

Beetaloo Sub-Basin Multi-Well Drilling, Stimulation and Well Testing Program

Environment Management Plan (ORI10-3)

EP 98, EP76

Beetaloo Sub-basin Multi-well EMP originally prepared by Origin B2 Pty Ltd, and updated by Tamboran B2 Pty Ltd

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- Appendix E Chemical Risk Assessment (AECOM 2024a)
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- Appendix K Land Condition Report
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Executive Summary

Tamboran B2 Pty Ltd (Tamboran) is a registered holder and the operator of exploration permits (EP) 98 and EP76, located in the Beetaloo Sub-basin. This Environment Management Plan (EMP) was the basis of Tamboran's application to the Northern Territory (NT) Minister for Environment for the drilling, hydraulic fracture stimulation (HFS) and well testing at Amungee NW well site and Velkerri 76 S2 well site (Figure 1).

This EMP covers two existing petroleum wells and four new exploration and appraisal (E&A) petroleum wells as follows:

- Amungee NW-1H (existing), Amungee NW-2H (new) and Amungee NW-3H (new) at the Amungee NW location.
- Velkerri 76 S2-1H (existing), Velkerri 76 S2-2H (new) and Velkerri 76 S2-3H (new) at the Velkerri 76 S2 location.

The drilling, stimulation and well testing of the E&A wells on each of the exploration sites is considered an important step in confirming the technical and commercial feasibility of the Velkerri shale. The Amungee NW site is located in the dry gas window, with recent data acquired from the existing Amungee NW-1H E&A well confirming better than originally determined shale gas prospectively. The Velkerri 76 S2 is located in the wet gas window, with indicative results collected during the drilling of Velkerri 76 S2-1 confirming the presence of wet gas.

The Amungee NW well site is an existing site located on the Amungee Mungee station within EP98. It contains the existing Amungee NW-1H E&A well, which was drilled in 2015 and 2016 under the previously approved Beetaloo Sub-basin EP98 and EP117 Exploration Drilling EMP ([Origin-2015](#)) and Amungee NW-1H EPT EMP ([ORI7-2](#)).

Also located on the Amungee Mungee station but within EP76, Velkerri 76 S2 was constructed under the Beetaloo Basin Velkerri 76 S2 Civil Construction EMP ([ORI4-1](#)) and contains the Velkerri 76 S2-1 E&A well which was vertically drilled in 2021 under the approved Beetaloo Basin Drilling, Stimulation and Well Testing Program Velkerri 76 S2 EMP ([ORI5-4](#)). Following this, Velkerri 76 S2-1 well deferred the horizontal drilling section, hydraulic fracturing and well testing to the 2025/2026 period.

This EMP update includes the regulated activities that are required to enable Tamboran to drill, stimulate, test, maintain and decommission the E&A wells on Amungee NW and Velkerri 76 S2 site within the 2022-2026 period. As at this date of this EMP version, there have been eight (8) regulation 22 notifications:

- ORI10-3.1 Water bore location change (Amungee NW2)
- ORI10-3.2 Change to HF fluids
- ORI10-3.3 Change to completion fluids
- ORI10-3.4 Bore infrastructure and EMP edits
- ORI10-3.5 Roll up of remaining civil works for Velkerri 76 S2 well site including gravel pits, access tracks and associated activities
- ORI10-3.6 Roll up of remaining DST activities for Velkerri 76 S2 drilling, stimulation and well testing activities
- ORI10-3.7 Roll up of Amungee NW-1H EPT.
- ORI10-3.8 Amungee Multi-well EMP update, including stormwater amendments and revised chemical risk assessment.

All wells target the Velkerri shale resource, though the Amungee NW is dry shale and the Velkerri 76 S2 wells are wet gas. The drilling, stimulation and well testing of the E&A wells at the existing sites is considered an important step in confirming the technical and commercial feasibility of the Velkerri shale resource. The use of multi-well pads is likely to significantly reduce the environmental footprint of any potential development.

The appraisal results collected from these wells will be used to:

- Validate reservoir flows from the Velkerri target formation at the sites with multiple wells
- Optimise HFS design and spacing between adjacent horizontal wells in a multi-well pad operation
- Optimise multi-well pad layout of surface operations for a potential future development scenario with the core objective of minimising the environmental footprint, including minimising land clearance, maximising water re-use and reducing greenhouse gas (GHG) emissions
- Determine optimal well spacing at a well pad to inform development of the Mechanical Earth Model (MEM) for a future potential development (subject to exploration success)
- Demonstrate design requirements and operability of multi-well pad operations across all seasons in the Beetaloo Sub-basin
- Assess the financial competitiveness in multi-well pad development scenario to inform Final Investment Decision for future development scenarios
- Demonstrate no impact on groundwater quality at a well site in a multi-well pad operation
- Collect additional data on flowback quality and quantity during a multi-well pad operation to assess options for minimising off-site wastewater disposal through future treatment and re-use
- Provide key data as input into future production approvals, including footprint optimisation, flowback characterisation, GHG emission intensity and solid and liquid waste management.

The EMP has been prepared in compliance with the NT Petroleum (Environment) Regulations 2016, Code of Practice: Onshore Petroleum Activities in the Northern Territory (referred to herein as the “Code of Practice”) and the Exploration Agreements between Tamboran, Native Title holders and the Northern Land Council (NLC).

The overall objective of the EMP is to ensure that the proposed activities, are carried out in a manner by which the environmental impacts and risks will be reduced to a level that is as low as reasonably practicable and are acceptable.

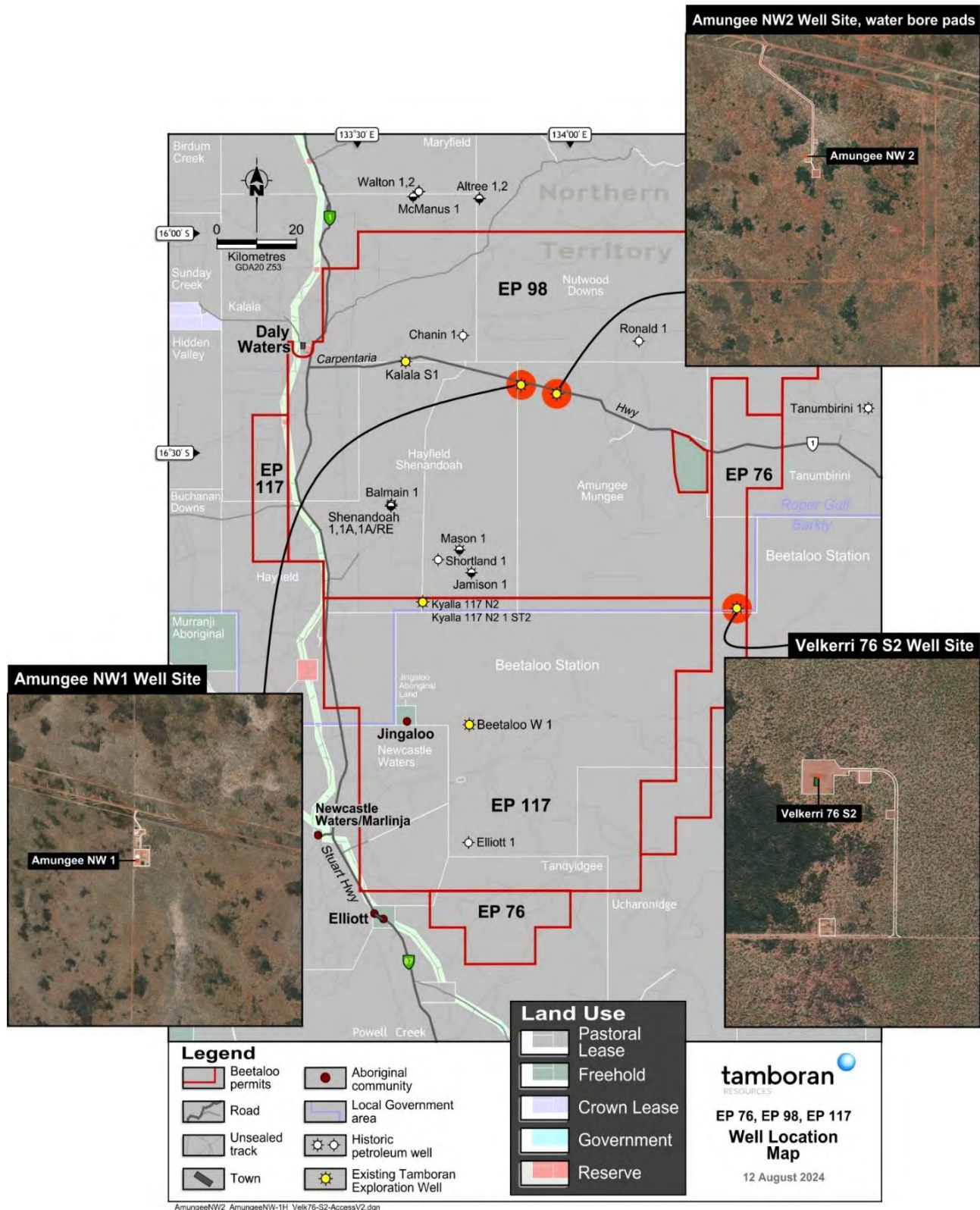


Figure 1: Location of Amungee NW, Amungee NW2 and Velkerri 76 S2 well sites

Description of the activity

This EMP covers the regulated activities required to enable Tamboran to drill, stimulate, test, maintain and potentially decommission the four additional E&A wells. To accommodate this scope, the activities described in Table 1 are proposed.

Table 1: Description of the proposed E&A activities for the Amungee NW and Velkerri 76 S2 well sites

Activity	Description
Amungee NW scope	
Civil construction activities	- Expansion of the existing Amungee NW well site from 3.56 ha to 10 ha to accommodate the new exploration and appraisal (E&A) wells and anticipated freshwater and wastewater storage - Upgrade of the access track intersection with the Carpentaria Highway to comply with Department of Infrastructure, Planning and Logistics requirements. Including construction of a new access track (1.1 km) into the Amungee NW2 location (1.5 ha) - Expansion of the existing camp pad from 0.9 ha to 1.2 ha - Installation of two additional E&A well cellars and conductors on the well pad to accommodate the proposed Amungee NW-2H and Amungee NW-3H wellhead and surface facilities - Construction of a drilling sump on the well pad to manage drilling fluids, muds and cuttings of up to 5,000 m³ - Construction of a site bund for wastewater storage - Construction of a sediment basin to manage stormwater during wastewater storage - Drilling of up to four additional groundwater monitoring/ extraction bores within the proposed exploration areas (if required), including 2 groundwater monitoring bores at Amungee NW2 (2.0 ha) approximately 11 km to the east of the existing Amungee NW well pad in preparation for future exploration activities - Construction of a helipad (up to 1 ha) and laydown area (up to 1 ha) - Construction of a 20 m x 2 km fence line and firebreak around the Amungee NW site (~4 ha).
Site set-up and mobilisation to support the Amungee NW-2H and Amungee NW-3H E&A wells	- Use of existing access tracks to and from the Amungee NW site from the Carpentaria Highway - Set-up of two temporary camps – a main camp located on the camp pad (~70-person capacity) and a drilling mini-camp located on the well pad (~8-person capacity) - Set-up of chemical and material storage areas - Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units - Set-up of hydraulic fracture stimulation (HFS) equipment, completions rig and equipment, well testing equipment, and other associated equipment at Amungee NW - Approximately 44 traffic movements per day during site demobilisation.
E&A activities at the Amungee NW site including drilling, hydraulic fracture stimulation (HFS) and well testing of Amungee NW-1H, Amungee NW-2H and Amungee NW-3H	- Operation of the two temporary camps - Transportation, handling and storage of bulk chemicals, fuels and wastes - Drilling of the Amungee NW-2H and Amungee NW -3H horizontal E&A wells, including the collection of reservoir quality data during drilling

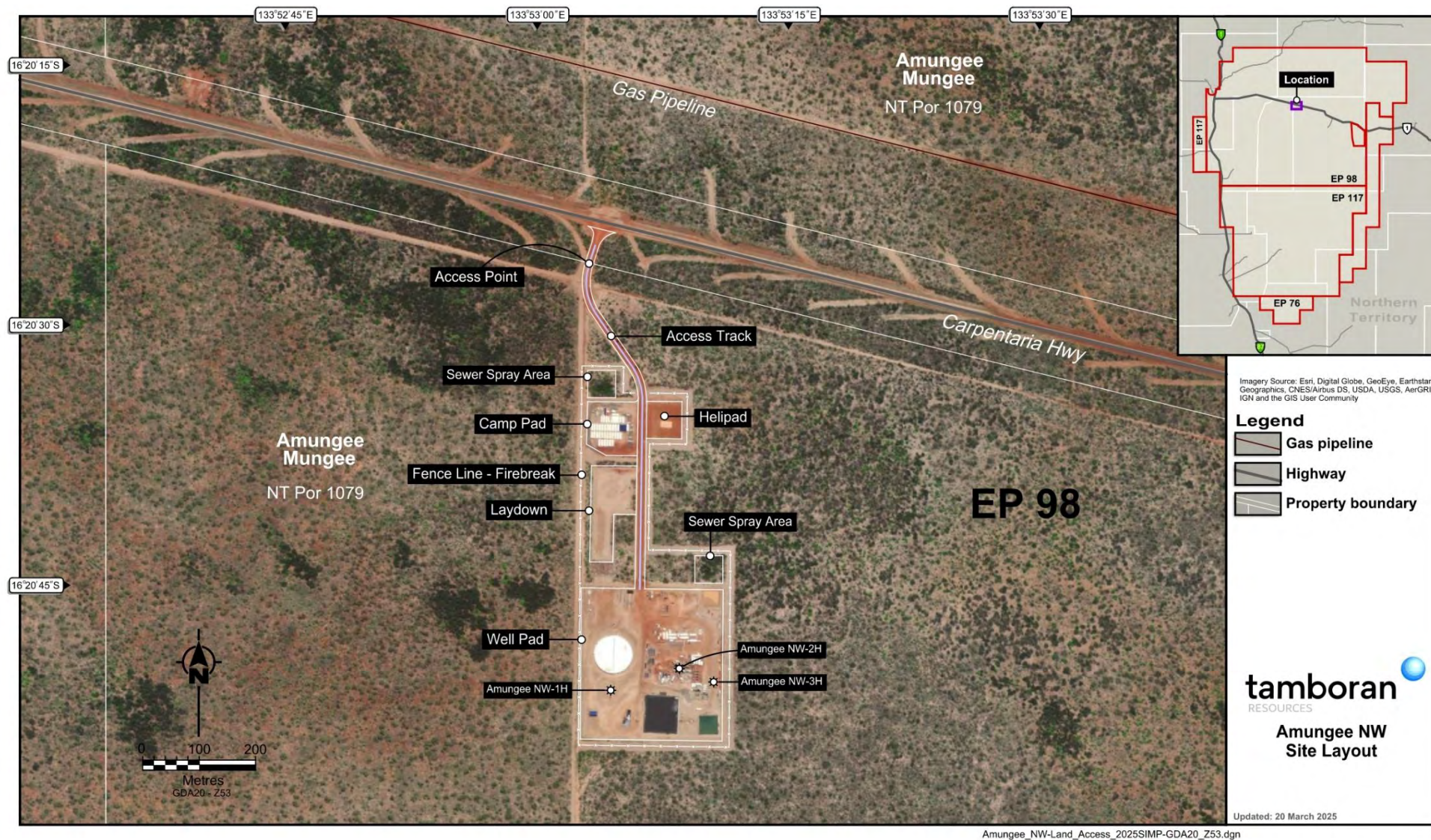
Activity	Description
	- Well design in accordance with the Code of Practice and approved Well Operations Management Plan (WOMP) including isolation of freshwater aquifers - HFS of Amungee NW-2H and Amungee NW-3H - Completion of Amungee NW-2H and Amungee NW-3H E&A wells - Extended production testing of the Amungee NW-1H, Amungee NW-2H and Amungee NW-3H E&A wells - Gas flaring in accordance with Code of Practice requirements and as per US EPA 40 CFR 63.11, with a flare tip combustion efficiency of 98% - Beneficial use of appraisal gas for on-site power generation and use - Maintenance and monitoring works on Amungee NW-1H, NW-2H and Amungee NW-3H wells (including well workovers) in accordance with approved WOMP - Build up testing, suspension and decommissioning Amungee NW-1H, Amungee NW-2H and Amungee NW-3H E&A wells (if required) in accordance with the Code of Practice - Groundwater extraction of approximately 110 ML under existing groundwater extraction licence (WEL GRF 10285) - Monitoring activities (including groundwater, stormwater, soils, leak detection and all other low impact ancillary data collection programs).
On-site wastewater management to support ongoing E&A program	- On-site wastewater storage and treatment in accordance with Code of Practice - Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater - Drill cuttings and flowback fluid quality testing in accordance with the Code of Practice - Disposal of drill cuttings within EP98 is subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code of Practice - Drilling waste storage and disposal located within the existing Amungee NW site or transported off-site - On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options) - Off-site disposal of wastewater in accordance with the <i>Waste Management and Pollution Control Act</i>.
Site demobilisation	- Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment - Approximately 44 traffic movements per day during site demobilisation.
Site rehabilitation	- Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment - Final rehabilitation activities to return the sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition.

Activity	Description
Velkerri 76 S2 scope	
Civil construction activities	• Velkerri 76 S2 well site (7.4 ha) and access track construction and maintenance (10.9 ha) • Construction and operation of approved gravel pits VGP1, VGP2, VGP3 (9 ha) • Installation of two additional E&A well cellars and conductors on the existing Velkerri 76 S2 well pad to accommodate the proposed Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells.
Site set-up and mobilisation to support Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H exploration wells	• Use of existing access tracks to and from the Velkerri 76 S2 site and gravel pits from the Stuart Highway (noting 80 km is an existing pastoral track constructed by the pastoralist that Tamboran currently maintain) • Use of the existing Velkerri 76 S2 well pad, camp pad and helicopter landing pad • Use of existing drilling sump to manage up to 3,000 m3 • Use of existing sediment basin and site bund for wastewater management and storage • Set-up of two temporary camps – a main camp located on the camp pad (~70-person capacity) and a drilling mini-camp located on the well pad (~8-person capacity) • Set-up of chemical and material storage areas • Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units • Set-up of HFS equipment, completions rig and equipment, well testing equipment, and other associated equipment at Velkerri 76 S2 • Approximately 44 traffic movements per day during site demobilisation.
E&A activities at the Velkerri 76 S2 site including drilling, HFS and well testing of Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H	• Operation of the two temporary camps • Transportation, handling and storage of bulk chemicals, fuels and wastes • Drilling of the Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H horizontal E&A wells, including the collection of reservoir quality data during drilling • Well design in accordance with the Code of Practice and approved Well Operations Management Plan (WOMP) including isolation of freshwater aquifers • HFS of Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H • Completion and well testing of the Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells • Use of existing surface facilities • Well testing of the Velkerri 76 S2-1 vertical well • Storage of condensate • Gas and condensate flaring in accordance with Code of Practice requirements and as per US EPA 40 CFR 63.11, with a flare tip combustion efficiency of 98% • Trucking of condensate (where beneficial usage is authorised) • Beneficial use of appraisal gas and condensate for on-site power generation and use • Maintenance and monitoring works (including well work overs) on Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H wells in accordance with approved WOMP

Activity	Description
	• Build up testing, suspension and decommissioning Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells (if required) in accordance with the Code of Practice • Groundwater extraction of approximately 110 ML under existing groundwater extraction licence (WEL GRF 10285) • Monitoring activities (including groundwater, stormwater, soils, leak detection and all other low impact ancillary data collection programs).
On-site wastewater management to support ongoing E&A program	• On-site wastewater storage and treatment in accordance with Code of Practice • Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater • Drill cuttings and flowback fluid quality testing in accordance with the Code of Practice • Disposal of drill cuttings within EP76 is subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code of Practice • Drilling waste storage and disposal located within the existing Velkerri 76 S2 site or transported off-site • On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options) • Off-site disposal of wastewater in accordance with the <i>Waste Management and Pollution Control Act</i>.
Site demobilisation	• Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment • Approximately 44 traffic movements per day during site demobilisation.
Site rehabilitation	• Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment • Final rehabilitation activities to return the sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition as outlined in the Velkerri 76 S2 Rehabilitation Plan (Appendix O).

Figure 2 shows the existing Amungee NW site and the layout of the proposed activities within the existing and well site, with the Velkerri 76 S2 site layout shown in Figure 3.

The proposed activities will occur within the subject land area which has been approved by the Native Title holders and the Northern Land Council (NLC) and covered by AAPA Certificate C2022/02 for the Amungee NW scope and C2020/003 for the Velkerri 76 S2 scope.



Amungee_NW-Land_Access_2025SIMP-GDA20_Z53.dgn

Figure 2: Existing Amungee NW site layout

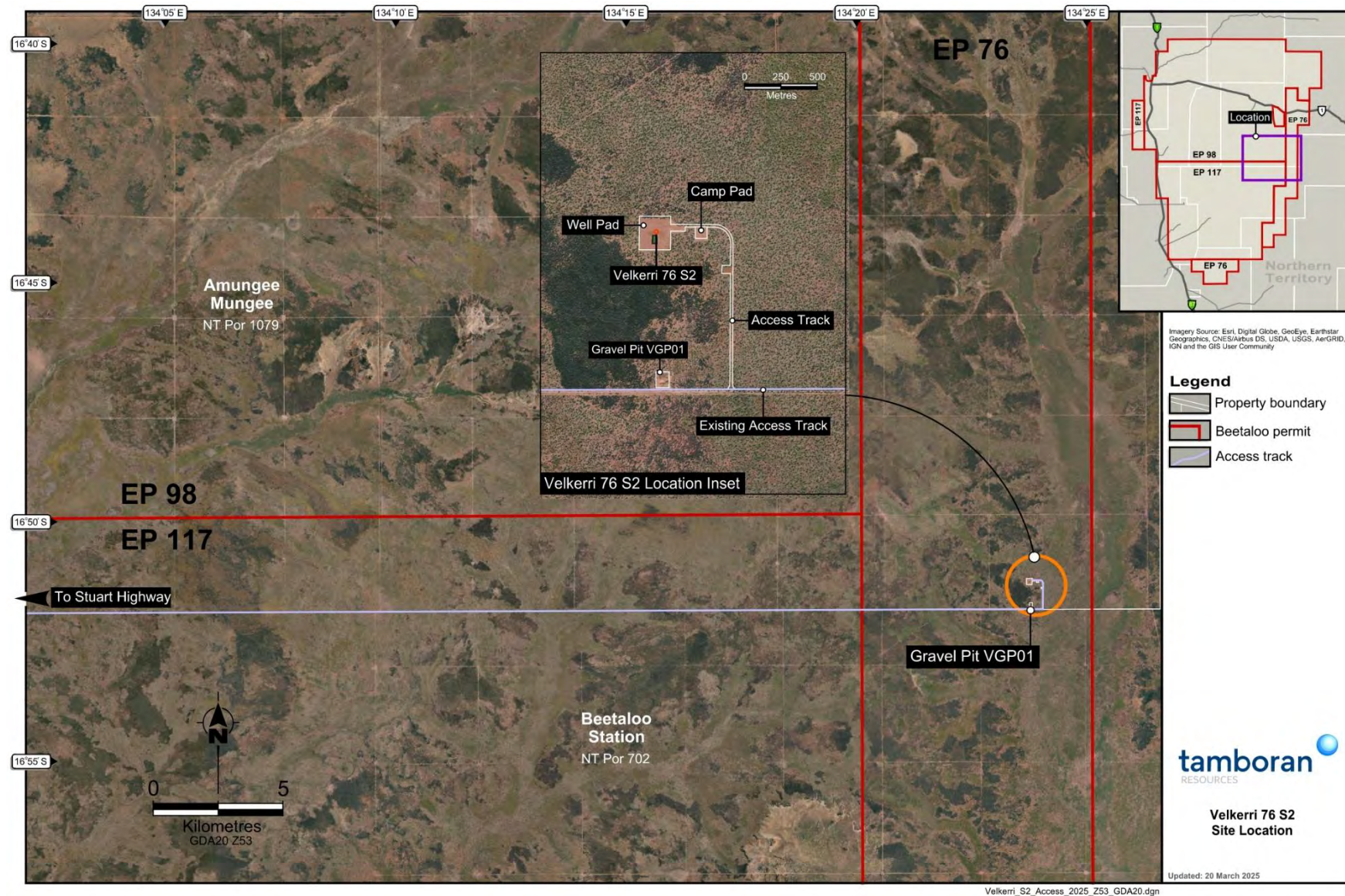


Figure 3: Existing Velkerri 76 S2 NW site layout

Description of the existing environment

The Amungee NW, Amungee NW2 and Velkerri 76 S2 sites are located on the Amungee Mungie Station, which is subject to pastoral land use. A Land Condition Assessment was completed in 2014, 2018 and 2021 to review the physical, natural and cultural heritage environment. A summary of the existing environment in which the existing well sites are located is provided in Table 2, Table 3 and Table 4.

