Modification Notice - Regulation 22

Interest Holder	Santos QNT Pty Ltd	EMP Title	McArthur Basin Hydraulic Fracturing Program NT Exploration Permit (EP) 161	Unique EMP ID No.	STO3-8	Change/ Mod No.	1	Date	5/11/2021

Brief Description	The modification to the activity is to re-use flowback fluid in up to 8 of 26 hydraulic fracturing stages at Tanumbirini wells (Tanumbirini-2H and Tanumbirini-3H). The proposal including monitoring and reporting is described in **Attachment 1**, including a risk assessment **Appendix 1**.
Geospatial Files Included?	

Does the proposed change result in a new, or increased, potential or actual environmental impact or risk?	If an INCREASE in an existing potential or actual environmental impact or risk is it provided for in the approved EMP?	Does the proposed change require additional mitigation measures to be included?	Has additional stakeholder engagement been conducted?	Does it require additional environmental performance standards and measurement criteria?	Does it affect compliance with Sacred Site Authority Certificates?	Does it affect current rehabilitation, weed, fire, wastewater, erosion and sediment control, spill or emergency response plans?	Will the environmental outcome continue to be achieved and will the impacts and risks be managed to ALARP and acceptable?
No	N/A	No	No	No	No	No	Yes

Current EMP Text	Amended EMP Text
See section 3.3 Hydraulic fracture stimulation is not part of the drilling process but is a completion technique applied after the well is drilled. The intent of hydraulic stimulation is to place highly conductive channels into the reservoir (illustrated in Figure 3-12) to increase the flow capacity of the well and increase the production of natural gas. Hydraulic stimulation involves the injection of hydraulic fracturing fluids (water, sand / proppant and minor chemical	section 3.3 changes in grey Hydraulic fracture stimulation is not part of the drilling process but is a completion technique applied after the well is drilled. The intent of hydraulic stimulation is to place highly conductive channels into the reservoir (illustrated in Figure 3-12) to increase the flow capacity of the well and increase the production of natural gas. Hydraulic stimulation involves the injection of hydraulic fracturing fluids (water / flowback fluid,

NORTHERN TERRITORY GOVERNMENT

additives) at high pressure into a cased wellbore, and it is usually conducted over a number of intervals along the production zone of the well. And later in Section 3.3 The stimulation process involves pumping water, a specific blend of chemical additives and a propping agent such as sand or ceramic beads down the well at sufficient pressure to create a fracture in the target formation. Proppant keeps the fractures open once the pump pressure is released which thereby improves the productive potential of the well.	sand / proppant and minor chemical additives) at high pressure into a cased wellbore, and it is usually conducted over a number of intervals along the production zone of the well. And later in Section 3.3 The stimulation process involves pumping water / flowback fluid, a specific blend of chemical additives and a propping agent such as sand or ceramic beads down the well at sufficient pressure to create a fracture in the target formation. Proppant keeps the fractures open once the pump pressure is released which thereby improves the productive potential of the well.

Wastewater Management Plan

- **Table 2-8 Hydraulic Fracture Stimulation waste streams – waste management hierarchy considerations**

Waste Stream	Avoid	Reduce	Reuse	Recycle	Treat	Dispose
Flowback fluids and produced water	Cannot avoid	Recycling of fluids reduces consumption of additives and therefore the production of waste.	No re-use of fluids is proposed.	No recycling of fluids is proposed.	Maximise evaporation rates to reduce volume	Remaining fluid will be assessed by licenced waste management service provider. It will be transferred to a 3rd party process facility for further treatment and/or disposal in accordance with NT Waste Management and Pollution Control Act.

Wastewater Management Plan update in grey

Table 2-8 Hydraulic Fracture Stimulation waste streams – waste management hierarchy considerations

Waste Stream	Avoid	Reduce	Reuse	Recycle	Treat	Dispose
Flowback fluids and produced water	Cannot avoid	Recycling of fluids reduces consumption of additives and therefore the production of waste.	Re-use of fluids is proposed in hydraulic fracturing fluid.	No recycling of fluids is proposed.	Maximise evaporation rates to reduce volume	Remaining fluid will be assessed by licenced waste management service provider. It will be transferred to a 3rd party process facility for further treatment and/or disposal in accordance with NT Waste Management and Pollution Control Act.

Attachment 1 to Modification Notice

Proposal

Hydraulic fracturing fluid is described in the approved EMP STO3-8 as (bore) water, sand / proppant and minor chemical additives. This proposal is to re-use flowback for up to 8 of the hydraulic fracturing stages (from a total of 26 stages) at Tanumbirini wells (Tanumbirini-2H and Tanumbirini-3H):

- For up to 8 hydraulic fracturing stages, hydraulic fracturing fluid will be flowback fluid/bore water, sand proppant, and minor chemical additives.
- For the remaining hydraulic fracturing stages, hydraulic fracturing fluid will be bore water, sand proppant, and minor chemical additives.

Improved overall environmental performance and outcomes through the re-use of flowback during hydraulic fracturing reducing waste, reducing the volume of flowback fluid in the tanks, and maintaining surface and subsurface risks at ALARP.

The proposal is in accordance with the *Code of Practice: Onshore Petroleum Activities in the Northern Territory*, and a risk assessment that has considered and assessed the observed flowback fluid characteristics is at **Appendix 1**.

Objectives met by the proposed modification

- Meet the requirements of the Code
- Risk remains ALARP subsurface during fracture stimulation and risk remains ALARP at the surface when flowback is in the above ground tanks
- Reduce use of groundwater for hydraulic fracturing fluid
- In accordance with the waste hierarchy minimise the total volume of waste (flowback/wastewater)
- Reduce the volume of flowback fluid in above ground tanks
- Hydraulic fracturing fluid composition in accordance with the Code
- Monitor and report to DEPWS

The *Code of Practice: Onshore Petroleum Activities in the Northern Territory*

1. Provides a framework for the management of water used in and produced by petroleum activities including re-use and recycling of water and wastewater (C.2), including flowback fluid (C.2.1(a)).
2. Identifies that waste hierarchy must be implemented, re-use of wastewater is preferred over treatment and/or disposal (C.3.1)
3. Stipulates a preference for the reuse of flowback fluid as a means of managing flowback fluid (C.4.2.3)
4. Stipulates requirements for the Wastewater Management Plan to include:
    a. Proposed method and location of water and wastewater re-use as part of the proposed activity (see C.7.1(c)iii)
    b. Strategies to minimise of reduce the volume of wastewater that will be disposed of off site (see C.7.1(c)iv)

c. The expected quality and quantity of water and wastewater that will be re-used (see C.7.1(c)iv)

d. An analysis of environmental impacts and environmental risks associated for any proposed re-use (C.7.1.1(b)i)

e. Proposed environmental performance standards and measurement criteria which demonstrate these environmental risks have been reduced to ALARP and acceptable (C.7.1.1(b)ii)

5. Stipulates requirements regarding hydraulic fracturing fluids and BTEX concentrations that are met by the proposed re-use (B.4.13.2, B.5)

The *Water Act 1992*

The Water Act prohibits allowing hydraulic fracturing waste (whether treated or untreated) to come into contact with waters. This includes all types of waters (including water in a waterway, groundwater and tidal water). However, The Water Act does not prohibit flowback fluid and produced water following hydraulic fracturing from being reused as the basis for fluids in future hydraulic fracturing events.

To provide certainty regard monitoring and reporting

In accordance with the Wastewater Management Plan (WWMP) Appendix G of the approved EMP STO3-8:

- Per section 2.7.2 of the WWMP sampling of the hydraulic fracture stimulation fluid will be undertaken:
    - An initial sample when the hydraulic fracture stimulation fluid includes only (bore) water, sand / proppant and minor chemical additives
    - A subsequent sample when the hydraulic fracture stimulation fluid includes flowback, sand / proppant and minor chemical additives.
- Per section 2.7.3 of the WWMP continuous and weekly monitoring of flowback fluid will be undertaken.

In accordance with Condition 7 of the Approval a report will be provided on the risk assessment of flowback wastewater from the hydraulic fracturing phase. The report will quantify the estimated reduction in flowback fluid volume at the completion of well flowback operations.

EHS Support

MEMO

To: [redacted], Santos Ltd.

