

# Modification Notice - Regulation 22

<b>Interest Holder</b>	<b>Santos QNT Pty Ltd</b>		<b>EMP Title</b>	<b>McArthur Basin Drilling Program NT Exploration Permit (EP) 161</b>		<b>Unique EMP ID No.</b>	STO2-7	<b>Change/Mod No.</b>	2	<b>Date</b>	8/09/2021
<b>Brief Description</b>	The modification to the activity is the use of an additional drilling chemicals during the regulated activity. Letter provided with supporting memo, and additional details below.										
<b>Geospatial Files Included?</b>											
<b>Does the proposed change result in a new, or increased, potential or actual environmental impact or risk?</b>	<b>If an INCREASE in an existing potential or actual environmental impact or risk is it provided for in the approved EMP?</b>	<b>Does the proposed change require additional mitigation measures to be included?</b>	<b>Has additional stakeholder engagement been conducted?</b>	<b>Does it require additional environmental performance standards and measurement criteria?</b>	<b>Does it affect compliance with Sacred Site Authority Certificates?</b>	<b>Does it affect current rehabilitation, weed, fire, wastewater, erosion and sediment control, spill or emergency response plans?</b>	<b>Will the environmental outcome continue to be achieved and will the impacts and risks be managed to ALARP and acceptable?</b>				
No	N/A	No	No	No	No	No	Yes				
<b>Current EMP Text</b>						<b>Amended EMP Text</b>					
See Appendix H: Spill Management Plan: MacArthur Basin Drilling Program NT Exploration Permit (EP) 161 Table 2-2: Proposed Drilling Chemicals						See additional Proposed Drilling Chemicals shaded in grey in updated Table 2-2: Proposed Drilling Chemicals below.					