The existing Amungee NW site contains the existing Amungee NW-1H, Amungee NW-2H and Amungee NW-3H well, well pad, camp pad and access track. The total existing disturbance footprint is approximately 5.56 ha (Figure 4). The proposed activities will increase the well pad from 3.56 ha to 10 ha and the camp pad from 0.9 ha to 1.2 ha. Along with an additional 1 ha for the helipad, 1 ha for the laydown yard and 4 ha for the fence line, the total disturbance proposed under this EMP is 12.74 ha, taking the total disturbance footprint at the site to approximately 18.3 ha.

The Amungee NW2 groundwater bore pads and access track total disturbance footprint is 3.5 ha, consisting of 2 ha for the two monitoring bore pads and 1.5 ha for the access track.

The existing disturbance footprint of the Velkerri 76 S2 site, which currently contains the Velkerri 76 S2-1 E&A well, is approximately 7.4 ha including well pad and laydown yard, camp pad, helipad and stockpile storage area. Existing access tracks connect Velkerri 76 S2 to existing off-site existing gravel pits on EP76 (VGP1, VGP2 and VGP3). There is no proposed increase to the Velkerri 76 S2 disturbance footprint under this EMP. The total disturbance footprint of the Velkerri 76 S2 well site and associated access tracks and gravel pits is 27.3 ha.



Figure 4: Overview of the existing Amungee NW site footprint during drilling of the Amungee NW-1H appraisal well in 2016

Amungee NW and Amungee NW2 locations are within open Corymbia woodland with dense grass and shrub cover. Similarly, the Velkerri 76 S2 well pad is located within Corymbia low woodland with a tussock grass understorey. These vegetation types are widespread in the tropical savannas of the Northern Territory and may provide habitat for some threatened species such as the Crested Shrike-tit (*Falcunculus frontatus whitei*) and Gouldian Finch (*Erythrura gouldiae*).

Ongoing routine field weed surveys have been completed at both locations. *Hyptis suaveolens* (Class B & C under the NT Weeds Management Act 2001) was found along the Amungee NW access track and Velkerri 76 S2 camp and wastewater irrigation area and is subject to active treatment. The low number of weed species at and around the sites indicates the surrounding habitat is in good condition. Weed management will continue to focus on preventing the introduction and spread of weeds.

The archaeology assessment did not identify culturally sensitive landforms or artefacts within the vicinity of the sites. Aboriginal Areas Protection Authority (AAPA) Certificate C2020/003 and C2022/02 has been granted for Amungee NW and for Velkerri 76 S2. The closest identified sacred site to Amungee NW is located over 8km away and 7km from the Velkerri 76 S2 well pad. There is also a segment of existing access track which intersects a restricted work area (RWA) on the way to the Velkerri 76 S2 well pad. The middle point of this segment of the track is 12m (either side) from the RWA. Tamboran has committed to comply with the conditions of the AAPA certificates.

Table 2: Summary of existing environment and surrounds at Amungee NW

Site ID	Amungee NW	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	GDA94, zone 53, 0389927E, 8190027N		
Landform and soil	Two types: laterite, ferruginous rubble, some red soil and sandy and loamy soil with some lateritic material on undulating plain		
Habitat type	<i>Corymbia dichromophloia</i> and <i>Eucalyptus chlorophylla</i> open woodland		
Vegetation Community	<i>Corymbia dichromophloia</i> and <i>Eucalyptus chlorophylla</i> mid high open woodland, over <i>Erythrophleum chlorostachys</i> , <i>Acacia difficilis</i> and <i>Santalum lanceolatum</i> mid high open shrubland, over <i>Chrysopogon fallax</i> and <i>Sorghum plumosum</i> open tussock grassland		
Dominant flora species	Upper Stratum <i>Corymbia dichromophloia</i> (7%), <i>Eucalyptus chlorophylla</i> (3%)		
	Mid Stratum <i>Erythrophleum chlorostachys</i> (6%), <i>Acacia difficilis</i> (4%), <i>Santalum lanceolatum</i> (3%)		
	Ground Stratum <i>Chrysopogon fallax</i> (16%), <i>Sorghum plumosum</i> (2%)		
Habitat Condition	Scattered tree hollows, common falling logs. Mistletoe and flowering plants absent.	Hydrogeology	
		Groundwater resources and use is from the Gum Ridge Formation. A seasonal perched shallow alluvium system has also been locally identified but is not utilised as a groundwater resource. The Anthony Lagoon formation and undifferentiated Cretaceous are unsaturated.	
Weeds	No weeds of national significance or NT declared weeds present. <i>Hyptis suaveolens</i> present on access tracks		
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch		

Table 3: Summary of existing environment and surrounds at Amungee NW2

Site ID	Amungee NW2	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	-16°20' 38.17, 133°53' 2.76		
Landform and soil	Two types: laterite, ferruginous rubble, some red soil and sandy and loamy soil with some lateritic material on undulating plain		
Habitat type	Open eucalypt woodland		
Vegetation Community	Open woodland with dense shrub cover and grass cover. This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Upper Stratum <i>Corymbia ferruginea</i>		
	Mid Stratum <i>Petalostimga pubescens</i> , <i>Hakea arborescens</i> , <i>Terminalia canescens</i>		
	Ground Stratum <i>Sorghum timorense</i> and <i>Chrysopogon fallax</i> , <i>Themeda avenacea</i>		
Habitat Condition	Previous exploration activities (Amungee NW-1H). Habitat disturbances include grazing and prior clearing. Moderate evidence of fire. No evidence of erosion. The weed <i>Hyptis suaveolens</i> present on access track. Evidence of cattle from wet/early dry season. Tree hollows, mistletoe and flowering plants absent. Scattered fallen logs and shallow litter. Termite mounds common.	Hydrogeology	
		Groundwater resources and use is from the Gum Ridge Formation. A seasonal perched shallow alluvium system has also been locally identified but is not utilised as a groundwater resource. The Anthony Lagoon formation and undifferentiated Cretaceous are unsaturated.	
Weeds	No weeds of national significance or NT declared weeds present. <i>Hyptis suaveolens</i> present on access tracks		
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch		

Table 4: Summary of existing environment and surrounds at Velkerri 76 S2

Site ID	Velkerri 76 S2	Habitat survey photos of the vegetation/habitat of the surrounding environment		
Location	-16°50' 29.01, 133°39' 0.16			
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils.			
Habitat type	Corymbia low woodland			
Vegetation Community	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland This vegetation community is considered regionally extensive and not subjected to extensive clearing.			
Dominant flora species	Upper Stratum <i>Corymbia dichromophloia</i> , <i>Eucalyptus setosa</i>			
	Mid Stratum <i>Acacia ancistrocarpa</i> , <i>Alphitonia pomaderroides</i> , <i>Brachychiton paradoxus</i>			
	Ground Stratum <i>Triodia bitextura</i> .			
Habitat Condition	Good condition with evidence of recent grazing. Vegetation appeared to have been heavily burnt in recent years. No evidence of hollow bearing trees and logs. Habitat contained moderate to high refuge opportunities in the form of dense leaf litter, tussock grass cover, and woody debris. Good continuous cover adjoining adjacent woodland habitat and regionally extensive. No evidence of weeds or feral animals.	Hydrogeology Groundwater resources and use is primarily from the Cambrian Limestone Aquifers (the Anthony Lagoon Formation and Gum Ridge Formation) with the shallower undifferentiated Cretaceous or perched alluvium systems being unsaturated.		
Weeds	No Weeds of National Significance present. <i>Hyptis suaveolens</i> present at camp and wastewater irrigation area.			
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch			

Chemical risk assessment

A chemical risk assessment has been completed for all chemicals to be used in drilling and HFS. All chemicals were considered low concern when standard chemical handling, storage and disposal practices were used. The chemicals and estimated quantities that may be added to the HFS proppant (sand) are shown in Table 5.

Table 5: Chemicals that may be used on each well pad (based on 3 wells per pad)

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Stimulation chemicals					
Acetic acid – 60%	3,000	9,000	L	Stimulation chemical storage area	No
BE-9 Biocide	17,000	51,000	L	Stimulation chemical storage area	Yes
Caustic Soda Liquid	15,000	45,000	L	Stimulation chemical storage area	No
DCA-11001 Breaker activator	5,000	15,000	L	Stimulation chemical storage area	Yes
DCA-13002 Breaker	300	900	kg	Stimulation chemical storage area	Yes
DCA-13003 Breaker	10,000	30,000	L	Stimulation chemical storage area	Yes
DCA-16001 Clay Stabiliser	42,000	126,000	L	Stimulation chemical storage area	No
DCA-17001 Corrosion inhibitor	1,000	3,000	L	Stimulation chemical storage area	Yes
DCA-19001 Crosslinker	600	1,800	kg	Stimulation chemical storage area	Yes
DCA-19002 Crosslinker	10,000	30,000	L	Stimulation chemical storage area	Yes
DCA-23001 Friction reducer	5,000	15,000	kg	Stimulation chemical storage area	No
DCA-23003 Friction reducer	18,000	54,000	L	Stimulation chemical storage area	No
DCA-25005 Gelling agent	35,000	105,000	kg	Stimulation chemical storage area	No
DCA-30001 Scale inhibitor	15,000	45,000	L	Stimulation chemical storage area	No
DCA-32002 Surfactant	15,000	45,000	L	Stimulation chemical storage area	Yes
DCA-32014 Surfactant	200	600	L	Stimulation chemical storage area	Yes
FE-2 Buffer	200	600	kg	Stimulation chemical storage area	No
Hydrochloric acid – 32%	50,000	150,000	L	Stimulation chemical storage area	Yes
Alcohols, C11-14-iso-, C13-rich, ethoxylated- Surfactant	5,285	15,855	L	Stimulation chemical storage area	Yes
Sodium (C14-16) olefin sulfonate - Surfactant	4,658	13,974	L	Stimulation chemical storage area	Yes
Diisobutyl glutarate - plasticiser	627	1,881	L	Stimulation chemical storage area	No
Diisobutyl succinate - plasticiser	209	627	L	Stimulation chemical storage area	No
Diisobutyl adipate- plasticiser	179	537	L	Stimulation chemical storage area	No
Sodium thiosulphate- stabilising agent	4,763	14,289	L	Stimulation chemical storage area	No
Sodium sulphate stabilising agent	913	2,739	L	Stimulation chemical storage area	No
Sodium sulphite stabilising agent	794	2,382	L	Stimulation chemical storage area	No
Ethylene glycol- crosslinker	5,112	15,336	L	Stimulation chemical storage area	Yes
Choline Chloride- Clay stabiliser	10,301	30,903	L	Stimulation chemical storage area	No
Glutaraldehyde- biocide	14,930	44,790	L	Stimulation chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Ammonium sulphate- breaker	4,479	13,491	L	Stimulation chemical storage area	Yes
Polyacrylamide- friction reducer	4,479	13,491	L	Stimulation chemical storage area	No
Sodium polyacrylate- gelling agent	746	2,238	L	Stimulation chemical storage area	No
Sodium bisulfite- stabiliser	149	447	L	Stimulation chemical storage area	No
Alkyl alcohol- surfactant	149	447	L	Stimulation chemical storage area	Yes
2-Propenoic acid, homopolymer, ammonium salt- biocide	149	447	L	Stimulation chemical storage area	Yes
Potassium persulfate- breaker	149	447	L	Stimulation chemical storage area	Yes
2-Ethoxy-naphthalene- surfactant	149	447	L	Stimulation chemical storage area	Yes
Sodium gluconate- stabiliser	8,576	25,728	L	Stimulation chemical storage area	No
Boric -crosslinker	4,288	12,864	L	Stimulation chemical storage area	Yes
Potassium hydroxide- pH control	10,745	32,235	L	Stimulation chemical storage area	Yes
Mannanase- crosslinker	2	6	L	Stimulation chemical storage area	Yes
Ammonium persulfate- breaker	7,451	22,353	L	Stimulation chemical storage area	Yes
Talc- buffer	384	1,152	L	Stimulation chemical storage area	No
Sodium bromate- breaker	50,441	151,323	L	Stimulation chemical storage area	Yes
Hepta sodium phosphonate- emulsifier	3,176	9,528	L	Stimulation chemical storage area	No
Distillates, hydrotreated light- friction reducer	54,231	162,693	L	Stimulation chemical storage area	No
Guar gum- viscosity regulator	15,141	45,423	L	Stimulation chemical storage area	No
Poly-oxyethylene nonylphenol ether- surfactant	4,466	13,398	L	Stimulation chemical storage area	Yes
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite- biocide	4,466	13,398	L	Stimulation chemical storage area	Yes
1,6-Hexanediol- cross linker	447	1,341	L	Stimulation chemical storage area	Yes
Hydrochloric acid- pH control	44,715	134,145	L	Stimulation chemical storage area	Yes
N-benzyl-alkyl pyridinium chloride- pH control	28	84	L	Stimulation chemical storage area	Yes
Formic acid- corrosion inhibitor	38	114	L	Stimulation chemical storage area	Yes
Sodium erythorbate- scaler prohibitor	334	1,002	L	Stimulation chemical storage area	No
Citric acid- pH control	15,878	47,634	L	Stimulation chemical storage area	No
Acetic acid- pH control	15,878	47,634	L	Stimulation chemical storage area	No
Isopropanol- clay management	83	249	L	Stimulation chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Ethoxylated C12-C16 alcohol - surfactant	57	171	L	Stimulation chemical storage area	Yes
Ethoxylated decanol - surfactant	19	57	L	Stimulation chemical storage area	Yes
Cinnamaldehyde- biocide	57	171	L	Stimulation chemical storage area	Yes
Ethoxylated tallow alkyl amine - surfactant	9	27	L	Stimulation chemical storage area	Yes
Methanol- corrosion inhibitor	2	6	L	Stimulation chemical storage area	Yes
Polyacrylamide - friction reducer	49,093	147,279	L	Stimulation chemical storage area	No
Polyethylene glycol trimethylnonyl ether - clay manager	87	261	L	Stimulation chemical storage area	Yes
Water in additive- stabiliser	66,804	200,412	L	Stimulation chemical storage area	No
Potassium sorbate food grade- corrosion inhibitor	14	42	L	Stimulation chemical storage area	No
Mannanase (Mannan endo-1,4-beta-mannosidase)- cross linker	2	6	L	Stimulation chemical storage area	Yes
Nonoxynol-9- surfactant	9	27	L	Stimulation chemical storage area	Yes
2-Ethylhexanol PO/EO polymer- stabiliser	9	27	L	Stimulation chemical storage area	No
Corn oil- friction reducer	662	1,986	L	Stimulation chemical storage area	No
AL-CI-1F - HT Acid Corrosion Inhibitor	1,022	3,066	L	Stimulation chemical storage area	Yes
AL-FE-1F - Iron Control	2,001	6,002	L	Stimulation chemical storage area	Yes
BFL-1F - Low Buffer	2,000	6,000	L	Stimulation chemical storage area	Yes
BHE-01F - Encapsulated AP	173	519	L	Stimulation chemical storage area	Yes
BIO-GQ510 - Biocide 5/10 Glut Quat	38,715	116,144	L	Stimulation chemical storage area	Yes
CSA-1F - Clay Control (70% Choline)	96,786	290,358	L	Stimulation chemical storage area	No
HCL-15B - 15% HCL	508,008	1,524,023	L	Stimulation chemical storage area	Yes
SFT-NE-1F - Flowback Surfactant (NE)	48,666	145,997	L	Stimulation chemical storage area	Yes
BFH-1F - High Buffer	2,000	6,000	L	Stimulation chemical storage area	Yes
FRP-BL1F - HVFR Anionic (Freshwater)	114,830	344,490	L	Stimulation chemical storage area	Yes
LGA-01F - Guar Gel Concentrate	13,594	40,781	L	Stimulation chemical storage area	Yes
SCI-1F - Scale Inhibitor	96,786	290,358	L	Stimulation chemical storage area	No
XLB-C1F - Instant Cross-linker	3,263	9,788	L	Stimulation chemical storage area	Yes

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Completion chemicals					
Sodium chloride – weighting agent	15,000	45,000	kg	Completion chemical storage area	No
ALDACIDE G biocide	500	1,500	L	Completion chemical storage area	Yes
OXYGON Oxygen scavenger	100	300	kg	Completion chemical storage area	No
BARACOR 100 corrosion inhibitor	2,000	6,000	L	Completion chemical storage area	Yes
Sodium Hypochlorite 10–30% cleaner	10,000	30,000	L	Completion chemical storage area	Yes
Drilling chemicals					
CON-DET wetting agent	50	150	kg	Drilling chemical storage area	No
SAPP- sodium acid phosphate cement treatment	50	150	kg	Drilling chemical storage area	No
Bentonite- lubricant	3,000	9,000	kg	Drilling chemical storage area	No
Caustic soda – pH control	1,400	4,200	kg	Drilling chemical storage area	No
EZ MUD DP or EZ MUD Liquid	2,000	6,000	kg	Drilling chemical storage area	No
ALDACIDE G	336	1008	kg	Drilling chemical storage area	Yes
STOPPIT	1,000	3,000	kg	Drilling chemical storage area	No
Soda ash	350	1050	kg	Drilling chemical storage area	Yes
BARACOR 100	250	750	kg	Drilling chemical storage area	Yes
Sodium chloride (flossy salt)	96,000	288,000	kg	Drilling chemical storage area	No
Barite	500	1,500	kg	Drilling chemical storage area	No
BARACARB	500	1,500	kg	Drilling chemical storage area	Yes
Citric acid	500	1,500	kg	Drilling chemical storage area	Yes
BARADEFOAM HP	500	1,500	kg	Drilling chemical storage area	No
Sodium Bicarbonate	500	1,500	kg	Drilling chemical storage area	No
PERFORMATROL	500	1,500	kg	Drilling chemical storage area	Yes
SOURSCAV	500	1,500	kg	Drilling chemical storage area	No
DRIL-N-SLIDE	500	1,500	kg	Drilling chemical storage area	No
STEELSEAL	500	1,500	kg	Drilling chemical storage area	Yes
BARAZAN D or BARAZAN D Plus	4,150	12,450	kg	Drilling chemical storage area	No
PAC L	2,300	6,900	kg	Drilling chemical storage area	Yes
Potassium chloride	22,500	67,500	kg	Drilling chemical storage area	No
QUIK-FREE	500	1,500	kg	Drilling chemical storage area	No
BAROFIBRE, BAROFIBRE Superfine and BAROFIBRE COARSE	500	1,500	kg	Drilling chemical storage area	No
BaraBlend-657	500	1,500	kg	Drilling chemical storage area	Yes
N-DRIL HT Plus	500	1,500	kg	Drilling chemical storage area	Yes
DEXTRID LTE	4,600	13,800	kg	Drilling chemical storage area	No
BARABUF	500	1,500	kg	Drilling chemical storage area	No
BDF 933 or BaraLube W-933	864	2,592	kg	Drilling chemical storage area	Yes
BAROLIFT	500	1,500	kg	Drilling chemical storage area	No
OXYGON	500	1,500	kg	Drilling chemical storage area	No

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
ENVIRO-THIN	500	1,500	kg	Drilling chemical storage area	No
Lime	500	1,500	kg	Drilling chemical storage area	Yes
Calcium chloride	37,000	111,000	kg	Drilling chemical storage area	Yes
Sodium bromide	8,610	24,480	kg	Drilling chemical storage area	Yes
Evolube TR	14,500	43,500	L	Drilling chemical storage area	Yes
Radiagreen EME	4,800	14,400	L	Drilling chemical storage area	Yes
Radiagreen EBL	4,800	14,400	L	Drilling chemical storage area	Yes
Polydrill	7,500	22,500	kg	Drilling chemical storage area	Yes
Alpine spotting beads	1,000	3,000	kg	Drilling chemical storage area	Yes
Barite - weighting agent	354,000	1,062,000	kg	Drilling chemical storage area	No
Bio-Paq HT - filtration control	1,134	3,410	kg	Drilling chemical storage area	Yes
Brine-Pac XTS - corrosion inhibitor	3,400	10,200	L	Drilling chemical storage area	Yes
Calcium chloride - salinity	180,000	540,000	kg	Drilling chemical storage area	Yes
CF Desco - deflocculant	2,270	6,810	kg	Drilling chemical storage area	Yes
Chek Loss - fibrous LCM Cellulose	1,360	4,080	kg	Drilling chemical storage area	No
Citric acid - pH control	1,361	4,083	L	Drilling chemical storage area	Yes
Ecco-Temp - HT extender	8,000	24,000	L	Drilling chemical storage area	Yes
Flowzan - viscosifier	5,000	15,000	kg	Drilling chemical storage area	No
KEM-SEAL™ PLUS – high temperature filtration control agent	4,000	12,000	Kg	Drilling chemical storage area	No
Mil-Lime alkalinity	1,361	4,083	L	Drilling chemical storage area	Yes
Magnesium oxide - pH buffer	7,500	22,500	kg	Drilling chemical storage area	No
Mil-bio SEA 98 - biocide	1,800	5,400	L	Drilling chemical storage area	Yes
Mil-carb - LCM / bridging	5,000	15,000	kg	Drilling chemical storage area	No
Milstarch filtration control	5,000	15,000	kg	Drilling chemical storage area	No
Navi-Lube - lubricant	16,650	49,980	L	Drilling chemical storage area	Yes
New-Drill Plus - shale stabiliser	1,000	3,000	kg	Drilling chemical storage area	No
Noxygen XT - oxygen scavenger	880	2,660	kg	Drilling chemical storage area	No
Ova Col 110 HC - cloud point glycol	13,000	39,000	kg	Drilling chemical storage area	Yes
Potassium chloride salt / shale stabiliser	40,800	122,500	kg	Drilling chemical storage area	Yes
Potassium hydroxide - pH source	1,250	3,750	kg	Drilling chemical storage area	Yes
Pyro-Trol II - HT filtration control	25	75	kg	Drilling chemical storage area	No
Pyro-Vis II - HT viscosifier	1,400	4,200	kg	Drilling chemical storage area	Yes
Soda ash - pH and hardness control	1,000	3,000	kg	Drilling chemical storage area	Yes
Sodium bicarbonate - pH and hardness control	1,000	3,000	kg	Drilling chemical storage area	No

Material name	Typical volume	Maximum volume	Unit	Storage area	Hazardous (Y/N)
Sodium chloride - salt	54,400	163,300	kg	Drilling chemical storage area	No
W.O. defoam - defoamer	600	1,820	L	Drilling chemical storage area	Yes
Xan-Plex D - viscosifier	3,000	9,000	kg	Drilling chemical storage area	No
TEQ-LUBE II - lubricant (25322-6-3)	14,400	43,200	kg	Drilling chemical storage area	Yes
TEQ-LUBE II - lubricant (39464-69-2)	14,400	43,200	kg	Drilling chemical storage area	Yes
NEW-THIN - Polymeric thinner	4,680	14,040	kg	Drilling chemical storage area	No
LC-LUBE - lubricant (graphite)	9,090	27,270	kg	Drilling chemical storage area	No
MAX-GUARD EA	26,000	78,000	L	Drilling chemical storage area	Yes
MAX-GUARD PLUS	26,000	78,000	L	Drilling chemical storage area	Yes
MAX-GUARD PLUS A	26,000	78,000	L	Drilling chemical storage area	Yes
SARALINE 185V	18,603	55,809	kg	Drilling chemical storage area	Yes
General operation chemicals					
Diesel	250	750	KL	Diesel storage tanks	Yes
Hydraulic oil	1,000	3,000	L	Workshop	Yes
Engine oil	1,000	3,000	L	Workshop	Yes
Degreasers	100	300	L	Workshop	Yes
Waste drilling fluids	2,500	7,500	m³	Drilling mud sump	Yes
Completion fluids	1.4	4.2	ML	Drilling mud sump	No
Condensate	10	10	KL	Drilling chemical storage area	Yes
Flowback	~10.8 ML per well		ML	Flowback tanks	Yes
Proppants*					
100 mesh sand	91,000	273,000	kg	Stimulation chemical storage area	No
Quartz or organophilic phyllosilicate- proppant	1,084	3,252	L	Stimulation chemical storage area	No
40/70 sand	1,650,000	4,950,000	kg	Stimulation chemical storage area	No
30/50 sand	610,000	1,830,000	kg	Stimulation chemical storage area	No
Silicon dioxide (quartz/sand) 100% Sand	4,757,614	14,272,842	kg	Stimulation chemical storage area	No
Silicon dioxide (quartz/sand) 40/70	5,435,287	16,305,860	kg	Stimulation chemical storage area	No
* Proppants are sand which is inert. They do not require special chemical bunding but are co-located in the stimulation chemical storage area, within the well pad bund. Residual proppant from a stimulation campaign is often used to assist with chemical spills on the well pad, where contaminated spill material is removed.					
Cleaning chemicals and spill response					
Soda ash – sodium carbonate	3,750	11,250	kg	Stimulation chemical storage area - spill response for acid spills	Yes
Flush fluid - distillates (petroleum), hydrotreated	1,500	4,500	L	Stimulation chemical storage area - Equipment cleaning	Yes

Key environmental risks assessed in the program

The environmental, heritage and social risks associated with drilling, stimulation and well testing activities have been assessed utilising the Tamboran risk assessment framework. The detailed risk assessment presents the range of potential impacts, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence. Key risks assessed under this EMP include:

- Protection of groundwater through sustainable use and zonal isolation
- Assessment and management of chemicals
- Generation and management of wastewater, including prevention of spills
- Generation and management of waste
- Management of erosion and sediment control
- Managing the risk of bushfire in the area
- Mitigating the introduction and spread of weeds
- Generation of greenhouse gases

It was considered that with the appropriate controls implemented to mitigate the impacts there were no residual risks above a rating of medium (Table 6).