From: [redacted], EHS Support

CC: [redacted], EHS Support

Date: 1 November 2021

Re: Northern Territories – Flowback Water Risk Assessment

Introduction

Santos Ltd. ("Santos") is conducting an exploration and appraisal program within Exploration Permit (EP)-161, located in the Beetaloo Sub-basin of the broader McArthur Basin. As requested, EHS Support LLC ("EHS Support") performed a risk assessment on flowback water from the Tanumbirini 1 well location for use as make-up water in the hydraulic fracturing process. This risk assessment leveraged the following existing risk assessments:

- Chemical Risk Assessment (CRA) on vendor chemicals that might be used in hydraulic fracturing (2019 CRA; EHS Support, 2019).
- Flowback Fluid 6 Month Report (Santos, 2020).

The McArthur Basin is located southeast of Katherine, Northern Territory (NT), and covers approximately 180,000 square kilometres. Santos has undertaken exploration activities within EP-161 since 2013, including drilling of two exploration wells (Tanumbirini-1 and Marmbulligan-1) and developing a water bore drilling and monitoring program in 2018. Santos prepared an Environment Management Plan (EMP) for McArthur Basin 2019 – 2020 Hydraulic Fracturing Program in the NT EP-161. The EMP proposed Hydraulic Fracture Stimulation (HFS) to be conducted 2019 through 2020 at the Tanumbirini 1, Tanumbirini 2H, Tanumbirini 3H, and Inacumba 1/1H well locations.

As part of the EMP, the 2019 CRA was completed for vendor chemicals within two hydraulic fluid system formulations that were identified for use within the NT EP-161 (EHS Support, 2019). The 2019 CRA evaluated the chemistry of the hydraulic fracturing fluid systems, estimated the probable concentration of these chemicals in flowback, presented ecotoxicity and developed Predicted No-Effects Concentrations (PNECs) where data were available, as well as bioaccumulation, and persistence information. Included in the 2019 CRA, chemicals that did not pass the Tier 1 screening evaluation were evaluated quantitatively for receptors identified in the conceptual exposure model (CEM; e.g., avian receptors). Quantitative Tier 2 evaluation of these chemicals did not identify unacceptable levels of risk. This risk assessment concluded there is no unacceptable risk to receptors due to use of vendor chemicals in the hydraulic fracturing fluid systems.

Per the approval conditions of the EMP, sampling and analysis of flowback/produced water is required to be routinely conducted and the risks associated with flowback/produced water reassessed. In May 2020, the Flowback Fluid 6 Month Report was submitted that assessed the analytical data for flowback/produced water to update the quantitative evaluation of risks to avian receptors based on exposure to geogenic chemicals in the flowback (Santos, 2020). This report included an assessment of chemical additives to determine if additional testing was required an avian risk assessment of chemicals detected above screening criteria to determine if flowback water posed unacceptable risks to avian receptors, and a terrestrial soil exposure assessment to evaluate potential releases to soils from storage tanks. This report concluded:

- Additive chemicals used in the hydraulic fracturing process are degradable or ionizable to specific chemical analytes included in Section C.8 of the Code of Practice (Department of Environment and Natural Resources [DENR] and Department of Primary Industry and Resources [DPIR], 2019) analytical suite or are not degradable and that no additional analytes needed to be added to the suite of analytes for flowback water.
- No chemicals detected in the wastewater at their maximum concentration, and under a hypothetical maximum release scenario, would result in soil levels above conservative screening criteria protective of terrestrial receptors
- Consistent with the 2019 CRA, there is no unacceptable risk to potential avian receptors should they be exposed to the flowback water stored in the enclosed tanks.

Therefore, no unacceptable risk to receptors was identified based on current or future flowback scenarios. At the time of these assessments, flowback water was to be transported off the well pad to a disposal or management facility. The following sections include an assessment of potential risks associated with use of this flowback water (from Tanumbirini 1) as make-up water in the hydraulic fracturing process of wells located on the same multi-well pad (i.e., Tanumbirini 2H and Tanumbirini 3H), and an evaluation of chemicals observed in flowback water samples relative to vendor chemicals injected down hole.

Assessment Methodology

Risk ratios were calculated and compared for injected vendor chemicals and chemicals detected in flowback water to determine the relative increase in risk based on the use of flowback or produced water as make-up water in the hydraulic fracturing process. Risk ratios, or hazard quotients (HQs), were calculated using the following methodology:

$$HQ = \frac{CI}{RBSL}$$

Where:

HQ = hazard quotient
CI = concentration injected
RBSL = risk-based screening level

In addition to the calculation of individual HQs, a cumulative hazard index (HI) was also calculated to evaluate potential additive effects of individual chemicals to target end points. To do this, individual HQs were summed for each fluid evaluated.

Two hydraulic fracturing fluid systems were assessed in the 2019 CRA and consisted of different compositions of chemicals. For the purposes of this evaluation, these two systems were combined into a composite fluid system. If chemicals were present in both fluid systems, the maximum concentration between the two fluid system was conservatively used in calculation of the HQ. Risk-based screening levels (RBSLs) presented in the 2019 CRA included PNECs for aquatic receptors. Derived using conservative ecotoxicity data, these PNECs were the RBSLs used to calculate the HQs for the chemicals in the composite fluid system injected as part of hydraulic fracturing activities. In toxicological testing, aquatic species are more sensitive than terrestrial species to chemicals due to their immersion within the fluid, additional modes of action (e.g., impacts on gill function), and the potential for secondary stressors to impact on health. Therefore, assessment of aquatic receptors is a conservative evaluation of potential risks.

To calculate HQs for flowback water, the maximum concentration of detected chemicals in five flowback water samples collected from Tanumbirini 1 well flowback enclosed in storage tank water (wastewater) from 15 January 2020 to 26 May 2021 (**Attachment A**) was conservatively selected to be the concentration injected (CI). The minimum of aquatic trigger values set forth by the Australian and New Zealand Environment and Conservation Council (ANZECC & ARMCANZ, 2000), Freshwater Trigger Values (FTVs), were used as the RBSLs to calculate HQs for flowback water chemicals. The FTVs are deemed to be protective of aquatic species such as fish, invertebrates, and algae assuming chronic, continual, and prolonged contact with surface water. In instances where no FTVs were available, alternative RBSLs protective of freshwater environments were employed.

It should be noted that the gross alpha and gross beta alternative RBSLs are only generic screening values and consistent with the Australian Drinking Water Guidelines (ADWG; NHMRC, 2017), trigger a more detailed assessment. As outlined in the 6-Month Flowback Report (Santos, 2020), an order-of-magnitude higher radiological exposure is acceptable as the natural background is higher than the screening level, and thresholds for active intervention have been established at corresponding doses 10 to 50 times higher than the corresponding screening value. Thus, gross alpha and gross beta required no further evaluation.

In addition to the risk evaluation, assessment of benzene, toluene, ethylbenzene, and xylene (BTEX) in flowback water was conducted pursuant to Section B.5 of the Code of Practice (DENR and DPIR, 2019). Section B.5 states that recycled produced water used in hydraulic fracturing fluids must not contain BTEX levels greater than those expected in produce water from the well being drilled, or in the event BTEX levels expected in produced water are unknown, then BTEX levels in water cannot exceed levels prescribed in Table 8 of Section B.5.

Results

Attachment B presents the results of the calculation of the HQs and cumulative HI for the composite hydraulic fracturing fluid system, including the chemicals and their Chemical Abstract Service (CAS) numbers, the maximum injected concentrations, the RBSL, the calculated HI, and the cumulative HI. Similarly, **Attachment C** presents the inputs and results of the risk ratio calculation for individual chemicals and cumulative HI for the flowback water.

Table 1 includes cumulative HIs for both assessed fluids. As shown below, the cumulative HI for the 2019 Composite System is nearly one order of magnitude greater than the HI calculated for the 2021 flowback water chemicals. Combining these fluids would only result in a 10 percent increase in the cumulative HI of the injected fluids.

Table 1 Cumulative Hazard Indices

Fluid	HI
2019 Composite System	3.1E+04
2021 Injected Flowback Chemicals	3.9E+03
Combined Risk (Composite System and Flowback as makeup water)	3.5E+04

Notes:
HI = hazard index

Santos is not making any changes to the operational procedures and controls used in hydraulic fracturing (consistent with the methodologies employed at the Tanumbirini 1 well location). These controls include well construction and associated zonal isolation, and extensive management and monitoring systems of the hydraulic fracturing activities to preclude impacts to the overlying aquifer systems and human and ecological receptors. In this context, this incremental increase in the HI in the injected fluid will not result in increased risk.