**Table 2.2: Proposed Drilling Chemicals**

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
<b>Drilling Fluid</b>						
ALDACIDE® G	HB003462	Glutaraldehyde	111-30-8	10 - 30%	Yes	Leasepad CSA
		Methanol	67-56-1	0.1 - 1%	Yes	Leasepad CSA
BARABUF®	HM003483	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
BARACARB® 5	HM003487	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BARACARB® 25	HM003486	Crystalline silica, quartz.	14808-60-7	0.1 - 1%	Yes	Leasepad CSA
BARACARB® 50	HM003488	Crystalline silica, quartz.	14808-60-7	0.1 - 1%	Yes	Leasepad CSA
BARACARB® 150	HM003484	Crystalline silica, quartz.	14808-60-7	0.1 - 1%	Yes	Leasepad CSA
BARACARB® 600	HM003489	Crystalline silica, quartz.	14808-60-7	0.1 - 1%	Yes	Leasepad CSA
BARACOR® 100	HM003391	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	68909-77-3	10 - 30%	Yes	Leasepad CSA
		Methanol	67-56-1	10 - 30%	Yes	Leasepad CSA
		Nitrilotriacetic acid, trisodium salt monohydrate	5064-31-3	1 - 5%	Yes	Leasepad CSA
BaraDeFoam® HP	HM003504	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BARAZAN® D PLUS	HM003535	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
BARAZAN® D	HM003534	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BARITE	HM000105	Crystalline silica, quartz.	14808-60-7	1 - 5%	Yes	Leasepad CSA
BAROFIBRE®	HM003539	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BAROLIFT®	HM003552	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BDF™-950	HM008609	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BDF™-933	HM008419	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
Bentonite	HM000126	Crystalline silica, quartz Crystalline silica, cristobalite Crystalline silica, tridymite	14808-60-7 14464-46-1 15468-32-3	1 - 5% 0.1 - 1% 0.1 - 1%	Yes	Leasepad CSA
BORE-HIB®	HM005877	Silicic acid, potassium salt	1312-76-1	30 - 60%	Yes	Leasepad CSA
Caustic Soda (Sodium Hydroxide)	HM003599	Sodium hydroxide	1310-73-2	60 - 100%	Yes	Leasepad CSA
CITRIC ACID	HM004421	Citric Acid	77-92-9	60 - 100%	Yes	Leasepad CSA
CON DET®	HM003454	Amides, coco, N,N-bis (hydroxyethyl)	68603-42-9	5 - 10%	Yes	Leasepad CSA
		Benzenesulfonic acid, dimethyl-, sodium salt	1300-72-7	1 - 5%	Yes	Leasepad CSA
		Isopropanol	67-63-0	1 - 5%	Yes	Leasepad CSA
		Potassium pyrophosphate	7320-34-5	1 - 5%	Yes	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
		Potassium hydroxide	1310-58-3	0.1 - 1%	Yes	Leasepad CSA
DEXTRID® LTE	HM003615	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
EZ-MUD® DP	HM003644	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
EZ-MUD®	HM003643	Hydrotreated light petroleum distillate	64742-47-8	10 - 30%	Yes	Leasepad CSA
		Ethoxylated alcohol	Proprietary	1 - 5%	Yes	Leasepad CSA
GEM™ CP	HM003659	Methyloxirane polymer with oxirane, monbutyl ether	9038-95-3	60 - 100%	Yes	Leasepad CSA
GEM™ GP	HM003660	Polyethylene glycol butyl ether	9004-77-7	60 - 100%	Yes	Leasepad CSA
N-DRIL® HT PLUS	HM003699	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	NF	No information available	Leasepad CSA
OXYGON™	HM003723	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
PAC™-L	HM003724	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
PERFORMATROL	HM004998	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
Potassium Chloride	HM003741	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	NF	Not classified	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
QUIK-FREE®	HM004906	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
SAPP	HM003755	Sodium acid pyrophosphate	7758-16-9	60 - 100%	Yes	Leasepad CSA
Soda Ash	HM003760	Sodium carbonate	497-19-8	60 - 100%	Yes	Leasepad CSA
Sodium Bicarbonate	HM001824	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
Sodium Chloride	HM001682	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	7647-14-5	60 - 100%	Not classified	Leasepad CSA
STEELSEAL® 100	HM006541	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
STEELSEAL® 50	HM006287	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
STEELSEAL® 400	HM006540	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
STOPPIT®	HM007395	Crystalline silica, quartz	14808-60-7	0.1 - 1%	Yes	Leasepad CSA
BaraCor® 95	HM003499	Monoethanolamine	141-43-5	60 - 100%	Yes	Leasepad CSA
BaraSure™ W-988	HM009037	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	60 - 100%	Not classified	Leasepad CSA
BDF™-971	HM008843	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA	NF	Not classified	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
Sodium Bromide Brine	HM003762	SODIUM BROMIDE	7647-15-6	>99%	Non-Hazardous	Leasepad CSA
<b>Cementing</b>						
D-Air 3000L	HM003191	Alkenes, C15-C18	93762-80-2	60 - 100%	Yes	Leasepad CSA
D-Air 3500L	HM008316	Hydrotreated distillate	Proprietary	60 - 100%	Yes	Leasepad CSA
Bentonite	HM000126	Crystalline silica, quartz Crystalline silica, cristobalite Crystalline silica, tridymite	14808-60-7 14464-46-1 15468-32-3	1 - 5% 0.1 - 1% 0.1 - 1%	Yes	Leasepad CSA
CFR-3	HM000209	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Calcium Chloride	HM000142	Calcium chloride	10043-52-4	60 - 100%	Yes	Leasepad CSA
Tuned Spacer V Spacer	HM008251	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Econolite Liquid	HM000478	Sodium silicate	1344-09-8	30 - 60%	Yes	Leasepad CSA
GasCon 469	HM000753	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
SA-1015	HM007221	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Halad 344	HM000816	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Halad 413	HM000817	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
Flocele	HM000709	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Therma-Vis	HM003775	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
HGS 3000	HM009395	Glass filaments. SODA LIME BOROSILICATE GLASS (SLBG)	65997-17-3	90 - 100%	Yes	Leasepad CSA
SCR-100	HM001253	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Latex 4000	HM008963	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Latex 3000	HM006737	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Stabilizer 434B	HM001300	Alkyl phenoxy ether sulphate, sodium salt	9014-90-8	30 - 60%	Yes	Leasepad CSA
WellLife 1260 or FDP-C1260	HM009149	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Tuned Defense Cement Spacer	HM009029	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
BridgeMaker II	HM008048	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA

Material Name	Haz Mat No	Contains	CAS Number	Concentration	Hazardous	Storage Location*
HR-5	HM000899	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
HTB Cement	HM004641	Portland cement Crystalline silica, quartz	65997-15-1 14808-60-7	60 - 100% 30 - 60%	Yes	Leasepad CSA
Class G Cement	HM001839	Portland cement Crystalline silica, quartz	65997-15-1 14808-60-8	60 - 100% 1 - 5%	Yes	Leasepad CSA
SilicaLite Liquid	HM001274	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
WellLife 1094	HM007634	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
Pol-E-Flake	HM004118	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
MicroBond HT	HM001065	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	NA		Not classified	Leasepad CSA
<b>HR-25</b>	HM000892	Tartaric acid	87-69-4	61 - 100%	Yes	Leasepad CSA

\*CSA = Chemical Storage Area



# MEMO

To: Andrew Stannard, Senior Environmental Advisor, Santos

From: Dana McCue, EHS Support LLC

CC: Nigel Goulding, EHS Support LLC

Date: August 12, 2021

Re: McArthur Basin New Drilling Fluid Chemical Risk Assessment

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Santos Ltd. (“Santos”) is conducting an exploration and appraisal program within Exploration Permit (EP) 161, which is located in the Beetaloo Sub-basin of the broader McArthur Basin. The McArthur Basin is located southeast of Katherine, Northern Territory, and covers approximately 180,000 square kilometres. Santos has undertaken exploration activities in EP 161 since 2013 including drilling of two exploration wells Tanumbirini-1 and Marmbulligan-1, and the development of a water bore drilling and monitoring program in 2018.