Table 6: Summary of residual risk ratings

	Residual Environmental Risk Level			
	Low	Medium	High	Very high
Total – 72	64	8	0	0

The medium risks identified were consistent with standard project and pastoral activities completed across the NT, and are related to soil erosion, spread of weeds, accidental ignition of fire/bushfires and nuisance dust generation.

The medium residual risks sources assessed under this EMP include:

- Loss in soil productivity and viability due to soil erosion from cleared areas (existing access tracks, well pad and camp pad)
- Impact to fauna habitats and listed threatened flora and fauna through the introduction and spread of weeds in the area
- Impact to fauna habitats and listed threatened flora and fauna through accidental ignition of fire from exploration activities (drilling, HFS, flaring, general access)
- Disturbance of sacred site or culturally sensitive area and decline in environmental value of area used for cultural purposes through the accidental ignition of fire by site activities
- Reduction in agriculture productivity through the introduction and spread of weeds in the area
- Reduction in agriculture productivity through bushfire from accidental ignition by site activities or site personnel
- Increased nuisance from dust emissions associated with the activities
- Increased nuisance from dust due to accidental ignition of bushfire during the site activities.

The assessment demonstrates that the risks associated with drilling and stimulation-related activities have been reduced to as low as reasonably practicable (ALARP) and are acceptable. The environmental

outcomes to be achieved during the proposed activities include no significant impacts to the following aspects:

- Ecological function and productivity of soils
- Ecological function of surface water bodies
- The viability of groundwater systems to support ecological, economic and community activities
- The protection of high valued habitats and threatened flora and fauna
- The maintenance of air quality
- The minimisation of GHG emissions
- The protection and enhancement of community and cultural values, places and amenity.

At completion of E&A activities, the sites will be returned to a safe, stable and non-polluting form consistent with pre-disturbed condition and as per the Velkerri 76 S2 Civil Construction EMP (NT-2050-15-MP-31) for the Velkerri 76 S2 site.

Stakeholder engagement

Community engagement for Tamboran's E&A project has focused on the host Traditional Owners facilitated by the Northern Land Council (NLC) and host pastoralists directly affected by the proposed activity. Detailed community and stakeholder engagement is ongoing and covers Tamboran's activities on a broader level and includes the information required under the NT Petroleum (Environment) Regulations 2016.

1 Introduction

1.1 Purpose

Tamboran B2 Pty Ltd (Tamboran) is a registered holder and the operator of exploration permits (EP) 98 and EP76, located in the Beetaloo Sub-basin. This Environment Management Plan (EMP) was the basis of Tamboran's application to the Northern Territory (NT) Minister for Environment for the drilling, hydraulic fracture stimulation (HFS) and well testing at Amungee NW well site and Velkerri 76 S2 well site (Figure 1).

This EMP covers a total of six exploration and appraisal (E&A) petroleum wells as follows:

- Amungee NW well site:
 - Amungee NW-1H (existing)
 - Amungee NW-2H (new)
 - Amungee NW-3H (new)
- Velkerri 76 S2 well site
 - Velkerri 76 S2-1H (existing)
 - Velkerri 76 S2-2H (new)
 - Velkerri 76 S2-3H (new).

The drilling, stimulation and well testing of the E&A wells on each of the exploration sites is considered an important step in confirming the technical and commercial feasibility of the Velkerri shale. The Amungee NW site is located in the dry gas window, with recent data acquired from the existing Amungee NW-1H E&A well confirming better than originally determined shale gas prospectively. The Velkerri 76 S2 is located in the wet gas window, with indicative results collected during the drilling of Velkerri 76 S2-1 confirming the presence of wet gas.

The Amungee NW well site is an existing site located on the Amungee Mungee station within EP98. It contains the existing Amungee NW-1H E&A well, which was drilled in 2015 and 2016 under the previously approved Beetaloo Sub-basin EP98 and EP117 Exploration Drilling EMP ([Origin-2015](#)) and Amungee NW-1H EPT EMP ([ORI7-2](#)).

Also located on the Amungee Mungee station but within EP76, Velkerri 76 S2 was constructed under the Beetaloo Basin Velkerri 76 S2 Civil Construction EMP ([ORI4-1](#)) and contains the Velkerri 76 S2-1 E&A well which was vertically drilled in 2021 under the approved Beetaloo Basin Drilling, Stimulation and Well Testing Program Velkerri 76 S2 EMP ([ORI5-4](#)). Following this, Velkerri 76 S2-1 well deferred the horizontal drilling section, hydraulic fracturing and well testing to the 2025-2026 period.

This EMP update includes the regulated activities that are required to enable Tamboran to drill, stimulate, test, maintain and decommission the E&A wells on Amungee NW and Velkerri 76 S2 site within the 2022-2026 period. As at this date of this EMP version, there have been eight (8) regulation 22 notifications:

- ORI10-3.1 Water bore location change (Amungee NW2)
- ORI10-3.2 Change to HF fluids
- ORI10-3.3 Change to completion fluids
- ORI10-3.4 Bore infrastructure and EMP edits
- ORI10-3.5 Roll up of remaining civil works for Velkerri 76 S2 well site including gravel pits, access tracks and associated activities
- ORI10-3.6 Roll up of remaining DST activities for Velkerri 76 S2 drilling, stimulation and well testing activities

- ORI10-3.7 Roll up of Amungee NW-1H EPT.
- ORI10-3.8 Amungee Multi-well EMP update, including stormwater amendments and addition of chemicals.

All wells target the Velkerri shale resource, though the Amungee NW is dry shale and the Velkerri 76 S2 wells are wet gas. The drilling, stimulation and well testing of the E&A wells at the existing sites is considered an important step in confirming the technical and commercial feasibility of the Velkerri shale resource. The use of multi-well pads is likely to significantly reduce the environmental footprint of any potential development.

The EMP has been prepared in compliance with the NT Petroleum (Environment) Regulations 2016, Code of Practice: Onshore Petroleum Activities in the Northern Territory (referred to herein as the “Code of Practice”) and the Exploration Agreements between Tamboran, Native Title holders and the Northern Land Council (NLC).

The overall objective of the EMP is to ensure that the proposed activities, are carried out in a manner by which the environmental impacts and risks will be reduced to a level that is as low as reasonably practicable and are acceptable.

More specifically, this EMP aims to:

- address regulatory requirements
- provide site-specific impact management strategies to assist Tamboran in maintaining a positive position in the local community throughout its program
- align with the principles of Ecological Sustainable Development (ESD) through the adoption of responsible development practices that are designed to maximise social benefit, while minimising the level of impact on the surrounding ecosystems
- provide a description of site-specific aspects of the existing environment (physical, biological, social and cultural)
- provide site-specific plans for monitoring and rehabilitation
- be a practical and usable document, with environmental management principles that are easily implemented and effective.

1.2 Project boundary

Tamboran propose to drill, stimulate and test up to six petroleum E&A wells on the Amungee NW well site (3 wells) and Velkerri 76 S2 well site (3 wells) within EP98 and EP 76 (total of four new wells). These wells will target the Velkerri shale resource.

The boundary of this EMP is defined as the area which may be affected by E&A activities. This includes:

- use and maintenance of existing access tracks to the Velkerri 76 S2 well site and Amungee NW well site
- 1.1 km access track to the Amungee NW2 location (1.5 ha)
- existing Amungee NW and Velkerri 76 S2 well pad, camp pad, and associated infrastructure (i.e. gravel pits (VGP1, VGP2 and VGP3), water bores, laydown yard, helipad and stockpile storage areas)
- existing Velkerri 76 S2 chemical storage areas, well pad bund, sediment basin, wastewater tanks and drilling sump
- proposed expansion of the existing Amungee NW well pad and camp pad, including the installation of a new fence line and fire break

- proposed construction and operation of a helipad and laydown yard at Amungee NW and operation of the helipad at Velkerri 76 S2
- proposed installation of the two impact monitoring bores (IMB) and an additional two groundwater extraction bores for additional water supply/ monitoring on the existing Velkerri 76 S2 well site (up to 6 in total) and 2 groundwater monitoring bores at the Amungee NW2 location (2.0 ha).
- groundwater extraction and compliance under the water extraction licence # GRF 10285
- drilling two additional petroleum E&A wells at Amungee NW well site and two additional and one re-entry petroleum E&A wells at Velkerri 76 S2 well site (three petroleum E&A wells per site)
- Proposed stimulation, well testing and suspension and abandonment of up to three petroleum E&A wells at each of the Amungee NW and Velkerri 76 S2 sites
- asset maintenance and monitoring activities
- site decommissioning and rehabilitation
- all activities ancillary of the above.

The proposed locations of the infrastructure and associated regulated activities are provided in Table 7, and shown in Figure 5 to

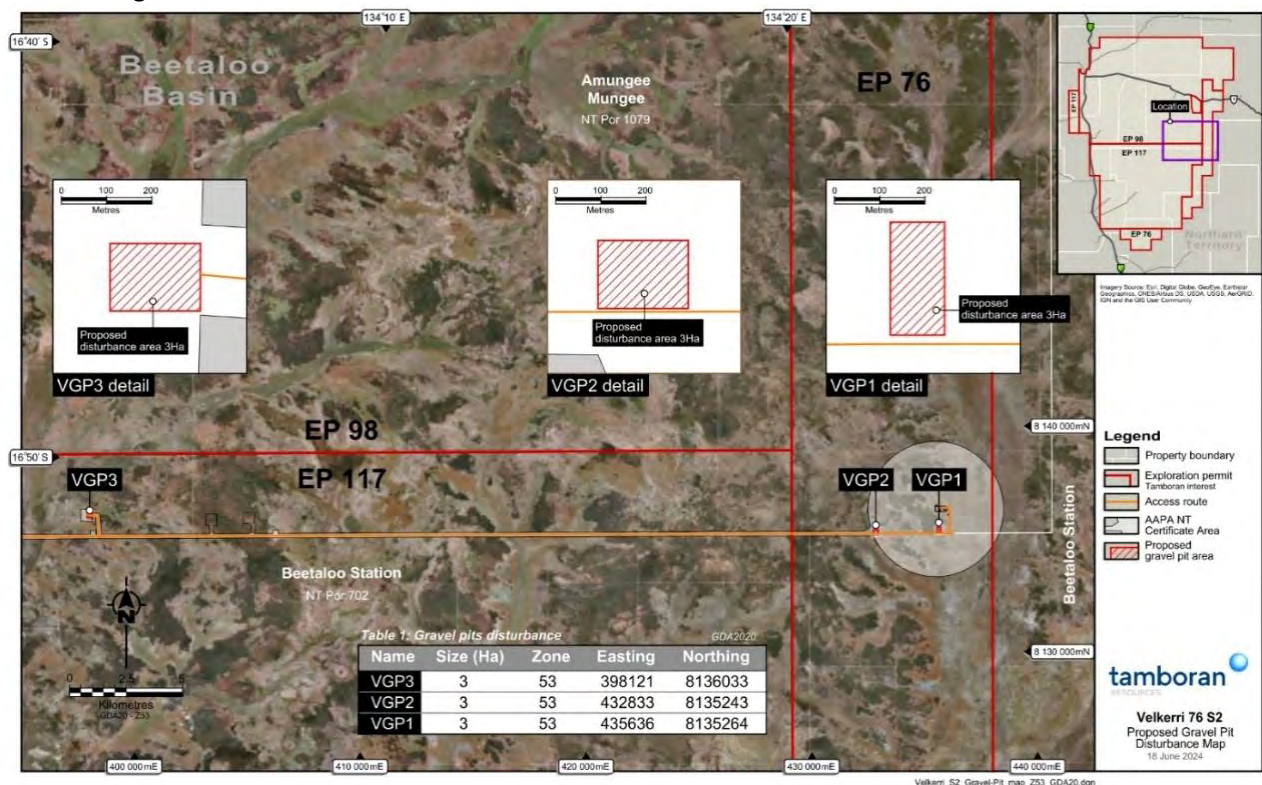


Figure 8.

Table 7: Associated exploration sites and infrastructure covered under this EMP

Exploration Permit	Infrastructure name	Station	Zone*	Approx. Easting	Approx. Northing
Amungee NW					
EP98	Amungee NW well site	Amungee Mungee	53	380859	8192299
EP98	Amungee NW-1H E&A well	Amungee Mungee	53	380859	8192299
EP98	Amungee NW-2H E&A well	Amungee Mungee	53	381023	8192312
EP98	Amungee NW-3H E&A well	Amungee Mungee	53	381040	8192311
EP98	Amungee NW main camp and proposed extension	Amungee Mungee	53	380855	8192763
EP98	Existing control monitoring bore RN040894	Amungee Mungee	53	380944	8192235
EP98	Amungee NW helipad	Amungee Mungee	53	380950	8192781
EP98	Amungee NW laydown	Amungee Mungee	53	380889	892531
EP98	Monitoring bores (x2) at the Amungee NW2 location	Amungee Mungee	53	389882	8190068
EP98	Access tracks	Amungee Mungee	Not Applicable		
EP98	Access track at Amungee NW2	Amungee Mungee	53	389488	8191084
Velkerri 76 S2					
EP 76	Velkerri 76 S2 well site	Amungee Mungee	53	435557	8137497
EP76	Velkerri 76 S2-1 E&A well	Amungee Mungee	53	435578	8136331
EP 76	Velkerri 76 S2-2H E&A well	Amungee Mungee	53	435578	8136346
EP 76	Velkerri 76 S2-3H E&A well	Amungee Mungee	53	435578	8136362
EP 76	Velkerri 76 S2 main camp	Amungee Mungee	53	435632	8136163
EP 76	Gravel Pit - VGP1	Amungee Mungee	53	398121	8136033
EP 76	Gravel Pit – VGP2	Amungee Mungee	53	432833	8135243
EP 76	Gravel Pit – VGP3	Amungee Mungee	53	398121	8136033
EP 76 / EP 117	Access tracks (tracks to gravel pits, well site and 80 km existing pastoral track – 18.3 ha)	Amungee Mungee	Refer Figure 5 and Figure 8		

* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.