In terms of the anticipated changes in flowback chemistry from use of produced water as make-up water, the minor increase in the HI will not result in material changes in risk. The risk assessments previously conducted on the flowback water (EHS Support, 2019; Santos, 2020) determined that the risk to avian receptors from storage of produced water was *de minimus* (HIs ranging from 2.9×10^{-4} to 4.4×10^{-2} versus a target of 1). In the context of the minimal increase in the HI of the injected fluid, the risk to avian receptors from storage of flowback water will continue to be *de minimus* (below a HI of 1).

As shown in **Attachment A**, BTEX were not detected in any flowback sample collected from Tanumbirini 1. **Table 2** presents a comparison of the maximum detection limit from the Tanumbirini 1 flowback data to the BTEX levels in water used for stimulation and drilling fluids from Table 8 in Section 8.5 of the Code of Practice (DENR and DPIR, 2019). Additionally, detection limits for BTEX did not exceed the Code of Practice thresholds. Therefore, conditions set forth in Section B.5 of the Code of Practice regarding BTEX are satisfied.

Table 2 BTEX Evaluation

Chemical	ANZECC Environmental Protection Guidelines (99% Protection Level) (µg/L)	Flowback Maximum Detection Limit (µg/L)
Benzene	600	1
Toluene	180	2
Ethylbenzene	80	2
Xylene	200	2

Notes:
% = percent
µg/L = micrograms per litre
ANZECC = Australian and New Zealand Environment Conversation Council

Conclusion

The use of flowback water from Tanumbirini 1 well location as make-up water in the hydraulic fracturing process on Tanumbirini 2H and 3H wells will not significantly increase risks to ecological (aquatic and avian) receptors, and the current storage and management methods for flowback are considered adequate to minimise risk to as low as reasonably practicable.

References

ANZECC & ARMCANZ. (2000) Water Quality Guidelines. 2000 and as updated. Available online: https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants. Accessed 27 September 2021.

DENR and DPIR. (2019). Code of Practice: Onshore Petroleum Activities in the Northern Territory. Northern Territories Government. https://depws.nt.gov.au/__data/assets/pdf_file/0011/705890/code-of-practice-onshore-petroleum-activity-nt.pdf

EHS Support. (2019). Technical Memorandum – Beetaloo McArthur Basin Hydraulic Fracturing Fluid System – Chemical Risk Assessment. July.

National Health and Medical Research Council (NHMRC). (2017). Australian Drinking Water Guidelines (ADWG).

Santos. (2020). Flowback Fluid 6 Month Report. 29 May.

Attachment A Tanumbirini Well 1 Tank Water

				FACILITY	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN
				SAMPLE_DATE	1/15/2020	1/15/2020	2/12/2020	2/12/2020	3/4/2020	3/4/2020	5/19/2020	5/19/2020	9/19/2020	3/18/2021	5/26/2021
				LOCATION	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1
				DESCRIPTION	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP
				WORK ORDER	EB2001149	EB2001149	EB2003972	EB2003972	EB2006500	EB2006500	EB2013758	EB2013758	EB2025191	EB2107660	EB2114926
				START_DEPTH	0.2	4	0.2	4	4	0.2	4	0.2	0.2	0.2	0.2
				SAMPLE TYPE	N	N	N	N	N	N	N	N	N	N	N
METHOD	PARAMETER-CHEMICAL	FRACTION	LOR	UNIT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
APHA 3125 B	Boron	D	100	µg/L			15400	16700			15900	14500	43300		
APHA 3125 B	Boron	D	5	µg/L	11000	10600								4610	5410
APHA 3125 B	Boron	D	500	µg/L					15900	16500					
APHA 3125 B	Boron	T	105	µg/L			15800	17000				17400	38800		
APHA 3125 B	Boron	T	5	µg/L	15800	15400								5600	5100
APHA 3125 B	Boron	T	525	µg/L					19200	18200	18900				
APHA 3125 B	Selenium	D	0.2	µg/L	1.8	1.6								4.3	0.9
APHA 3125 B	Selenium	D	2	µg/L			< 2	< 2	3	2	3	3	8		
APHA 3125 B	Selenium	T	0.2	µg/L										5.1	0.7
APHA 3125 B	Selenium	T	0.5	µg/L	1.3	1.8									
APHA 3125 B	Selenium	T	2	µg/L			< 2	3	4	2	5	4	8		
APHA 3125 B	Zinc	D	1	µg/L	226	2								3	2
APHA 3125 B	Zinc	D	5	µg/L			< 5	< 5	425	10	7	8	< 5		
APHA 3125 B	Zinc	T	1	µg/L										8	5
APHA 3125 B	Zinc	T	5	µg/L	1610	33	10	105	6590	12	93	24	103		
APHA_1030F	Ionic Balance	N	0.01	%	3.52	0.17	3.31	7.64	3.02	4.31	5.16	5.43	10.0	4.56	7.16
APHA_1030F	Total Anions	N	0.01	meq/L	157	134	146	182	184	160	180	176	382	91.8	86.7
APHA_1030F	Total Cations	N	0.01	meq/L	146	134	156	212	174	147	162	158	467	83.8	75.1
APHA_2320_B	Bicarbonate Alkalinity as CaCO3	N	1	mg/L	908	596	836	817	735	909	920	925	601	432	422
APHA_2320_B	Carbonate Alkalinity as CaCO3	N	1	mg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	249	< 1	< 1
APHA_2320_B	Hydroxide Alkalinity as CaCO3	N	1	mg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
APHA_2320_B	Total Alkalinity as CaCO3	N	1	mg/L	908	596	836	817	735	909	920	925	850	432	422
APHA_2510_B	Electrical Conductivity @ 25°C	N	1	µS/cm	15100	13200	14100	18100	17400	14600	16200	16100	36500	8240	7800
APHA_2540_C	Total Dissolved Solids @180°C	T	10	mg/L	9920	8650	8610	11000	10300	9050	10200	10100	21600	5100	4810
APHA_2540_D	Suspended Solids	N	5	mg/L	24	528	6	< 5	41	15	8	6	236	7	6
APHA_3112_CV_FIMS	Mercury	D	0.0001	mg/L		< 0.0001				< 0.0001				< 0.0001	< 0.0001
APHA_3112_CV_FIMS	Mercury	D	0.0005	mg/L	< 0.0005		< 0.0005	< 0.0005				< 0.0005	< 0.0005		
APHA_3112_CV_FIMS	Mercury	D	0.0025	mg/L							< 0.0025				
APHA_3112_CV_FIMS	Mercury	D	0.0050	mg/L					< 0.0050						
APHA_3112_CV_FIMS	Mercury	T	0.0001	mg/L		< 0.0001	< 0.0001	< 0.0001		< 0.0001		< 0.0001		< 0.0001	
APHA_3112_CV_FIMS	Mercury	T	0.0005	mg/L	< 0.0005								< 0.0005		< 0.0005
APHA_3112_CV_FIMS	Mercury	T	0.0025	mg/L							< 0.0025				
APHA_3112_CV_FIMS	Mercury	T	0.0050	mg/L					< 0.0050						
APHA_3120	Calcium	D	1	mg/L	122	49	123	179	122	124	157	153	38	140	128
APHA_3120	Magnesium	D	1	mg/L	58	57	67	86	69	60	66	63	123	64	61
APHA_3120	Potassium	D	1	mg/L	32	31	35	44	37	34	34	34	101	26	26
APHA_3120	Sodium	D	1	mg/L	3100	2890	3300	4490	3700	3100	3400	3310	10400	1630	1450
APHA_4110	Bromide	N	0.500	mg/L											29.4
APHA_4110	Bromide	N	1.00	mg/L	59.6	51.3	56.3	77.7	70.1	53.8	78.4	77.5		31.0	
APHA_4110	Bromide	N	2.00	mg/L									171		
APHA_4500_Cl	Chloride	N	1	mg/L	4930	4330	4570	5880	6010	5000	5700	5560	12700	2820	
APHA_4500_Cl	Chloride	N	10	mg/L											2640
APHA_4500_Cl_G	Free Chlorine	N	0.02	mg/L	< 0.02	< 0.02	< 0.02		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
APHA_4500_Cl_G	Free Chlorine	N	0.10	mg/L				< 0.10							
APHA_4500_Cl_G	Total Residual Chlorine	N	0.02	mg/L	< 0.02	< 0.02	< 0.02		< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02
APHA_4500_Cl_G	Total Residual Chlorine	N	0.10	mg/L				< 0.10							
APHA_4500_CN_O	Total Cyanide	T	0.004	mg/L	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004	< 0.004
APHA_4500_F_C	Fluoride	N	0.1	mg/L	1.8	1.8	1.6	1.6	0.8	1.7	1.6	1.7	1.8	0.8	0.8
APHA_4500_H_B	pH - Lab	N	0.01	pH Unit	8.01	6.70	7.87	7.88	8.10	7.84	7.83	7.85	8.67	8.07	8.11
APHA_4500_NH3_G	Ammonia as N	N	0.01	mg/L	34.8	29.3	28.9	33.6	36.1	33.6	35.4	34.5		2.70	1.72
APHA_4500_NH3_G	Ammonia as N	N	0.10	mg/L									9.81		
APHA_4500_NO2_B	Nitrite as N	N	0.01	mg/L	< 0.01	0.06	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	
APHA_4500_NO2_B	Nitrite as N	N	0.10	mg/L											< 0.10
APHA_4500_NO3_F	Nitrate as N	N	0.01	mg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	0.04	< 0.01	< 0.01	< 0.01	< 0.01	
APHA_4500_NO3_F	Nitrate as N	N	0.1	mg/L											< 0.1
APHA_4500_NORG_D	Total Kjeldahl Nitrogen as N	N	0.1	mg/L											4.8
APHA_4500_NORG_D	Total Kjeldahl Nitrogen as N	N	0.5	mg/L	41.8	42.8	45.0	46.2			41.2	41.5	48.1	6.9	
APHA_4500_NORG_D	Total Kjeldahl Nitrogen as N	N	1.0	mg/L					39.7	41.2					
APHA_4500_NORG+NO3	Total Nitrogen as N	N	0.1	mg/L											4.8