Santos has proposed the use of one additional (contingency) chemical in their drilling fluid system. This technical memorandum assessed this proposed new chemical using a screening of potential human health and ecological hazards that should be considered for potential exposure to the drilling fluids and cuttings during transportation, drilling operations, and recycling and disposal of drilling mud and cuttings.

The purpose of the assessment was to determine if the additional chemical introduces a new environmental impact or environmental risk not provided for in the current plan for the activity; or, an increase, not provided for in the current plan for the activity, in an existing environmental impact or environmental risk. The assessment included the following components:

- Human health and environmental hazard assessment consistent with the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS)
- Predicted No Effect Concentrations (PNECs) for water and soil derived to assess aquatic and terrestrial receptors, respectively
- PBT (persistence, bioaccumulative, toxic) assessment

**Table 1** presents the information compiled for the chemical and the assessment results. The information for the new chemical was then compared to the environmental fate properties (such as persistence, bioavailability and bioaccumulation), ecotoxicity and human health toxicity/hazards for the chemicals in the existing fluid system. The existing drilling fluid system (refer **Table 2**) contains both low and high toxicity chemicals.

Based on this assessment, the additional new drilling chemical exhibits similar or lesser PBT to the chemicals in the existing drilling fluid and cementing systems. As such the additional chemical does not introduce a new environmental impact or environmental risk not provided for in the current plan for the activity.



## Tables

Table 1  
Evaluation of Proposed Drilling Fluid Chemical  
McArthur Basin, Northern Territory Chemical Risk Assessment

Chemical Name	CAS Number	Ecotoxicity <sup>1</sup>	Toxicity <sup>1</sup>	Biodegradation <sup>1</sup>	Bioaccumulative <sup>1</sup>	Discussion
Sodium Bromide Brine	7647-15-6	<p><b>Aquatic Toxicity</b></p> <p><u>Acute Aquatic-Fish</u> -96-hr LC<sub>50</sub> <i>Scopphthalmus maximus</i> - 440 mg/L (ECHA) [KI. Score = 1]</p> <p><u>Acute Aquatic-Invertebrate</u> -48 hr EC<sub>50</sub> <i>Daphnia magna</i> -1000 mg/L (ECHA) [KI. Score =1]</p> <p><u>Acute Aquatic-Aquatic Algae and Cyanobacteria</u> -72-hr EC<sub>50</sub> <i>Scenedesmus pannonicus</i> - 8460 mg/L (ECHA)[KI. Score = 2]</p> <p><u>Chronic Aquatic</u> -21 day NOEC invertebrates (<i>Daphnia magna</i>) - 7.5 mg/L (reproduction) (ECHA)[KI.Score = 2]</p> <p><b>Terrestrial Toxicity</b></p> <p>-14-day EC<sub>50</sub> earthworm (<i>Eisenia Andrei</i>) - &gt;1,000 mg/kg (mortality) (ECHA) [KI. Score = 1]</p> <p>-21 day NOEC plants (<i>Glycine max</i>) - 320 mg/kg (growth) (ECHA) [KI.Score =1]</p> <p>-21 day NOEC plants (<i>Lycopersicon esculentum</i>) - 1000 mg/kg (growth) (ECHA) [KI.Score =1]</p> <p>-21 day NOEC plants (<i>Avena sativa</i>) - 180 mg/kg (growth) (ECHA) [KI.Score =1]</p> <p><b>PNEC water</b> = not derived <b>PNEC soil</b> = not derived</p>	<p><u>Qualitative Assessment:</u> Human Health Hazard: Low concern. Sodium bromide brine is not a skin sensitizer nor is it irritating to the skin or eye. Sodium bromide brine has a dermal LD<sub>50</sub> &gt; 2000 mg/kg/day and no systemic or local toxicity was observed.</p> <p>Ecological Hazard - Low concern</p> <p><u>PBT Assessment:</u> Does not meet the screening criteria for toxicity.</p>	<p><u>Environmental Fate:</u> <u>Properties:</u> Readily biodegradable</p> <p><u>PBT Assessment:</u> Does not meet the screening criteria for persistence.</p>	<p>Log Kow (KOWWIN v1.68, EPISUITE) is estimated to be -0.37</p> <p><u>PBT Assessment:</u> Does not meet the screening criteria for bioaccumulation.</p>	<p><b>NICNAS:</b> Poses no unreasonable risk to human health or the environment based on Tier I assessment under the NICNAS IMAP assessment framework. (<a href="https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7647-15-6">https://www.industrialchemicals.gov.au/chemical-information/search-assessments?assessmentcasnumber=7647-15-6</a>)</p> <p>Inorganic substance comprising ions of low ecotoxicological concern. This chemical is not expected to pose an unreasonable risk to the environment provided that ANZECC water quality guidelines for physical and chemical stressors are not exceeded.</p> <p><b>PBT Assessment:</b> The overall conclusion is that sodium bromine brine is not a PBT substance.</p> <p><b>Management:</b> No additional management required.</p>