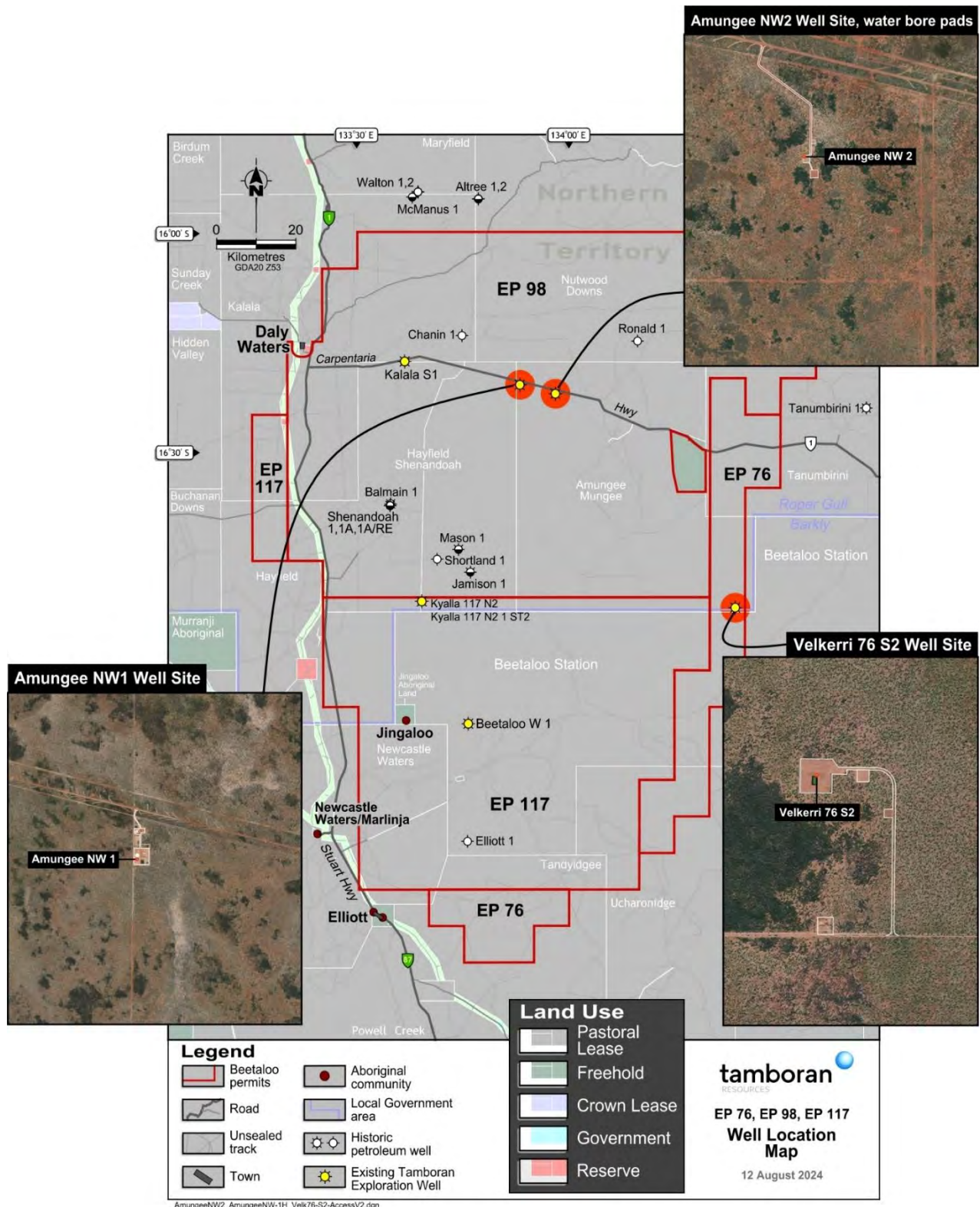


Figure 5: Location of the Amungee NW, Amungee NW2 and Velkerri 76 S2 sites

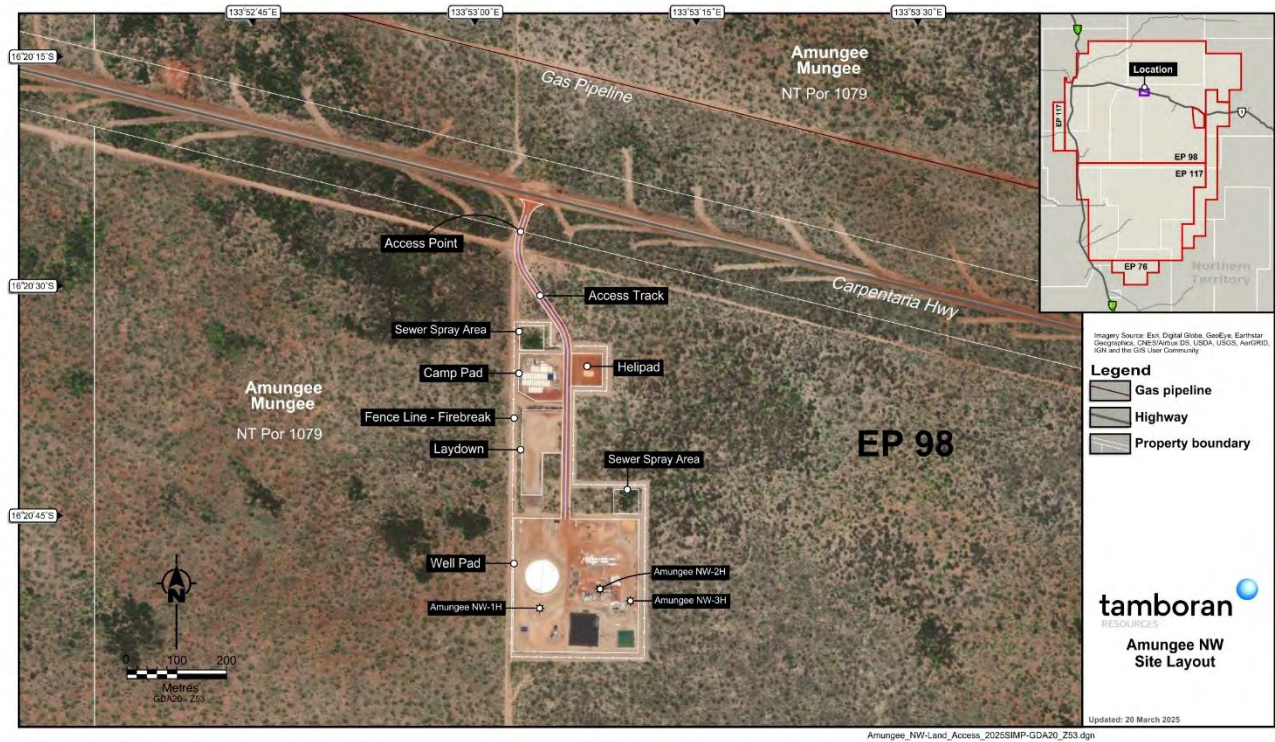


Figure 6: Amungee NW site layout

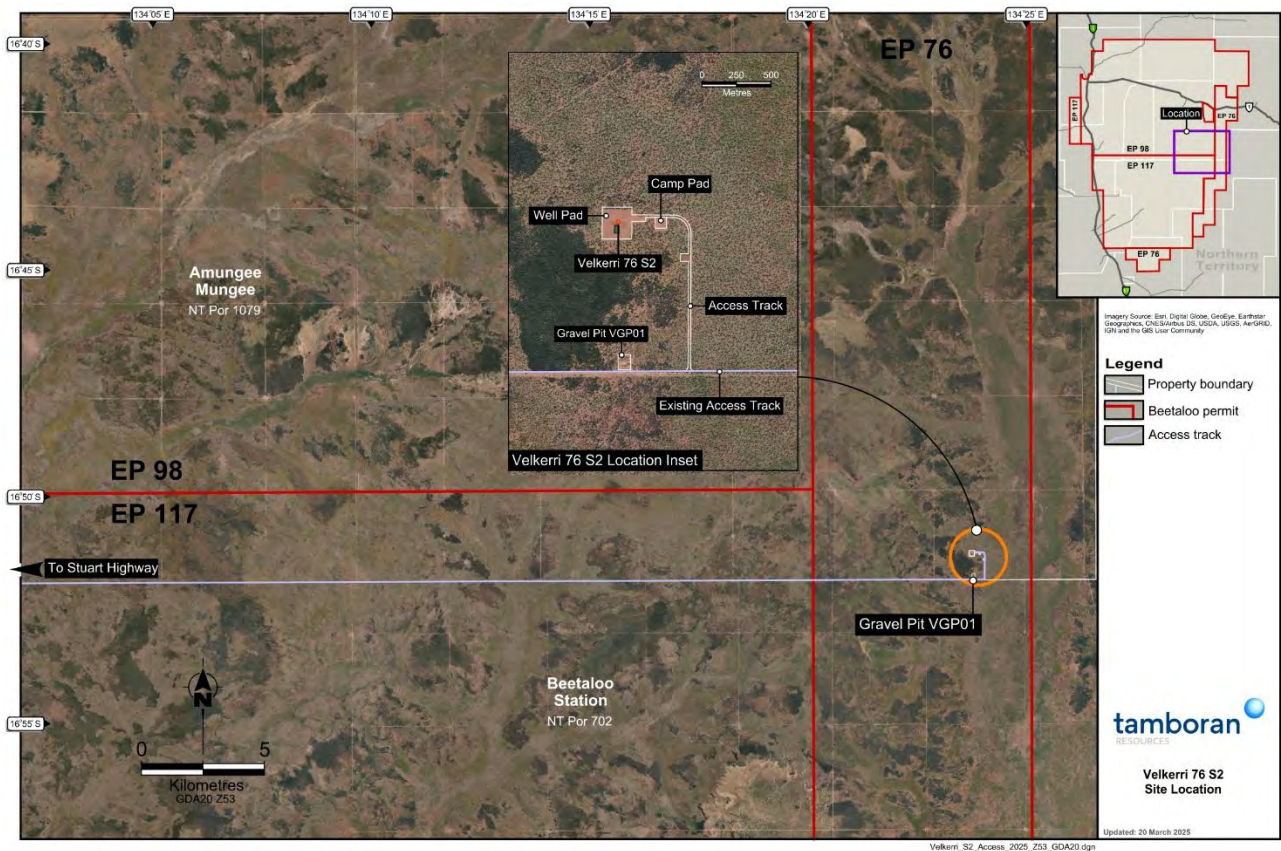


Figure 7: Velkerri 76 S2 NW site layout

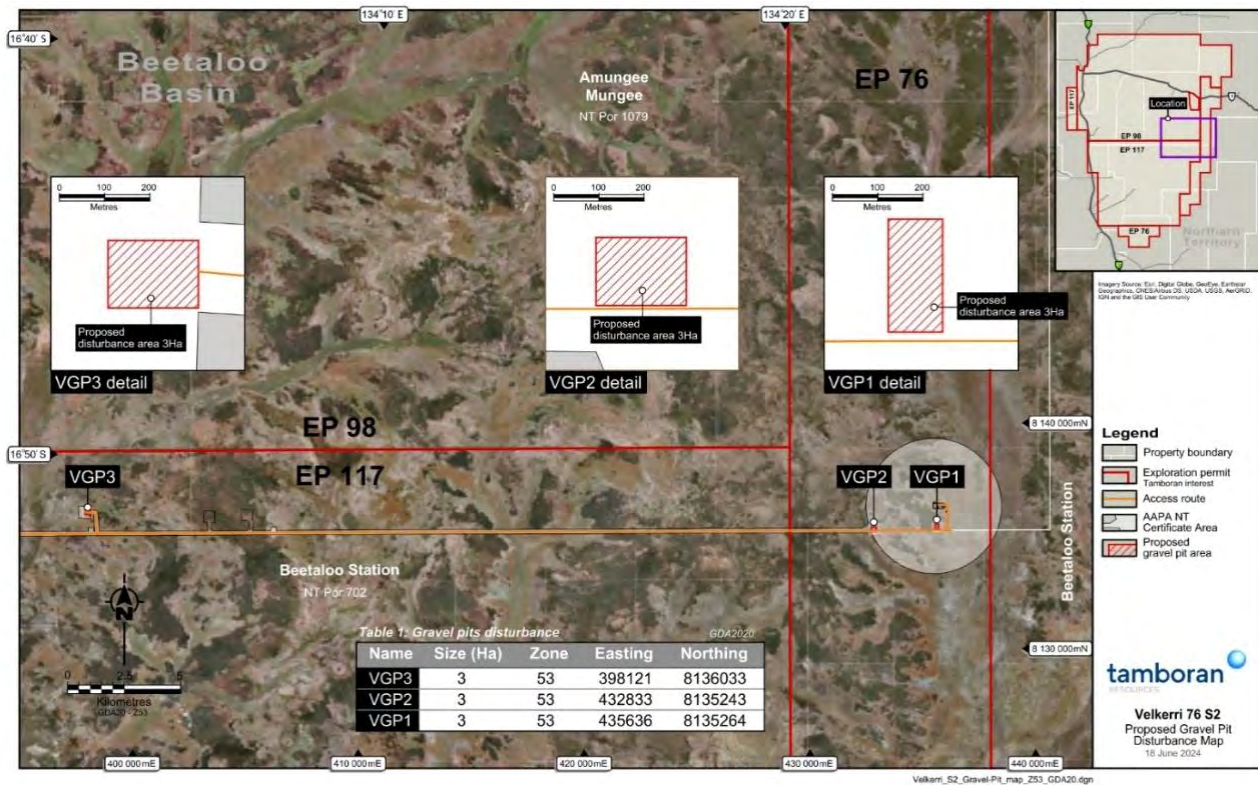


Figure 8: Location of gravel pits VGP1, VGP2 and VGP3

1.3 Proponent

Attribute	Details
Name:	Matt Kerne
Position:	Vice President, Environment and Approvals
Company:	Tamboran B2 Pty Ltd
Address:	C/- Tower One, International Towers, Suite 1, Level 39, 100 Barangaroo Avenue, Barangaroo NSW 2000 Australia
Contact details:	Tamboran.contact@tamboran.com +61 2 8330 6626
Non-operating proponent	
Name:	Ann Flynn
Position:	Director
Company	Falcon Oil & Gas Australia Limited
Address:	C/- 17 Phoenix Street, Nightcliff, Northern Territory 0814 Australia
Contact details	aflynn@falconoilandgas.com

1.4 Multi-well pads

The additional two E&A wells proposed at the Amungee NW and Velkerri 76 S2 sites covered under this EMP are a natural evolution in the Beetaloo Sub-basin E&A project to provide a proof-of-concept for a multi-well pad use within the Velkerri shale resource. The installation of the additional wells on the existing well pads at Velkerri 76 S2 and on the extended well pad at Amungee NW will obtain critical subsurface and surface information used to understand the potential productivity of the reservoir and minimise the environmental impact of a future development. The use of multi-well pads is likely to significantly reduce the environmental footprint of any potential development and significantly increase the economic viability of the resource.

The appraisal results collected from these wells will be used to:

- Validate reservoir flows from the Velkerri target formation at both the Amungee NW and Velkerri 76 S2 site with multiple wells.
- Optimise HFS design and spacing between adjacent horizontal wells in a multi-well pad operation.
- Optimise multi-well pad layout of surface operations for a potential future development scenario, with the core objective of minimising the environmental footprint, including minimising land clearance, maximising water reuse and reducing greenhouse gas emissions (GHG).
- Determine optimal well spacing at a well pad to inform development of the Mechanical Earth Model (MEM) for a potential future Velkerri development (subject to E&A success).
- Demonstrate design requirements and operability of multi-well pad operations across all seasons in the Beetaloo Sub-basin.
- Assess the financial competitiveness in multi-well pad development scenarios to inform Final Investment Decision for future development scenarios.
- Demonstrate no impact to groundwater quality at a well site in a multi-well pad operation.
- Collect additional data on flowback quality and quantity during a multi-well pad operation to assess options for minimising off-site wastewater for off-site disposal through future treatment and re-use.
- Provide key data as input into future Environmental Impact Statements including footprint optimisation, flowback characterisation, GHG emission intensity and solid and liquid management.

1.5 Broader exploration project

Tamboran is part-way through a 5-year exploration and appraisal work program, with seven exploration wells being drilled across its tenure by Tamboran. The ongoing drilling and testing of E&A wells are a tenure commitment that must be fulfilled by Tamboran to comply with the tenure work program requirements. Once Tamboran's 5-year work program commitments have been achieved, Tamboran will submit a new work program to DME for approval, to further assess and evaluate the prospectively of the shale resources in the region.

To provide an understanding of how the Beetaloo exploration and appraisal program may evolve in the future, a project conceptual road map is provided in Figure 9. As demonstrated in this conceptualisation, the Beetaloo project is in the early appraisal phase, which aims to assess whether hydrocarbons from a prospective shale formation identified during exploration can be successfully and commercially 'produced'. The conceptualisation also illustrates the reality of E&A programs, with multiple avenues for appraisal failure that may result in some or all prospective resources being assessed as unviable.

Given the level of uncertainty about the future viability of the project beyond the exploration and appraisal phase, the cumulative impact assessment has been restricted to the current existing wells and those approved and proposed (11 wells: five existing, two additional approved and four proposed under this EMP). This boundary of the cumulative impact ensures an assessment can be made about what is reasonably known and planned, rather than what could eventuate, if a successful result was achieved. The cumulative impact of the project will be continuously refined as a part of subsequent project approvals.

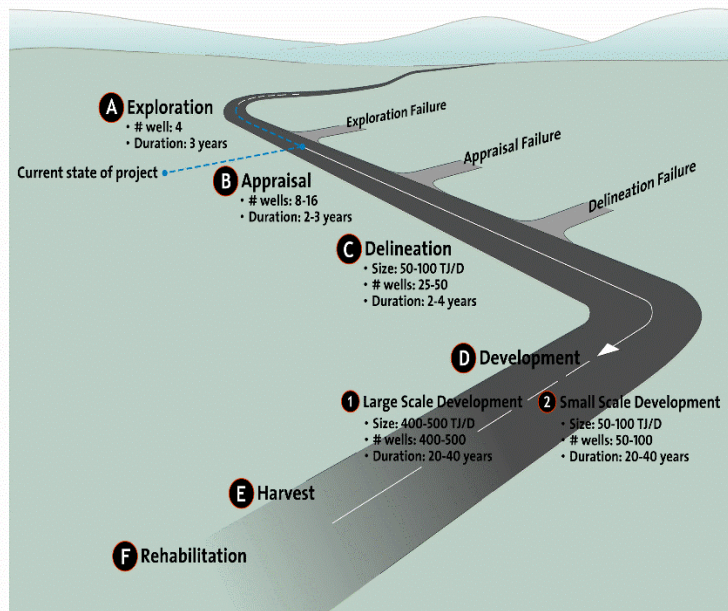


Figure 9: Conceptual Beetaloo Sub-basin project pathway from exploration to development

2 Environmental legislation and other requirements

Key Northern Territory (NT) and Commonwealth legislation, agreements, operating consents, guidelines and Codes of Practice relevant to the activities described in this EMP are summarised in Table 8. This EMP has been prepared in relation to these requirements.

Table 8: Key legislation

Legislation	Requirement	How Tamboran meets the requirement	Administered by
Northern Territory			
<i>Petroleum Act 1984</i>	Petroleum exploration licences are required in the areas where activities are proposed.	Exploration permits obtained. Minister provides the final sign off authorising Petroleum activities.	Department of Mines and Energy (DME)
	Compensation to be paid to native title holders and owners/occupiers of land where petroleum activities are proposed.	Exploration Agreements obtained with native title holders. Compensation paid to pastoralists for all activities proposed under this EMP.	
	The NT Schedule of Onshore Petroleum Exploration and Production Requirements ('NT Schedule'), should be listed. It covers key regulatory requirements for operational management of well activities in conjunction with the NT Code of Practice for Petroleum Activities.	Requirements addressed in the Well Operations Management Plan (WOMP)	DME
NT Petroleum (Environment) Regulations 2016	Ensuring all regulated activities have an approved EMP.	This EMP has been developed to satisfy this requirement.	Department of Lands, Planning and Environment (DLPE)
	That the EMP is developed in accordance with the NT Petroleum (Environment) Regulations 2016 (the Regulations).	Tamboran has developed this EMP in accordance with the Regulation requirements.	
	That stakeholder engagement for the regulated activities is undertaken.	Tamboran has completed stakeholder engagement in accordance with the Regulations, as summarised in section 5 of this EMP.	
	That activities are conducted in accordance with the Code of Practice: Onshore petroleum activities in the Northern Territory.	The EMP outlines how the activities will be conducted in accordance with the Code.	

Legislation	Requirement	How Tamboran meets the requirement	Administered by
	Reporting requirements for incidents and hydraulic fracturing.	The EMP summarises how incidents and flowback monitoring results will be reported.	
<i>Bushfires Management Act 2016</i> and Regulations	Compliance with total fire bans and fire permitting.	Tamboran will not undertake flaring or the lighting of fires during periods of total fire bans and will obtain a permit where flaring occurs during declared fire danger periods.	Bushfires NT
	Requirements for occupiers to prevent and control fires.	Addressed through Tamboran's Bushfire Management Plan (Appendix A) which includes bushfire preventative and response measures.	
	Aerial burning permits.	Tamboran will acquire permits where aerial burning to manage fuel loads is proposed as a part of its ongoing bushfire management activities. Tamboran does not consider that aerial burning will be required.	
<i>Control of Roads Act 1953</i> and <i>Northern Territory Traffic Act 1987</i>	Any proposed development which may affect the Territory road network, including traffic, operation, management, capacity or safety, or result in the construction or installation of new infrastructure within the NTG road network, requires assessment and Road Agency Approval.	Tamboran has completed engagement with the Department of Lands and Infrastructure (DLI) regarding proposed and ongoing traffic management.	DLI
<i>Emergency Management Act 2013</i>	Establishes the requirements for local, regional and Territory emergency management plans. Describes the functions and powers of the NTES, Territory Emergency Controller, Territory Recovery Controller and Territory Emergency Management Committee.	Tamboran complies with the Act through the development of an emergency response plan and the identification of NTES as a stakeholder.	NTES
<i>Environment Protection Act 2019</i>	Activities which have the potential to cause a significant impact to the environment are required to be referred to the NT EPA for assessment under the <i>Environment Protection Act 2019</i> .	Tamboran has completed a self-assessment. The level of potential environmental impact is not considered significant.	Northern Territory Environment Protection Authority (NT EPA) DLPE
<i>Heritage Act 2011</i>	Requirements to avoid impacts to heritage places and objects.	Tamboran completed desktop studies and field scouts to confirm the presence / absence of	Heritage Branch, DLPE

Legislation	Requirement	How Tamboran meets the requirement	Administered by
		heritage places and objects within the vicinity of the proposed activities.	
<i>Northern Territory Aboriginal Sacred Sites Act 1989</i>	The legislation establishes a procedure for the protection and registration of sacred sites and the issuing of sacred site clearance certificates. Access and work within sacred sites require authorisation.	All areas of Tamboran's proposed activities have had sacred site clearances completed by traditional owners. Aboriginal Areas Protection Authority (AAPA) certificates for all exploration activities have been obtained for all activities proposed in this EMP.	AAPA
<i>Public and Environmental Health Act 2011</i>	Requirements for camp kitchens and wastewater (sewage and greywater) management and permitting in the NT.	Tamboran's camps are registered, and a wastewater works design approval for the camps sewage treatment plan irrigation area has been obtained.	Department of Health
<i>Radiation Protection Act 2004</i>	Requirements for the management of radiation for the health and safety of community and protection of the environment.	Tamboran complies with the Act through proper handling of and disposal of drill cuttings.	Department of Health
<i>Territory Parks and Wildlife Conservation Act 1976</i>	Prohibits impacts to protected places, impacts to threatened flora and fauna and interference with protected wildlife.	Tamboran complies with the Act through the avoidance of impacts to protected places (essential habitat, sanctuaries, parks etc.) and flora and fauna. This is completed through ecological surveys and the controls implemented to limit the impact on wildlife.	Parks and Wildlife DLPE
Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Regulations 2011	Regulations stipulating the transportation requirements for dangerous goods by road and rail. This includes implementing all required signage, spill management, reporting and licencing requirements for chemical transportation during drilling and stimulation activities.	Any chemical transported and stored for exploration activities is undertaken in a manner that will comply with these requirements.	NT WorkSafe, Department of the Attorney-General and Justice
<i>Waste Management and Pollution Control Act 1998 (WMPCA)</i>	Requirements covering general environmental duty, waste management, including waste management hierarchy, waste transportation and waste disposal requirements.	The storage, transportation and disposal of wastes will comply with the requirements of this Act. The transportation and disposal of listed wastes will only be completed by a licenced contractor and at a licenced disposal facility.	NT EPA

Legislation	Requirement	How Tamboran meets the requirement	Administered by
		Any interstate disposal will be completed with an approved consignment authority.	
	S12 General environmental duty: Applies to activities outside of the well site area, or if a spill or leak occurs that leaves the well site area, or 1 km from the centreline of a pipeline.	Tamboran will conduct all activities outside the approved disturbance area (camp area, well pad, access tracks authorised in the EMP) in a manner that prevents environmental harm.	
	S14 Duty to notify of incidents causing or threatening to cause pollution: Applies if an incident occurs outside of the well site area, or if a spill or leak occurs that leaves the well site area, or 1 km from the centreline of a pipeline, that causes or threatens to cause material or serious environmental harm.	Tamboran will report all incidents that causes or threatens to cause pollution beyond the boundary of the authorised activity (beyond the well pad or camp pad), in accordance with Section 14 of the WMPCA.	
Water Act 1992 and Water Regulations 1992	The Act requires that all groundwater take in the Beetaloo Sub-basin must have obtained a Water Extraction Licence (WEL).	Tamboran has obtained a WEL GRF 10285 (450 ML/year) covering water usage for exploration activities (Appendix B). WELs are renewed periodically to support operational activities.	Water Resources Division, DLPE
	The take of surface water for petroleum activities is prohibited.	No surface water take is proposed under this activity.	
	Prohibits wastewater releases to surface water bodies or reinjection.	No wastewater release to surface water proposed.	
	The Act requires an interest holder to obtain a permit if activities undertaken under the Act all result in interference with a waterway.	The proposed activities occur on existing EPs with additional clearing to occur on EP98 to expand the well pad. No activities will result in interference with a waterway.	
	The Act requires an interest holder to obtain a bore work permit for any new groundwater bores.	Tamboran will obtain a bore work permit for any new groundwater bores as required.	

Legislation	Requirement	How Tamboran meets the requirement	Administered by
<i>Weeds Management Act 2001</i>	Requires the occupier of the land (in this case Tamboran) to: (a) to prevent the spread of weeds in, into and out of the Territory; and (ab) to minimise the impact of weeds in the Territory; and (ac) to ensure that the management of the spread of weeds is an integral component of land management; and (ad) to ensure that the management of the impact of weeds is an integral component of land management; and (b) to ensure there is community consultation in the creation of weed management plans; and (c) to ensure that there is community responsibility in implementing weed management plans.	Tamboran will comply with the requirement of this Act through the implementation of weed prevention, detection and eradication controls through its approved Weed Management Plan (Appendix C).	Weed Management Branch, DLPE
<i>Work Health and Safety (National Uniform Legislation) Act 2011</i>	Provides for a nationally consistent framework to secure the health and safety of workers and workplaces. Includes requirements for hazardous chemical assessments, hazardous chemical register, access to safety data sheets, labelling, and the use, handling, generation and storage of hazardous chemicals at a workplace.	Tamboran has a Safety Management Plan that outlines how the requirements of the Act are achieved. This includes the management of chemical storage dossiers, safety data sheets (SDS) and appropriate procedures and controls to prevent worker exposure to hazards.	NT WorkSafe, Department of the Attorney-General and Justice
Commonwealth			
<i>Environment Protection and Biodiversity Conservation Act 1999</i>	Requires approvals for any activity likely to have an impact on a Matter of National Environmental Significance (MNES).	A self-assessment was completed as a part of this EMP to determine whether a MNES is likely to be impacted by the proposed activities within this EMP. Impacts to MNES are not anticipated to occur.	Department of Climate Change, Energy, the Environment and Water (DCCEEW)
<i>National Greenhouse and Energy Reporting Act 2007</i>	An Act that requires operators who generate emissions over a threshold to report information related to greenhouse gas emissions, greenhouse gas projects, energy consumption and energy productions of corporations.	All energy consumption and greenhouse gas data used/generated from this activity will be reported as required in accordance with this Act.	DCCEEW

Legislation	Requirement	How Tamboran meets the requirement	Administered by
National Environment Protection Council Act 1994 (National Environment Protection (Assessment of Site Contamination) Measure 1999) (NEPM)	This Act provides a nationally consistent approach to the assessment of site contamination to ensure sound environmental management practices to protect human health and the environment.	Tamboran uses the NEPM to assess risk of contamination and for the assessment of the drilling fluids for disposal.	DCCEEW
<i>Native Title Act 1993</i>	Legislation that provides for ways in which future dealings affecting native title may proceed and the recognition and protection of native title. The Right to Negotiate requirements are the most relevant provisions applying to Tamboran's exploration activities.	The Right to Negotiate process was applied to the grant of Tamboran's permits, resulting in Section 31 Agreements and Exploration (Ancillary) Agreements covering Tamboran's permits. The traditional owners were and continue to be represented by the NLC. Tamboran continues to implement the Exploration Agreements, with all work programs being reviewed and approved by traditional owners. This includes engagement with the NLC as the nominated representative of the Native Title Holders (NTH). Tamboran has engaged with traditional owners on the activities proposed in this EMP in accordance with the requirements of the Exploration Agreement. This includes on country meetings where the proposed activities covered under this plan have been discussed.	Prime Minister and Cabinet (Divisions 6 and 7 of Part 2, and Part 11) Attorney-General's Department (except to the extent administered by the Minister responsible for Indigenous Affairs)

2.1 Alignment with the principles of Ecologically Sustainable Development (ESD)

This EMP is consistent with the principles of Ecologically Sustainable Development (ESD) through the adoption of responsible practices that are designed to maximise social benefit, while minimising the level of impact on the surrounding ecosystems.

Principles of Ecologically Sustainable Development (as defined in the NT Petroleum (Environment) Regulations 2016)

1. Decision making principle – decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations
2. Precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation
3. Principle of evidence-based decision making – decisions should be based on the best available evidence in the circumstances that is relevant and reliable
4. Principle of intergenerational and intragenerational equity – that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations
5. Principle of sustainable use – natural resources should be used in a manner that is sustainable, prudent, rational, wise and appropriate
6. Principle of biological diversity and ecological integrity – the conservation and maintenance of biological diversity and ecological integrity should be a fundamental consideration in decision-making
7. Principle of improved valuation, pricing and incentive mechanisms – improved valuation, pricing and incentive mechanisms should be promoted including market based environmental incentives, the polluter pays principle, life cycle analyses, and the inclusion of environmental factors in the valuation of assets and services.