Attachment A
Tanumbirini Flowback Water Analytical Results
McArthur Basin
Santos Ltd.

				FACILITY	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN
				SAMPLE_DATE	1/15/2020	1/15/2020	2/12/2020	2/12/2020	3/4/2020	3/4/2020	5/19/2020	5/19/2020	9/19/2020	3/18/2021	5/26/2021
				LOCATION	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1
				DESCRIPTION	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP
				WORK ORDER	EB2001149	EB2001149	EB2003972	EB2003972	EB2006500	EB2006500	EB2013758	EB2013758	EB2025191	EB2107660	EB2114926
				START_DEPTH	0.2	4	0.2	4	4	0.2	4	0.2	0.2	0.2	0.2
				SAMPLE TYPE	N	N	N	N	N	N	N	N	N	N	N
METHOD	PARAMETER-CHEMICAL	FRACTION	LOR	UNIT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
APHA_4500_NORG+NO3	Total Nitrogen as N	N	0.5	mg/L	41.8	42.8	45.0	46.2			41.2	41.5	48.1	6.9	
APHA_4500_NORG+NO3	Total Nitrogen as N	N	1	mg/L					39.7	41.2					
APHA_4500_P_E	Reactive Phosphorus as P	T	0.01	mg/L	0.69	0.31	0.62	0.74	< 0.01	0.35	0.71	0.74	0.01	0.08	
APHA_4500_P_E	Reactive Phosphorus as P	T	0.05	mg/L											< 0.05
APHA_4500_P_H	Total Phosphorus as P	T	0.01	mg/L											0.25
APHA_4500_P_H	Total Phosphorus as P	T	0.05	mg/L	0.94	1.03	0.99	1.06			0.94	0.98	2.14	0.31	
APHA_4500_P_H	Total Phosphorus as P	T	0.10	mg/L					0.98	1.82					
APHA_4500_SIO2	Reactive Silica	N	0.05	mg/L	127	125	120	125			118	122	87.1	34.1	
APHA_4500_SIO2	Reactive Silica	N	0.50	mg/L											31.6
APHA_4500_SIO2	Reactive Silica	N	1.00	mg/L					45.9	123					
APHA_4500_SO4_E	Sulfate as SO4 2-	D	1	mg/L	< 1	2	22	4	12	42	23	22		175	
APHA_4500_SO4_E	Sulfate as SO4 2-	D	10	mg/L									201		184
APHA_5310_B_DOC	Dissolved Organic Carbon	N	10	mg/L										19	
APHA_5310_B_DOC	Dissolved Organic Carbon	N	5	mg/L	112	234	84	71	47	79	53	50	137		24
APHA_5310_B_TOC	Total Organic Carbon	N	10	mg/L										18	
APHA_5310_B_TOC	Total Organic Carbon	N	2	mg/L		247									
APHA_5310_B_TOC	Total Organic Carbon	N	5	mg/L	108		89	83	52	85	57	57	219		24
ASTM_D_6303-98	Formaldehyde	N	0.1	mg/L	1.0	0.3	0.1	0.6	< 0.1	0.1	0.3	0.2	0.3	< 0.1	< 0.1
CSN_75_7611_75_7612	Gross alpha	N	0.13	Bq/L											< 0.13
CSN_75_7611_75_7612	Gross alpha	N	0.16	Bq/L										0.27	
CSN_75_7611_75_7612	Gross alpha	N	0.23	Bq/L		0.26									
CSN_75_7611_75_7612	Gross alpha	N	0.24	Bq/L			< 0.24								
CSN_75_7611_75_7612	Gross alpha	N	0.26	Bq/L	0.62					0.68					
CSN_75_7611_75_7612	Gross alpha	N	0.29	Bq/L								0.62			
CSN_75_7611_75_7612	Gross alpha	N	0.30	Bq/L				1.06	0.39		0.57				
CSN_75_7611_75_7612	Gross alpha	N	0.57	Bq/L									< 0.57		
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.26	Bq/L											0.56
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.32	Bq/L										0.42	
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.46	Bq/L		< 0.46									
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.49	Bq/L			< 0.49								
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.52	Bq/L	< 0.52					0.56					
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.58	Bq/L								0.58			
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.59	Bq/L							0.88				
CSN_75_7611_75_7612	Gross beta activity - 40K	N	0.61	Bq/L				< 0.61	< 0.61						
CSN_75_7611_75_7612	Gross beta activity - 40K	N	1.14	Bq/L									< 1.14		
Field Measure	Carbon Dioxide - Field	D		mg/L					na	na					
Field Measure	Carbon Dioxide - Field	T		mg/L					na	na	125	130		45	45
Field Measure	CH4 - Field	N		% LEL					na	na					
Field Measure	Clarity - Field	N		No Unit	Hi Tb	Hi Tb			M Tb	M Tb	M Tb	M Tb	Hi Tb	Clear	Clear
Field Measure	Colour - Field	N		No Unit	BLACK	BLACK			BLACK	BLACK	GRAY	GRAY	GREEN	NA	NA
Field Measure	Depth To Bottom - Field	N		mbgl					na	na					
FIELD MEASURE	Dissolved Oxygen - Field	N		mg/L									0.74		
Field Measure	Electrical Conductivity - Field	N		µS/cm			15302	18584	17223	14583	16500	16808	36100.00	8930	9835
Field Measure	Field Ambient Temperature	N		°C	28.1	30.9	32.1	29.8	24.3	30.3	28.6	28.4	28.70	31.3	23.1
Field Measure	Odour - Field	N		No Unit	HYDR	HYDR			SEWAGE	SEWAGE	SEWAGE	SEWAGE	HYDR	SEWAGE	ORGANIC
Field Measure	pH - Field	N		pH Unit	7.04	7.13	7.2	7.4	8.02	7.96	7.47	7.44	8.53	7.78	7.60
FIELD MEASURE	Redox - Field	N		mV									-214.00		
Field Measure	Total Alkalinity - Field	N		mg/L					na	na	780	740		370	356
IN_HOUSE_LC-MSMS_EDC	2,4-Dinitrophenol	N	0.01	µg/L	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
IN_HOUSE_LC-MSMS_EDC	2-Methyl-4,6-dinitrophenol	N	0.05	µg/L	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
IN_HOUSE_LC-MSMS_EDC	4-Chloro-3-Methylphenol	N	0.10	µg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
IN_HOUSE_LC-MSMS_EDC	4-Nitrophenol	N	0.10	µg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
IN_HOUSE_LC-MSMS_EDC	Dinoseb	N	0.10	µg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
IN_HOUSE_LC-MSMS_EDC	Hexachlorophene	N	0.10	µg/L	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
USEPA_6020	Aluminium	D	0.01	mg/L					0.01	0.01	0.02	0.01		< 0.01	< 0.01
USEPA_6020	Aluminium	D	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05					< 0.05		
USEPA_6020	Aluminium	T	0.01	mg/L					0.28	0.07	0.05	0.05		0.04	0.04
USEPA_6020	Aluminium	T	0.05	mg/L	0.08	0.20	0.12	0.15					0.63		
USEPA_6020	Antimony	D	0.001	mg/L					< 0.001	0.002	0.002	0.002		0.002	< 0.001

