback water to a surface water resources would not be diluted by surface water within the resource, as many of the surface water features in the area are ephemeral with high variations in duration and flow volume.	Low	This assumption may overestimate or underestimate the calculated risks to receptors, dependent on-site-specific conditions.
Exposure Assessment – EPC	The estimated EPC for the irrigated soils assumes that the EPC of the initially produced water concentration of CMIT/MIT is diluted to 10 percent of the original concentration from blending with other wells in a collective system and aggregation in dams and tanks before being treated and used for irrigation. This is considered a conservative assumption as greater dilution than that assumed is likely to occur.	Medium	Medium to high potential to overestimate risks.
Exposure Assessment	The use of the food consumption relationship with body weight for mammalian and avian receptors.	Low to Medium	Low to medium potential to underestimate or overestimate risk
Toxicity Assessment	The use of toxicity values in a risk assessment is based on extrapolations from animal data, adjust factors for inherent uncertainty in the toxicological estimate and use of surrogate toxicity criteria	Low	Low potential to underestimate risk
Toxicity Assessment	The use of LOAEL/NOAEL for calculation of the TRVs	Low to Medium	Low to medium potential to underestimate or overestimate risk
Toxicity Assessment	The use of the allometric scaling method to estimate the population-level effects on wildlife based on individual level of exposures.	Low to Medium	Low to medium potential to underestimate or overestimate risk

References

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Department of the Environment and Energy (DoEE). (2017). Exposure draft: Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction. Commonwealth of Australia, available at http://www.environment.gov.au/water/coal-and-coal-seam-gas/national-assessment-chemicals/consultation-risk-assessment-guidance-manual

EU Scientific Committee on Consumer Safety [EU SCCS]. (2009). Opinion on the mixture of 5-chloro-2-methyl-4-isothiazolin-3-one and 2-methyl-2H-isothiazol-3-one [3:1], Colipa No P56, Scientific Committee on Consumer Safety, SCCS/1238/09.

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OECD. (1992). Test No. 301: Ready Biodegradability. (Biodégradabilité Facile.) Paris: OECD Publishing.

URS. (2014). Santos GLNG Project: Gas Field Development Project Environmental Impact Statement. Available online at: http://www.santosglng.com/environment-and-water/gas-field-development-project-eis.aspx

Attachment 1 Safety Data Sheet

Material Safety Data Sheet

1 . Product and company identification

Product name : M275

Supplier : Baker Petrolite
A Baker Hughes Company
12645 W. Airport Blvd.
Sugar Land, TX 77478
For Product Information/MSDSs Call: 800-231-3606
(8:00 a.m. - 5:00 p.m. cst, Monday - Friday) 281-276-5400

Material Uses : Special: Microbiocide

Code : M275

Validation date : 1/19/2011.

Print date : 1/19/2011.

Version : 4

Responsible name : Global Regulatory Affairs - Telephone 281-276-5400 or 800-231-3606

In case of emergency : CHEMTREC: 800-424-9300 (U.S. 24 hour)
Baker Petrolite: 800-231-3606
(001)281-276-5400
CANUTEC: 613-996-6666 (Canada 24 hours)
CHEMTREC Int'l 01-703-527-3887 (International 24 hour)

2 . Hazards identification

Physical state : Solid. [Granular.]

Odor : Mild.

Color : Tan. Red.

OSHA/HCS status : This material is considered hazardous by the OSHA Hazard Communication Standard (29 CFR 1910.1200).

Emergency overview : DANGER!

CAUSES EYE AND SKIN BURNS. HARMFUL IF SWALLOWED. CAUSES RESPIRATORY TRACT IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.

Do not ingest. Do not get in eyes or on skin or clothing. Use only with adequate ventilation. Keep container tightly closed and sealed until ready for use. Wash thoroughly after handling.

Routes of entry : Dermal contact. Eye contact. Inhalation.

Potential acute health effects

Inhalation : Irritating to respiratory system.

Ingestion : Toxic if swallowed. May cause burns to mouth, throat and stomach.

Skin : Corrosive to the skin. Causes burns. May cause sensitization by skin contact.

Eyes : Corrosive to eyes. Causes burns.

Potential chronic health effects

Chronic effects : Contains material that may cause target organ damage, based on animal data. Once sensitized, a severe allergic reaction may occur when subsequently exposed to very low levels.

Carcinogenicity : Contains material which can cause cancer. Risk of cancer depends on duration and level of exposure.

Target organs : Contains material which may cause damage to the following organs: upper respiratory tract, skin, eyes.

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2 . Hazards identification

Over-exposure signs/symptoms

Inhalation : respiratory tract irritation, coughing

Ingestion : stomach pains

Skin : pain or irritation, redness, blistering may occur

Eyes : pain, watering, redness

Medical conditions aggravated by over-exposure : Pre-existing skin disorders and disorders involving any other target organs mentioned in this MSDS as being at risk may be aggravated by over-exposure to this product.

See toxicological information (section 11)

3 . Composition/information on ingredients

Name	CAS number	%
Diatomaceous earth, calcined	91053-39-3	30 - 60
Magnesium nitrate	10377-60-3	5 - 10
5-chloro-2-methyl-4-isothiazolin-3-one	26172-55-4	5 - 10
2-Methyl-4-isothiazolin-3-one	2682-20-4	1 - 5
Crystalline silica: cristobalite	14464-46-1	0.1 - 1
Crystalline silica: Quartz (SiO2)	14808-60-7	0.1 - 1

4 . First aid measures

Eye contact : Get medical attention immediately. Immediately flush the eye(s) continuously with lukewarm, gently flowing water for at least 20-60 minutes while holding the eyelid(s) open.

Skin contact : Wash affected area with soap and mild detergent for at least 20 - 60 minutes. Wash clothing before reuse. Clean shoes thoroughly before reuse. Get medical attention immediately.

Inhalation : Move exposed person to fresh air. If not breathing, if breathing is irregular or if respiratory arrest occurs, provide artificial respiration or oxygen by trained personnel. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention immediately.

Ingestion : Wash out mouth with water. Do not induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.

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. Wear suitable protective clothing and gloves. Remove contaminated clothing and shoes.

5 . Fire-fighting measures

Flammability of the product : No specific fire or explosion hazard.

Extinguishing media

Suitable : Use an extinguishing agent suitable for the surrounding fire.

Not suitable : None known.

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.

Hazardous thermal decomposition products : carbon dioxide,carbon monoxide,nitrogen oxides,sulfur oxides,halogenated compounds,metal oxide/oxides

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5 . Fire-fighting measures

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.

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 spilled material. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment (see Section 8).

Environmental precautions : Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers.

Methods for cleaning up

Small spill : Move containers from spill area. Vacuum or sweep up material and place in a designated, labeled waste container. Dispose of via a licensed waste disposal contractor.

Large spill : Move containers from spill area. Approach release from upwind. Dike spill area and do not allow product to reach sewage system or surface or ground water. Notify any reportable spill to authorities. (See section 12 for environmental risks and 13 for disposal information.) Vacuum or sweep up material and place in a designated, labeled waste container. 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

Handling : Put on appropriate personal protective equipment (see Section 8). Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Persons with a history of skin sensitization problems should not be employed in any process in which this product is used. Do not get in eyes or on skin or clothing. Do not ingest. Use only with adequate ventilation. Empty containers retain product residue and can be hazardous. Do not reuse container.

Storage : Store in accordance with local regulations. Store in a dry, cool and well-ventilated area, away from incompatible materials (see Section 10). 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 unlabeled containers. Use appropriate containment to avoid environmental contamination.

8 . Exposure controls/personal protection

Occupational exposure limits		TWA (8 hours)			STEL (15 mins)			Ceiling			
Ingredients:	List name	ppm	mg/m³	Other	ppm	mg/m³	Other	ppm	mg/m³	Other	Notations
Crystalline silica: cristobalite	US ACGIH	-	0.025	-	-	-	-	-	-	-	[a]
Crystalline silica: cristobalite, as quartz	OSHA PEL 1989	-	0.05	-	-	-	-	-	-	-	[b][A]
Crystalline silica: Quartz (SiO2)	US ACGIH	-	0.025	-	-	-	-	-	-	-	[a]
Crystalline silica: Quartz (SiO2), as quartz	OSHA PEL 1989	-	0.1	-	-	-	-	-	-	-	[b][A]

Form: [a]Respirable fraction; see Appendix C [b]Respirable dust
Notes: [A]as quartz

Consult local authorities for acceptable exposure limits.

Only components of this product with established exposure limits appear in the box above.

If OSHA permissible exposure levels are shown above they are the OSHA 1989 levels or are from subsequent OSHA regulatory actions. Although the 1989 levels have been vacated the 11th Circuit Court of Appeals, Baker Hughes recommends that these lower exposure levels be observed as reasonable worker protection.

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8 . Exposure controls/personal protection

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. If user operations generate dust, fumes, gas, vapor or mist, use process enclosures, local exhaust ventilation or other engineering controls to keep worker exposure to airborne contaminants below any recommended or statutory limits.

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. Ensure that eyewash stations and safety showers are close to the workstation location. Take off contaminated clothing and wash before reuse.

Personal protection

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.

Hands : Chemical-resistant gloves: Nitrile gloves. Butyl rubber gloves.

Eyes : Wear chemical safety goggles. When transferring material wear face-shield in addition tc chemical safety goggles.

Skin : Wear long sleeves and chemical resistant apron to prevent repeated or prolonged skin contact.

9 . Physical and chemical properties

Physical state : Solid. [Granular.]

Flash point : Closed cup: >93.4°C (>200.1°F) [SFCC]

Auto-ignition temperature : Not available.

Flammable limits : Not available.

Color : Tan. Red.

Odor : Mild.

pH : Not available.

Boiling/condensation point : Not available.

Initial Boiling Point : Not available.

Melting/freezing point : Not available.

Relative density : Not available.

Density : 6 (lbs/gal)

Vapor density : >1 [Air = 1]

Odor threshold : Not available.

Evaporation rate : Not available.

VOC : Not available.

Viscosity : Not available.

Solubility (Water) : Dispersible

Vapor pressure : 2.1 kPa (15.8 mm Hg) at 21°C (Calculated Value for all Components.)

Pour Point : -29°C (-20.2°F)

Partition coefficient (LogKow) : Not available.

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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.

Hazardous polymerization : Under normal conditions of storage and use, hazardous polymerization will not occur.

Conditions to avoid : No specific data.

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.

Conditions of reactivity : Slightly flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and heat.

11 . Toxicological information

Acute toxicity

Product/ingredient name	Result	Species	Dose	Exposure
Magnesium nitrate	LD50 Oral	Rat	5440 mg/kg	-
5-chloro-2-methyl-4-isothiazolin-3-one	LD50 Dermal	Rabbit	660 mg/kg	-
	LD50 Oral	Rat	457 mg/kg	-
	LC50 Inhalation Vapor	Rat	0.33 mg/l	4 hours
M275	LD50 Dermal	Rabbit	>5000 mg/kg	-

Irritation/Corrosion

Conclusion/Summary

Skin : Skin Irritation Score = 4 (Extreme Irritant/Corrosive).

Eyes : Eye Irritation Score = 4 (Extreme Irritant/Corrosive).

Carcinogenicity

Classification

Product/ingredient name	ACGIH	IARC	EPA	NIOSH	NTP	OSHA
Magnesium nitrate	-	2A	-	-	-	-
Crystalline silica: cristobalite	A2	1	-	+	Proven.	None.
Crystalline silica: Quartz (SiO2)	A2	1	-	+	Proven.	+

Chronic toxicity Remarks

1) Diatomaceous earth, calcined

Not available.

2) Magnesium nitrate

Repeated small oral doses of nitrate may cause weakness, depression, headache and mental impairment. Magnesium nitrate is a methemoglobin-forming agent, chronic exposure may effect the ability of the blood carry oxygen causing the lips and skin to turn blue.

Generally, nitrates can be reduced to nitrites, under anaerobic conditions (without oxygen). Nitrosating agents that arise from nitrite under acidic gastric conditions react readily with nitrosatable compounds, especially secondary amines and alkyl amides, to generate N-nitroso compounds. Many N-nitroso compounds are carcinogenic. Ingested nitrate under conditions that result in endogenous (originating from within an organ) nitrosation has been classified IARC as probably carcinogenic to humans or Group 2A carcinogens (IARC monographs, vol. 94; 2006).

3) 5-chloro-2-methyl-4-isothiazolin-3-one

Not available.

4) 2-Methyl-4-isothiazolin-3-one

Not available.

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11 . Toxicological information

5) Crystalline silica: cristobalite

Silica crystalline as Cristobalite is a component of this product. Cristobalite is listed by NTP as a suspect carcinogen, by OSHA as a possible carcinogen, and by IARC as a possible carcinogen. Silica exists in several forms, but only the crystalline materials produce the chronic pulmonary condition termed specifically silicosis. Chronic inhalation of airborne crystalline silica dust may lead to fibrotic lung disease, silicosis or cancer (based on animal studies and limited evidence of carcinogenicity in humans).

An inhalation study in humans at a dose of 16 mppcf/8H/17.9Y intermittent produced toxic effects to the lungs, thorax, or respiration resulting in fibrosis, focal (pneumoconiosis), cough and dyspnea (RTECS).