Tamboran's exploration activities align with the principles of ESD:

- Exploration activities are an essential step in defining a potential future commercial resource which can generate sustainable, long-term benefits to the local community, to the Barkly region generally and more broadly into the rest of the NT (Principles 1 and 5)
- Complying with the Petroleum Code of Practice and industry best practice to reduce the risk to the environment and communities to an acceptable level. Noting the Inquiry Panel's Final Report Statement that "provided that all of the recommendations made in this Report are adopted and implemented in their entirety, not only should the risks associated with an onshore shale gas industry be minimised to an acceptable level, in some instances, they can be avoided altogether." (Scientific Inquiry into Hydraulic Fracturing in the Northern Territory 2018) (All principles)
- The activities that are the subject of the EMP do not constitute threats of serious or irreversible environmental damage and there is no impact on the conservation of biological diversity and ecological integrity (Principles 4 and 6)
- Beyond royalty payments to the NT Government (as owner of the natural resource), and payments to Native Title Holders (as per Exploration Agreements) and host pastoralists (as per Access and Compensation Agreements), Tamboran seeks to maximise broad-based local participation in education, training, employment and enterprise opportunities engendered by its presence (Principles 1 and 5)
- Prioritising the use of local employment to deliver exploration activities (Principles 1 and 5)

- Obtaining sacred site clearances from host Traditional Owners through open engagement with custodians, the Statutory Representative body – the Northern Land Council (NLC) and the Aboriginal Ara Protection Authority (AAPA) (Principles 1, 4 and 5)
- Obtaining Land Access Agreements with host pastoralists (Principles 1 and 5)

3 Description of regulated activities

This EMP covers the regulated activities required to enable Tamboran to drill, stimulate, test, maintain and decommission the four proposed horizontal E&A wells within the 2022-2026 period. To accommodate this scope, the activities summarised in Table 9 are proposed to be executed under this EMP.

Table 9: Amungee E&A program activity summary

Activity	Description
Amungee NW scope	
Civil construction activities	- Expansion of the existing Amungee NW site well pad from 3.56 ha to 10 ha to accommodate the new exploration and appraisal (E&A) wells and anticipated freshwater and wastewater storage - Upgrade of the access track intersection with the Carpentaria Highway to comply with Department of Infrastructure, Planning and Logistics requirements. Including construction of a new access track (1.1 km) into the Amungee NW2 location (1.5 ha) - Expansion of the existing camp pad from 0.9 ha to 1.2 ha - Installation of two additional E&A well cellars and conductors on the well pad to accommodate the proposed Amungee NW-2H and Amungee NW-3H wellhead and surface facilities - Construction of a drilling sump on the well pad to manage drilling fluids, muds and cuttings of up to 5,000 m³ - Construction of a site bund for wastewater storage - Construction of a sediment basin to manage stormwater during wastewater storage - Drilling of up to four additional groundwater monitoring/ extraction bores within the proposed exploration areas (if required), including 2 groundwater monitoring bores at Amungee NW2 (2.0 ha) approximately 11 km to the east of the existing Amungee NW well pad in preparation for future exploration activities - Construction of a helipad (up to 1 ha) and laydown area (up to 1 ha) - Construction of a 20 m x 2 km fence line and firebreak around the Amungee NW site (~4 ha)
Site set-up and mobilisation to support the Amungee NW-2H and Amungee NW-3H E&A wells	- Use of existing access tracks to and from the Amungee NW site from the Carpentaria Highway - Set-up of two temporary camps – a main camp located on the camp pad (~70-person capacity) and a drilling mini-camp located on the well pad (~8-person capacity) - Set-up of chemical and material storage areas - Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units - Set-up of hydraulic fracture stimulation (HFS) equipment, completions rig and equipment, well testing equipment, and other associated equipment at Amungee NW - Approximately 44 traffic movements per day during site demobilisation
E&A activities at the Amungee NW site including drilling, hydraulic fracture stimulation (HFS) and well testing of Amungee NW-1H, Amungee NW-2H and Amungee NW-3H	- Operation of the two temporary camps - Transportation, handling and storage of bulk chemicals, fuels and wastes - Drilling of the Amungee NW-2H and Amungee NW -3H horizontal E&A wells, including the collection of reservoir quality data during drilling

Activity	Description
	- Well design in accordance with the Code of Practice and approved Well Operations Management Plan (WOMP) including isolation of freshwater aquifers - HFS of Amungee NW-2H and Amungee NW-3H - Completion of Amungee NW-2H and Amungee NW-3H E&A wells - Extended production testing of the Amungee NW-1H, Amungee NW-2H and Amungee NW-3H E&A wells - Gas flaring in accordance with Code of Practice requirements and as per US EPA 40 CFR 63.11, with a flare tip combustion efficiency of 98% - Beneficial use of appraisal gas for on-site power generation and use - Maintenance and monitoring works on Amungee NW-1H, NW-2H and Amungee NW-3H wells (including well workovers) in accordance with approved WOMP - Build up testing, suspension and decommissioning Amungee NW-1H, Amungee NW-2H and Amungee NW-3H E&A wells (if required) in accordance with the Code of Practice - Groundwater extraction of approximately 110 ML under existing groundwater extraction licence (WEL GRF 10285) - Monitoring activities (including groundwater, stormwater, soils, leak detection and all other low impact ancillary data collection programs)
On-site wastewater management to support ongoing E&A program	- On-site wastewater storage and treatment in accordance with Code of Practice - Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater - Drill cuttings and flowback fluid quality testing in accordance with the Code of Practice - Disposal of drill cuttings within EP98 is subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code of Practice - Drilling waste storage and disposal located within the existing Amungee NW site or transported off-site - On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options) - Off-site disposal of wastewater in accordance with the <i>Waste Management and Pollution Control Act</i>
Site demobilisation	- Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment - Approximately 44 traffic movements per day during site demobilisation
Site rehabilitation	- Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment - Final rehabilitation activities to return the sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition

Activity	Description
Velkerri 76 S2 scope	
Civil construction activities	• Velkerri 76 S2 well site (7.4 ha) and access track construction and maintenance (10.9 ha) • Construction and operation of approved gravel pits VGP1, VGP2, VGP3 (9 ha) • Installation of two additional E&A well cellars and conductors on the existing Velkerri 76 S2 well pad to accommodate the proposed Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells
Site set-up and mobilisation to support the Velkerri 76 S2-2H and Velkerri 76 S2-3H exploration well	• Use of existing access tracks to and from the Velkerri 76 S2 site and gravel pits from the Stuart Highway (noting 80 km is an existing pastoral track constructed by the pastoralist that Tamboran currently maintain) • Use of the existing Velkerri 76 S2 well pad, camp pad and helicopter landing pad • Use of existing drilling sump to manage up to 3,000 m³ • Use of existing sediment basin and site bund for wastewater management and storage • Set-up of two temporary camps – a main camp located on the camp pad (~70-person capacity) and a drilling mini-camp located on the well pad (~8-person capacity) • Set-up of chemical and material storage areas • Set-up of drilling rig, including blow-out preventors, fluid systems and associated equipment such as pipe racks, power generation, offices, ablution blocks and cementing units • Set-up of HFS equipment, completions rig and equipment, well testing equipment, and other associated equipment at Velkerri 76 S2 • Approximately 44 traffic movements per day during site demobilisation
E&A activities at the Velkerri 76 S2 site including drilling, HFS and well testing of Velkerri 76 S2-2H and Velkerri 76 S2-3H	• Operation of the two temporary camps • Transportation, handling and storage of bulk chemicals, fuels and wastes • Drilling of the Velkerri 76 S2-2H and Velkerri 76 S2-3H horizontal E&A wells, including the collection of reservoir quality data during drilling • Well design in accordance with the Code of Practice and approved Well Operations Management Plan (WOMP) including isolation of freshwater aquifers • HFS of Velkerri 76 S2-2H and Velkerri 76 S2-3H • Completion and well testing of the Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells • Use of existing surface facilities • Well testing of the Velkerri 76 S2-1 vertical well • Storage of condensate • Gas and condensate flaring in accordance with Code of Practice requirements and as per US EPA 40 CFR 63.11, with a flare tip combustion efficiency of 98% • Trucking of condensate (where beneficial usage is authorised) • Beneficial use of appraisal gas and condensate for on-site power generation and use

Activity	Description
	- Maintenance and monitoring works (including well work overs) on Velkerri 76 S2-2H and Velkerri 76 S2-3H wells in accordance with approved WOMP - Build up testing, suspension and decommissioning Velkerri 76 S2-2H and Velkerri 76 S2-3H E&A wells (if required) in accordance with the Code of Practice - Groundwater extraction of approximately 110 ML under existing groundwater extraction licence (WEL GRF 10285) - Monitoring activities (including groundwater, stormwater, soils, leak detection and all other low impact ancillary data collection programs)
On-site wastewater management to support ongoing E&A program	- On-site wastewater storage and treatment in accordance with Code of Practice - Use of the drilling sump, enclosed wastewater storage tanks and wastewater treatment tanks to manage drilling and flowback wastewater - Drill cuttings and flowback fluid quality testing in accordance with the Code of Practice - Disposal of drill cuttings within EP76 is subject to the outcomes of chemical analysis in accordance with clause C.4.1.2 of the Code of Practice - Drilling waste storage and disposal located within the existing Velkerri 76 S2 site or transported off-site - On-site treatment of wastewater through evaporation or other alternative methods (such as enhanced evaporation or other mechanical water treatment options) - Off-site disposal of wastewater in accordance with the <i>Waste Management and Pollution Control Act</i>
Site demobilisation	- Demobilisation of exploration equipment, including camps, drilling rigs, HFS equipment, completion rigs, well testing equipment, wastewater storage tanks and various service provider equipment - Approximately 44 traffic movements per day during site demobilisation
Site rehabilitation	- Decommissioning and removal of all surface infrastructure and wastes from site including the removal of drilling sump, wastewater tanks, cellars, equipment, non-drilling waste, wastewater and all ancillary equipment - Final rehabilitation activities to return the sites back to a safe, stable and non-polluting form consistent with pre-disturbed condition as outlined in the Velkerri 76 S2 Rehabilitation Plan (Appendix O)

3.1 Timeframes

The anticipated key activity dates for the drilling, stimulation and well testing program are detailed in Table 10 and illustrated in Figure 10. The drilling, stimulation and well testing of the proposed additional horizontal wells at Velkerri 76 S2 is contingent on the well testing results of the existing Velkerri 76 S2-1 vertical E&A well. These additional wells will likely be drilled if the well test results confirm the potential viability of the shale resource through sustained gas and condensate flow rates.

It should be noted that the below timeframes are indicative, with final dates and decision to complete activities dependent on a range of additional considerations, including access, commercial and joint venture constraints.

Table 10: Anticipated activity dates

Activity	Estimated dates
Proposed scope covered under this EMP	
Amungee NW site preparation – well pad preparation, sump construction, cellar installation and drilling rig commissioning	June 2022
E&A well drilling Amungee NW-2H, Amungee NW-3H	August 2022
E&A well stimulation Amungee NW-2H, Amungee NW-3H	H2 2022
E&A well testing Amungee NW-1H, NW-2H, Amungee NW-3H	H2 2022 and H1 2023
E&A well suspension Amungee NW-2H, Amungee NW-3H	H1 2023
Amungee NW full site demobilisation and stabilisation	H1 2023
E&A well drilling Velkerri 76 S2-2H, Velkerri 76 S2-3H	H2 2022/H1 2023
E&A well stimulation Velkerri 76 S2-2H, Velkerri 76 S2-3H	H1/H2 2023
E&A well testing Velkerri 76 S2-1, Velkerri 76 S2-2H Velkerri 76 S2-3H	H2 2023
E&A well suspension Velkerri 76 S2-1, Velkerri 76 S2-2H, Velkerri 76 S2-3H	H22023
Velkerri 76 S2 full site demobilisation and stabilisation	H2 2023
Well decommissioning (all wells)	2028
Rehabilitation of site	2028 or when each site is no longer required

*Worst case assumes 6-month well test

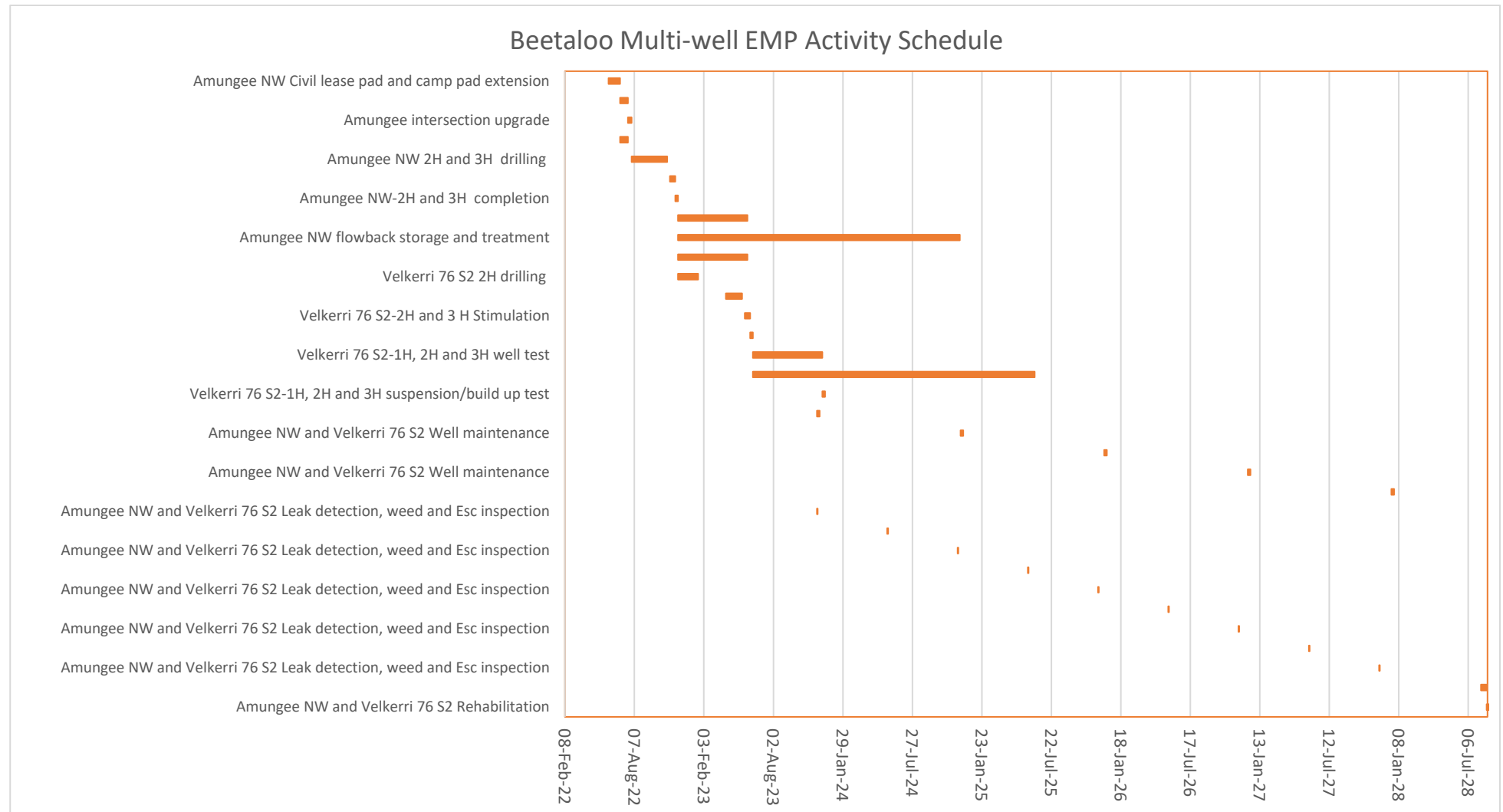


Figure 10: Indicative timeline of Amungee NW and Velkerri 76 S2 activities

3.2 Site setting

The Amungee NW and Velkerri 76 S2 sites were chosen using a multi-criteria analysis based on the geological, environmental, cultural and social suitability of the site. Field ecological, cultural heritage and Native Title clearances were obtained to ensure avoidance of the following areas:

- High conservation value
- High habitat value
- Water courses or major overland flow paths
- Areas of cultural significance
- Sensitive receptors (homestead and communities)
- Existing pastoralist groundwater extraction bores
- Major roads.

A description of the existing environment is provided in section 4. The sites are in Corymbia woodlands which are regionally extensive vegetation communities, not threatened and in good condition.

Approximate separation distances to the nearest environmental and community receptors are illustrated in Figure 11 and with separation distances provided in Table 11.

Table 11: Sensitive receptor separation distances

Receptor	Amungee NW	Velkerri 76 S2
Closest pastoralist bore	4km	11.4km
Nearest homestead	27km	50km
Nearest community	56km (Daly Waters)	100km (Jingaloo)
Stuart Highway	56km	100km
Carpentaria Highway	1km	40km
Bullwaddy Conservation Reserve	40km	30km
Lake Woods	161km	125km
Nearest mapped major watercourse (Newcastle Creek)	20km	13km
Aboriginal protected areas	8km	7km

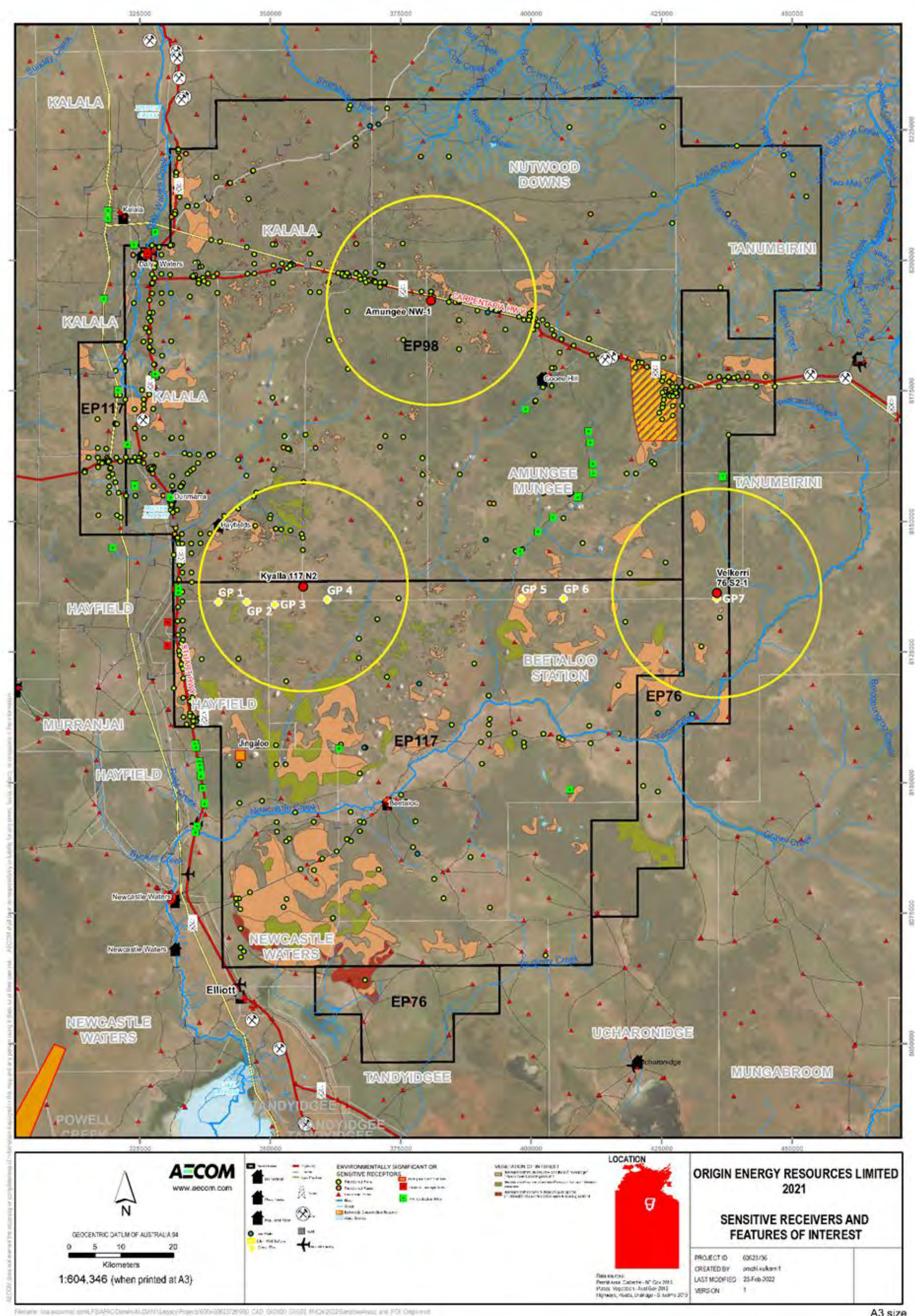


Figure 11: Proximity of active exploration sites (including Amungee NW and Velkerri 76 S2) to sensitive receivers and features of interest

3.2.1 Previous site approvals

The Amungee NW and Velkerri 76 S2 sites are existing exploration have been approved under the EMPs shown in Table 12.

Table 12: Approved activities

EMP	Activity	Approved date Closed date	Status
Amungee NW			
Beetaloo Sub-basin, EP98 and EP117 Exploration Drilling EMP (NT-2050-15-MP-0010)	Drilling of Amungee NW-1H and installation of groundwater bores	3 June 2015 15 July 2021	Superseded by Amungee NW-1H EMP NT-2050-35-PH-0018
Hydraulic Stimulation & Well Testing EMP (NT-2050-35-PH-0018)	Hydraulic fracture stimulation (HFS) and well testing of Amungee NW-1H	23 August 2016 15 July 2021	Superseded by Amungee NW-1H EMP NT-2050-35-PH-0018
Beetaloo Basin Groundwater Monitoring Bore Installation Program EP98 (NT-2050-15-MP-0014)	Installation of 2 x groundwater bores	22 November 2018 21 March 2024	Superseded by Beetaloo Multiwell EMP (ORI10-3.4)
ORI7-2 Amungee NW-1H (EP98) EMP (NT-2050-35-PH-0018)	Extended production testing and ongoing operation/maintenance	15 July 2021 22 January 2025	Superseded by Beetaloo Multiwell EMP (ORI10-3.7)
Velkerri 76 S2			
Beetaloo Basin Groundwater Monitoring Bore Installation Program Velkerri 76 EMP (NT-2050-15-MP-0017)	Construction of gravel pits and installation of up to 4 x groundwater bores at the Velkerri 76 site	10 July 2019 19 November 2024	Superseded by Beetaloo Multiwell EMP (ORI10-3.5 and ORI10-3.6)
Beetaloo Basin Velkerri 76 S2 Civil Construction EMP (NT-2050-15-MP-3-1)	Construction of the Velkerri 76 S2 site	26 September 2019 22 January 2025	Superseded by Beetaloo Multiwell EMP (ORI10-3.5)
Beetaloo Sub-basin Velkerri 2019-2024 Drilling, HFS and well testing EMP (NT-2050-15-MP-032)	Drilling, HFS and well testing of Velkerri 76 S2-1, plus installation of 2 x additional groundwater bores	23 December 2019 22 January 2025	Superseded by Beetaloo Multiwell EMP (ORI10-3.6)

The activities proposed under this EMP at the existing Amungee NW and Velkerri 76 S2 sites are summarised in Table 13. It should be noted that some figures, such as water use, stimulations stages and proppant usage, are anticipated levels based upon previous experience and may be higher or lower depending on operational requirements.