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Tanumbirini Flowback Water Analytical Results
McArthur Basin
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				FACILITY	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN
				SAMPLE_DATE	1/15/2020	1/15/2020	2/12/2020	2/12/2020	3/4/2020	3/4/2020	5/19/2020	5/19/2020	9/19/2020	3/18/2021	5/26/2021
				LOCATION	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1
				DESCRIPTION	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP
				WORK ORDER	EB2001149	EB2001149	EB2003972	EB2003972	EB2006500	EB2006500	EB2013758	EB2013758	EB2025191	EB2107660	EB2114926
				START_DEPTH	0.2	4	0.2	4	4	0.2	4	0.2	0.2	0.2	0.2
				SAMPLE TYPE	N	N	N	N	N	N	N	N	N	N	N
METHOD	PARAMETER-CHEMICAL	FRACTION	LOR	UNIT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
USEPA_6020	Antimony	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					0.006		
USEPA_6020	Antimony	T	0.001	mg/L					< 0.001	0.002	0.002	0.003		0.001	< 0.001
USEPA_6020	Antimony	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					0.006		
USEPA_6020	Arsenic	D	0.001	mg/L					0.002	0.009	0.010	0.012		0.004	0.006
USEPA_6020	Arsenic	D	0.005	mg/L	0.006	0.015	0.012	0.012					0.027		
USEPA_6020	Arsenic	T	0.001	mg/L					0.004	0.010	0.011	0.012		0.005	0.006
USEPA_6020	Arsenic	T	0.005	mg/L	0.011	0.017	0.014	0.011					0.025		
USEPA_6020	Barium	D	0.001	mg/L					4.70	5.41	6.42	6.64		1.64	1.19
USEPA_6020	Barium	D	0.005	mg/L	5.17	0.969	4.63	8.89					4.58		
USEPA_6020	Barium	T	0.001	mg/L					5.39	4.97	7.13	7.30		1.86	1.12
USEPA_6020	Barium	T	0.005	mg/L	5.18	2.33	4.92	8.16					6.39		
USEPA_6020	Beryllium	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Beryllium	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Beryllium	T	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Beryllium	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Cadmium	D	0.0001	mg/L					< 0.0001	< 0.0001	< 0.0001	< 0.0001		< 0.0001	< 0.0001
USEPA_6020	Cadmium	D	0.0005	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005					< 0.0005		
USEPA_6020	Cadmium	T	0.0001	mg/L					< 0.0001	< 0.0001	< 0.0001	< 0.0001		< 0.0001	< 0.0001
USEPA_6020	Cadmium	T	0.0005	mg/L	< 0.0005	< 0.0005	< 0.0005	< 0.0005					< 0.0005		
USEPA_6020	Chromium	D	0.001	mg/L					0.005	0.039	0.038	0.039		0.007	0.007
USEPA_6020	Chromium	D	0.005	mg/L	0.037	0.035	0.042	0.049					0.010		
USEPA_6020	Chromium	T	0.001	mg/L					0.007	0.042	0.045	0.047		0.004	0.004
USEPA_6020	Chromium	T	0.005	mg/L	0.045	0.045	0.044	0.047					0.053		
USEPA_6020	Cobalt	D	0.001	mg/L					0.001	< 0.001	0.001	0.001		< 0.001	< 0.001
USEPA_6020	Cobalt	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Cobalt	T	0.001	mg/L					0.002	0.001	0.002	0.001		< 0.001	< 0.001
USEPA_6020	Cobalt	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Copper	D	0.001	mg/L					< 0.001	0.002	0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Copper	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Copper	T	0.001	mg/L					0.009	0.002	0.078	0.005		0.002	0.001
USEPA_6020	Copper	T	0.005	mg/L	0.016	0.007	< 0.005	0.010					< 0.005		
USEPA_6020	Iron	D	0.05	mg/L	0.92	0.20	0.07	0.23	0.14	0.30	0.18	0.09	< 0.05	0.23	0.49
USEPA_6020	Iron	T	0.05	mg/L	9.97	14.0	2.10	4.00	6.45	0.78	1.98	1.39	3.28	0.64	0.65
USEPA_6020	Lead	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Lead	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Lead	T	0.001	mg/L					0.005	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Lead	T	0.005	mg/L	0.007	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Manganese	D	0.001	mg/L					0.233	0.488	0.603	0.555		0.100	0.067
USEPA_6020	Manganese	D	0.005	mg/L	0.654	0.252	0.466	0.688					< 0.005		
USEPA_6020	Manganese	T	0.001	mg/L					0.276	0.466	0.628	0.581		0.115	0.071
USEPA_6020	Manganese	T	0.005	mg/L	0.701	0.459	0.462	0.593					0.612		
USEPA_6020	Molybdenum	D	0.001	mg/L					0.004	0.003	0.002	0.002		0.006	0.006
USEPA_6020	Molybdenum	D	0.005	mg/L	0.005	< 0.005	< 0.005	< 0.005					0.010		
USEPA_6020	Molybdenum	T	0.001	mg/L					0.006	0.005	0.004	0.005		0.002	0.002
USEPA_6020	Molybdenum	T	0.005	mg/L	0.029	0.059	0.012	0.011					0.011		
USEPA_6020	Nickel	D	0.001	mg/L					0.017	0.008	0.007	0.007		0.002	0.026
USEPA_6020	Nickel	D	0.005	mg/L	0.040	0.010	0.012	0.015					0.015		
USEPA_6020	Nickel	T	0.001	mg/L					0.019	0.009	0.010	0.008		< 0.001	0.007
USEPA_6020	Nickel	T	0.005	mg/L	0.090	0.028	0.010	0.026					0.018		
USEPA_6020	Silver	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Silver	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Silver	T	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Silver	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Strontium	D	0.001	mg/L					16.9	13.5	17.3	17.1		4.56	3.93
USEPA_6020	Strontium	D	0.005	mg/L	12.1	6.52	11.9	21.8					22.6		
USEPA_6020	Strontium	T	0.001	mg/L					17.3	12.0	20.8	20.2		5.54	4.28
USEPA_6020	Strontium	T	0.005	mg/L	12.0	9.10	13.6	21.5					24.0		
USEPA_6020	Thorium	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Thorium	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		