Table Notes:

EC<sub>50</sub> = effects concentration of half the maximal response

DF = drilling fluid

LC<sub>50</sub> = lethal concentration of 50 percent of population

mg/kg = milligram per kilogram

mg/L = milligrams per litre

N/A = not applicable

NICNAS = National Industrial Chemicals Notification and Assessment Scheme

NOEC = no observed effect concentration

PBT = persistence, bioaccumulative, toxic

PNEC = predicted no effect concentration

1 = Ecotoxicity, toxicity, biodegradation and bioaccumulation data obtained from ECHA

Table 2  
Existing Drilling Fluid and Cementing Chemicals  
McArthur Basin, Northern Territory Chemical Risk Assessment

Chemical	CAS No.
2-Bromo-2-(bromomethyl)pentanedinitrile	35691-65-7
4-Vinylcyclohexene	100-40-3
Acrylamide, sodium acrylate polymer	25085-02-3
Acrylic acid polymer with sodium AMPS, sodium salt	37350-42-8
Aliphatic alcohol ethoxylate	9004-77-7
Alkenes, C15-C18	93762-80-2
Amylodextrin	9005-84-9
Barium Sulfate	7727-43-7
Bentonite	1302-78-9
Butadiene	106-99-0
Calcium chloride	10043-52-4
Calcium Chloride, dihydrate	10035-04-8
Calcium hydroxide	1305-62-0
Cellophane	9005-81-6
Choline chloride	67-48-1
Citric Acid	77-92-9
Crystalline silica, cristobalite	14464-46-1
Crystalline silica, quartz	14808-60-7
Crystalline silica, tridymite	15468-32-3
Dilutan Gum	125005-87-0
Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues	68909-77-3
FD&C Blue 1	3844-45-9
Functionalized Styrene Butadiene Latex	403824-26-0
Glutaraldehyde	111-30-8
Glyoxal	107-22-2
Heterocyclic polymer containing nitrogen compounds	9003-39-8
Humic acids, sodium salts, polymers with N,N-dimethyl-2-propenamide, sodium 2-methyl-2-[(1-oxo-2-propen-1-yl)amino]-1-propanesulfonate (1:1) and 2-propenenitrile, sodium bisulfite-terminated	473268-27-8
Hydrotreated light petroleum distillate	64742-47-8
Lecithins	8002-43-5
Magnesium oxide	1309-48-4
Methanol	67-56-1
Monoethanolamine	141-43-5
N,N-dimethylacrylamide copolymer with calcium AMPS	103115-52-2
Nitrilotriacetic acid, trisodium salt monohydrate	5064-31-3
Polypropylene glycol	25322-69-4
Portland cement	65997-15-1
Potassium chloride	7447-40-7
Silica, amorphous - fumed	7631-86-9
Silica, amorphous precipitated	67762-90-7
Soda Lime Borosilicate Glass	65997-17-3
Sodium acid pyrophosphate	7758-16-9
Sodium Carbonate	497-19-8
Sodium carboxymethyl cellulose	9004-32-4
Sodium Chloride	7647-14-5
Sodium erythorbate	6381-77-7
Sodium Hydroxide	1310-73-2
Sodium Lignosulfonate	8061-51-6
Sodium silicate	1344-09-8
Sodium sulfate	7757-82-6
Starch	9005-25-8
Starch, carboxymethyl ether	9057-06-1

Table 2  
Existing Drilling Fluid and Cementing Chemicals  
McArthur Basin, Northern Territory Chemical Risk Assessment

Chemical	CAS No.
Strontium chloride	10476-85-4
Styrene	100-42-5
Sulfurous acid, monosodium salt, polymer with formaldehyde and acetone	40104-76-5
Tartaric acid	87-69-4
Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4
Xanthan Gum	11138-66-2