Table 13: Amungee NW site activity summary table

Component	Existing Amungee NW site	EMP scope	Total site activity summary
General			
Number of E&A wells	1 existing appraisal well: Amungee NW-1H	Two additional E&A wells: Amungee NW-2H, Amungee NW-3H	3
Number of stimulations	Existing Amungee NW-1H has been stimulated	Stimulation of Amungee NW-2H, Amungee NW-3H	3
Number of water extraction/monitoring bores	3 existing bores: RN039896 (production bore), RN038493 (production), RN040894 (monitoring/production)	3 bores on the Amungee NW site and 1 control bore on the Amungee NW2 site	7
Number of gravel pits approved under EMP	0	Gravel to be sourced from approved DIPL gravel pits covered by AAPA certificate C2022/02	Gravel to be sourced from approved DIPL gravel pits covered by AAPA certificate C2022/02
Operational workforce	~20 people during operations	70 people during drilling and stimulation activities 2-4 people during well testing	22 to 90 people
Main camp capacity	N/A camp decommissioned	70-person	70-person
Drilling mini-camp	N/A camp decommissioned	8-person	8-person
Stages per well	10	25	~25
Proppant use	1,500 t	180 t -250 t of proppant per stage per well	12,500t
Disturbance			
AAPA certificate	All works covered under C2020/003 and C2022/02		
Total area of disturbance	5.56 ha (3.56 ha well pad, 0.90 ha camp pad and 1.10 ha access track)	Additional 12.74 ha (6.44 ha well pad, 0.3 ha camp pad, 1 ha helipad, 1 ha laydown area and 4 ha fence line / firebreak)	18.3ha
Traffic			
Peak traffic movements (per day)	<16 vehicles per day during peak mobilization and demobilisation.	44	44
Average traffic movements first 6-9 months post mobilisation	4-6 trucks per day	10-15 (for 6-months)	10-15 (for 6-months)
Average traffic movements for remaining 6 months	1 per week	3-4 (for 6-months)	3-4 (for 6-months)
Truck load-out: wastewater transport	<10 truck movements	~20 truck movements	~20 truck movements
Water use and stormwater management			
Groundwater extraction licence	All take covered under existing WEL GRF 10285.		
Estimated groundwater usage	N/A	110ML	110ML
Stormwater retention basin	N/A basin decommissioned	New 20 x 20m sediment retention basin	New 20 x 20m sediment retention basin
Wastewater management			
Flowback/wastewater volume generated on-site	0.2ML	24ML (12ML per well)	24ML

Component	Existing Amungee NW site	EMP scope	Total site activity summary
Enclosed wastewater tank capacity	0ML	Wet season: 26.5ML (5 x 5.3ML tanks) Dry season: 10.6ML (2 x 5.3ML tanks)	Wet season: 26.5ML Dry season: 10.6ML
Open treatment tank capacity (including freeboard)	0ML	Wet season: 6.5ML (5 x 5.3ML tanks) Dry season: 34.4ML (8 x 5.3ML tanks)	Wet season: 6.5ML Dry season: 34.4ML
Bunded tank pad containment capacity	1.2ML	6ML	6ML
Flowback/wastewater volume (final predicted for treatment and off-site disposal)	<0.2ML	~1ML	~1ML
Sump capacity	N/A sump rehabilitated	~5,000m ³	5,000m ³
Total volume of drilling mud and cuttings generated	N/A	~1,500m ³	~1,500m ³
Total volume of waste drilling and completion fluid per well	N/A	2ML per well	4ML
Transfer pumps	2x 6 inch- up to 23 ML/day	6x 6 inch- up to 23 ML/day	6x 6 inch- up to 23 ML/day
Greenhouse gases and emissions			
Flares	Vertical flare	Vertical flare	Vertical flares
tCO ₂ -e emissions	N/A	76, 289 to 142,178 tCO ₂ -e (Maximum 180 day well test)	76, 289 to 142,178 tCO ₂ -e (Maximum 180 day well test)

Table 14: Velkerri 76 S2 site activity summary table

Component	Existing Velkerri 76 S2 site	EMP scope	Total site activity summary
General			
Number of E&A wells	One appraisal well: Velkerri 76 S2-1H spudded 12 August 2021	Two additional E&A wells: Velkerri 76 S2-2H, Velkerri 76 S2-3H	3 E&A wells (One vertical and two horizontal wells)
Number of stimulations	Velkerri 76 S2-1 suspended, vertical stimulation delayed	Stimulation of Velkerri 76 S2-2H, Velkerri 76 S2-3H	3 stimulations
Number of water extraction/monitoring bores	Two existing bores: RN041133 (monitoring), RN041134 (production / monitoring) and 2 additional proposed	0	4
Number of gravel pits approved under EMP	3	3	3
Operational workforce	~20 people during operations	70 people during drilling and stimulation activities 2-4 people during well testing	<70 people
Main camp capacity	N/A camp decommissioned	70-person	70-person
Drilling mini-camp	N/A camp decommissioned	8-person	8-person
Stages per well	20	20	N/A
Proppant use	1,500 t	180 t -250 t of proppant per stage per well	10,500 to 14,000t

Component	Existing Velkerri 76 S2 site	EMP scope	Total site activity summary
Disturbance			
AAPA certificate	All works covered under C2020/003		
Total area of disturbance	7.4 ha (4.5 ha well pad, 1 ha laydown yard, 1.2 ha camp pad, 0.5 ha helipad, 0.2 ha stockpile storage area)	N/A no change to existing disturbance area 27.3 ha	6.70 ha
	3 x 3 ha gravel pit		9.0 ha
	82 km of access tracks (pastoral track and constructed track to well site and gravel pits)		10.9 ha
Traffic			
Peak traffic movements (per day)	<16 vehicles per day during peak mobilization and demobilization	44	44
Average traffic movements first 6-9 months post mobilisation	4-6 trucks per day	10-15 (for 6-months)	10-15 (for 6-months)
Average traffic movements for remaining 6 months	1 per week	3-4 (for 6-months)	3-4 (for 6-months)
Truck load-out: wastewater transport	N/A	~40 truck movements	~40 truck movements
Water use and stormwater management			
Groundwater extraction licence	All take covered under existing WEL GRF 10285		
Estimated groundwater usage	N/A	110 ML	110 ML
Stormwater retention basin	Existing sediment basin	Existing sediment basin	Existing sediment basin
Wastewater management			
Flowback/wastewater volume generated on-site	1.8 ML ¹	24 ML (12 ML/well)	24 ML (12 ML/well)
Enclosed wastewater tank capacity	N/A	Wet season: 26.5 ML (5 x 5.3 ML tanks) Dry season: 10.6 ML (2 x 5.3ML tanks)	Wet season: 26.5 ML Dry season: 10.6 ML
Open treatment tank capacity (including freeboard)	3.2 ML (1 x 3.2 ML tanks)	Wet season: 6.5 ML (5 x 5.3ML tanks) Dry season: 34.4 ML (8 x 5.3ML tanks)	Wet season: 6.5 ML Dry season: 34.4 ML
Bunded tank pad containment capacity	10 ML	10 ML	10 ML
Maximum flowback wastewater on-site	1.8 ¹ ML	14.91 ML	14.91 ML
Flowback/wastewater volume (final predicted for treatment and off-site disposal)	0.2 ML	1 ML	1 ML
Sump capacity	~3,000 m ³	Use existing sump	3,000 m ³

¹ Assumes a vertical 4 stage HFS

Component	Existing Velkerri 76 S2 site	EMP scope	Total site activity summary
Total volume of drilling mud and cuttings generated	N/A	~1,500 m ³	~1,500 m ³
Total volume of waste drilling and completion fluid per well	N/A	2 ML per well	4 ML
Transfer pumps	6 x 6 inch: up to 23 ML/day	6 x 6 inch: up to 23 ML/day	6 x 6 inch: up to 23 ML/day
Greenhouse gases and emissions			
Flares	Vertical and horizontal flare	Horizontal flare	Vertical and horizontal flare
tCO ₂ -e emissions	N/A	70,229 to 130,852 tCO ₂ -e (Maximum 180 day well test)	70,229 to 130,852 tCO ₂ -e (Maximum 180 day well test)

3.2.2 Existing Amungee NW-1H exploration well

A schematic of the existing Amungee NW-1H well is provided in Figure 12. The Amungee NW-1H well was drilled in two parts. The vertical section of the well was drilled to a total depth of 2,611 m below ground level (mbgl), with a 1,229 m horizontal section completed in 24 of November 2015. The well was re-entered, cased and cemented from the 16 June 2016 to 11 July 2016 in preparation for a hydraulic fracture stimulation (HFS).

Verification of the well integrity of the Amungee NW-1H E&A well was completed via:

- A CBL completed on the surface casing section of the well confirming the isolation of the Gum Ridge formation from the intermediate casing
- A CBL/VDL completed on the 4.5" production casing. The CBL/VDL demonstrates that the well had in excess of 500 m of good quality cement separating the Velkerri B shale from the rest of the E&A well
- A casing pressure test of the 4.5" production casing section prior to stimulation. A 10,000 psi casing pressure test, confirmed that integrity of the E&A well was sufficient to commence HFS

Following verification of well integrity, a HFS was successfully executed from 25 August 2016 to 8 September 2016. A total of 11 HFS stages were pumped into the Amungee NW-1H lateral section, effectively placing 1,100 tonnes of proppant and 10.640ML of fluid. Following stimulation, a 57 day well test was initiated. The well produced an average of approximately 1.1TJ/day of hydrocarbon, with a flowback recovery of 3.1ML (~18% of the stimulation volume). The well was subsequently suspended in November 2016, with the site demobilised. In 2021, the Amungee NW-1H E&A well was brought back online and underwent 3-day extended production testing under NT-2050-35-PH-0018. Additional production testing is to be completed under this EMP. A well completion report was submitted to the DME and is available at <https://geoscience.nt.gov.au/gemis/ntgsjspui/handle/1/87095>.

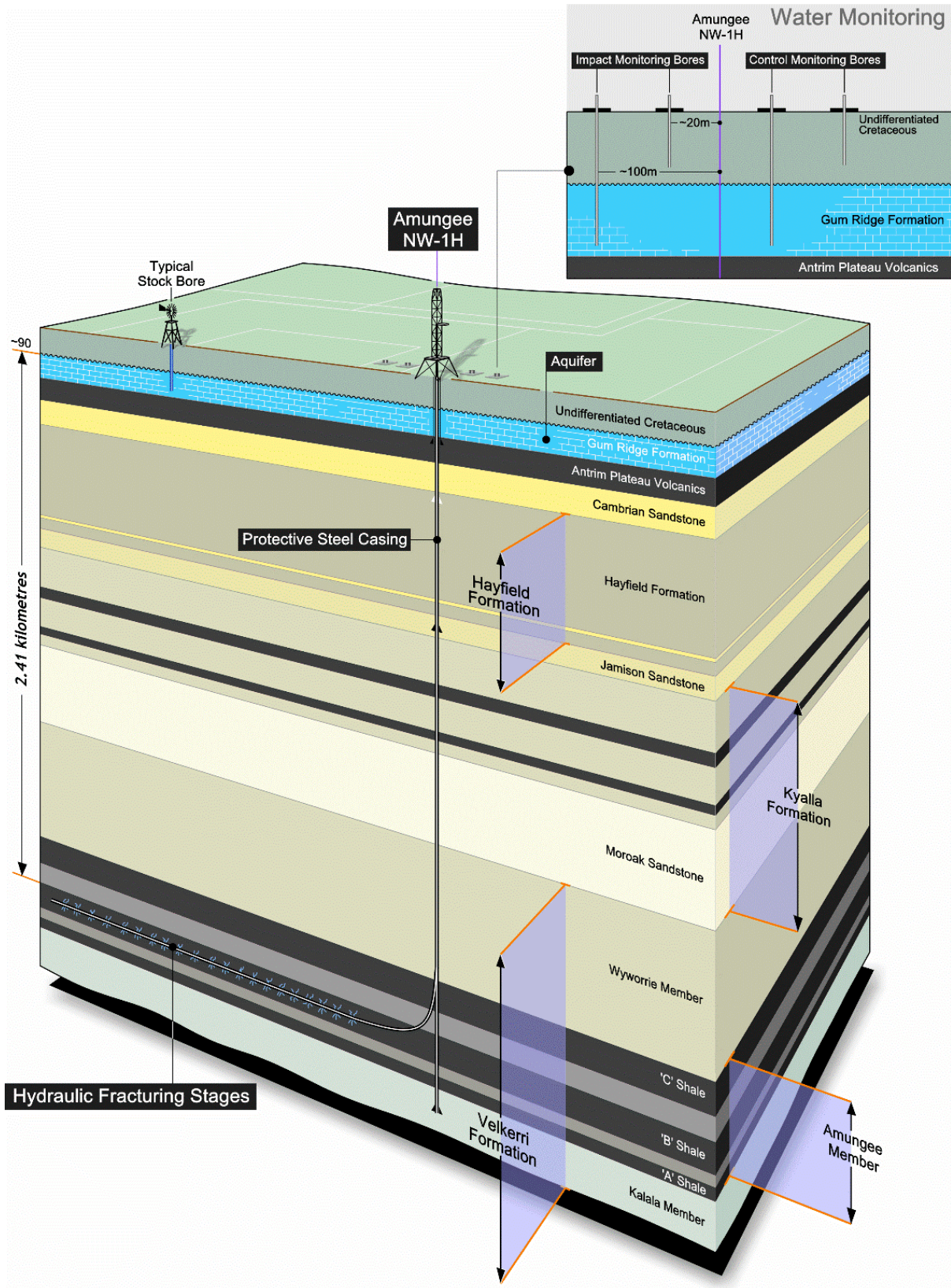


Figure 12: Schematic of the existing Amungee NW-1H E&A well

3.2.3 Proximity to sensitive receptors

The existing Velkerri 76 S2-1 E&A well was spudded on the 12 August 2021, with the well completed on 16 October 2021. The Velkerri 76 S2 well was drilled into the Kalala member (below the Velkerri) at a total depth of 2,128 m below ground level (mbgl). The well is currently suspended, with a vertical HFS proposed to be completed in 2022. A copy of the Velkerri 76 S2 well schematic is provided in Figure 13.

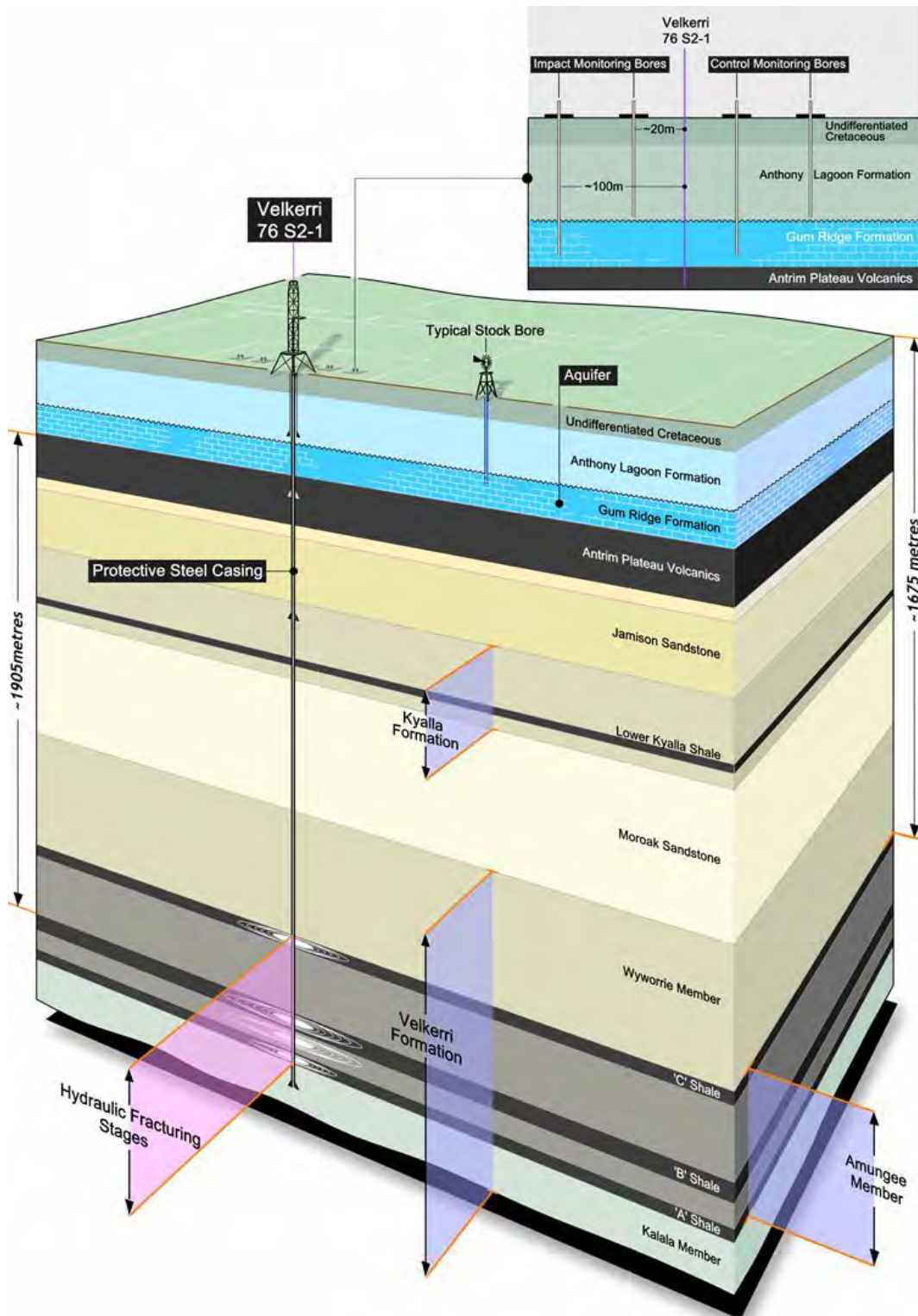


Figure 13: Velkerri 76 S2-1 well schematic

3.3 Groundwater bore installation

Groundwater monitoring / extraction bores have been installed at each of the Amungee NW (three existing bores) and Velkerri 76 S2 sites (two existing control bores). Up to 3 additional groundwater monitoring/production bores are to be installed under this EMP at Amungee NW site and 1 new control monitoring bore located at the Amungee NW2 site (refer Table 6). Additional groundwater monitoring bores will be installed on the Velkerri 76 S2 site prior to the stimulation of the vertical well in 2022 under the existing approved Velkerri 76 S2 drilling, stimulation and well testing EMP.

The Amungee NW bores will be installed on the proposed activity area (either on the well pad, camp pad or laydown area). The new Amungee NW2 monitoring bore will be installed in a lightly vegetated area which is the location of a future exploration site. The bores target the Gum Ridge Formation, as the Anthony Lagoon formation is absent at the Amungee NW site.

The bores will be drilled and constructed by a licenced water bore driller and in accordance with the current version of the Minimum Construction Requirements for Water Bores in Australia. (4th ed. 2020). A qualified hydrogeologist will supervise the drilling activities and will determine the appropriate screening depth of each bore. Each aquifer intersected will be isolated from overlying aquifers with a cemented casing string. Drilling will be undertaken with air or mud rotary techniques. If mud rotary techniques are employed, the circulation fluid will be water based and will utilised standard water bore drilling polymer or bentonite-based density and viscosity modifying additives.

Additionally, each bore will be completed with a self-draining concrete block centred on the bore casing constructed at the surface, with dimensions 1m² area, 75mm above the final ground surface and 25mm below final ground surface. This provides further protection of the underlying aquifer from any surface spills.

A bore construction permit will be obtained for each bore, and they will be added to Tamboran's water extraction licence GRF 10285 if additional production bores are required to meet the water requirements at each site.

A survey of the bore will be undertaken in Australian Height Datum to accurately determine depth to water table. Within 28 days of bore completion, the driller will provide a statement of bore (Form 21) with registered number, which will be provided to DLPE. All cuttings and drilling mud will be disposed as per the Minimum Construction Requirements for Water Bores in Australia.

3.4 Civil construction activities

The well pad and camp pad at Amungee NW will be extended to accommodate the two proposed E&A wells. The civil construction activities include:

- Expansion of the existing well pad disturbance footprint from approximately 3.56 ha to 10 ha, with 6.44 ha of vegetation being cleared. Additional clearing predominantly required to accommodate enclosed wastewater tanks as required in code of practice. The well pad will be engineered to allow heavy vehicles, drilling rig and associated equipment to manoeuvre and operate safely. The proposed disturbance area includes the provision for up to 20 m firebreaks to reduce potential fire risks to infrastructure.
- Expansion of the existing camp pad at Amungee NW from 0.9 ha to 1.2 ha and involves clearing of 0.3 ha of vegetation.
- Construction of a new 1 ha helipad to allow wet season/ emergency access to the site.
- Construction of a new 1 ha laydown yard to allow for the storage of equipment and materials.
- Construction of new fence line around the the well site up to the Carpentaria highway. The area required for the fence is 2 m width and 20 m length, with approximately 4 ha cleared.
- Access track interception with Carpentaria highway upgrade.

Each proposed additional disturbance area will be cleared of vegetation. Prior to clearing, the areas will be walked down to identify the presence of fauna prior to clearing activities. Where fauna is encountered, clearing will cease in the immediate area until the fauna has moved on. Felled vegetation will be pushed up along the edges of the well site to aid in erosion and sediment control.

Following vegetation clearing, the new disturbance areas will be stripped of up to 150 mm of topsoil, with the topsoil stockpiled around the edge of the well site or on the designated stockpile area. The stockpiled topsoil will be used a growth medium to support vegetation reinstatement. The topsoils will be allowed to germinate with native species from the area to maintain soil condition and seed bank.

The anticipated stockpile depth will typically be less than 1.5 m to maximise viability of the topsoil for future use. Seed bank viability in the lower half of the stockpile may become compromised, however the upper levels are likely to continue to provide a valid seed bank. Furthermore, the vegetation community in the area are adapted to soils lacking in nutrients, there is low to no rainfall for over 8 months of the year and occur in free draining soils. The vegetation community is adapted to the harsh conditions that occur in a semi-arid area and likely to recover quickly post rehabilitation.

The proposed timeframe for the topsoil to be stockpiled around the well site could be up to 5 years or more, depending on whether the infrastructure will be required to support future exploration activities.

The topsoil stockpiles around the well site will also be used to create a bund to prevent wastewater from leaving the site in the event of a tank failure and prevent overland flow entering the site in the event of a significant regional flood. The bund will be of an appropriate height to contain 110% of the volume of the largest wastewater storage tank on site.

Once the site has been stripped of topsoil, the cleared areas will be grubbed to remove roots and rocks, levelled, compacted and sheeted with gravel to aid forming the working surface. The compacted surface will also minimise the infiltration of any spills and allow for material recovery. The well pad will be constructed with an approximate 0.2-degree fall terminating at a purpose-built stormwater retention basin to manage rainfall that falls on the well pad. The retention basin will only be in operation during stimulation and well testing activities, with the basin being removed at other times. Any stormwater collected will be beneficially used on-site (for dust suppression within the activity area) or tested prior to release outside of the approved activity area (i.e. surrounding area). The site will be fenced with a stock-proof fence to prevent livestock access.

The access track intersection with the Stuart Highway will also be upgraded in line with DIPL requirements. This includes potentially installing a turn in lane and construction of a bitumen seal as per DIPL bitumen seal. A road corridor permit and traffic control will be utilised to mitigate the risk to road users.

Equipment and machinery likely to be used during construction works include:

- Excavators
- Dozers
- Graders
- Rollers
- Water carts
- Haulage trucks
- Bob cats
- Light 4WD vehicles
- Bitumen spray and seal trucks
- Site offices and crib huts.

The Velkerri 76 S2 well site is mostly cleared, with only minor additional clearing for the gravel pits and slight extension of the well site no greater than 27.3 ha.