An intratracheal (inside the airway tube between the voice box and chest cavity) dose of 200 mg/kg in rats produced lung, thorax, or respiration effects resulting in fibrosis, focal (pneumoconiosis).(RTECS) An intrapleural (inside the membrane lining of the lung cavity) dose of 90, and 100 mg/kg in rats produced tumors, and blood lymphomas (malignant but treatable cancer) including Hodgkin's disease (a type of lymphoma cancer). (RTECS)

6) Crystalline silica: Quartz (SiO2)

Crystalline silica as quartz is a component of this product. Prolonged inhalation of respirable crystalline quartz may cause delayed chronic lung injury - silicosis. Silicosis is a form of disabling pulmonary fibrosis which can be progressive and may lead to death. Silicosis may progress without further exposure to silica (Hathaway et al, 1991). Chronic inhalation of silica dust suppressed the immune response in mice (Scheuchenzuber et al, 1985), and a decreased immune response has also been shown in silicotics (Barlogova et al, 1981). The effect of silica on the immune mechanism may be mediated by its toxicity to pulmonary macrophages, a critical component of the immune response, and may have implications for the increased susceptibility of silicotics to respiratory infections, particularly tuberculosis. Inhaled crystalline silica particles induced several signs of pulmonary injury and inflammation in rats exposed to an airborne concentration of 50 mg/m3 for 6 hours per day for 5 days (Driscoll et al, 1991).

IARC (International Agency for Research on Cancer) rates crystalline silica as a "Probable Human Carcinogen" (Group 2A). The US NTP (National Toxicology Program) rates respirable crystalline silica as an "Anticipated Carcinogen".

Silica has been inactive for inducing DNA damage in the B. subtilis rec assay (Kanematsu et al, 1980), chromosome damage or sister chromatid exchanges in hamster cells (Price-Jones et al, 1980), chromosome damage in human cells (Oshimura et al, 1984), in vitro oncogenic transformation of hamster cells into cancer cells (Oshimura et al, 1984), and induction of micronuclei in mouse bone marrow (Vanchugova et al, 1985). Crystalline silica has caused DNA strand breaks in vitro; etching the surface with hydrofluoric acid reduced this activity.

At the time of this review, no reproductive studies were found for silica in humans. Few reproductive data are available for silica. As a component of welding fume, it caused infertility and fetal death in rats (Dabrowski et al, 1966). Intratracheal instillation of silica prolonged the estrus cycle in rats (Parsadanian, 1967). So-called "soluble silica" was tested for reproductive effects in rats, but the results were not available at the time of this review (Smith et al, 1973).

12 . Ecological information

Aquatic ecotoxicity

Product/ingredient name	Result	Species	Exposur
2-Methyl-4-isothiazolin-3-one	Acute EC50 0.18 to 0.19 ppm Fresh water	Daphnia - Water flea - Daphnia magna - <24 hours	48 hours
	Acute LC50 0.056 to 0.084 ppm Marine water	Crustaceans - Calanoid copepod - Acartia tonsa	48 hours
	Acute LC50 0.07 to 0.09 ppm Fresh water	Fish - Rainbow trout,donaldson trout - Oncorhynchus mykiss	96 hours
5-chloro-2-methyl-4-isothiazolin-3-one	Acute EC50 0.18 to 0.3 ppm Fresh water	Daphnia - Water flea - Daphnia magna - <24 hours	48 hours
	Acute LC50 0.084 to 0.56 ppm	Crustaceans - Calanoid copepod -	48 hours

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12 . Ecological information

	Marine water Acute LC50 0.19 to 0.31 ppm Fresh water	Acartia tonsa Fish - Rainbow trout,donaldson trout - Oncorhynchus mykiss	96 hours
M275	Acute LC50 9.2 mg/L	Fish	96 hours

Conclusion/Summary : Not available.

Biodegradability

Conclusion/Summary : Not available.

13. Disposal considerations

Waste disposal : The generation of waste should be avoided or minimized wherever possible. Empty containers or liners may retain some product residues. 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 spilled material and runoff and contact with soil, waterways, drains and sewers.

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Refer to Section 7: HANDLING AND STORAGE and Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION for additional handling information and protection of employees.

14 . Transport information

Regulatory information	UN number	Proper shipping name	Classes	PG*	Label	Additional information
DOT Classification	UN3261	CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (Contains: 5-chloro-2-methyl-4-isothiazolin-3-one, 2-Methyl-4-isothiazolin-3-one)	8	II		-
TDG Classification	UN3261	CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (Contains: 5-chloro-2-methyl-4-isothiazolin-3-one, 2-Methyl-4-isothiazolin-3-one)	8	II		-
IMDG Class	UN3261	CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (Contains: 5-chloro-2-methyl-4-isothiazolin-3-one, 2-Methyl-4-isothiazolin-3-one)	8	II		**Emergency schedules (EmS)** F-A S-B
IATA-DGR Class	UN3261	CORROSIVE SOLID, ACIDIC, ORGANIC, N.O.S. (Contains: 5-chloro-2-methyl-4-isothiazolin-3-one, 2-Methyl-4-isothiazolin-3-one)	8	II		-

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14 . Transport information

PG* : Packing group

DOT Reportable Quantity Not applicable.

Marine pollutant Not applicable.

North-America NAERG : 154

15 . Regulatory information

HCS Classification : Toxic material
Corrosive material
Sensitizing material
Carcinogen
Target organ effects

U.S. Federal regulations : **United States inventory (TSCA 8b)**: All components are listed or exempted.

SARA 302/304/311/312 extremely hazardous substances: No products were found.
SARA 302/304 emergency planning and notification: No products were found.
SARA 302/304/311/312 hazardous chemicals: magnesium nitrate
SARA 311/312 MSDS distribution - chemical inventory - hazard identification: M275: Immediate (acute) health hazard, Delayed (chronic) health hazard

CERCLA: Hazardous substances.: No products were found.
Clean Air Act (CAA) 112 accidental release prevention: No products were found.
Clean Air Act (CAA) 112 regulated flammable substances: No products were found.
Clean Air Act (CAA) 112 regulated toxic substances: No products were found.
Clean Air Act Section 112(b) Hazardous Air Pollutants (HAPs) :
Not listed

SARA 313

	Product name	CAS number	Concentration
Supplier notification :	Magnesium nitrate	10377-60-3	5 - 10

United States inventory (TSCA 8b) : All components are listed or exempted.

Canada

WHMIS (Canada) : Class D-2A: Material causing other toxic effects (Very toxic).
Class D-2B: Material causing other toxic effects (Toxic).
Class E: Corrosive material

Canada (CEPA DSL): : All components are listed or exempted.

Additional information

This product is subject to regulation under the US Federal Insecticide, Fungicide and Rodenticide ACT (FIFRA) and is therefore exempt from US Toxic Substance Control Act (TSCA) Inventory listing requirements. EPA Registration No. 10707-44

16 . Other information

Label requirements : CAUSES EYE AND SKIN BURNS. HARMFUL IF SWALLOWED. CAUSES RESPIRATORY TRACT IRRITATION. MAY CAUSE ALLERGIC SKIN REACTION. CONTAINS MATERIAL THAT MAY CAUSE TARGET ORGAN DAMAGE, BASED ON ANIMAL DATA. CANCER HAZARD - CONTAINS MATERIAL WHICH CAN CAUSE CANCER.

National Fire Protection Association (U.S.A.) :

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16 . Other information

Date of printing : **1/19/2011.**

Indicates information that has changed from previously issued version.

Notice to reader

NOTE: The information on this MSDS is based on data which is considered to be accurate. Baker Hughes, however, makes no guarantees or warranty, either expressed or implied of the accuracy or completeness of this information.

The conditions or methods of handling, storage, use and disposal of the product are beyond our control and may be beyond our knowledge. For this and other reasons, we do not assume responsibility and expressly disclaim liability for loss, damage or expense arising out of or in any way connected with the handling, storage, use or disposal of this product.

This MSDS was prepared and is to be used for this product. If the product is used as a component in another product, this MSDS information may not be applicable.

SAFETY DATA SHEET

BIOMATE MBC781

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Trade name or designation of the mixture	BIOMATE MBC781
Issue date	28/07/2008
Version number	9.1
Revision date	14/01/2022
Supersedes date	11/02/2021

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

Identified uses	Biocide
Uses advised against	None known.

1.3. Details of the supplier of the safety data sheet

SUEZ Water Technologies & Solutions (UK) Limited Partnership
Hydro House
Newcombe Way
Orton Southgate
Peterborough
PE2 6SE
Tel.: +44 (0)1733 385444, Fax : 01733 391775
e-mail : emea.productregulatory.wts@suez.com

1.4. Emergency telephone number

Multilingual emergency number (24/7)

Europe, Middle East, Africa, Israel (Europe and English language speaking countries):
+44(0)1235 239670
Middle East & Africa (speaking Arabic):
+44(0)1235 239671

National Poisons Information Centre
NHS Direct on 111
Or a doctor

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

The mixture has been assessed and/or tested for its physical, health and environmental hazards and the following classification applies.

Classification according to Regulation (EC) No 1272/2008 as amended

Health hazards

Skin corrosion/irritation	Category 1C	H314 - Causes severe skin burns and eye damage.
Serious eye damage/eye irritation	Category 1	H318 - Causes serious eye damage.
Skin sensitisation	Category 1A	H317 - May cause an allergic skin reaction.

SAFETY DATA SHEET
BIOMATE MBC781

Environmental hazards

Hazardous to the aquatic environment, acute aquatic hazard	Category 1	H400 - Very toxic to aquatic life.
Hazardous to the aquatic environment, long-term aquatic hazard	Category 1	H410 - Very toxic to aquatic life with long lasting effects.

Hazard summary Causes severe skin burns and eye damage. May cause an allergic skin reaction. Dangerous for the environment if discharged into watercourses.

2.2. Label elements

Label according to Regulation (EC) No. 1272/2008 as amended

Contains: Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1) (CAS 55965-84-9) (15,5 g/l)

Hazard pictograms

Signal word Danger

Hazard statements

H314	Causes severe skin burns and eye damage.
H317	May cause an allergic skin reaction.
H410	Very toxic to aquatic life with long lasting effects.

Precautionary statements

Prevention

P273	Avoid release to the environment.
P280	Wear protective gloves/protective clothing/eye protection/face protection/hearing protection.

Response

P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTRE/doctor.

Storage Not available.

Disposal

P501 Dispose of contents/container in accordance with local/regional/national/international regulations.

Supplemental label information EUH071 - Corrosive to the respiratory tract.

2.3. Other hazards This mixture does not contain substances assessed to be vPvB / PBT according to Regulation (EC) No 1907/2006, Annex XIII. The product does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

SECTION 3: Composition/information on ingredients

Mixtures

Chemical description Isothiazolinone in aqueous solution

Chemical name	%	CAS-No. / EC No.	REACH Registration No.	Index No.	Notes
Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1)	1 - < 3	55965-84-9 -	-	613-167-00-5	
Classification: Acute Tox. 3;H301, Acute Tox. 2;H310, Acute Tox. 2;H330, Skin Corr. 1C;H314, Eye Dam. 1;H318, Skin Sens. 1A;H317, Aquatic Acute 1;H400(M=100), Aquatic Chronic 1;H410(M=100)					
Cupric nitrate	< 0,2	3251-23-8 221-838-5	01-2119969290-34	-	
Classification: Ox. Sol. 1;H271, Met. Corr. 1;H290, Skin Corr. 1B;H314, Eye Dam. 1;H318, Aquatic Acute 1;H400(M=10), Aquatic Chronic 1;H410(M=1)					

SAFETY DATA SHEET
BIOMATE MBC781

List of abbreviations and symbols that may be used above

ATE: Acute toxicity estimate.
M: M-factor
PBT: persistent, bioaccumulative and toxic substance.
vPvB: very persistent and very bioaccumulative substance.
All concentrations are in percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume. #: This substance has been assigned Union workplace exposure limit(s).

The full text for all H-statements is displayed in section 16.

SECTION 4: First aid measures

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves. Wash contaminated clothing before reuse.

4.1. Description of first aid measures

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

Skin contact Remove contaminated clothing immediately and wash skin with soap and water. Call a physician or poison control centre immediately. Chemical burns must be treated by a physician. Wash contaminated clothing before reuse.

Eye contact Immediately flush eyes with plenty of water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Call a physician or poison control centre immediately.

Ingestion Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Call a physician or poison control centre immediately.

4.2. Most important symptoms and effects, both acute and delayed Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.

4.3. Indication of any immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Chemical burns: Flush with water immediately. While flushing, remove clothes which do not adhere to affected area. Call an ambulance. Continue flushing during transport to hospital. Keep victim under observation. Symptoms may be delayed.

SECTION 5: Firefighting measures

General fire hazards No unusual fire or explosion hazards noted.

5.1. Extinguishing media

Suitable extinguishing media Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

5.2. Special hazards arising from the substance or mixture During fire, gases hazardous to health may be formed.

5.3. Advice for firefighters

Special protective equipment for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Special fire fighting procedures Move containers from fire area if you can do so without risk. Prevent spillage and fire-fighting water from entering in public sewers or the immediate environment.

Specific methods Use standard firefighting procedures and consider the hazards of other involved materials.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

For non-emergency personnel Wear appropriate protective equipment and clothing during clean-up. Do not breathe mist/vapours. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. It is possible to pass or work near the treated system during product application.

For emergency responders Keep unnecessary personnel away. Avoid breathing mist/vapours. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. Use personal protection recommended in Section 8 of the SDS.

6.2. Environmental precautions Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground. Transport and store in approved containers according to applicable national and international regulations.