				FACILITY	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN
				SAMPLE_DATE	1/15/2020	1/15/2020	2/12/2020	2/12/2020	3/4/2020	3/4/2020	5/19/2020	5/19/2020	9/19/2020	3/18/2021	5/26/2021
				LOCATION	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1
				DESCRIPTION	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP
				WORK ORDER	EB2001149	EB2001149	EB2003972	EB2003972	EB2006500	EB2006500	EB2013758	EB2013758	EB2025191	EB2107660	EB2114926
				START_DEPTH	0.2	4	0.2	4	4	0.2	4	0.2	0.2	0.2	0.2
				SAMPLE TYPE	N	N	N	N	N	N	N	N	N	N	N
METHOD	PARAMETER-CHEMICAL	FRACTION	LOR	UNIT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
USEPA_6020	Thorium	T	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Thorium	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Tin	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Tin	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Tin	T	0.001	mg/L					0.001	< 0.001	< 0.001	< 0.001		< 0.001	< 0.001
USEPA_6020	Tin	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Uranium	D	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		< 0.001	0.001
USEPA_6020	Uranium	D	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Uranium	T	0.001	mg/L					< 0.001	< 0.001	< 0.001	< 0.001		0.001	0.002
USEPA_6020	Uranium	T	0.005	mg/L	< 0.005	< 0.005	< 0.005	< 0.005					< 0.005		
USEPA_6020	Vanadium	D	0.01	mg/L					< 0.01	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01
USEPA_6020	Vanadium	D	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05					< 0.05		
USEPA_6020	Vanadium	T	0.01	mg/L					< 0.01	< 0.01	< 0.01	< 0.01		< 0.01	< 0.01
USEPA_6020	Vanadium	T	0.05	mg/L	< 0.05	< 0.05	< 0.05	< 0.05					< 0.05		
USEPA_8015	>C10 - C16 Fraction	N	100	µg/L	2860		1550	1840	950	1130	760	800	1110	190	200
USEPA_8015	>C10 - C16 Fraction	N	570	µg/L		6930									
USEPA_8015	>C10 - C16 Fraction minus Naphthalene (F2)	N	100	µg/L	2860		1550	1840	950	1130	760	800	1110	190	200
USEPA_8015	>C10 - C16 Fraction minus Naphthalene (F2)	N	570	µg/L		6930									
USEPA_8015	>C10 - C40 Fraction (sum)	N	100	µg/L	6840		4000	3370	3000	3780	1650	1860	2050	450	380
USEPA_8015	>C10 - C40 Fraction (sum)	N	570	µg/L		140000									
USEPA_8015	>C16 - C34 Fraction	N	100	µg/L	3980		2450	1530	2050	2650	890	1060	940	260	180
USEPA_8015	>C16 - C34 Fraction	N	570	µg/L		128000									
USEPA_8015	>C34 - C40 Fraction	N	100	µg/L	< 100		< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100	< 100
USEPA_8015	>C34 - C40 Fraction	N	570	µg/L		5340									
USEPA_8015	C6 - C36 Fraction (Sum)	N	20	µg/L	7020		4120	3480	3090	3880	1670	1920	2120	430	370
USEPA_8015	C6 - C36 Fraction (Sum)	N	230	µg/L		136000									
USEPA_8260	Benzene	N	1	µg/L	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1
USEPA_8260	C6 - C10 Fraction	N	20	µg/L	30	180	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
USEPA_8260	C6 - C10 Fraction minus BTEX (F1)	N	20	µg/L	30	180	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20	< 20
USEPA_8260	Ethylbenzene	N	2	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
USEPA_8260	meta- & para-Xylene	N	2	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
USEPA_8260	ortho-Xylene	N	2	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
USEPA_8260	Toluene	N	2	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
USEPA_8260	Total Xylenes	N	2	µg/L	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
USEPA_8270_UT	2-Nitrophenol	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	2-Nitrophenol	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	3-Methylcholanthrene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	3-Methylcholanthrene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	7.12-Dimethylbenz(a)anthracene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	7.12-Dimethylbenz(a)anthracene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Acenaphthene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Acenaphthene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Acenaphthylene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Acenaphthylene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Anthracene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Anthracene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Benzo(a)anthracene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Benzo(a)anthracene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Benzo(a)pyrene	N	0.05	µg/L					< 0.05				< 0.05	< 0.05	< 0.05
USEPA_8270_UT	Benzo(a)pyrene	N	0.19	µg/L	< 0.19	< 0.19				< 0.19					
USEPA_8270_UT	Benzo(a)pyrene	N	0.22	µg/L			< 0.22	< 0.22							
USEPA_8270_UT	Benzo(a)pyrene	N	0.25	µg/L								< 0.25			
USEPA_8270_UT	Benzo(a)pyrene	N	0.26	µg/L							< 0.26				
USEPA_8270_UT	Benzo(a)pyrene TEQ (zero)	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Benzo(a)pyrene TEQ (zero)	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Benzo(b+j)fluoranthene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Benzo(b+j)fluoranthene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Benzo(g.h.i)perylene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Benzo(g.h.i)perylene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			

Attachment A
Tanumbirini Flowback Water Analytical Results
McArthur Basin
Santos Ltd.

				FACILITY	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN	MCARTHUR BASIN
				SAMPLE_DATE	1/15/2020	1/15/2020	2/12/2020	2/12/2020	3/4/2020	3/4/2020	5/19/2020	5/19/2020	9/19/2020	3/18/2021	5/26/2021
				LOCATION	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1	TAN1FBCT1
				DESCRIPTION	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP	TANUMBIRINI 1 WELL FLOWBACK STORAGE CONCEPT TANK/POND 1 - 4m BOTTOM - 0.2m TOP
				WORK ORDER	EB2001149	EB2001149	EB2003972	EB2003972	EB2006500	EB2006500	EB2013758	EB2013758	EB2025191	EB2107660	EB2114926
				START_DEPTH	0.2	4	0.2	4	4	0.2	4	0.2	0.2	0.2	0.2
				SAMPLE TYPE	N	N	N	N	N	N	N	N	N	N	N
METHOD	PARAMETER-CHEMICAL	FRACTION	LOR	UNIT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT	RESULT
USEPA_8270_UT	Benzo(k)fluoranthene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Benzo(k)fluoranthene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Chrysene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Chrysene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Dibenz(a.h)anthracene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Dibenz(a.h)anthracene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Fluoranthene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Fluoranthene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Fluorene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Fluorene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Indeno(1.2.3.cd)pyrene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Indeno(1.2.3.cd)pyrene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	m-Cresol	N	0.1	µg/L					0.8				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	m-Cresol	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Naphthalene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Naphthalene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	p-Cresol	N	0.1	µg/L					8.7				39.1	< 0.1	< 0.1
USEPA_8270_UT	p-Cresol	N	0.2	µg/L	184	108	141	279		123	86.8	70.4			
USEPA_8270_UT	Phenanthrene	N	0.1	µg/L					0.8				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Phenanthrene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Pyrene	N	0.1	µg/L					< 0.1				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Pyrene	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270_UT	Sum of polycyclic aromatic hydrocarbons (PAHs)	N	0.1	µg/L					0.8				< 0.1	< 0.1	< 0.1
USEPA_8270_UT	Sum of polycyclic aromatic hydrocarbons (PAHs)	N	0.2	µg/L	< 0.2	< 0.2	< 0.2	< 0.2		< 0.2	< 0.2	< 0.2			
USEPA_8270B_PAH	2.3.4.6-Tetrachlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2.4.5-Trichlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2.4.6-Trichlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2.4-Dichlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2.4-Dimethylphenol	N	1.0	µg/L	1.1	< 1.0	< 1.0	< 1.0	< 1.0	1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2.6-Dichlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	2-Chlorophenol	N	1.0	µg/L	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
USEPA_8270B_PAH	Pentachlorophenol	N	2.0	µg/L	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0
USEPA_8270B_PAH	Phenol	N	1.0	µg/L			5.9	7.7			< 1.0	< 1.0	3.4	< 1.0	< 1.0
USEPA_8270B_PAH	Phenol	N	1.3	µg/L					< 1.3						
USEPA_8270B_PAH	Phenol	N	4.7	µg/L		8.6									
USEPA_8270B_PAH	Phenol	N	4.8	µg/L	37.1					10.7					

Notes	
BLANK CELL	Information not available
FRACTION	T - Total
	D - Dissolved
	N - Null
SAMPLE TYPE	N - Normal Grab Sample
WORKORDER (Empty)	Field measurement only
m	metre
µg/L	micrograms per litre
mg/L	milligrams per litre

Notes	
%	percent
meq/L	milliequivalents per litre
µS/cm	microSiemens per centimetre
Bq/L	becquerel per litre
% LEL	percent lower explosive limit
°C	degrees Celsius
m³	cubic metre
L	litre
mV	millivolt

Attachment B Composite Fluid Hazard Quotients

Attachment B
Composite Fluid Hazard Quotients
McArthur Basin
Santos Ltd.