3.5 Amungee NW drilling sump construction

A new drilling sump will be required at the Amungee NW site to accommodate up to 5,000 m³ of drilling waste and fluids. The Amungee site will utilise a “remote sump” in which the sump will be located away from the drilling rig. Drilling waste will be stored in tanks/skips adjacent to the rig and transported to the drilling sump as required.

An overview of the anticipated sump design is provided in Appendix D. The sump will be excavated to the required depth, lined with a coletanche liner. The coletanche liner will be “welded” in place using a heat gun, with joints tested periodically as per the manufacturers recommended Quality Assurance requirements.

No additional sumps will be constructed/extended at the Velkerri 76 S2 site, with the existing sump capacity likely to be sufficient.

3.6 Cellar construction

To accommodate an additional two E&A wells at each site, an additional two cellars will be installed at each of the Amungee NW and Velkerri 76 S2 sites.

The 8 m³ cellars will be constructed on the proposed extended Amungee NW well pad and the existing Velkerri 76 S2 well pad to accommodate the wellhead equipment and blow-out preventer (BOP). The cellars are concrete lined and will be prefabricated off-site. The cellars are transported to the site in one piece and lowered into an excavated pit. A conductor casing is installed within the cellar to approximately 20 m using an auger. The conductor casing is designed to prevent the upper sections of the exploration well from caving in when drilling through the unconsolidated sediments. The cellar itself will be fenced at all times to exclude fauna ingress. A picture of a cellar is provided in Figure 14.



Figure 14: Picture of a cellar prior to installation

3.7 Gravel pit construction

No gravel pits will be constructed on Amungee NW site under this EMP. The surface disturbance associated with this activity – i.e. 3.5 ha will be used to construct the new access track to Amungee NW2 (1.5 ha) and 2 bore pads (2 ha).

Gravel will be sourced from one of the three gravel pits (VGP1, VGP2 or VGP3) for Velkerri 76 S2 activities summarised in Table 13.1 and shown in Figure 8. Approximately 10,000 m³ of gravel in total will be required to surface the well pad, camp pads and access tracks. This may be extracted from one pit, or from multiple pits depending on the volume and quality of the gravel encountered at each proposed gravel pit location (Figure 8).

Table 13.1 Gravel pit locations

Exploration Permit	Infrastructure Name	Station	Zone*	Approx Easting	Approx Northing	Disturbance Area (ha)
EP76	VGP1	Amungee Mungee	53	435623	8135301	3.0^
EP 76	VGP2	Amungee Mungee	53	433019	8135263	3.0^
EP117	VGP3	Amungee Mungee	53	397906	8136039	3.0^
Total Disturbance Area (Ha)						9.0

* Universal Transverse Mercator (UTM) geographic coordinate system is Geocentric Datum of Australia (GDA) 94.

A typical image of a gravel pit in the Beetaloo is provided in Figure 15.



Figure 15: Example of a typical operational gravel pit

Gravel pits will be cleared, with topsoil and subsoil stripped, segregated and stockpiled onsite for future revegetation.

Gravel pit rehabilitation will commence within 12 months once there is no viable gravel left. However, if viable gravel remains, gravel pits may be transferred to the pastoralist subject to approval from both DLPE and pastoralist.

Gravel pits are anticipated to be up to 3 m in depth, with the final depth dependent on the level of gravel present at the site. Fencing will be used around gravel pits where the pit batters represent a potential fall hazard to livestock and fauna.

Upon cessation of activities, the gravel pits will be recontoured back to a stable, safe and non-polluting form. Subsoils and topsoil will be reinstated across the gravel pit and natural revegetation used as the primary vegetation reinstatement measure.

3.8 Exploration well drilling

3.8.1 Well design

The well design process is the first step in ensuring the integrity for each proposed well. Tamboran's sub-surface team, (geologists, geophysicists and petroleum engineers) summarise the key information and data required by the drilling engineers to design each E&A well. This forms the Basis of Well Design (BOWD).

Critical inputs into the BOWD

- Existing geological data available for the site
- Downhole formations that need to be isolated (i.e. freshwater aquifers), hydrocarbon-bearing zones, aquifers and saline units that could be encountered during drilling operations
- The sub-surface well objective (production and/or reservoir evaluation)
- The fracture gradient, which describes how much pressure is required to fracture a specific formation
- The pore pressure, which is the in situ fluid pressure within a reservoir

- The orientation and separation of each vertical and horizontal well
- Other conditions that may affect the integrity of the well (formation fluid composition, stress regime, etc.)

The BOWD is used in combination with the requirements outlined in the Code of Practice, NT Petroleum (Environment) Regulations 2016 and Tamboran's internal standards to develop an appropriate well design that ensures well integrity is maintained throughout the life of the well and addresses all regulatory and risk management requirements.

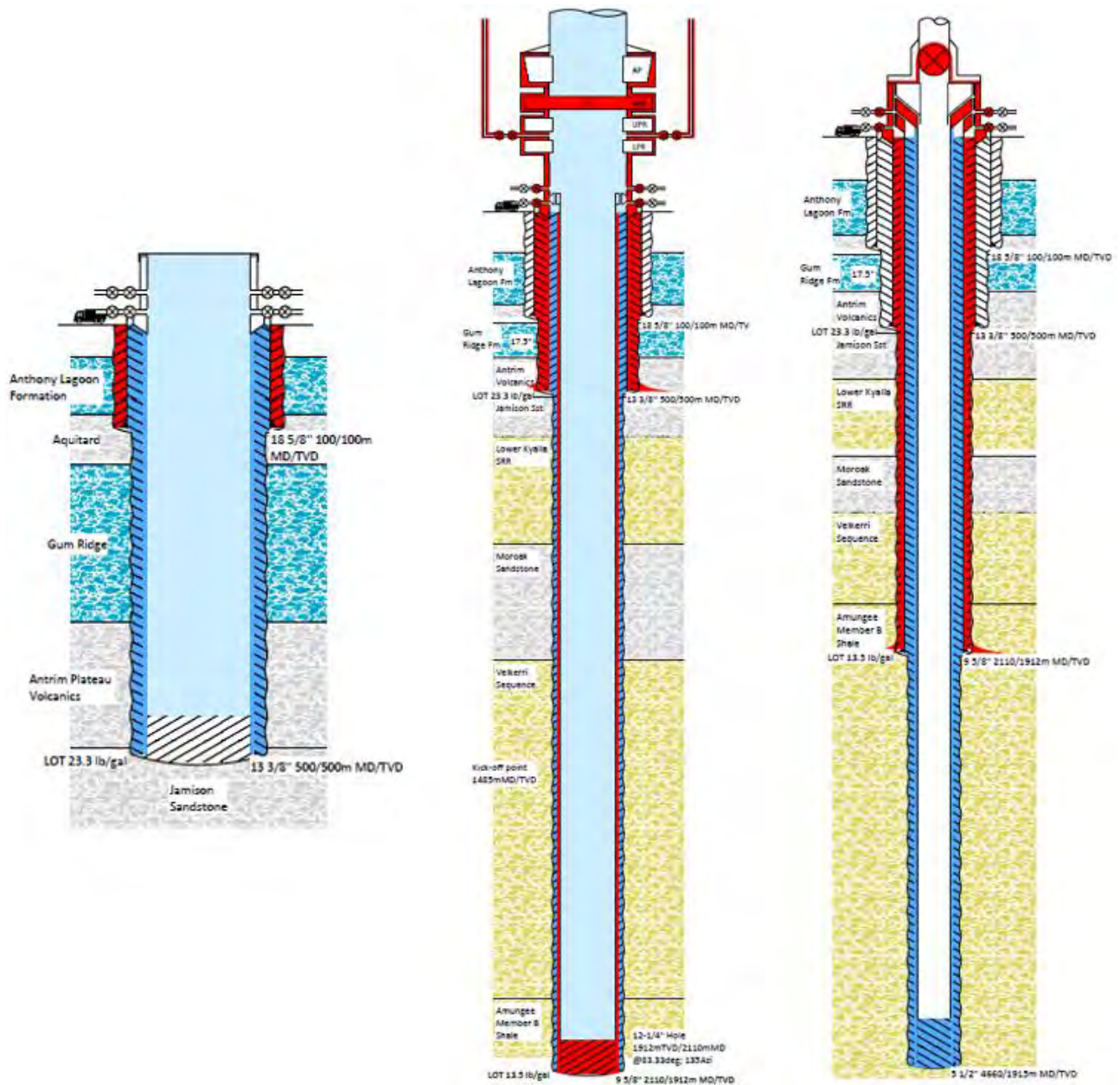
The design process includes the definition of Well Acceptance Criteria (WAC). WAC are critical thresholds that are tested during well construction and typically form components of the well barrier envelope. The barrier envelope is the combination of one or more well barrier elements that are combined to prevent uncontrolled flow of fluids and hydrocarbons into another formation, or to escape at surface. The isolation and protection of aquifers is a critical component of the WAC. The WAC must be met or exceeded to confirm well integrity before proceeding to the next phase of well construction or operation. If a well WAC is not achieved, an approved remedy and/or risk assessment must be in place prior to moving forward with operations.

The well design and WAC form a critical part of the Well Operations Management Plan (WOMP), which is a regulatory document that summarises how each well will comply with the required standards from the design to decommissioning of a well. This document is prepared and submitted to DME for approval prior to the commencement of any drilling and stimulation activities. Where required, any deviation from the approved WOMP will need to be reviewed and approved by DME prior to proceeding.

To accommodate multiple wells, each well is separated on surface by 10-15 m. This separation distance is calculated from the hole centre to hole centre and is selected to accommodate the rig package and future well interventions. Petroleum wells on a multi well pad (both within Australia and internationally) are typically separated by 8-10 m but may be located in closer proximity where safe to do so (for example Coal Seam Gas Wells are shallower, need smaller drilling rigs to drill and may be separated by 3-5m). Well deviations from the vertical plane during drilling are monitored using standard survey tools as discussed in section 3.8.3.

Each lateral in a horizontal well on the same pad is drilled at a sub-surface separation distance of at least 200-400m (with the final separation distance determined from the existing well test results and updated mechanical earth model) to ensure the stimulated zones between wells are not connected during stimulation. If two stimulation zones within the target reservoir were connected, this could reduce the productivity of each of the wells. It would not represent an environmental risk, as the stimulated zones are within the Velkerri shale formation.

Indicative well sections for the proposed additional wells at Amungee NW and Velkerri 76 S2 are shown in Figure 16 with a series of well schematics shown in Figure 17 and Figure 18.



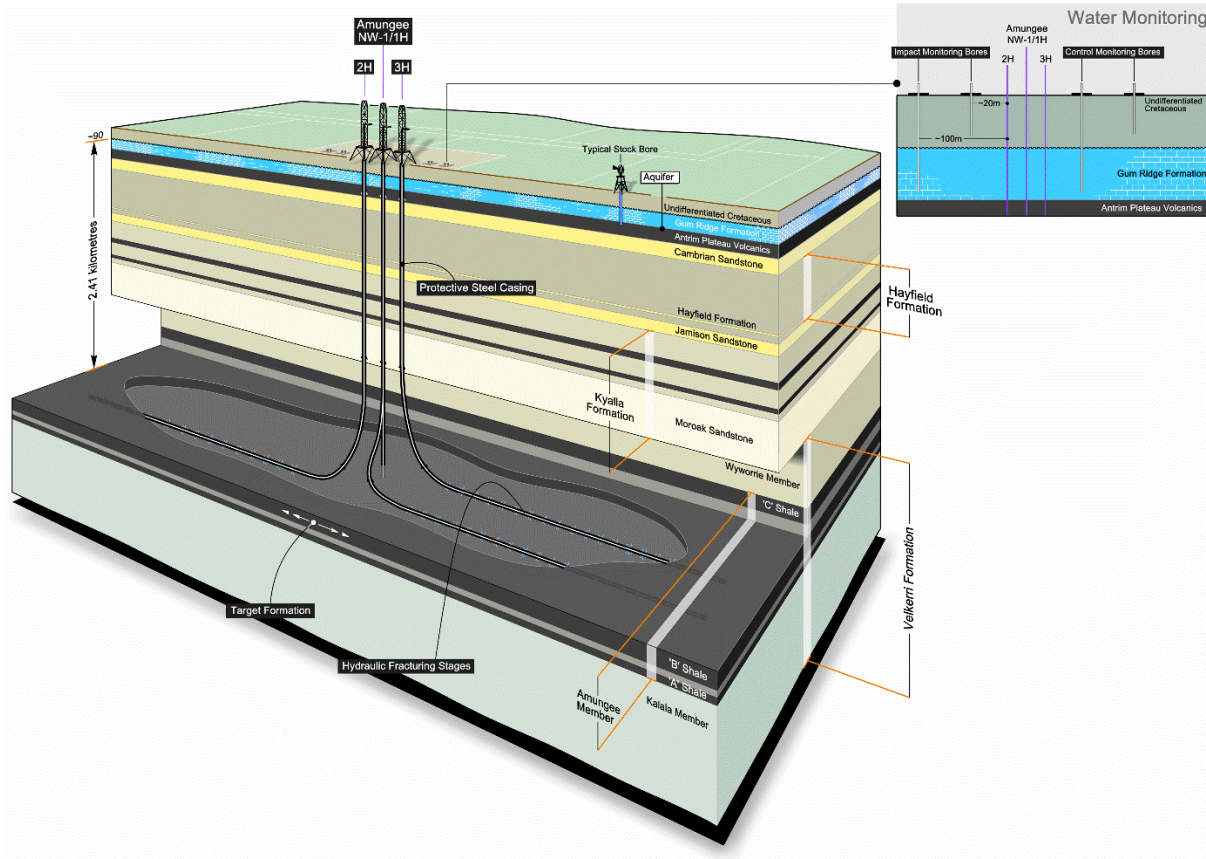


Figure 17: Amungee NW multi-well schematic

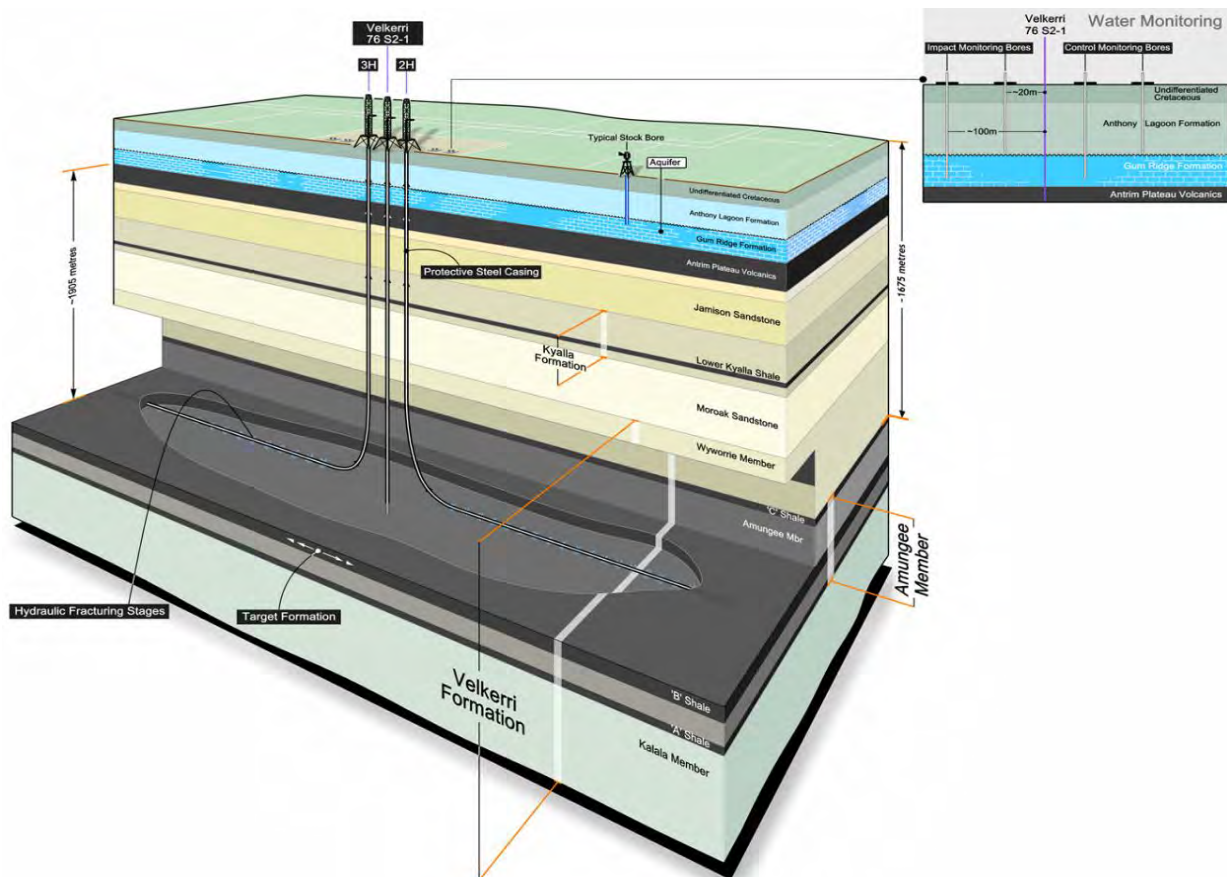


Figure 18: Amungee NW multi-well schematic

3.8.2 Site preparation

A drilling rig package will be mobilised to site and constructed to prepare for the commencement of drilling activities. The rig package comprises the main rig, as well as the supporting vehicles, equipment and facilities outlined below:

- Rig mat, an impermeable liner containing all spills from the drilling rig
- Drilling rig, comprising a rig floor, a mast or derrick, rig engine, Blow Out Preventer (BOP) system and catwalk
- Pipe rack for storing drill pipe and casing and potentially a pipe arm, which is a piece of equipment designed to bring the pipe and casing up to the drill floor
- Rig fluid system, including tanks (water and mud), shakers, mud treatment system and pipes for storing and pumping fluids down the drill string
- Storage trailers and racks for equipment
- Bunded chemical storage areas for mud chemicals, diesel and wastes
- A workshop
- Portable on-site offices
- Rig mini-camp, wastewater treatment system and irrigation area
- Temporary accommodation housing approximately 70 people
- Diesel power generators
- Third-party equipment such as cementing trucks, fuel trucks and wireline evaluation units.

Throughout drilling operations there will be ongoing vehicle movements, from the initial rig mobilisation to the interchange of drilling support services or delivery of equipment (a discussion of traffic is provided in section 3.24). Drilling operations are generally a 24-hour per day operation.

An overview of the drilling rig layout is provided in Figure 19, Figure 20 and Figure 21.

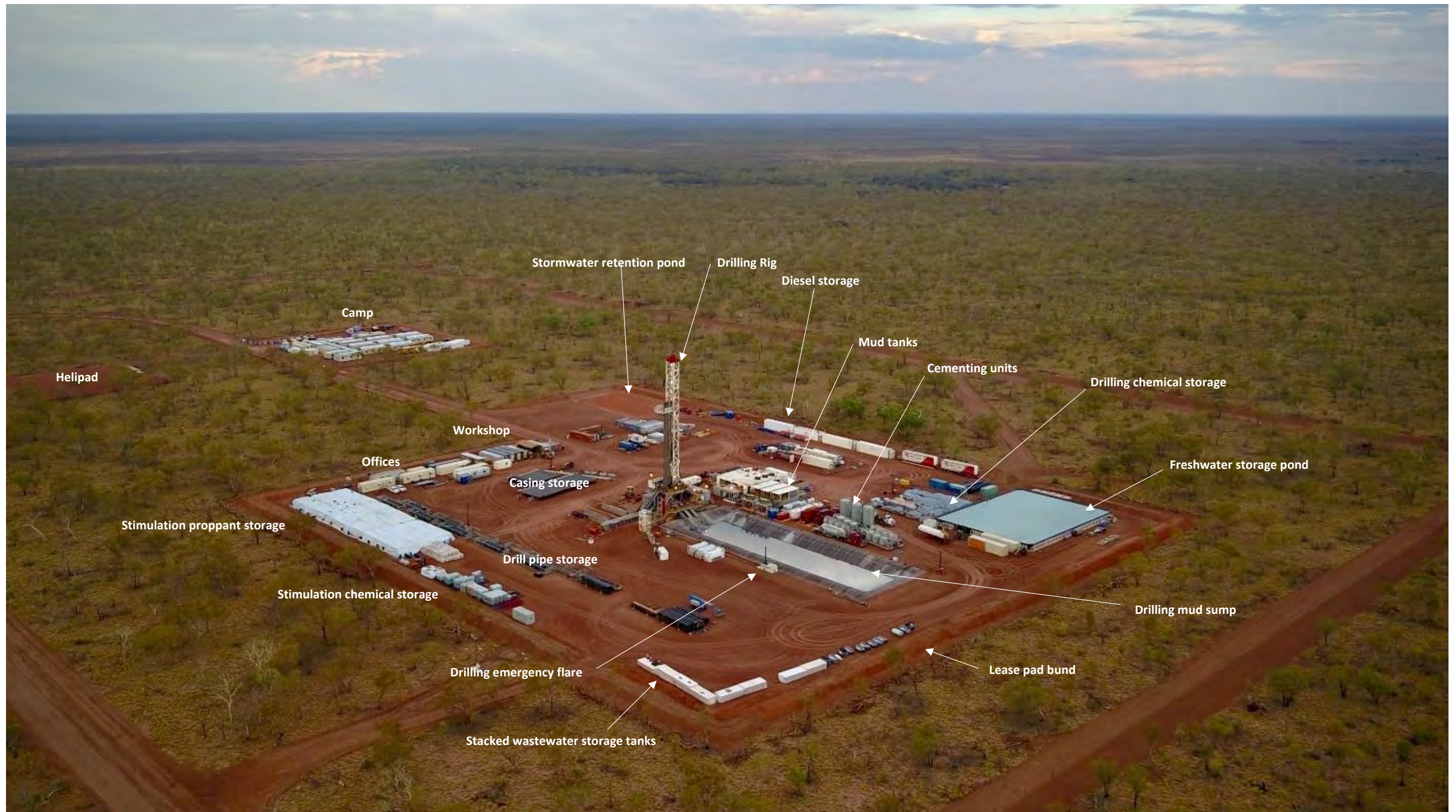


Figure 19: Example of a drilling operation at the Kyalla 117 N2-1H E&A well in November 2019. The additional wells on the Amungee and Velkerri 76 S2 are likely to utilise a similar rig set-up