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6.3. Methods and material for containment and cleaning up

Keep spills and clean-up residuals out of municipal sewers and open bodies of water.
Absorb the spill with spill pillows or inert solids such as clay or vermiculite.
Transfer contaminated materials to suitable containers for disposal.
Deactivate spill area with freshly prepared solution of 5% sodium bicarbonate and 5% sodium hypochlorite in water.
Apply solution to the spill area at a ratio of 10 volumes deactivation solution per estimated volume of residual spill to deactivate any residual active ingredient.
Let stand for 30 minutes.
Flush the spill area with copious amounts of water to chemical sewer in accordance with local procedures, permits and regulations.
DO NOT add deactivation solution to the waste pail to deactivate the adsorbed material.
Prevent entry into waterways, sewer, basements or confined areas.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use.

6.4. Reference to other sections

For personal protection, see section 8 of the SDS. For waste disposal, see section 13 of the SDS.

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Do not breathe mist/vapours. Do not get in eyes, on skin, or on clothing. Provide adequate ventilation. Wear appropriate personal protective equipment. Avoid release to the environment. Observe good industrial hygiene practices.

7.2. Conditions for safe storage, including any incompatibilities

Store locked up. Store in tightly closed container. Store away from incompatible materials (see Section 10 of the SDS). Store containers closed when not in use, away from extreme temperatures . Product evolves carbon dioxide gas slowly.
Store upright in original vented container.
Store samples in plastic bottles only.
No more then 6 months pressure build-up may rupture glass bottles.

7.3. Specific end use(s)

Only for industrial users The material which has been in contact with this product can be cleaned with water. Product is especially designed for the cleaning and disinfection by applying, soaking or circulating of a diluted aqueous solution. The minimum contact time is: 12 hours. Proper treatment levels and frequency of addition should be determined by a study of the normalised system performance and depend on many factors, such as water quality, microbial species, biological activity in the water streams, and conditions particular for a given installation. The product should be used in accordance with control procedures that SUEZ Water Technologies & Solutions establishes for a specific application.

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Occupational exposure limits

No exposure limits noted for ingredient(s).

Biological limit values

No biological exposure limits noted for the ingredient(s).

Recommended monitoring procedures

Follow standard monitoring procedures.

Derived no effect levels (DNELs)

Not available.

Predicted no effect concentrations (PNECs)

Components	Value	Assessment factor	Notes
Cupric nitrate (CAS 3251-23-8)			
Freshwater	7,8 µg/l	1	
Marine water	5,2 µg/l	1	
Sediment (freshwater)	87 mg/kg	1	
Sediment (marine water)	676 mg/kg	1	
Soil	65 mg/kg	1	
STP	230 µg/l	1	

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8.2. Exposure controls

Appropriate engineering controls	Good general ventilation should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

General information	Use personal protective equipment as required. Personal protection equipment should be chosen according to the CEN standards and in discussion with the supplier of the personal protective equipment.
Eye/face protection	Wear safety glasses with side shields (or goggles) and a face shield. Face shield is recommended . CEN : EN 166
Skin protection	
- Hand protection	For prolonged or repeated skin contact use suitable protective gloves. Suitable gloves can be recommended by the glove supplier. Full shoulder length butyl gloves (Protection against unintentional short-term contact) Full shoulder length neoprene gloves (Protection against unintentional short-term contact) Full shoulder length nitrile gloves (Protection against unintentional short-term contact) Penetration time: > 480 min Coating thickness: 0.5 mm CEN : EN 374-1/2/3/4; EN 420
- Other	Wear appropriate chemical resistant clothing. Chemical resistant clothing that ensures full coverage of the hands, arms and body. Rubber boots. CEN : EN ISO 13688; EN ISO 6530; EN ISO 6529; EN 14605
Respiratory protection	In case of insufficient ventilation, wear suitable respiratory equipment. In case of insufficient ventilation, use a breathing mask with filter type: A2 E2-P CEN : EN 140; EN 14387
Thermal hazards	Wear appropriate thermal protective clothing, when necessary.
Hygiene measures	Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants. Contaminated work clothing should not be allowed out of the workplace.
Environmental exposure controls	Inform appropriate managerial or supervisory personnel of all environmental releases. Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. Fume scrubbers, filters or engineering modifications to the process equipment may be necessary to reduce emissions to acceptable levels. Do not empty into drains, dispose of this material and its container to hazardous or special waste collection point.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Appearance	
Colour	Yellow to blue-green
Physical state	Liquid
Odour	Slight
Odour threshold	Not available.
pH (concentrated product)	3
pH in aqueous solution	4 (5% SOL.)
Melting point/freezing point	-2 °C
Initial boiling point and boiling range	104 °C
Flash point	Not available.
Evaporation rate	< 1 (Ether = 1)
Flammability (solid, gas)	Not applicable.

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Upper/lower flammability or explosive limits

Explosive limit - lower (%)	Not available.
Explosive limit – upper (%)	Not available.
Vapour pressure	18 mm Hg / 2,4 kPa
Vapour pressure temp.	21 °C
Vapour density	< 1 (Air = 1)
Relative density	1,03
Relative density temperature	21 °C
Solubility	
Solubility (water)	100 %
Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	8 cps
Viscosity temperature	21 °C
Explosive properties	Not explosive.
Oxidising properties	Not oxidising.
Kinematic viscosity	Not available.
Particle characteristics	Not available.

9.2. Other information

Pour point	1 °C
Shelf life	360 days
Specific gravity	1,03
VOC	0 % (Calculated)

SECTION 10: Stability and reactivity

10.1. Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
10.2. Chemical stability	Material is stable under normal conditions.
10.3. Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
10.4. Conditions to avoid	Do not freeze.
10.5. Incompatible materials	Strong oxidising agents. Strong reducing agents.
10.6. Hazardous decomposition products	Hydrogen chloride. Carbon oxides. Nitrogen oxides (NOx). Sulphur oxides.

SECTION 11: Toxicological information

General information Occupational exposure to the substance or mixture may cause adverse effects.

Information on likely routes of exposure

Inhalation	May cause irritation to the respiratory system.
Skin contact	Causes severe skin burns. May cause an allergic skin reaction.
Eye contact	Causes serious eye damage.
Ingestion	Causes digestive tract burns.
Symptoms	Burning pain and severe corrosive skin damage. Causes serious eye damage. Symptoms may include stinging, tearing, redness, swelling, and blurred vision. Permanent eye damage including blindness could result.

11.1. Information on hazard classes as defined in Regulation (EC) No 1272/2008

Acute toxicity

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Product	Species	Test Results
BIOMATE MBC781		
Acute		
Dermal		
LD50	Rabbit	> 5000 mg/kg
Inhalation		
LC50	Rat	> 5 mg/l, 4 Hours
Oral		
LD50	Rat	4468 mg/kg

Components	Species	Test Results
Cupric nitrate (CAS 3251-23-8)		
Acute		
Oral		
LD50	Rat	940 mg/kg
Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1) (CAS 55965-84-9)		
Acute		
Dermal		
LD50	Rabbit	90 mg/kg
Inhalation		
LC50	Rat	0,33 mg/l, 4 hour
Oral		
LD50	Rat	67 mg/kg

Skin corrosion/irritation Causes severe skin burns and eye damage.

Serious eye damage/eye irritation Causes serious eye damage.

Respiratory sensitisation Based on available data, the classification criteria are not met.

Skin sensitisation May cause an allergic skin reaction.

Germ cell mutagenicity Based on available data, the classification criteria are not met.

Carcinogenicity Based on available data, the classification criteria are not met.

Reproductive toxicity Based on available data, the classification criteria are not met.

Specific target organ toxicity - single exposure Based on available data, the classification criteria are not met.

Specific target organ toxicity - repeated exposure Based on available data, the classification criteria are not met.

Aspiration hazard Based on available data, the classification criteria are not met.

Mixture versus substance information No information available.

11.2. Information on other hazards

Endocrine disrupting properties The product does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

Other information Not available.

SECTION 12: Ecological information

12.1. Toxicity Very toxic to aquatic life with long lasting effects.

Product		Species	Test Results
BIOMATE MBC781			
Aquatic			
Crustacea	10% Mortality	Daphnia magna	6 mg/l, 48 H

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Product		Species	Test Results
	LC50	Daphnia magna	2,9 mg/l, 48 H
		Mysid Shrimp	5,14 mg/l, 96 H
Fish	LC50	Bluegill sunfish	12,1 mg/l, 96 H
		Fathead minnow	6,6 mg/l, 96 H
		Rainbow trout	8,7 mg/l, 96 H
			4,6 mg/l, 14 D
		Sheepshead minnow	20 mg/l, 96 H
	LOEC	Fathead minnow	4 mg/l, 36 D
	NOEL	Bluegill sunfish	6,5 mg/l, 96 H
		Fathead minnow	2,5 mg/l, 96 H
			1,3 mg/l, 36 D
		Rainbow trout	6,5 mg/l, 96 H
			3,3 mg/l, 14 D
		Sheepshead minnow	12 mg/l, 96 H

12.2. Persistence and degradability

- **COD (mgO2/g)** 17 (calculated data)
- **BOD 5 (mgO2/g)** 0 (calculated data)
- **BOD 28 (mgO2/g)** 0 (calculated data)
- **Closed Bottle Test (% Degradation in 28 days)** 0 (calculated data)
- **Zahn-Wellens Test (% Degradation in 28 days)** 0 (calculated data)
- **TOC (mg C/g)** 6 (calculated data)

12.3. Bioaccumulative potential

Partition coefficient n-octanol/water (log Kow)

Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1) 0,49

Bioconcentration factor (BCF) Not available.

12.4. Mobility in soil No data available.

12.5. Results of PBT and vPvB assessment This mixture does not contain substances assessed to be vPvB / PBT according to Regulation (EC) No 1907/2006, Annex XIII.

12.6. Endocrine disrupting properties The product does not contain components considered to have endocrine disrupting properties according to REACH Article 57(f) or regulation (EU) 2017/2100 or Commission Regulation (EU) 2018/605 at levels of 0.1% or higher.

12.7. Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Residual waste Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

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Contaminated packaging	Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal. According to Hazardous Waste Regulations. European List of Wastes (LoW) code recommendation : 15 01 10 15 Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified. 15 01 Packaging (including separately collected municipal packaging waste). 15 01 10 Packaging containing residues of or contaminated by dangerous substances. Depending on the origin and state of the waste, other codes may be applicable too.
Disposal methods/information	Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations. According to Hazardous Waste Regulations. European List of Wastes (LoW) code recommendation : 16 03 05 16 Wastes not otherwise specified in the list. 16 03 Off-specification batches and unused products. 16 03 05 Organic wastes containing dangerous substances. Depending on the origin and state of the waste, other codes may be applicable too.
Special precautions	Dispose in accordance with all applicable regulations.

SECTION 14: Transport information

General

IMDG Regulated Marine Pollutant.

ADR

14.1. UN number	UN3265
14.2. UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1, Mixture)
14.3. Transport hazard class(es)	
Class	8
Subsidiary risk	-
Tunnel restriction code	(E)
14.4. Packing group	III
14.5. Environmental hazards	Yes
14.6. Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

RID

14.1. UN number	UN3265
14.2. UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1, Mixture)
14.3. Transport hazard class(es)	
Class	8
Subsidiary risk	-
14.4. Packing group	III
14.5. Environmental hazards	Yes
14.6. Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

ADN

14.1. UN number	UN3265
14.2. UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1, Mixture)
14.3. Transport hazard class(es)	
Class	8
Subsidiary risk	-
14.4. Packing group	III
14.5. Environmental hazards	Yes

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14.6. Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IATA

14.1. UN number	UN3265
14.2. UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1, Mixture)
14.3. Transport hazard class(es)	
Class	8
Subsidiary risk	-
14.4. Packing group	III
14.5. Environmental hazards	Yes
ERG Code	Not available.
14.6. Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

14.1. UN number	UN3265
14.2. UN proper shipping name	CORROSIVE LIQUID, ACIDIC, ORGANIC, N.O.S. (Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1, Mixture)
14.3. Transport hazard class(es)	
Class	8
Subsidiary risk	-
14.4. Packing group	III
14.5. Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-B
14.6. Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
14.7. Transport in bulk according to Annex II of MARPOL and the IBC Code	Not established.

ADN; ADR; IATA; IMDG; RID

Marine pollutant

General information	IMDG Regulated Marine Pollutant.

SECTION 15: Regulatory information

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

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EU regulations

Regulation (EC) No. 1005/2009 on substances that deplete the ozone layer, Annex I and II, as amended

Not listed.

Regulation (EU) 2019/1021 On persistent organic pollutants (recast), as amended

Not listed.

Regulation (EU) No. 649/2012 concerning the export and import of dangerous chemicals, Annex I, Part 1 as amended

Not listed.

Regulation (EU) No. 649/2012 concerning the export and import of dangerous chemicals, Annex I, Part 2 as amended

Not listed.

Regulation (EU) No. 649/2012 concerning the export and import of dangerous chemicals, Annex I, Part 3 as amended

Not listed.

Regulation (EU) No. 649/2012 concerning the export and import of dangerous chemicals, Annex V as amended

Not listed.

Regulation (EC) No. 166/2006 Annex II Pollutant Release and Transfer Registry, as amended

Cupric nitrate (CAS 3251-23-8)

Regulation (EC) No. 1907/2006, REACH Article 59(10) Candidate List as currently published by ECHA

Not listed.

Authorisations

Regulation (EC) No. 1907/2006, REACH Annex XIV Substances subject to authorization, as amended

Not listed.

Restrictions on use

Regulation (EC) No. 1907/2006, REACH Annex XVII Substances subject to restriction on marketing and use as amended

Not listed.