2019 Risk Assessment All Injected Chemicals				
Chemical Name	**CAS Number**	**Concentration in Injected Fluid[1] (mg/L)**	**PNEC/Water Guideline[2] (mg/L)**	**Cumulative HI[3] 3.1E+04 / Injected HQ[4]**
1,4-Dioxane-2,5-dione, 3,6-dimethyl-, (3R,6R)-, polymer with rel-(3R,6S)-3,6-dimethyl-1,4-dioxane-2,5-dione and (3S,6S)-3,6-dimethyl-1,4-dioxane-2,5-dione	9051-89-2	2.180395055	Not Derived	NA
2-Ethyl hexanol	104-76-7	0.069582725	0.012	5.8E+00
Acetaldehyde	75-07-0	0.070329169	0.3	2.3E-01
Acetic acid	64-19-7	2.284766665	3	7.6E-01
Acrylamide acrylate copolymer	9003-06-9	1.715997873	0.1	1.7E+01
Acrylamide, sodium acrylate polymer	25987-30-8	3.634096402	Not Derived	NA
Acrylonitrile	107-13-1	0.001674747	0.017	9.9E-02
Alcohols, C10-16, ethoxylated propoxylated	69227-22-1	1.208143751	0.14	8.6E+00
Alcohols, C12-15, ethoxylated	68131-39-5	0.994845881	0.14	7.1E+00
Alcohols, C12-16, ethoxylated	68551-12-2	0.08765519	0.14	6.3E-01
Alcohols, C6-12, ethoxylated propoxylated	68937-66-6	3.382802501	0.14	2.4E+01
Aldol	107-89-1	1.291718013	0.13	9.9E+00
Amides, tall-oil fatty, N,N-bis(hydroxyethyl)	68155-28-4	1.195028284	0.007	1.7E+02
Amine oxides, cocoalkyldimethyl	61788-90-7	0.628592318	0.009	7.0E+01
Benzaldehyde	100-52-7	0.195293296	0.002	9.8E+01
Bismuth Oxide	1304-76-3	0.089170426	1	8.9E-02
Butyl alcohol	71-36-3	1.290433834	0.08	1.6E+01
Chlorous acid, sodium salt	7758-19-2	0.117798911	0.001	1.2E+02
Crontonaldehyde	123-73-9	0.120785178	0.0005	2.4E+02
Choline Chloride	67-48-1	8.317348398	0.3	2.8E+01
Cinnamaldehyde	104-55-2	1.384082138	0.04	3.5E+01
Citric acid	77-92-9	0.389070137	0.44	8.8E-01
Cocobetaine	61789-40-0	2.620295494	0.0032	8.2E+02
Crystalline silica, quartz	14808-60-7	0.028679825	Not Derived	NA
Diethanolamine	111-42-2	0.280884739	0.02	1.4E+01
Diethylene glycol	111-46-6	0.11687695	27	4.3E-03
Disodium octaborate tetrahydrate	12008-41-2	0.022781342	0.37	6.2E-02
Ethanol	64-17-5	2.739490027	1	2.7E+00
Ethoxylated branched C13 alcohol	78330-21-9	0.184471899	0.14	1.3E+00
Ethylene glycol	107-21-1	1.08173432	10	1.1E-01
Fatty acids, C8-C16, ethylhexyl ester	135800-37-2	6.30757949	0.001	6.3E+03
Fatty acids, tall-oil, ethoxylated	61791-00-2	1.035150382	0.12	8.6E+00
Glutaraldehyde	111-30-8	0.000753519	0.0025	3.0E-01
Glycerine	56-81-5	0.450579913	100	4.5E-03
Guar gum	9000-30-0	7.507944626	0.006	1.3E+03
Hydrochloric acid	7647-01-0	2.555152036	Not Derived	NA
Hydrotreated light petroleum distillate	64742-47-8	6.523213849	0.001	6.5E+03
Hydroxypropyl guar	39421-75-5	0.733552621	Not Derived	NA
Iron gluconate	299-29-6	2.499587971	2.7	9.3E-01
Methanol	67-56-1	0.689274123	10	6.9E-02
Nitrogen		13756.55134	Not Derived	NA
Polyethylene glycol	25322-68-3	0.164247642	10	1.6E-02
Polypropylene glycol	25322-69-4	1.026434987	0.2	5.1E+00
Potassium chloride	7447-40-7	8.272096147	0.1	8.3E+01
Silica dioxide	112926-00-8	0.001881528	Not Derived	NA
Siloxanes and Silicones, di-Me, reaction products with sil	67762-90-7	0.107094752	Not Derived	NA
Sobitan, mono-9-octadecenoate, (Z)	1338-43-8	0.184284807	0.32	5.8E-01
Sodium bicarbonate	144-55-8	1.927044202	Not Derived	NA
Sodium bisulfite	7631-90-5	0.132632751	0.8	1.7E-01
Sodium carbonate	497-19-8	0.001694084	Not Derived	NA
Sodium Chloride	7647-14-5	1.192124789	Not Derived	NA
Sodium diacetate	126-96-5	0.121136547	1.7	7.1E-02
Sodium hydroxide	1310-73-2	0.642163624	Not Derived	NA
Sodium iodide	7681-82-5	0.006290713	0.0034	1.9E+00
Sodium perborate tetrahydrate	10486-00-7	1.023217229	0.37	2.8E+00
Sodium persulfate	7775-27-1	0.021840726	1.2	1.8E-02
Sodium polyacrylate	9003-04-7	0.664509403	1.2	5.5E-01
Sodium Sulfate	7757-82-6	0.027108254	11	2.5E-03
Sodium Sulfite	7757-83-7	0.004268447	0.7	6.1E-03
Sodium thiosulfate	7772-98-7	0.937147041	1	9.4E-01
Sorbitan monooleate polyoxyethylene derivative	9005-65-6	0.191268232	0.2	9.6E-01
Tributyl tetradecyl phosphonium chloride	81741-28-8	0.286902347	0.000019	1.5E+04
Triethanol amine	102-71-6	0.468964728	0.32	1.5E+00
Ulexite	1319-33-1	0.788123245	Not Derived	NA

Attachment B
Composite Fluid Hazard Quotients
McArthur Basin
Santos Ltd.

2019 Risk Assessment All Injected Chemicals				
Chemical Name	**CAS Number**	**Concentration in Injected Fluid[1] (mg/L)**	**PNEC/Water Guideline[2] (mg/L)**	**Cumulative HI[3] 3.1E+04** **Injected HQ[4]**
Tracer - CFT (fluorobenzoic acids) (APW 001, APW 002, APW 003, APW 004, APW 005, APW 006, APW 007, APW 008, APW 009, APW 010, APW 011, APW 013, APW 014, APW 015, APW 016, APW 017, APW 018, APW 019, APW 020, APW 022, APW 023, APW 031, APW 035, APW 037, APW 039, APW 041, APW 046, APW 047, APW 048, APW 050)	455-38-9, 446-17-3, 455-40-3, 434-75-3, 42860-10-6, 2991-28-8, 385-00-2, 445-29-4, 121602-93-5, 455-86-7, 725-89-3, 61079-72-9, 433-97-6, 456-22-4, 1583-58-0, 454-92-2, 455-24-3, 76006-33-2, 1201-31-6, 446-30-0, 213598-09-5, 403-16-7, 328-67-6, 115029-23-7, 403-17-8, 394-30 9, 21739-92-4, 657-06-7, 153556-42-4, 161622-05-5	0.7035	0.043	1.6E+01
Tracers - GFT (perfluorocarbons) (APG 001,APG 002,APG 003,APG 004,APG 005,APG 006,APG 007,APG 008,APG 009,APG 010,APG 011,APG 012,APG 013,APG 014,APG 015)	306-92-3,423-03-0,335-21-7,423-02-9,288666,50285-18-2,374-60-7,355-02-2,374-76-5,306-94-5,1806-22-7,1736-47-6,306-98-9,2994-71-0,354-97-2	0.46462	Not Derived	NA
Tracers - Water Flow Assurance (APFAW 001, APFAW 002)	58-08-2, 1934-21-0	1	0.9	1.1E+00

Notes:
CAS = chemical abstract service
HI = hazard index
HQ = hazard quotient
mg/L = milligrams per litre
PNEC = predicted no-effects concentration

1/ Injected concentration is maximum of ALL FRAC and COILCHEM Systems evaluated in 2019 Risk Assessment.
2/ PNEC and water guidelines derived in EHS Support. 2019. Technical Memorandum – Beetaloo McArthur Basin Hydraulic Fracturing Fluid System – Chemical Risk Assessment. July.
3/ HI calculated by summing HQ for individual chemicals.
4/ HQ calculated using following equation:

$$HQ = \frac{CI}{RBSL}$$

Where:
HQ = hazard quotient
CI = concentration injected
RBSL = risk-based screening level (e.g., PNEC)

Attachment C Flowback Fluid Hazard Quotients

Attachment C
Flowback Water Hazard Quotients
McArthur Basin
Santos Ltd.