Other EU regulations

Directive 2012/18/EU on major accident hazards involving dangerous substances, as amended

Reaction mass of 5-chloro-2-methyl-2H-isothiazol-3-one and 2-methyl-2H-isothiazol-3-one (3:1) (CAS 55965-84-9)

Other regulations	The product is classified and labelled in accordance with Regulation (EC) 1272/2008 (CLP Regulation) as amended. This Safety Data Sheet complies with the requirements of Regulation (EC) No 1907/2006, as amended.
National regulations	Follow national regulation for work with chemical agents in accordance with Directive 98/24/EC, as amended.
15.2. Chemical safety assessment	No Chemical Safety Assessment has been carried out.
Biocides	2: Private area and public health area disinfectants and other biocidal products. 11: Preservatives for liquid-cooling and processing systems

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

SECTION 16: Other information

List of abbreviations

ADN: European Agreement Concerning the International Carriage of Dangerous Goods by Inland Waterways.
ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road.
CEN: European Committee for Standardization.
CLP: Classification, Labeling and Packaging REGULATION (EC) No 1272/2008 on classification, labeling and packaging of substances and mixtures.
EC50: Effective Concentration 50%.
IATA: International Air Transport Association.

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IBC Code: International Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk.
IMDG: International Maritime Dangerous Goods.
LC50: Lethal Concentration 50%.
LD50: Lethal Dose 50%.
MARPOL: International Convention for the Prevention of Pollution from Ships.
NOEL: No observed effect level.
PBT: Persistent, bioaccumulative and toxic.
RID: Regulations concerning the International Carriage of Dangerous Goods by Rail.
STEL: Short term exposure limit.
TOC: Total Organic Carbon.
vPvB: Very persistent and very bioaccumulative.
COD: Chemical Oxygen Demand
EC-No: European Commission Number
BOD: Biochemical oxygen demand.

References

Safety data sheets of raw materials.

Information on evaluation method leading to the classification of mixture

The classification for health and environmental hazards is derived by a combination of calculation methods and test data, if available.

Full text of any H-statements not written out in full under Sections 2 to 15

H271 May cause fire or explosion; strong oxidiser.
H290 May be corrosive to metals.
H301 Toxic if swallowed.
H310 Fatal in contact with skin.
H314 Causes severe skin burns and eye damage.
H317 May cause an allergic skin reaction.
H318 Causes serious eye damage.
H330 Fatal if inhaled.
H400 Very toxic to aquatic life.
H410 Very toxic to aquatic life with long lasting effects.

Revision information

This document has undergone significant changes and should be reviewed in its entirety.

Training information

Provide training on safe handling while considering the type of application and exposure scenarios. Follow training instructions when handling this material.

Disclaimer

The information provided in this Safety Data Sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

Based on EC Directive / Regulations

(EU) No 1357/2014
(EC) No 1907/2006 (REACH)
(EC) No 1272/2008

Further information

Correction in Section: 2,3,4,5,6,7,8,9,10,11,12,13,14,15

Attachment 2 Vendor WMF Chemicals and Exposure Point Concentration

Attachment 2
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)

Product Name	Chemical Name	CAS Number	%	Proper Shipping Name	Supplier	Area	Transport		Onsite Storage		Operation		Annual Usage (ROP volumes based on peak rate of 10ML/d)	Purpose / Function
							mass/volume	concentration	mass/volume	concentration	mass/volume	concentration		
Biomate MBC781	Cupric Nitrate	3251-23-8	<0.5	Biomate MBC781	Suez Water Technologies and Solutions Pty Ltd	Reverse Osmosis Plant	1000L IBC		2 x 1000L (IBC)		9 MG/L (AVG. EST)		TBD	biocide
	Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	5-12											
	Water	7732-18-5	>85											

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concern
IBC = intermediate bulk container
L = litres
mg/kg = milligrams per kilogram
mg/L = milligrams per litre
ML/d = millilitre per day
NA = not applicable
ROP = reverse osmosis process
TBD = to be determined, product proposed for use

Attachment 2
Summary of Exposure Point Concentration Development
(Water Treatment Chemicals)

Product Name	Chemical Name	CAS Number	Fate	Permeate Concentration		COPC concentration in soil from release of permeate	COPC concentration in soil from 20 years of irrigation	Brine Concentration	
				(mg/L)	Permeate notes	(mg/kg)	mg/kg	(mg/L)	Brine Notes
Biomate MBC781	Cupric Nitrate	3251-23-8	No residual	NA	Cupric nitrate fully dissociates to copper (Cu^{2+}) and nitrate (NO_3^-) anions. These anions are removed by the RO system, (95%) goes to brine, 5% stays within permeate. Residual concentrations are de minimis and subject to immobilization in the pond.	NA	NA	NA	Cupric nitrate fully dissociates to copper (Cu^{2+}) and nitrate (NO_3^-) anions. These anions are removed by the RO system, (95%) goes to brine, 5% stays within permeate. Residual concentrations are de minimis and subject to immobilization in the pond.
	Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9		0.0108	Membrane has 99% rejection efficiency, therefore, 0.09 mg/L of product in permeate. Comprises 5-12% of total product; therefore, 0.09 mg/L x 0.12 = 0.0108 mg/L in permeate.	0.69	0.82	NA	Will biodegrade in pond
	Water	7732-18-5		NA		NA	NA	NA	

AVG = average
CAS = Chemical Abstracts Service
COPC = constituent of potential concern
IBC = intermediate bulk container
L = litres
mg/kg = milligrams per kilogram
mg/L = milligrams per litre
ML/d = millilitre per day
NA = not applicable
ROP = reverse osmosis process
TBD = to be determined, product proposed for use

Attachment 3 Risk Assessment Dossier

MIXTURE OF 5-CHLORO-2-METHYL-2H-ISOTHIAZOL-3-ONE AND 2-METHYL-2H-ISOTHIAZOL-3-ONE (3:1)
(CAS NUMBER 55965-84-9)

This dossier on the mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT) (3:1) presents the most critical studies pertinent to the risk assessment of the mixture in coal seam gas applications. This dossier does not represent an exhaustive or critical review of all available data. The majority of information presented in this dossier was obtained from the ECHA database that provides information on chemicals that have been registered under the EU REACH (ECHA). Where possible, study quality was evaluated using the Klimisch scoring system (Klimisch et al., 1997).

Screening Assessment Conclusion – CMIT and MIT were not identified in chemical databases used by NICNAS as an indicator that the chemicals are of concern and are not PBT substances. The mixture of CMIT and MIT were assessed as tier 3 chemicals for acute and chronic aquatic toxicity. Therefore, CMIT/MIT are classified overall as **tier 3** chemicals and require a quantitative risk assessment for end uses.

1 BACKGROUND

The methylisothiazolinones in this assessment belong to a larger group of preservatives and industrial biocides which all have an isothiazolinone heterocyclic ring system. CMIT is the monochloro derivative of parent chemical MIT.

Methylisothiazolinones are made industrially by oxidative cyclisation of the linear organic di-sulfide, N,N’-dimethyl-3,3’-dithiodipropionamide (CAS RN 999-72-4), in a process that uses chlorine as the oxidant. This manufacturing process inevitably produces a mixture of MIT and CMIT, as well as a small amount of the dichloro derivative (DCMIT; CAS RN 26542-23-4). These mixtures are generally not separated into their constituent chemicals and CMIT is not commercially available except as a mixture with MIT (NICNAS, 2020).

The mixture of CMIT and MIT is biodegradable at expected environmental exposure concentrations and would also be removed by common biological wastewater treatment facilities. The mixture is not expected to bioaccumulate, and has a low potential to adsorb to soil.

The acute toxicity of CMIT/MIT is moderate to highly toxic by the oral, inhalation and dermal routes. It is corrosive to the skin and eye and is expected to be a skin sensitiser according to a local lymph node assay. Repeated exposures to rats by the oral, dermal, or inhalation routes have shown no systemic toxicity; however, evidence of localised irritation (site-of-contact) was observed by all routes of exposure. CMIT/MIT may exhibit weak genotoxic effects in some *in vitro* tests, whereas the *in vivo* studies consistently show no genotoxic activity. It has no reported reproductive or developmental effects; and, is not considered carcinogenic.

The mixture of CMIT and MIT exhibits significant acute and chronic aquatic toxicity. The mixture is also toxic to sediment dwelling organisms but less toxic to terrestrial receptors.

2 CHEMICAL NAME AND IDENTIFICATION

Chemical Name (IUPAC): Reaction mass of 2-methyl-2H-isothiazol-3-one and 5-chloro-2-methyl-2H-isothiazol-3-one

CAS RN: 55965-84-9

Molecular formula: C_4H_5NOS. C_4H_4ClNOS

Molecular weight: 264.8 g/mol

Synonyms: Bio-Perge; Isothiazolinone chloride; 5-Chloro-2-methyl-4-isothiazolin-3-one -2-methyl-4-isothiazolin-3-one mixture; 3(2H)-Isothiazolone, 5-chloro-2-methyl-, mixt. with 2-methyl -3 (2H) -isothiazolone

3 PHYSICO-CHEMICAL PROPERTIES

Key physical and chemical properties for these substances are shown in Table 1.

Table 1 Overview of the Physico-chemical Properties of Mixture of CMIT and MIT (3:1)

Property	Value	Klimisch score	Reference
Physical state at 20°C and 101.3 kPa	Solid, pale yellow to yellow	1	ECHA
Melting Point	22.2°C at 101.3 kPa	1	ECHA
Boiling Point	100.1°C at 101.3 kPa	1	ECHA
Density	1,256 kg/m^3 @ 20°C	1	ECHA
Partition Coefficient (log K_{ow})	0.75 @ 27°C	1	ECHA
Water Solubility	3,000 g/L @ 20°C	1	ECHA
Vapour Pressure	2.2 Pa @ 20°C	1	ECHA

Combined formulations of CMIT and MIT are marketed under several trade names, such as Kathon CG, Kathon 886, Kathon 886 WT, Kathon™ 886, ACTICIDE LG, ACTICIDE 14 L, ACTICIDE 14P, Microcare IT, Microcare ITL, etc. (EU SCCS, 2009). Initially, all formulations were prepared as a mixture of two individual active ingredients CMIT and MIT and salts. However, Kathon™ 886 biocide is now defined as a combination of the two active ingredients produced by an integrated production process, resulting in an approximate total of 14% active ingredients, 16% magnesium nitrate, 10% magnesium chloride and 62% water. There is no indication as to when this change was made in the manufacturing process (EU SCCS, 2009).

As such, magnesium nitrate and magnesium chloride are present in the commercial CMIT/MIT mixture as an inert ingredient and impurity, respectively. The amount of these two salts vary depending on the source (EU SCCS, 2009).

4 DOMESTIC AND INTERNATIONAL REGULATORY INFORMATION

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

Table 2 Existing International Controls

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

5 ENVIRONMENTAL FATE SUMMARY

A. Summary

The mixture of CMIT and MIT is biodegradable at expected environmental exposure concentrations, is not expected to bioaccumulate, and has a low potential to adsorb to soil.

B. Partitioning

The mixture of CMIT and MIT is readily soluble in water. Given low Henry's Law constants for MIT and CMIT (0.005 Pa-m^3/mol and 0.0036 Pa-m^3/mol, respectively), these chemicals are considered slightly volatile from water and moist soil. The mixture is also expected to volatilise from dry soil surfaces based upon its vapour pressure.

Based on hydrolysis measurements made using OECD Guideline 111, CMIT/MIT was stable (<10% degradation) at pH 4 and 7. At pH 9 extensive degradation of CIT/MIT was observed. The rate constant was found to be 0.0283 per day and the DT50 and DT90 to be 24.5 days and 81 days, respectively (ECHA). [Kl. Score = 1].

In the presence of sunlight, CMIT/MIT is susceptible to rapid photodegradation with DT50 and DT90 values of 117 and 389 hours, respectively. (ECHA). [Kl. Score = 1].

C. Biodegradation

The biodegradation of the test substance, a 14% aqueous solution of 3 parts 5 -Chloro-2 -methyl-2H-isothiazol-3 -one and 1 part 2 -Methyl-2H-isothiazol-3 -one (cited as ACTICIDE® 14 in the study report), was investigated in a closed-bottle seawater test according to OECD guideline 306. The test substance was incubated with natural seawater over a period of 28 days under aerobic conditions, and oxygen content was determined by means of an oxygen electrode after 0, 5, 15 and 28 days.

ACTICIDE® 14 can be considered inhibitory to bacteria in the seawater sample. Due to inhibition of bacteria, the biodegradability of ACTICIDE® 14 could not be established in this test (ECHA). [Kl. Score = 1].

Biodegradation studies on CMIT and MIT separately have also been conducted. In these studies, CMIT is classified as being readily biodegradable, failing the 10 -day window and MIT is classified as being not readily biodegradable according to the criteria of the test, although significant biodegradation occurred (ECHA).

An OECD Guideline 301 B (Ready Biodegradability: CO2 Evolution Test) was performed on MIT. 50% of the test substance biodegraded within 29 days. Although extensive metabolism occurs over the 29-day interval, the test material does not meet the requirements for readily biodegradable but can be considered ultimately biodegradable. [Kl Score=1](ECHA). The same test with CMIT showed up to 62% of the test substance biodegraded within the same time frame of 29 days. [Kl Score=1](ECHA). The rate of biodegradation in these tests does not satisfy the OECD criterion for readily biodegradability (60% in a 10-day window), but the results do show that these chemicals are biodegradable at more realistic environmental exposure concentrations (NICNAS, 2020).

The primary aerobic biodegradability of MIT has been examined in a river sediment-water system by use of a 14C-labelled model compound. During the 7-day experiment 14C-labelled MIT was rapidly metabolized as only 12.6% of the initial MIT was present after 24 hours of incubation at 25C. The calculated half-life for the parent compound was 9.1 hours (Reynolds, 1994a). The primary biodegradability of CMIT has been examined with the same type of sediment and water as described for MIT. The 14C-labelled CMIT was rapidly metabolized as only 30% of the initial CMI remained after 24 hours of incubation at 25C. The calculated half-life for the intact CMIT was 17.3 hours (Reynolds, 1994b).

In soil, CMIT and MIT are rapidly biodegradable with reported half-lives of 10.4 hours and 6.5 hours, respectively (ECHA). [Kl. Score = 1].

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

D. Environmental Distribution

An OECD Guideline 106 (Adsorption - Desorption Using a Batch Equilibrium Method) was conducted on the CMIT/MIT mixture. The adsorption/desorption characteristics of [14C]-CMIT/MIT were studied in two UK sewage sludges; Basildon (pH 6.6, 29.3% organic carbon) and Chelmsford (pH 6.7, 23.7% organic carbon) and three UK soils, Farditch silt loam (pH 5.5, 4.19% organic carbon), Longwoods sandy loam (pH 7.1, 1.62% organic carbon) and Kenslow loam (pH 4.9, 3.88% organic carbon) using the batch equilibrium method. The Kfoc values obtained ranged from 34 to 54 mL/g (mean of 44 mL/g). The Freundlich exponents (1/n) ranged from 0.564 to 0.778, indicating a non-linear relationship between adsorption and concentration with a higher degree of adsorption to soil at lower concentrations. The determined Kfoc values indicated that CMIT/MIT can be classified as being of intermediate to high mobility in soil. [Kl Score=1](ECHA).

Soil adsorption coefficients (K_{oc}) for MIT (log K_{oc} = 1.08) and CMIT (log K_{oc} – 1.28) indicate both chemicals will have very high mobility in soil (NICNAS, 2020). Likewise, if released to water, based on their high solubility, they are not expected to adsorb to suspended solids or sediments.

E. Bioaccumulation

Bioaccumulation studies are not available for the CMIT/MIT mixture. Individually, MIT and CMIT are not expected to bioaccumulate. Studies of the bioconcentration of MIT and CMIT in bluegill sunfish (Lepomis macrochirus) at an exposure concentration of 0.12 mg/L showed bioconcentration factors (BCF) in this species of 2.3 and 114 L/kg respectively (Madsen, et al., 2001).

The low bioconcentration potential, hydrophilicity, and the reactivity of both chemicals with biomolecules indicate that they will not biomagnify in aquatic or terrestrial food webs (NICNAS, 2020).

6 HUMAN HEALTH HAZARD ASSESSMENT

A. Summary

The acute toxicity of CMIT/MIT is moderate to highly toxic by the oral, inhalation and dermal routes. It is corrosive to the skin and eye and is expected to be a skin sensitiser according to a local lymph node assay. Repeated exposures to rats by the oral, dermal, or inhalation routes have shown no systemic toxicity; however, evidence of localised irritation (site-of-contact) was observed by all routes of exposure. CMIT/MIT may exhibit weak genotoxic effects in some *in vitro* tests, whereas the *in vivo* studies consistently show no genotoxic activity. It has no reported reproductive or developmental effects; and, is not considered carcinogenic.

B. Toxicokinetics and Metabolism

Rats were given by gavage a single dose of 3.75 mg/kg bw, 11.25 mg/kg bw or 22.5 mg/kg bw radiolabeled CMIT. CMIT was rapidly and extensively excreted in the urine and faeces following oral administration. A majority of the radioactivity was excreted from the rats in 24 hour (77-87%). Renal and fecal routes of elimination were equally important. Tissues contained 0.93-1.44% (female and male, respectively) of dosed radioactivity in the low dose group and 3.94-4.72% (female and male, respectively) in the high dose group. The highest amount of radioactivity was found in blood, particularly in red blood cells (0.67-1.09% of the dose in the low dose group, and 3.41-4.11% in the high dose group), followed by muscle (0.15%) in low dose group, and by muscle and liver (0.25%) in high dose group. Gender differences in excretion appeared to be minimal. CMIT was extensively metabolized. Approximately twenty-nine radioactive components were observed in urine and faeces samples from the HPLC radio profiling. Among these N-methyl malonamic acid was detected as the major component in the urine (15.35-18.19%). 3 -mercapturic acid conjugate of 3 -sulfinyl-N-methyl-propionamide was detected as the major component in the feces (up to 32.54%). All other metabolites accounted for less than 5% of the dose. Metabolites are thought to result from reduction and oxidation reactions involving phase I enzymes followed by conjugation to glutathione, giving rise to conjugates to glutathione or to mercapturic acid. (ECHA). [Kl. Score = 1].

C. Acute Toxicity

<u>Oral</u>

An acute oral toxicity study was conducted in 1977 before implementation of the GLP. Groups of CD rats were administered orally via gavage Kathon 886 at 221, 313, 442, 625 or 883 mg/kg b.w. Clinical signs were observed in all dose levels of this study. Under the conditions of the study, the acute oral

LD50 in male rats is based on the lowest value, 457 mg/kg Kathon 886 corresponding to 64 mg/kg active ingredient (a.i.) (pure CMIT/MIT). (ECHA). [Kl Score = 2].

Inhalation

An acute inhalation toxicity study was conducted in accordance with GLP and as per OECD 403 guideline. Groups of male and female CD (BR) rats were exposed to an aerosol of Kathon 886 via nose only at concentrations of 0.19, 0.32, 0.50, 1.26, 2.24, and 3.02 mg test material/L. Signs of respiratory irritation, including gasping, rales, hyperpnea, dyspnea and vocalization, were seen in some animals in all groups immediately post-exposure. The number of animals showing these signs and the severity of the respiratory irritation correlated with the concentration of the test material to which the animals were exposed in the report. The signs of respiratory irritation disappeared in all surviving animals, taking from two to twelve days. Under the conditions of the study, a combined male and female LC50 value of 0.33 mg a.i per liter of air was determined (ECHA). [Kl Score = 1].

Dermal

An acute dermal toxicity study was conducted in 1976 before implementation of the GLP. Male albino rabbits were exposed dermally to Kathon 886 at 313, 625, 1250 and 2500 mg/kg under occlusive conditions. Skin irritation consisted of severe erythema and edema followed by eschar formation. LD50 was determined to be 660 mg Kathon™ 886/kg bw with 95% confidence limits of 370 and 1210 mg/kg. This corresponds to LD50 = 87.12 mg/kg a.i. (pure CMIT/MIT). (ECHA). [Kl Score = 2].

D. Irritation

Skin

Two OECD 404 guideline compliant studies are provided indicating CMIT/MIT is corrosive to the skin.

A skin irritation/corrosion study was conducted according to OECD Guideline 404. As part of the study, white rabbits under semiocclusive conditions were exposed to the test substance for 1 or 4 hours. A severe edema (score = 4) was observed in five animals and one animal had a moderate edema (score = 3) one hour after patch removal. This edema was raised more than 2 mm and extended beyond the area of exposure. By day 3, this irritation reversed such that only 3 animals had a slight edema. There was total recovery after 8 days. One animal had a well-defined erythema with slight eschar formations. A reversal was observed after 72 h with total recovery after 11 days. Under the conditions of the study, the material was classified as corrosive to skin following a 1-hour or 4-hour exposure period, but the effects were fully reversible [Kl. Score = 2](ECHA).

A second skin irritation/corrosion study was also conducted according to the OECD Guideline 404. In the study, the irritating or corrosive potential of a 13.9 % aqueous solution of a 3:1 mixture of 5 -chloro-2 -methyl-2H-isothiazol-3 -one and 2 -methyl-2H-isothiazol-3 -one in water (named ACTICIDE 14 in this study report) was evaluated. One male New Zealand White rabbit was treated by on the exposed skin with 0.5 ml of the test item for 4 hours. The test substance was removed, and the treated skin was observed for abnormalities, their severity and eventual reversibility. Findings were scored according to the system proposed by Draize. Severe erythema and edema were observed shortly after treatment. While erythema was not reversible, edema was not observed after day 7. (ECHA). [Kl. Score = 1].

Eye

An in vivo eye irritation study indicated that Kathon™ 886 produces severe lesion to the eyes of rabbit which were not reversible. Kathon™ 886 should be considered as corrosive to the eyes of rabbits. (ECHA). [Kl. Score = 2].

E. Sensitisation

A local lymph node assay (LLNA) study in CBA/J mice was conducted in compliance with the proposed Local Lymph Node Assay protocol prepared by the Interagency Coordinating Committee for Validation of Alternative Methods (ICCVAM) Immunotoxicology Working Group (IWG): National Institutes of Health Publication N°: 99-449, Appendix J, 1999. Groups of mice were exposed to Kathon 886 at nominal concentrations of 0, 30, 50, 70, 90, 360, 1000 ppm a.i. in 4:1 acetone/olive oil and evaluated for skin sensitisation reactions. All concentrations evaluated produced a stimulation index greater than or equal to 3. The results of the study indicate that the test material CMIT/MIT exhibits a statistically significant, generally dose-related potential to induce contact hypersensitivity in mice. [Kl Score=1] (ECHA).

The potential of a 14% aqueous solution of 3 parts 5 -chloro-2 -methyl-2H-isothiazol-3 -one and 1 part 2 -methyl-2H-isothiazol-3 -one (ACTICIDE 14) to cause skin sensitisation was investigated in a Guinea Pig Maximisation Test according to OECD guideline 406. Male and female Dunkin-Hartley guinea pigs were treated with the test substance by intradermal injection (mixed with Freud`s complete Adjuvant) and 6 days later by cutaneous application under occlusive dressing for 48 hours (induction). Two weeks later, animals were treated with the test substance by cutaneous application for 24 hours at a site different from the first application sites (challenge). After another week, animals of the low-dose group were treated with the test substance by dermal application at a lower dose (rechallenge). Slight to moderate erythema were observed after intradermal induction, and local irritation after cutaneous induction. At challenge, all substance-induced animals and half of the control animals presented signs of severe skin reactions. Therefore, animals of the low dose group and a new control group were re-challenged one week later with 100 -1000 -fold less substance by dermal route. In the rechallenge, only animals treated with the high concentration (0.025% ACTICIDE 14) responded positive (4 of ten animals), while animals treated with factor ten lower amounts and the control animals showed no signs of toxicity. [Kl Score = 1](ECHA).

F. Repeated Dose Toxicity

Oral

CMIT/MIT was tested in several oral repeated dose toxicity studies in rabbits, rats and dogs for 4 weeks and 3 months.

The toxic potential of a 13.9 % aqueous solution of a 3:1 mixture of 5 -chloro-2 -methyl-2H-isothiazol-3 -one and 2 -methyl-2H-isothiazol-3 -one in water (ACTICIDE 14) was evaluated in a 90-day repeated dose dietary toxicity study in non-rodents according to OECD guideline 409. Male and female beagle dogs were treated with the test item by dietary administration over a period of 90 days. The animals were observed for clinical signs, alterations in body weight and food consumption throughout the study period. At selected timepoints before and during the study, blood was collected for haematology and clinical chemistry. At the end of the treatment period, the animals were sacrificed and subjected to detailed macroscopic and microscopic pathological examination.

A dose-dependent loss of bodyweight and reduction in food consumption was observed, while all other observed alterations/abnormalities could not be related to treatment and were considered incidental. The applied doses could analytically not be verified, and thus the exposure doses of the test animals were calculated from the worst-case recovered values.

The observed effects on body weight gain were only seen at the two highest doses and were probably the result of the poor palatability of the diet rather than any toxic properties of ACTICIDE 14. Thus, it was concluded that there was no evidence of organ or systemic toxicity when ACTICIDE 14 was offered in the diet at an analysed dose level up to 555 ppm (nominal concentration 750 ppm) which is equivalent to 22 mg ai/kg body weight/day (30 mg ai/kg body weight/day) to the laboratory beagle for up to 13 weeks. A No Observed Adverse Effect Level (NOAEL) of 22 mg/kg bw/day was established. (ECHA). [Kl. Score = 1].

In a repeated dose 90-day oral toxicity study in rodents, no systemic toxic effects and no adverse effects on the histopathology of any tissues/organs distant from the site of dosing (drinking water) was observed. A NOAEL of 250 ppm ai in water (16.3 mg a.i./kg/day in males and 24.7 mg a.i./kg/day in females) was established. (ECHA). [Kl. Score = 1].

In another oral toxicity study, administration of Kathon™ biocide to male and female rats in the drinking water for 24 months at concentrations up to and including 300 ppm a.i. showed no effects on the type or incidence of neoplasms in any group. No systemic effects were observed. Treatment-related morphologic changes were observed only in the stomach of both sexes in mid and high dose groups. Gastric irritation was the primary effect observed. No adverse effects on the histopathology of any tissues/organs distant from the site of dosing. Based on the study findings, a NOAEL of 300 ppm was established (17.2 mg a.i./kg bw/day in males and 25.7 mg a.i./kg bw/day in females). (ECHA). [Kl. Score = 1].

Inhalation

In a 90-day sub-chronic inhalation study, conducted in accordance with GLP and as per OECD 403 guideline, groups of male and female CD (SD) BR rats were exposed to an aerosol of Kathon 886 via nose only at concentrations of 0.34, 1.15 and 2.64 mg/m^3. There were no systemic effects in this study. Rats at the highest dose (2.64 mg/m^3) exhibited very mild, low grade respiratory irritation. No adverse effects on the histopathology of any tissues/organs distant from the site of dosing. A NOAEL of 0.34 mg/m^3 was established. (ECHA). [Kl. Score = 1].