Parameter - Chemical	Maximum Concentration	Units	Freshwater Trigger Value (FTV, µg/L)[1]				Alternative SW Screening Criteria (µg/L)[2]	Reference	Minimum RBSL[3]	Cumulative HI[4] 3.9E+03
			FTVs by Protection Level (% Species)							
			99%	95%	90%	80%				HQs[5]
Boron	38800	µg/L	90	370	680	1300	NC		90	4.3E+02
Selenium	8	µg/L	5	11	18	34	NC		5	1.6E+00
Zinc	6590	µg/L	2.4	8	15	31	NC		2.4	2.7E+03
Ionic Balance	10	%	NC	NC	NC	NC	NC		NC	NA
Total Anions	382	meq/L	NC	NC	NC	NC	NC		NC	NA
Total Cations	467	meq/L	NC	NC	NC	NC	NC		NC	NA
Bicarbonate Alkalinity as CaCO3	925000	µg/L	NC	NC	NC	NC	NC		NC	NA
Carbonate Alkalinity as CaCO3	249000	µg/L	NC	NC	NC	NC	NC		NC	NA
Total Alkalinity as CaCO3	925000	µg/L	NC	NC	NC	NC	NC		NC	NA
Electrical Conductivity @ 25°C	36500	µS/cm	NC	NC	NC	NC	NC		NC	NA
Total Dissolved Solids @180°C	21600000	µg/L	NC	NC	NC	NC	NC		NC	NA
Suspended Solids	528000	µg/L	NC	NC	NC	NC	NC		NC	NA
Calcium	179000	µg/L	NC	NC	NC	NC	NC		NC	NA
Magnesium	123000	µg/L	NC	NC	NC	NC	2000000	a	2000000	6.2E-02
Potassium	101000	µg/L	NC	NC	NC	NC	NC		NC	NA
Sodium	10400000	µg/L	NC	NC	NC	NC	NC		NC	NA
Bromide	171000	µg/L	NC	NC	NC	NC	NC		NC	NA
Chloride	12700000	µg/L	NC	NC	NC	NC	120000	b	120000	1.1E+02
Total Residual Chlorine	30	µg/L	NC	NC	NC	NC	NC		NC	NA
Fluoride	1800	µg/L	NC	NC	NC	NC	120	b	120	1.5E+01
pH - Lab	8.67	pH Unit	NC	NC	NC	NC	NC		NC	NA
Ammonia as N	36100	µg/L	320	900	1430	2300	NC		320	1.1E+02
Nitrite as N	60	µg/L	NC	NC	NC	NC	NC		NC	NA
Nitrate as N	40	µg/L	NC	NC	NC	NC	NC		NC	NA
Total Kjeldahl Nitrogen as N	48100	µg/L	NC	NC	NC	NC	NC		NC	NA
Total Nitrogen as N	48100	µg/L	NC	NC	NC	NC	NA		NC	NA
Reactive Phosphorus as P	740	µg/L	NC	NC	NC	NC	NC		NC	NA
Total Phosphorus as P	2140	µg/L	NC	NC	NC	NC	NC		NC	NA
Reactive Silica	127000	µg/L	NC	NC	NC	NC	NC		NC	NA
Sulfate as SO4 2-	201000	µg/L	NC	NC	NC	NC	2000000	a	2000000	1.0E-01
Dissolved Organic Carbon	234000	µg/L	NC	NC	NC	NC	NC		NC	NA
Total Organic Carbon	247000	µg/L	NC	NC	NC	NC	NC		NC	NA
Formaldehyde	1000	µg/L	NC	NC	NC	NC	1610	c	1610	6.2E-01
Aluminium	630	µg/L	27	55	80	150	NC		27	2.3E+01
Antimony	6	µg/L	9	9	9	9	NC		9	6.7E-01
Arsenic	25	µg/L	0.8	13	42	140	NC		0.8	3.1E+01
Barium	8160	µg/L	NC	NC	NC	NC	1000	d	1000	8.2E+00
Chromium	53	µg/L	3.3	3.3	3.3	3.3	NC		3.3	1.6E+01
Cobalt	2	µg/L	1.4	1.4	1.4	1.4	NC		1.4	1.4E+00
Copper	78	µg/L	1	1.4	1.8	2.5	NC		1	7.8E+01
Iron	14000	µg/L	NC	NC	NC	NC	300	b	300	4.7E+01
Lead	7	µg/L	1	3.4	5.6	9.4	NC		1	7.0E+00
Manganese	701	µg/L	1200	1900	2500	3600	NC		1200	5.8E-01
Molybdenum	59	µg/L	34	34	34	34	NC		34	1.7E+00
Nickel	90	µg/L	8	11	13	17	NC		8	1.1E+01
Strontium	24000	µg/L	NC	NC	NC	NC	2500	e	2500	9.6E+00
Tin	1	µg/L	NC	NC	NC	NC	73	d	73	1.4E-02
Uranium	2	µg/L	0.5	0.5	0.5	0.5	NC		0.5	4.0E+00
>C10 - C16 Fraction	6930	µg/L	NC	NC	NC	NC	443	f	443	1.6E+01
>C16 - C34 Fraction	128000	µg/L	NC	NC	NC	NC	640	f	640	2.0E+02
>C34 - C40 Fraction	5340	µg/L	NC	NC	NC	NC	640	f	640	8.3E+00
C6 - C10 Fraction	180	µg/L	NC	NC	NC	NC	443	f	443	4.1E-01
m-Cresol	0.8	µg/L	NC	NC	NC	NC	200	g	200	4.0E-03
p-Cresol	279	µg/L	NC	NC	NC	NC	100	g	100	2.8E+00
Phenanthrene	0.8	µg/L	0.6	2	4	8	NC		0.6	1.3E+00
Sum of PAHs	0.8	µg/L	NC	NC	NC	NC	NC		NC	NA
2.4-Dimethylphenol	1.1	µg/L	NC	2	NC	NC	NC		2	5.5E-01
Phenol	37.1	µg/L	85	320	600	1200	NC		85	4.4E-01

Notes:

% = percent
µg/L = micrograms per litre
µS/cm = microSiemens per centimetre
HI = hazard index
HQ = hazard quotient
meq/L = milliequivalents per litre
NC = No appropriate screening criterion
RBSL = risk-based screening level
PAHs = polycyclic aromatic hydrocarbons

1/ Default Freshwater Trigger Values. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. 2021.
Available online at: https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants

2/ Alternative water screening criteria notes

a - Major ions of concern for livestock drinking water quality -
Available online at: https://www.waterquality.gov.au/sites/default/files/documents/anzecc-armcanz-2000-guidelines-vol1.pdf

b - Canadian Council of Ministers of the Environment. Water Quality Guidelines for the Protection of Aquatic Life.
Available online at: https://ccme.ca/en/summary-table

c - Chronic aquatic life water quality criterion from Hohreiter DW1, Rigg DK.Derivation of ambient water quality criteria for formaldehyde.
Chemosphere. 2001. Chemosphere. Nov;45(4-5):471-86. https://www.ncbi.nlm.nih.gov/pubmed/11680743

d - From Oak Ridge National Laboratory - Risk Assessment Information System) https://rais.ornl.gov/tools/eco_search.php

e - Canadian Environmental Protection Act, 1999 Federal Environmental Quality Guidelines Strontium. Environment and Climate Change Canada July 2020.
https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/federal-environmental-quality-guidelines-strontium.html

f - California Regional Water Quality Control Board. 2019. INTERIM FINAL - Environmental Screening Levels. Table IP-5, California EPA Aquatic Toxicity Levels

g - Guidelines for chemical compounds in water found to cause tainting of fish flesh and other aquatic organisms -
Available online at: https://www.waterquality.gov.au/sites/default/files/documents/anzecc-armcanz-2000-guidelines-vol1.pdf

4/ Minimum of FTVs is Protection Level of 99% of species

3/ HI calculated by summing HQ for individual chemicals.

5/ HQ calculated using following equation:

$$HQ = \frac{CI}{RBSL}$$

Where:

HQ = hazard quotient
CI = concentration injected
RBSL = risk-based screening level