Dermal

The toxic potential of a 13.9 % aqueous solution of a 3:1 mixture of 5 -chloro-2 -methyl-2H-isothiazol-3 -one and 2 -methyl-2H-isothiazol-3 -one in water (ACTICID 14) was evaluated in a 90-day repeated dose dermal toxicity study in rats according to EPA OPP 82 -3 guideline. Male and female Sprague-Dawley rats were treated with the test item on exposed skin daily for 6 hours over a period of 90 days. The test article was kept in place and prevented from oral ingestion by means of a semi-occlusive dressing for exposure and remainders of the test item were then removed with water. The animals were observed for mortality, clinical signs, body weight gain and food consumption. At the end of the treatment period, blood and urine were collected for haematology and clinical chemistry. The animals were subjected to detailed macroscopic and microscopic pathological evaluation, including scoring of observed skin abnormalities.

Mortalities observed in two control animals and one high-dose male are considered to be incidental and not related to the application of the test material. Treatment with the test article ACTICIDE 14 applied dermally to intact skin produced skin reactions (slight to moderate erythema and desquamation, slight edema and atonia as well as eschar formation) with dose-dependent grades of severity. Females appeared to be more sensitive than males. There were no other effects at the end of the treatment period that could be attributed to the test substance. A NOAEL for systemic toxicity was established as 2.625 mg a.i. /kg bw/day. A NOAEL for local irritation was established as 0.105 mg a.i./kg bw/day in males. No NOAEL for local irritation was established for female rats. (ECHA). [Kl. Score = 1].

A 90-day subchronic dermal toxicity study was conducted in White New Zealand Rabbits. Doses of 100, 200 and 400 ppm of Kathon 886 were applied 5 days per week for a minimum total of 65 applications. Slight to severe erythema and slight edema were noted in a dose-related manner (0.1 mg/kg/day and above). There were no systemic effects in this study. No adverse effects on the histopathology of any tissues/organs distant from the site of dosing. A NOAEL of 400 ppm a.i. based on skin irritation (0.4 mg/kg bw/day) was established. (ECHA). [Kl. Score = 2].

G. Genotoxicity

In Vitro Studies

Several in vitro studies of genotoxicity were performed with CMIT/MIT. Positive results were observed in three Ames assays and in three tests in mammalian cells (one chromosomal aberration test and two mouse lymphoma assays), with or without S9 activation. (ECHA).[Kl. Score =1 or Kl. Score =2]. In contrast, CMIT/MIT was not mutagenic in primary culture of rat hepatocytes [Unscheduled DNA Synthesis (UDS)] and in a mouse cell transformation test.(ECHA) [Kl. Score =1 or Kl. Score = 2].

In Vivo Studies

CMIT/MIT was tested in one in vivo chromosomal aberration assay in mice (bone marrow) and one micronucleus test in mice (bone marrow). Negative results were observed in these in vivo studies. (ECHA). [Kl. Score = 1].

In the absence of genotoxicity, additional tests were carried out in tissue other than bone marrow. Two UDS assays in rats confirmed the absence of genotoxicity of CMIT/MIT when tested in vivo. (ECHA). [Kl. Score = 1].

H. Carcinogenicity

Oral

An OECD Guideline 453 (Combined Chronic Toxicity / Carcinogenicity Studies) on male and female Crl:CD BR rats was performed. Administration of the substance to male and female rats in the drinking water for 24 months at concentrations up to and including 300 ppm a.i. (17.2 mg a.i./kg of body weight/day in males and 25.7 mg a.i./kg of body weight/day in females) showed no effects on the type or incidence of neoplasms in any group.

No treatment-related signs of toxicity were seen at 30 ppm a.i.(2.0 mg a.i./kg of body weight/day in males and 3.1 mg a.i./kg of body weight/day in females), the No-Observed Effect Level (NOEL) in this study [Kl Score = 1](ECHA).

Dermal

The mouse skin painting carcinogenicity study was initiated prior to the adoption of carcinogenicity study guidelines. However, the principles of OECD Guideline 451, in general, were followed. Kathon™CG, when applied dermally to the closely clipped skin on the backs of male CD-1 mice at a concentration of 400 ppm active substance and at a dose of 25 microliters (µL) 3 times per week for 30 months, showed no local or systemic tumorigenic potential. No adverse effects were seen on the histopathology of any tissues/organs distant from the site of dosing. (ECHA). [Kl. Score = 2].

I. Reproductive/Developmental Toxicity

An OECD Guideline 416 (Two-Generation Reproduction Toxicity Study) was performed on male and female Sprague-Dawley rats exposed to Kathon™ 886F biocide in the drinking water. No treatment-related deaths or clinical signs of systemic toxicity in either sex up to and including 300 ppm. No treatment-related effects on body weights up to and including 100 ppm in males and females and 300 ppm in females. In 300 ppm males, a treatment-related decrease (5 %) in mean body weight was seen during weeks 1 through 6 of treatment. No treatment-related effects on premating feed consumption in either sex at any dose level. Treatment-related and concentration-dependent decreases in water consumption were noted in all-Kathon™ exposed groups in both the P1 and P2 animals through most of the premating, gestation and lactation periods. No treatment-related effects on any endpoint of mating or fertility in either generation at any dose level. No treatment related effects on sperm motility, testicular sperm count or caudal epididymal reserves of P1 and P2 males at any dose level. Treatment-related microscopic findings were limited to the stomach of male and female parental animals at 100 and/or 300 ppm. These changes included an increased incidence of focal superficial erosions of the glandular mucosa, edema and inflammation of the submucosa of the glandular and nonglandular areas, and hyperplasia and hyperkeratosis of the nonglandular stomach. Based on these findings, a NOAEL for parental animal toxicity of 30 ppm (2.8-4.4 mg/kg/day in the P1 animals and 4.3-5.5 mg/kg/day in the P2 animals) was established. The reproductive and developmental NOEL was 300 ppm (22.7-28.0 mg/kg/day in the P1 animals and 35.7-39.1 mg/kg/day in the P2 animals).(ECHA). [Kl. score = 1]

An OECD Guideline 415 (One-Generation Reproduction Toxicity Study) was performed on male and female Sprague-Dawley rats exposed to Kathon™ 886F biocide in the drinking water. Kathon™ 886 NAR has no adverse effects on the reproductive capability of male or female rats and no effect on fetal health or survival to day 21 at concentrations up to and including 225 ppm in the drinking water. These values correspond to a dose level of 16.3 mg/kg/day in males and 24.7 mg/kg/day in females. (ECHA). [Kl. score = 1]

The potential of a 14% aqueous solution of 3 parts 5 -chloro- 2 -methyl-2H-isothiazol-3 -one (CMIT) and 1 part 2 -methyl-2H-isothiazol-3 -one (MIT) (ACTICIDE 14) to induce teratogenic effects in rats was evaluated in a Prenatal Developmental Toxicity Study (according to guideline EPA OPP 83 -3). Pregnant female Sprague-Dawley rats were treated with the test substance by oral gavage during the period of organogenesis (days 6 -15 post coitum). Animals were observed for mortality, signs of toxicity, food consumption and body weight gain during the treatment and a post-exposure period of 5 days. At day 20 of gestation, animals were sacrificed and examined for macroscopic pathological

abnormalities. Uterine contents were examined for signs abnormal pregnancy courses, and fetuses were examined for external, visceral and skeletal abnormalities.

Treatment with the test article resulted in maternal toxicity with clearly distinguished dose-dependent grades of severity (clinical signs, moderately reduced body weight gain, slightly reduced food consumption). In spite of the observed adverse maternal effects, treatment with the test article did not have any influence on the embryonic and fetal development, as there was no embryotoxicity and no teratogenicity detected in any of the dose groups. (ECHA). [Kl. Score = 1].

An equivalent OECD Guideline 414 (Prenatal Developmental Toxicity Study) was performed on male and female Sprague-Dawley rats exposed to Kathon™ 886F biocide administered orally by gavage. No developmental effects were observed. Kathon™ 886 is non-teratogenic to the rat when administered at dosages of 100 mg/kg/day (15 mg ai/kg bw/day) during organogenesis. (ECHA). [Kl. Score = 1].

An OECD Guideline 414 (Prenatal Developmental Toxicity Study) was performed on pregnant New Zealand white rabbits exposed to Kathon™ 886 MW Biocide administered orally by gavage. No treatment-related deaths were observed at doses of 0, 0.5, 2 or 8 mg a.i./kg. At 20 mg a.i./kg, 16/16 animals were sacrificed moribund on or before day 15 G. Based on the results of this study, a maternal NOEL of 2 mg a.i./kg and an embryo-fetal NOEL of 8 mg a.i./kg was established. No treatment related increases were detected in the type or incidence of external, visceral or skeletal malformations, variations due to retarded development or in the total of these two categories combined. (ECHA). [Kl. Score = 1].

J. Derivation of Toxicological Reference and Drinking Water Guidance Values

Toxicological reference values were derived for the mixture of CMIT and MIT using methodology discussed in enHealth (2012). The approach used to develop drinking water guidance values is described in the Australian Drinking Water Guidelines (ADWG, 2011) as shown below.

Non-Cancer

A two-year drinking water study has been conducted in rats with a CMIT/MIT mixture (14.2% a.i.; 10.13% CMI/3.85% MI). No systemic toxicity was observed at doses up to 300 ppm a.i., although there was gastric irritation of the stomach at doses of 100 and 300 ppm a.i. The NOAEL for systemic toxicity in this study is 300 ppm (corresponding to 17.2 mg a.i./kg bw/day in males and 25.7 mg a.i./kg bw/day in females). The lowest NOAEL from this study (17 mg/kg bw/day) will be used to derive the oral reference dose.

Oral Reference Dose (oral RfD)

Oral RfD = NOAEL / (UF_A x UF_H x UF_L x UF_{Sub} x UF_D)

Where:
UF_A (interspecies variability) = 10
UF_H (intraspecies variability) = 10
UF_L (LOAEL to NOAEL) = 1
UF_{Sub} (subchronic to chronic) = 1
UF_D (database uncertainty) = 1

Oral RfD = 17.2/(10 x 10 x 1 x 1 x 1) = 17.2/100 = 0.17 mg/kg-day

Drinking water guidance value

Drinking water guidance value = (animal dose) x (human weight) x (proportion of intake from water) / (volume of water consumed) x (safety factor)

Using the oral RfD:

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

Where:
Human weight = 70 kg (ADWG, 2011)
Proportion of water consumed = 10% (ADWG, 2011)
Volume of water consumed = 2L (ADWG, 2011)

Drinking water guidance value = (0.17 x 70 x 0.1)/2 = 0.60 mg/L

Cancer

The mixture of CMIT and MIT was not carcinogenic to rats in a two-year dietary study. Thus, a cancer reference value was not derived.

K. Human Health Hazard Assessment of Physico-Chemical Properties

CMIT/MIT does not exhibit the following physico-chemical properties:

- Explosivity
- Flammability
- Oxidising potential

7 ENVIRONMENTAL EFFECTS SUMMARY

A. Summary

The mixture of CMIT and MIT exhibits significant acute and chronic aquatic toxicity. The mixture is also toxic to sediment dwelling organisms but less toxic to terrestrial receptors.

B. Aquatic Toxicity

Acute Studies

Table 3 lists the results of acute aquatic toxicity studies conducted on the mixture of CMIT and MIT.

Table 3 Acute Aquatic Toxicity Studies on CMIT/MIT

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Rainbow Trout (*Oncorhynchus mykiss*)	96-hour LC_{50}	0.19	1	ECHA

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Water Flea *(Daphnia magna)*	48-hour EC_{50}	0.16	1	ECHA
Skeletonema costatum	72-hour EC_{50} growth rate	0.0063	1	ECHA
Selenastrum capricornutum	72-hour EC_{50} growth rate	0.0273	1	ECHA

Chronic Studies for MIT/CMIT

Table 4 lists the results of chronic aquatic toxicity studies conducted on the mixture of CMIT and MIT.

Table 4 Chronic Aquatic Toxicity Studies on CMIT/MIT

Test Species	Endpoint	Results (mg/L)	Klimisch Score	Reference
Rainbow Trout (*Oncorhynchus mykiss*)	38-day NOEC	0.02	1	ECHA
Water Flea *(Daphnia magna)*	21-day NOEC	0.10	1	ECHA
Skeletonema costatum	72-hour NOEC	0.0014	1	ECHA

C. Sediment Toxicity

The 28-day no observed effect concentration (NOEC) for Oligochaete (*Lumbriculus variegatus*) is 0.27 mg/kg dry weight based on survival (ECHA) [Kl. score = 2].

The 28-day no observed effect concentration (NOEC) for the midge *Chironomus riparius* is 3.65 mg/kg dry weight based on survival (ECHA) [Kl. score = 1].

D. Terrestrial Toxicity

An OECD Guideline 208 (Terrestrial Plants Test: Seedling Emergence and Seedling Growth Test) was conducted on CMIT/MIT. No apparent signs of treatment-related phytotoxicity was observed to any of the three species tested (Trifolium pratense, Oryza sativa and Brassica napus). A 21-day NOEC of 1000 mg/kg soil dw, the highest concentration tested, was derived from the study results (ECHA). [Kl. Score = 1].

Effects on soil microflora carbon respiration transformation (OECD Guideline 217) and effects on nitrogen transformation activity of soil microorganisms (OECD Guideline 216) was also studied. Greater than 50 % respiration rate inhibition was demonstrated at test concentrations of 50, 100 and 500 mg CMIT/MIT per kg dry weight soil. A 28-day NOEC value of 1 mg/kg soil dw (based on respiration rate) was determined. (ECHA) [Kl. Score = 1]. CMIT/MIT inhibited the nitrogen transformation process in active soil within the range of concentrations evaluated. A 28-day NOEC value of 10 mg/kg soil dw (based on nitrate formation rate) was determined. (ECHA) [Kl. Score = 1]..

An acute toxicity test with the earthworm *Eisenia fetida* under static conditions in artificial soil was performed with ACTICIDE® 14 (14.3% aqueous solution of CIT and MIT (3:1)) according to OECD

Guideline 207 and ISO 11 268-1. Five concentrations were tested ranging from 100 to 1000 mg ACTICIDE® 14/kg dry soil (nominal). ACTICIDE® 14 caused clear sub-lethal but only moderate lethal effects in earthworms. A NOEC of 100 mg/kg dry soil (=14.3 mg a.i./kg dry soil) due to reduced mobility of the worms and a 14-day LC50 of >1000 mg/kg dry soil (>143 mg a.i./kg dry soil) was determined. (ECHA). [Kl. Score = 1].

Results from toxicity studies on mallard duck (*Anas platyrhynchos*) and bobwhite quail (*Colinus virginianus*) demonstrate that C(M)IT/MIT exhibits slight to moderate toxicity to birds. The 21-day oral LD50 for bobwhite quail is 64.5 mg/kg bw. The short-term (8-day) dietary LC50 for mallard duck is 945 mg/kg and bobwhite quail is 3532 mg/kg (ECHA). [Kl. Score = 1].

E. Calculation of PNEC

The PNEC calculations for CMIT/MIT follow the methodology discussed in DEWHA (2009).

PNEC water

Experimental results are available for three trophic levels. Acute EC_{50} values are available for fish (0.19 mg/L), invertebrates (0.16 mg/L) and algae (0.0063 mg/L). Results from chronic studies are also available for all three trophic levels, with the lowest NOEC value being 0.0014 mg/L for algae. On the basis that the data consists of short-term and long-term results from three trophic levels, an assessment factor of 10 has been applied to the lowest reported NOEC of 0.0014 mg/L for algae. The $PNEC_{water}$ for CMIT/MIT is 0.00014 mg/L.

PNEC sediment

Experimental results are available for two sediment dwelling organisms. The lowest NOEC was observed in a chronic sediment-spiked test with Oligochaete, the 28-day NOEC was 0.27 mg/kg dw. Using an assessment factor of 50, the $PNEC_{sediment}$ was determined to 0.0054 mg/kg dw.

PNEC soil

Experimental results are available for three trophic levels. Acute $E(L)C_{50}$ values are available for earthworms (>1000 mg/kg dw). Long-term studies have also been conducted on plants and soil microorganisms. On the basis that the data consists of acute tests from one trophic level and long-term tests from two trophic levels, an assessment factor of 50 has been applied to the lowest reported NOEC value of 1 mg/kg dw for soil microorganisms. The $PNEC_{soil}$ is 0.02 mg/kg dw.

8 CATEGORISATION AND OTHER CHARACTERISTICS OF CONCERN

A. PBT Categorisation

The methodology for the Persistent, Bioaccumulative and Toxic (PBT) substances assessment is based on the Australian and EU REACH Criteria methodology (DEWHA, 2009; ECHA, 2008).

The biodegradability of the mixture of CMIT and MIT could not be established. Biodegradation studies on CMIT and MIT separately have been conducted. An OECD Guideline 301 B (Ready Biodegradability: CO2 Evolution Test) was performed. 50% of the MIT biodegraded within 29 days. While the substance does not qualify as readily biodegradable, the data suggest it is ultimately

biodegradable. The same test with CMIT showed up to 62% of the test substance biodegraded within the same time frame of 29 days. [KI Score=1](ECHA). The rate of biodegradation in these tests does not satisfy the OECD criterion for readily biodegradability (60% in a 10-day window), but the results do show that these chemicals are biodegradable at more realistic environmental exposure concentrations. Thus, CMIT/MIT do not meet the criteria for persistence.

Bioaccumulation studies are not available for the CMIT/MIT mixture. Individually, the experimental BCF for CMIT is 67-114 in bluefish sunfish, and the BCF for MIT was determined to be 2.3. Thus, CMIT/MIT do not meet the criteria for bioaccumulation.

The chronic toxicity data on the mixture of CMIT and MIT has a NOEC < 0.1 mg/L.. The lowest acute LC_{50} value for the mixture are < 1 mg/L. Therefore, CMIT/MIT meets the criteria for toxicity.

The overall conclusion is that the mixture of CMIT/MIT is not a PBT substance.

B. Other Characteristics of Concern

Only tier 3 chemicals which trigger persistence and bioaccumulative thresholds are considered to be chemicals with a potential for cumulative impacts. As noted in the prior section, both CMIT/MIT mixture do not meet the criteria for persistence or bioaccumulation.

No other characteristics of concern were identified for the mixture of CMIT and MIT.

9 SCREENING ASSESSMENT

Chemical Name	CAS No.	Overall PBT Assessment [1]	Chemical Databases of Concern Assessment Step		Persistence Assessment Step		Bioaccumulative Assessment Step	Toxicity Assessment Step			Risk Assessment Actions Required[3]
			Listed as a COC on relevant databases?	Identified as Polymer of Low Concern	P criteria fulfilled?	Other P Concerns	B criteria fulfilled?	T criteria fulfilled?	Acute Toxicity [2]	Chronic Toxicity[2]	
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	Not a PBT	No	No	No	No	No	Yes	3	3	3

Footnotes:

1 - PBT Assessment based on PBT Framework.

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

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

Notes:

PBT = Persistent, Bioaccumulative and Toxic

B = bioaccumulative

P = persistent

T = toxic

10 REFERENCES, ABBREVIATIONS AND ACRONYMS

A. References

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B. Abbreviations and Acronyms

°C	degrees Celsius
µg/L	micrograms per litre
a.i.	active ingredient
ADWG	Australian Drinking Water Guidelines
AICS	Australian Inventory of Chemical Substances
bw	body weight
CFR	Code of Federal Regulations
COC	constituent of concern
DEWHA	Department of the Environment, Water, Heritage and the Arts
EC	effective concentration
ECHA	European Chemicals Agency
EU	European Union
g/L	grams per litre
GLP	Good Laboratory Practice
IUPAC	International Union of Pure and Applied Chemistry
kg/m^3	kilogram per cubic metre
KI	Klimisch scoring system
kPa	kilopascal
LC	lethal concentration
LD	lethal dose
LLNA	local lymph node assay
LOAEL	lowest observed adverse effect concentration
LOEC	lowest observed effective concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per litre
NICNAS	The National Industrial Chemicals Notification and Assessment Scheme
NOAEL	no observed adverse effect level
NOEC	no observed effective concentration
NOEL	No-Observed Effect Level
OECD	Organisation for Economic Co-operation and Development
Pa	Pascal
PBT	Persistent, Bioaccumulative and Toxic

PNEC	Predicted No Effect Concentration
ppm	parts per million
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RfD	reference dose
SGG	Synthetic Greenhouse Gases
UDS	Unscheduled DNA Synthesis
USEPA	United States Environmental Protection Agency

Attachment 4 Risk Characterisation Tables

Attachment 4, Table 1
Summary of Theoretical Biodegradation of Vendor Chemicals in Stimulation Fluids
(Flowback Fluid in Frac Tank, Water Feed Pond, Permeate Pond) and Water Treatment

Flowback Fluid Concentrations					
	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Frac Tank Concentration in flowback (150% of injected fluid volume) per coal seam per 20% of mass returned calculated using equation: Frac Tank Concentration = FBconcentration (mg/L)/ FB dilution 150% x percent mass returned (mg/L) x Biodegradation (half life)(mg/L)	
				Temporal Scenario (days)	
		Fluids	Half-Life (days)	0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-02	1.66E-64

Water Feed Pond Concentrations					
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Concrentration in Combined Balance Water Feed Pond to WMF	
				Temporal Scenario (days)	
		Fluids	Half-Life (days)	0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-03	1.66E-65

Permeate Pond Concentrations					
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Concentration in Permeate after 99% treatment efficiency by RO plant	
				Temporal Scenario (days)	
		Fluids	Half-Life (days)	0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	1.61E-04	8.82E-05

Notes:
mg/l = milligrams per liter
NA = not applicable
WMF = Water management facility
FB = Flowback
RO = Reverse osmosis

Attachment 4, Table 2
Comparison of Theoretical Concentrations of COPCs to Drinking Water Guidelines
Stimulation Fluids and WMF

Frac Tank								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Frac Tank Concentration in flowback Including Biodegredation Half-Life (mg/l)		Drinking Water Screening Level (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-02	1.66E-64	6.00E-01	1.2E-01	2.8E-64

Water Feed Pond								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Concentration in Water Feed Pond Including Biodegredation Half-Life (mg/l)		Drinking Water Screening Level	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-03	1.66E-65	6.00E-01	1.2E-02	2.8E-65

Permeate Pond								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Concentration in Permeate Pond Including Biodegredation Half-Life (mg/l)		Drinking Water Screening Level (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	1.61E-04	8.82E-05	6.00E-01	2.7E-04	1.5E-04

Notes:
mg/l = milligrams per liter
NA = not applicable
FB = Flowback
RO - reverse osmosis

Attachment 4, Table 3
Comparison of Theoretical Concentrations of COPCs to PNECs (Water)
Stimulation Fluids and WMF

Frac Tank								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Flowback Including Biodegredation Half-Life (mg/l)		PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-02	1.66E-64	1.40E-04	5.2E+02	1.2E-60

Water Feed Pond								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Water Feed Pond Including Biodegredation Half-Life (mg/l)		PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	7.26E-03	1.66E-65	1.40E-04	5.2E+01	1.2E-61

Permeate Pond								
Constituent Name	CAS No.	Estimated concentration in pre-injection fluid systems (mg/L)	Fate and Transport Properties	Estimated Initial Vendor Chemical Concentration In Permeate Pond Including Biodegredation Half-Life (mg/l)		PNEC aquatic (mg/L)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
				Temporal Scenario (days)			Temporal Scenario (days)	
			Half-Life (days)	0	150		0	150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	0.54	0.72	1.61E-04	8.82E-05	1.40E-04	1.1E+00	6.3E-01

Notes:
mg/l = milligrams per liter
NA = not applicable
FB = Flowback
RO - reverse osmosis

Attachment 4, Table 4
Summary of Theoretical Concentrations of Vendor Chemicals in Soils Irrigated with Flowback Water
Stimulation Fluids

Frac Tank					
Constituent Name	**CAS No.**	**Estimated Initial Vendor Chemical Concentration In flowback Including Biodegredation Half-Life (mg/l)**	**Estimated Initial Vendor Chemical Concentration In flowback Including Biodegredation Half-Life (mg/l)**	**Estimated Vendor Chemical Concentration in Soils Due to Incidental Release from Frac tank (Day 0 Aqueous EPC) (mg/kg) (a)**	**Estimated Vendor Chemical Concentration in Soils Due to Incidental Release from Frac tank (Day 150 Aqueous EPC) (mg/kg) (a)**
		Day 0	**150**		
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	7.26E-02	1.66E-64	3.11E+03	7.10E-60

Water Feed Pond					
Constituent Name	**CAS No.**	**Estimated Initial Vendor Chemical Concentration In Water Feed Pond Including Biodegredation Half-Life (mg/l)**	**Estimated Initial Vendor Chemical Concentration In Water Feed Pond Including Biodegredation Half-Life (mg/l)**	**Estimated Vendor Chemical Concentration in Soils Due to Incidental Release from Water Feed Pond (Day 0 Aqueous EPC) (mg/kg) (a)**	**Estimated Vendor Chemical Concentration in Soils Due to Incidental Release from from Water Feed Pond (Day 150 Aqueous EPC) (mg/kg) (a)**
		Day 0	**150**		
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	7.26E-03	1.66E-65	6.23E-01	1.42E-63

Notes:
mg/l = milligrams per liter
NA = not applicable
FB = Flowback
RO - reverse osmosis

a/ Concentration in soil calculated by the following equation. Refer to text for further information.

$$\frac{\text{(Estimated Vendor Chemical Concentration x Volume of water per Hectare)}}{\text{(Mass per Hectare)}}$$

where: Volume of Frac Tank = 9000000 L
and Volume of Water Feed Pond = 180000000 L

Attachment 4, Table 5
Summary of Theoretical Concentrations of Vendor Chemicals in Soils Irrigated with Permeate Stimulation Fluids and WMF

Permeate Pond					
Constituent Name	**CAS No.**	**Estimated Initial Vendor Chemical Concentration In flowback Including Biodegredation Half-Life (mg/l)**	**Estimated Initial Vendor Chemical Concentration In flowback Including Biodegredation Half-Life (mg/l)**	**Estimated Vendor Chemical Concentration in Irrigated Soils (Day 0 Aqueous EPC) (mg/kg) (a)**	**Estimated Vendor Chemical Concentration in Irrigated Soils (Day 150 Aqueous EPC) (mg/kg) (a)**
		Day 0	**Day 150**		
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.61E-04	8.82E-05	1.23E-02	6.72E-03

Notes:
a/ Concentration in irrigated soils calculated by the following equation. Refer to text for further information.

$$\frac{\text{(Estimated Vendor Chemical Concentration in Irrigation Water x Volume of water per Hectare)}}{\text{(Mass per Hectare)}}$$

Attachment 4, Table 6
Comparison of Theoretical Concentrations of COPCs to PNECs (Solid)
Stimulation Fluids and WMF

Frac Tank Incident Release						
Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Soils from Frac Tank Release (Day 0 EPC) (mg/kg)	Estimated Vendor Chemical Concentration In Soils from Frac Tank Release (Day 150 EPC) (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
					Day 0	Day 150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	3.11E+03	7.10E-60	2.0E-02	1.6E+05	3.5E-58

Water Feed Pond Incident Release						
Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Soils from Water Feed Pond Release (Day 0 EPC) (mg/kg)	Estimated Vendor Chemical Concentration in Soils from Water Feed Pond Release (Day 150 EPC) (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
					Day 0	Day 150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	6.23E-01	1.42E-63	2.0E-02	3.1E+01	7.1E-62

Permeate Pond Irrigation Scenario						
Constituent Name	CAS No.	Estimated Vendor Chemical Concentration in Soils from Peremate Pond Irrigation (Day 0 EPC) (mg/kg)	Estimated Vendor Chemical Concentration in Soils from Peremate Pond Irrigation (Day 150 EPC) (mg/kg)	PNECsoil (mg/kg)	Ratio of COPC Concentrations and Screening Criteria (Ratio greater than one = unacceptable potential risk)	
					Day 0	Day 150
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.23E-02	6.72E-03	2.0E-02	6.1E-01	3.4E-01

Notes:
mg/kg = milligrams per kilogram

Attachment 4, Table 7
Risk Estimates for Small Mammal from Vendor Chemicals in Stimulation Fluids and WMF

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Mammal		Avian Receptor	
			Test Animal			Test Animal		Northern Quoll		Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight	Derived TRV	Body Weight (kg)	Derived TRV
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.70E+01	Rat	0.35	NA	Bobwhite Quail	0.178	0.8	1.4E+01	0.39	1.7E+01

Notes:
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.
CAS = Chemical Abstracts Service
kg = kilogram
NA = not applicable
NOAEL = No observed adverse effect level
NOAELt = No observed adverse effect level test animal
NOEC = no observed effect concentration
TRV = toxicity reference value

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

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

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

Constituent Name	CAS No.	EPC [1] Day 0	EPC [1] Day 150	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CS (mg/kg)	CS (mg/kg)	TRVs	Day 0	Incidental Ingestion	Day 150	Incidental Ingestion
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.2E-02	6.7E-03	1.4E+01	6.3E-06	4.5E-07	3.4E-06	2.5E-07

Notes:
1/ EPC is estimated concentration in irrigated soils presented in Attachment 3, Table 5.
CAS = Chemical Abstracts Service
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilograms per day
NA = not applicable
TRV = toxicity reference value

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

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

Attachment 4, Table 8
Risk Estimates for Avian Receptor from Vendor Chemicals in Stimulation Fluids and WMF

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Avian NOAELt [1]	Avian NOAEL		Mammal		Avian Receptor	
			Test Animal			Test Animal		Northern Quoll		Cattle Egret	
			Animal	Body Weight (kg)		Animal	Body Weight (kg)	Body Weight	Derived TRV	Body Weight (kg)	Derived TRV
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.70E+01	Rat	0.35	NA	Bobwhite Quail	0.178	0.8	1.4E+01	0.39	1.7E+01

Notes:
1/ If an avian NOAEL was not available, the mammal NOAEL was used to derive the TRV for the avian receptor.
CAS = Chemical Abstracts Service
kg = kilogram
NA = not applicable
NOAEL = No observed adverse effect level
NOAELt = No observed adverse effect level test animal
NOEC = no observed effect concentration
TRV = toxicity reference value

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

Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value	Source (b)
Ingestion	IR-S	Ingestion rate soil	kg/day	0.031	BPJ
	IR-F	Ingestion rate food	kg/day	0.157	The Cattle Egret feeds mostly on grasshoppers, other insects, and small mammals (Marchant& Higgins, 1990). For this evalution, diet is assumed to consist entirely of earthworms (BPJ) to link the potential COPCs in soil and feed habits of egret. The ingestion rate is calculated using USEPA T-REX model equations.
	HR	Home Range ratio	unitless	0.5	BPJ
	BW	Body weight	kg	0.390	Siegfried, 1969
	PR	Prey Ratio	unitless	0.50	The cattle egret mainly consumes insects; a prey ratio of 0.5 is conservatively assumed and likely overestimates potential consumption of worms.

Notes:

a/ Units:
kg/day = kilograms per day
kg = kilogram
b/ Source:
BPJ - Best Professional Judgement
W.R. Siegfried (1969) Energy Metabolism of the Cattle Egret, ZoologicaAfricana, 4:2, 265-273, DOI: 10.1080/00445096.1969.11447375
Marchant & Higgins (1990). Handbook of Australian, New Zealand and Antarctic Birds : Volume 1: Ratites to Ducks : Part B: Australian Pelican to Ducks
COPC = constituent of potential concern
USEPA = United States Environmental Protection Agency

Constituent Name	CAS No.	EPC [1] Day 0	EPC [1] Day 150	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CS (mg/kg)	CS (mg/kg)	TRVs	Day 0	Incidental Ingestion	Day 150	Incidental Ingestion
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.2E-02	6.7E-03	1.7E+01	1.7E-03	1.0E-04	9.5E-04	5.7E-05

Notes:
1/ EPC is estimated concentration in irrigated soils presented in Attachment 3, Table 5.
CAS = Chemical Abstracts Service
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
mg/kg/day = milligrams per kilograms per day
NA = not applicable
TRV = toxicity reference value

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

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

Attachment 4, Table 9
Risk Estimates for Kangaroo from Vendor Chemicals in Ponded Irrigation Water
Stimulation Fluids and WMF

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Kangaroo	
			Animal	Body Weight (kg)	Body Weight	Derived TRV
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	17	Rat	0.35	25	0.03

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value

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

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

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
Fleming, 2001
Fleming, Peter; Laurie Corbett, Robert Harden, Peter Thomson (2001). Managing the Impacts of Dingoes and Other Wild Dogs. Commonwealth of Australia: Bureau of Rural Sciences.

Constituent Name	CAS No.	EPC[1] Day 0	EPC[1] Day 150	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	CW (mg/l)	TRVs	Day 0	Ingestion	Day 150	Ingestion
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.61E-04	8.82E-05	2.8E-02	3.7E-07	1.3E-05	2.0E-07	7.2E-06

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is produced water concentration in Table 5 for Day 0 and Day 150

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365\ ^{days}/_{year}}$$

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

Attachment 4, Table 10
Risk Estimates for Dingo from Vendor Chemicals in Ponded Irrigation Water
Stimulation Fluids and WMF

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Dingo	
			Animal	Body Weight (kg)	Body Weight	Derived TRV
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	17	Rat	0.35	13.00	0.03

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value

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

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

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
Dawson, 1995
Dawson, Terence J. (1995). Kangaroos: Biology of the Largest Marsupials. Cornell University Press, Ithaca, New York. Second printing: 1998. ISBN 0-8014-8262-3.

Constituent Name	CAS No.	EPC[1] Day 0	EPC[1] Day 150	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	CW (mg/l)	TRVs	Day 0	Ingestion	Day 150	Ingestion
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.61E-04	8.82E-05	2.8E-02	1.8E-07	6.3E-06	9.8E-08	3.4E-06

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is produced water concentration in Table 5 for Day 0 and Day 150

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365^{days}/_{year}}$$

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

Attachment 4, Table 11
Risk Estimates for Cattle from Vendor Chemicals in Livestock Water Stimulation Fluids and WMF

Constituent Name	CAS No.	Mammal NOAELt	Mammal NOAEL		Mammal	
			Test Animal		Kangaroo	
			Animal	Body Weight (kg)	Body Weight	Derived TRV
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	17	Rat	0.35	454	2.83

Notes:
NOAELt = No observed adverse effect level test animal
kg = kilogram
NA = not applicable
TRV = toxicity reference value

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

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

Notes:
a/ Units:
l/day = litres per day
day/yr = days per year
yr = year
kg = kilogram
b/ References:
BPJ - Best Professional Judgement
API, 2004
API. (2004). Risk-Based Screening Levels for the Protection of Livestock Exposed to Petroleum Hydrocarbons, Regulatory Analysis and Scientific Affairs No. 4733 July 2004.

Constituent Name	CAS No.	EPC[1] Day 0	EPC[1] Day 150	Toxicity	Total Intake (mg/kg/day)	Hazard Quotient	Total Intake (mg/kg/day)	Hazard Quotient
		CW (mg/l)	CW (mg/l)	TRVs	Day 0	Ingestion	Day 150	Ingestion
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.61E-04	8.82E-05	2.8E+00	5.8E-07	2.1E-07	3.2E-07	1.1E-07

Notes:
CW = concentration in water
EPC = exposure point concentration
mg/kg/day = milligrams per kilograms per day
mg/l = milligrams per liter
NA = not available/applicable
TRV = toxicity reference value
1/ EPC is produced water concentration in Table 5 for Day 0 and Day 150

$$Total\ Intake = \frac{EPC\ \times IR\ \times EF\ \times ED}{BW\ \times ED\ x\ 365^{\ days}/_{year}}$$

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

Attachment 4, Table 12
Human Receptor Exposure Assumptions

Media	Exposure Route	Parameter Code	Parameter Definition	Units (a)	Parameter Value - Resident	Source (b)	Parameter Value - Agricultural Worker	Source (b)
Soil	Ingestion	IR	Ingestion rate	mg/day	100	enHealth, 2012, USEPA, 2016	100	enHealth, 2012
		EF	Exposure frequency	day/yr	20	BPJ	4	BPJ
		ED	Exposure duration	yr	10	BPJ	35	BPJ
		RBA	Relative bioavailability factor	unitless	chemical-specific	enHealth, 2012	chemical-specific	(f) enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012	85	enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012	79	(f) enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012	25,550	enHealth, 2012
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012	1.0E-06	enHealth, 2012
	Dermal	SA	Surface area for contact (exposed)	cm^2/day	4,700	(d) enHealth, 2012, USEPA, 2016	5,664	(d) enHealth, 2012, USEPA, 2016
		ABS	Absorption Factor	unitless	chemical-specific	enHealth, 2012	chemical-specific	BPJ
		EF	Exposure frequency	day/yr	20	BPJ	4	BPJ
		ED	Exposure duration	yr	10	BPJ	35	(f) enHealth, 2012
		BW	Body weight	kg	51	(c) enHealth, 2012	85	(f) enHealth, 2012
		LT	Lifetime	yr	82	enHealth, 2012	79	enHealth, 2012
		AT-NC	Averaging time - noncancer	days	3,650	enHealth, 2012	12,775	enHealth, 2012
		AT-C	Averaging time - cancer	days	25,550	enHealth, 2012	25,550	enHealth, 2012
		AF	Soil Adherence Factor	mg soil/cm^2 skin	0.07	(e) enHealth, 2012, USEPA, 2016	0.08	(e) enHealth, 2012, USEPA, 2016
		CF	Conversion factor	kg/mg	1.0E-06	enHealth, 2012	1.0E-06	enHealth, 2012

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

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

c/ The body weight is the time weighted average calculated from enHealth exposure factors for a male or female child aged 8 to 18 years old.
d/ Exposed body surface area is the time weighted average of head, forearms, hands, lower legs, and feet.
Forearms are considered 45% of arm surface area; lower leg is considered 40% of leg surface area (USEPA, 2016).
e/ Adherence factor calculated for exposed body part surface area is the time weighted average of head, forearms, hands, lower legs, and feet.
f/ Male exposure factor used based on enHealth recommendation.

Attachment 4, Table 13
Risk Estimates for Resident from Vendor Chemicals in Soils Irrigated with Permeate Stimulation Fluids and WMF

Irrigated with Permeate (Day 0 EPC)							
Constituent Name	CAS No.	EPC (Day 0)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.23E-02	1.7E-01	1.3E-09	4.3E-09	7.7E-09	2.5E-08

Irrigated with Permeate (Day 150 EPC)							
Constituent Name	CAS No.	EPC (Day 150)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	6.72E-03	1.7E-01	7.2E-10	2.4E-09	4.2E-09	1.4E-08

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

$$Dermal\ Intake = \frac{EPC\ x\ EF\ x\ ED\ x\ SAexp\ x\ AF\ x\ ABS\ x\ CFsoil}{BW\ \times AT}$$

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
Consistent with enHealth guidance a default value of 1 used for both the RBA and ABS values (see Table 12).

Attachment 4, Table 14
Risk Estimates for Agricultural Worker from Vendor Chemicals in Soils Irrigated with Permeate Stimulation Fluids and WMF

Irrigated with Permeate (Day 0 EPC)							
Constituent Name	CAS No.	EPC (Day 0)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	1.23E-02	1.7E-01	1.6E-10	7.2E-10	9.3E-10	4.2E-09

Irrigated with Permeate (Day 150 EPC)							
Constituent Name	CAS No.	EPC (Day 150)	Toxicity mg/kg-day	Oral Intake	Dermal Intake	Hazard Quotient	
		CS (mg/kg)	RfDo	CADDoral	CADDderm	Incidental Ingestion	Dermal
Mixture of 5-chloro-2-methyl-2h-isothiazolol-3-one (CMIT) and 2-methyl-2h-isothiazol-3-one (MIT)	55965-84-9	6.72E-03	1.7E-01	8.7E-11	3.9E-10	5.1E-10	2.3E-09

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

$$Dermal\ Intake = \frac{EPC\ x\ EF\ x\ ED\ x\ SAexp\ x\ AF\ x\ ABS\ x\ CFsoil}{BW\ \times AT}$$

Notes:
CADD = chronic average daily dose
CS = concentration in soil
EPC = exposure point concentration
mg/kg = milligrams per kilogram
NA = not available/applicable
RfDo = oral reference dose
Consistent with enHealth guidance a default value of 1 used for both the RBA and ABS values (see Table 12).