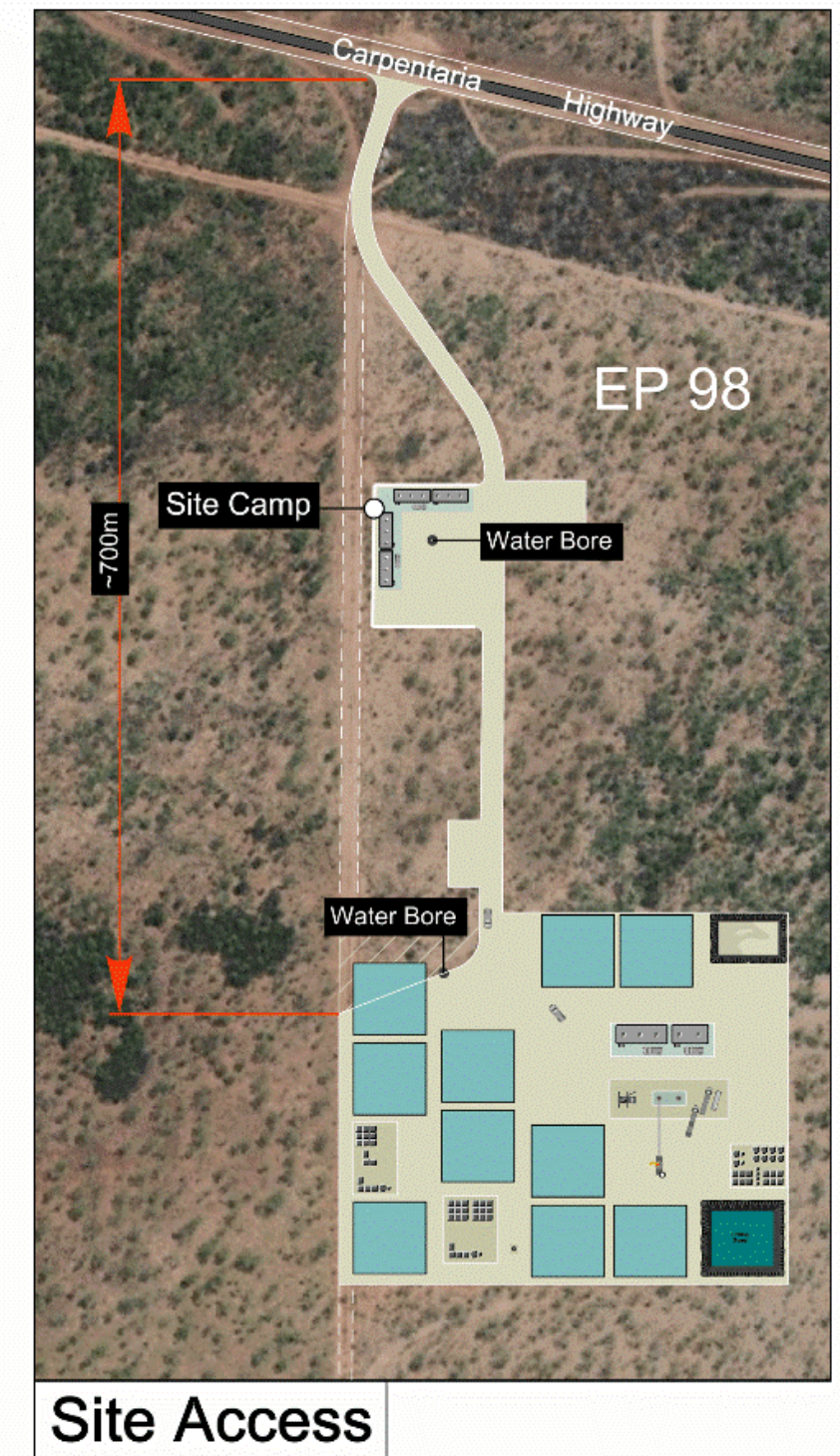


Figure 20: Example of the proposed well site layout at Amungee NW

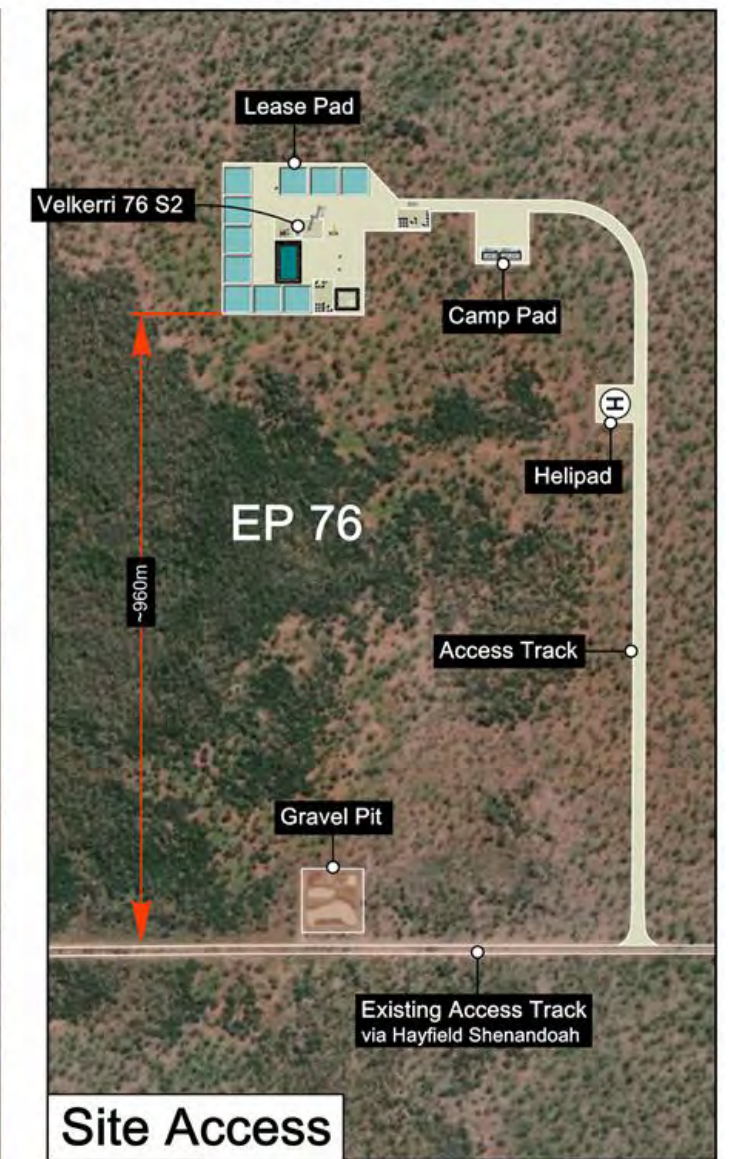


Figure 21: Example of the proposed well site layout at Velkerri 76 S2

3.8.3 Drilling

Drilling of multiple wells on a pad requires the use of specialised surveying tools to ensure the well path is constructed to design and to eliminate the risk of sub-surface collision with the existing wells on location. These survey tools use drill bit Global Positioning System (GPS) tracking to monitor the downhole position and trajectory of the well when drilling. Safety envelopes are established around each existing well to detect when a well has begun to deviate into the proximity of the adjacent well. This reduces the likelihood of a subsurface collision, which represents a significant well integrity and economic risk to the project through loss of multiple assets. The use of GPS surveying tools is a standard industry control that has been effectively used for multi-well pad drilling within Australia and internationally.

Once the rig is functional, the top-hole sections will be drilled, cased and cemented for each E&A well to depths which will enable isolation of the shallow aquifers (Anthony Lagoon Formation (if present) and Gum Ridge Formation) in this region.

The top-hole section of each proposed E&A well will be designed to isolate the top regional aquifers. At the Amungee NW site, the 'surface casing', which will be installed to isolate the Gum Ridge Formation as the Anthony Lagoon formation is absent. At the Velkerri 76 S2 site, a two-casing string will be utilised within each E&A well to isolate the Anthony Lagoon formation (the 'conductor casing,') and the Gum Ridge Formation (the 'surface casing'). Each individual section will be cased and cemented (with specifically engineered cement) to seal the aquifer off from the rest of the wellbore to prevent fluid crossflow between formations. If an aquifer is discovered during drilling that was not identified prior to commencement of drilling, Tamboran will notify to the Minister as required under the Regulations and the Code.

Defining the contact between the Aquifers and adjacent formations is critical to ensure the appropriate casing setting points to isolate the two units. Data from the existing wells and control monitoring bores provides a high confidence that the casing setting point will effectively isolate each of the aquifer units.

Commonly during the drilling of the Gum Ridge or Anthony Lagoons Formations, partial to total losses of drilling fluid have been observed due to high permeability conduits, fractures and cavernous zones expected in karstic formations. Loss of circulation material (LCM) is typically used to respond to fluid losses, with additives used to block fluid pathways to re-establish fluid circulation. LCM is often in the form of viscosity enhancers (such as bentonite and polymers), fibrous material (such as coconut coir, nut hulls etc.) or granular material (such as marble chips) with the type of LCM used dependent on the level of losses and formation type. Where drilling fluid losses cannot be stopped, the drilling fluid systems are reduced back to water to maintain dynamic well control (a continuous supply of water to overcome formation pressures) and to minimise drilling additive losses to the formation. Once the zone of high losses has been drilled through on water, the section is then cased off to regain fluid circulation and allow drilling to continue unimpeded. It is anticipated that LCM will be utilised and there is a potential that casing off high loss zones will be deployed to manage fluid losses for the additional wells proposed under this EMP.

During cement operations, cement may also be lost to the formation resulting in cement slumping or 'patchy' cement sections. In the event that cementing of either the conductor casing or the surface casing for a well is unsuccessful (i.e. the cement does not return to surface or slumping is observed) the following practices may be deployed depending on the casing section:

- For the conductor casing: a top up cement job will be undertaken – this process involves spotting cement from surface in the annulus of the conductor casing and formation
- Surface casing: the use of an External Casing Packer (ECP) and a two-stage cement job will be utilised to provide hydraulic isolation between the casing and formation
- A cement evaluation log is performed to analyse the cement quality in the annulus and determine the appropriate corrective actions
- A Leak-Off Test (LOT) or Formation Integrity Test (FIT) is undertaken to confirm cement integrity.

Once the surface casing is cemented in place, the BOP is installed on top of the casing string. A BOP contains a series of rams and elements that may be closed to prevent a release of pressure and isolate the well at surface. Once installed, the BOP is function and pressure tested to confirm its integrity.

Drilling will then progress down to the target 'kick off' point as part of the intermediate hole section, which is anticipated to be around 300-500 m above the target shale formation. When the intermediate hole of each E&A well has reached its target depth, intermediate casing is installed and cemented in place.

The design of the well casing strings of each exploration well is illustrated in Figure 15.

Prior to each new hole section of an exploration well being drilled, a Formation Integrity Test (FIT) or Leak-off Test (LOT) is performed to validate the integrity of each casing shoe and provide an operating envelope for drilling the next hole section.

Once the kick-off point has been reached, the build section of each E&A well will be drilled into one of the selected Velkerri shale targets. Once in the targeted shale zone, the well will be drilled horizontally for a distance of between 1,500-2,800 m laterally, with each horizontal wellbore on the site location separated from each other in the horizontal plane by approximately 200-500 m.

An open hole Diagnostic Fracture Injection Test (DFIT) may be run to further investigate the local rock properties. This test involves injecting small volumes (<10,000 L) of water, with salts (NaCl) and biocide (assessed in the drilling chemical risk assessment Appendix E), into the formation to create small fractures, allowing the resulting pressure to fall naturally. The fluid contains no proppant; hence the fracture relaxes and closes naturally when the pressure is released. The pressure decline is monitored on-site, and data is analysed to assist reservoir characterisation. This hole section is again cased and cemented in place.

Where a well deviates from the required specification or WAC, a section may need to be plugged and abandoned as per section 3.16. The section of the well may be redrilled (either partially or completely) to ensure compliance with the Code of Practice and relevant well acceptance criteria.

Once drilling has been completed, the drill rig will be 'walked' to the next well or will be demobilised from site.

3.8.3.1 Drilling fluids, muds and cuttings

A low toxicity water-based drilling mud is anticipated to be used as the base fluid for drilling, which primarily contain salts and polymers. Drilling mud is required to maintain well control, provide formation stability, lubricate and control the temperature of the drill bit and lift cuttings to the surface. The fluid system consists of water with a sodium or potassium-based salt (to prevent formation swelling) and a viscosifying agent such as bentonite. Other low toxicity chemicals such as barite, citric acid, sodium bicarbonate and loss circulation material may also be used. The chemicals used for drilling are consistent with those used for water bore drilling. The details associated with the chemicals used during drilling have been included in the Chemical Risk Assessment attached in Appendix E.

To assist in bore-hole stability, synthetic based muds (also known as non-aqueous based muds) may be utilised to drill the horizontal and intermediate section of each of the well (typically commencing from the Hayfield mudstone or below). Drilling using synthetic based muds (SBM) will only occur in section that are below any potable aquifers, with all aquifers protected behind cemented casing.

As per section B.5.1.1, the Benzene, Toluene, Ethylbenzene and Xylene (BTEX) of all drilling fluids and muds will not increase the levels of the overall fluid above the BTEX content specified in Table 8 of the Code of Practice. Testing of the fluids systems will be carried out to validate BTEX levels.

The main difference between SBM and aqueous based muds (other than chemistry) is that synthetic based muds are recycled through a closed loop process with very little wastage. Typically, these muds are rented from providers and are removed from site and re-used repeatedly at other operations.

Where SBM are utilised, the aqueous drilling fluids in the mud tanks will be discharged to the mud sump and replaced with SBM. A cuttings dryer is utilised to separate the SBM from drill cuttings, with the dried cuttings transferred to a bin via a screw conveyor belt (Figure 22). The cuttings, free of SBM (typically removing >90%) are then transferred to the sump for storage and disposal. The SBM is removed from site by the SBM supply company and is re-used.

All waste drilling fluids, muds and cuttings will be managed in the lined drilling sump on-site. The sump has been designed to support multiple E&A wells. All waste drilling fluids within the sump will be managed and disposed of in accordance with section 3.13.1.



Figure 22: Example of a cuttings dryer used to recover synthetic based drilling fluids

3.9 Hydraulic fracture stimulation activities

Upon completion of drilling operations, each of the horizontal E&A wells will HFS. The hydraulic fracturing process is a series of operations designed to increase the available surface contact area of the shale formation. This enhances the volume of hydrocarbons that migrate into the wellbore and flow to surface.

The process of a hydraulic fracturing completed on each exploration well is conducted in the following sequential stages:

- i Well integrity verification
- ii Site set-up
- iii Stimulation activities.

3.9.1 Well integrity validation

Prior to the stimulation of each E&A well, the wellbore will be assessed to ensure that sufficient well integrity is in place to withstand hydraulic fracturing pressures as per the Code of Practice (B.4.7.2 and B.4.13.2) and Section 302A of the Schedule of Onshore Petroleum Exploration and Production Requirements.

The assessment will include the following completed for each exploration well:

- Cement evaluation logs are run to ensure that at a minimum 150 mTVD of good quality cement is present from the target reservoir to the nearest aquifer to ensure zonal isolation.

- Confirmation of geological barriers and assessment of geological hazards
- Mechanical integrity evaluation of the production casing via a pressure test to the Maximum Allowable Operating Pressure (MAOP) of 10,000 psi. The pressure test will consist of (a) 10-minute low pressure (300 psi) leak test and (b) 20-minute high (10,000 psi) pressure strength test.
- Tamboran's pressure test acceptance criteria is a 2% pressure drop per five (5) minutes over a stabilised test duration with a decreasing dP/dT trend.
- Pressure tests will be undertaken using fresh water which will be re-used.
- Well Barrier Integrity Verification Report (WBIV) certified by an independent and reputable validator must be completed and submitted to DME before and after hydraulic fracturing.

3.9.2 Site set-up

The hydraulic fracturing operation of each E&A well requires various pieces of equipment as illustrated in Figure 23.

Equipment used for stimulation

- A data van, which is an on-site office to execute stimulation activities
- Water storage – the wastewater tanks will be constructed on-site, capable of managing the total volume of both make-up water and flowback water. Tanks storing flowback will be double lined with leak detection capable of monitoring any leaks between the primary and secondary liner. Specific information on the wastewater tank construction is provided in section 3.9.3
- Proppant trailer which is a large sand storage and delivery trailer that holds the proppant
- Hydration unit which is used to add stimulation additives and viscosifying fluids
- Blender unit which is used to mix proppant and fluid additives prior to its injection into the well
- High pressure pumps which inject the hydraulic fracturing fluid mixtures from the blender unit down the well via the surface lines and hydraulic fracturing wellhead or coiled tubing unit
- Coiled tubing unit – a large length of coiled steel pipe that can be temporarily installed in the well to perform various downhole operations
- Wireline unit for plug and perforation deployment
- Ancillary support buildings including offices, workshop, cranes, chemical storage area, equipment storage, laydowns and all other activities required to support stimulation activities.

The anticipated well site layout for the hydraulic fracture operation is provided in Appendix D.

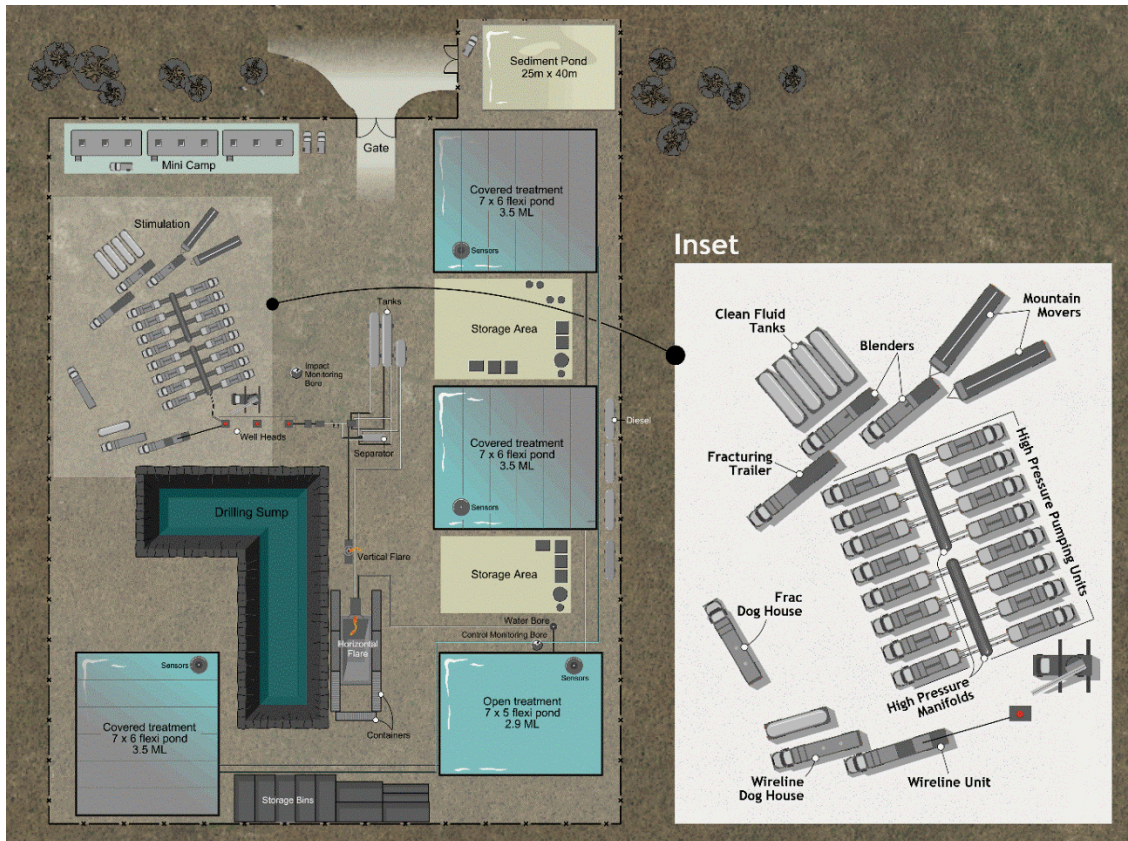


Figure 23: Example Hydraulic Fracture Stimulation spread used for each E&A well (Note: additional tanks will be installed where the frack spread is located during well test)

3.9.3 Wastewater tank set-up

In accordance with section C.4.2.2 of the Code of Practice, all flowback must be stored in enclosed tanks unless being treated for disposal or re-use. To comply with this requirement, a series of enclosed and open wastewater tanks will be constructed on-site to store and treat flowback wastewater produced during well testing. The number of enclosed and open tanks utilised on-site will vary depending on the season, as summarised Table 14 and Table 15. Further information on the wastewater management strategy that underpins the wastewater tank set-up is provided in section 3.13.

It should be emphasised that due to the unknowns associated with exploration, on-site wastewater management will be an adaptive process, with enclosed tank and treatment capacity adjusted (added or removed) to meet operational requirements (including meeting mandatory Code of Practice requirements). Tanks will be periodically converted to enclosed tanks (have lids installed) and vice versa, as flowback volume increase/decrease. This ensures maximum evaporation potential, whilst ensuring sufficient enclosed tank storage is available at any point in time.

Table 15: Wet season tank wastewater tank set-up, operating capacity and freeboard levels

Tank type	Tank dimensions	Tank maximum operating capacity	Tank wet season freeboard volume ⁵	Total storage availability (minus freeboard)
Amungee NW				
5x 5.3ML enclosed tanks (depending on total volume of fluid)	3,058 m ²	5.3 ML	N/A	26.5 ML
5x 5.3ML open treatment tanks	3,058 m ²	1.3 ML	4 ML	6.5 ML
Total tank storage capacity (minus freeboard)				33 ML
Velkerri 76 S2				
5x 5.3ML enclosed tanks (depending on total volume of fluid)	3,058 m ²	5.3 ML	N/A	26.5 ML
5x 5.3ML open treatment tank	3,058 m ²	1.3ML	4 ML	6.5 ML
Total tank storage capacity (minus freeboard)				33 ML

⁵ Freeboard not required for enclosed tanks as these tanks have a cover installed

Table 16: Dry season wastewater tank set-up, operating capacity and freeboard levels

Tank type	Tank dimensions	Tank maximum operating capacity	Tank wet season freeboard volume	Total storage availability (minus freeboard)
Amungee NW				
5x 5.3ML enclosed tanks (depending on total volume of fluid)	3,058 m ²	5.3 ML	N/A	10.6 ML
8x 5.3ML open treatment tanks	3,058 m ²	4.3 ML	1 ML	34.4 ML
Total tank storage capacity (minus freeboard)				45 ML
Velkerri 76 S2				
5x 5.3ML enclosed tanks (depending on total volume of fluid)	3,058 m ²	5.3 ML	N/A	10.6 ML
5x 5.3ML open treatment tank	3,058m ²	4.3 ML	1 ML	34.4 ML
Total tank storage capacity (minus freeboard)				45 ML

Each tank will be engineered to meet both the Code of Practice and site environmental conditions requirements, including:

- Double-lined tank with leak detection in the interstitial space capable of detecting leaks between the primary and secondary liner
- Wastewater tank liners to have an impermeable membrane with coefficient of permeability of less than 10⁻⁹ m/s permeability, 120N puncture resistance and 49N tear resistance
- Tanks are not connected and non-return valves used to prevent uncontrolled discharge from multiple tanks should one fail
- Tanks designed to prevent the risk of build-up of explosive gasses
- Wastewater tanks designed and engineered to Australian Standards (AS3990 Mechanical Equipment – Steel Work, AS 1170.1 Hydrostatic loading, AS1170.2 Wind Rating (cyclonic wind rating)
- Enclosed tanks to have vents and ignition exclusion zones to eliminate the build-up of explosive gasses
- Controls are installed (such as pipe caps and non-return valves) to prevent siphoning of a tank.

Any new wastewater storage tanks will be installed in accordance with the following steps (illustrated in Figure 24):

- Each tank site is flattened to a maximum slope of <0.5% and compacted to above 120kPa- with the well pad containing a mixture of silt, clay and gravel. Predicted permeability (based on type of material present) exceeds 1x10⁻⁷m/s
- Each tank panel is transported to the site in flat packs
- Each tank panel is assembled using a simple pin-type set-up, with each tank panel lifted into place using a telehandler. No cranes or suspended overhead loads are required
- Each panel is free standing and capable of withstanding 100km/hr winds on their own. They are connected to the adjacent panel using engineered steel pins, which increase the wind rating to above the cyclonic wind load requirements. The structure is engineered to a level that can withstand up to 70% erosion of the panel length, without causing any structural damage. This means the risk of water erosion during rainfall events is low
- Geomembranes are installed under each of the tanks to prevent rock/root penetration
- The first 0.5mm HDPE liner is installed and fixed to the structure. Liners are pre-fabricated, welded and tested off-site, preventing the need for on-site welding
- A moisture and pressure probe is installed between the primary and secondary liner to detect moisture and water pressure
- The second liner is installed and fixed to the structure
- Level sensors are installed within the tanks
- For the enclosed tanks, the covers are installed. The covers have built in vents and rainwater collection system
- Tanks are filled with fresh water and are tested for leaks over a 24-hour period. If moisture and pressure is detected via the leak detection system, the tank is drained to an existing storage tank on-site and leakage point repaired. Leak testing on all tanks will be completed during the well testing to ensure the tanks are free from lea



1. Panel Transportation



2. Panel assembly



3. Tank assembly



4. Geomembrane installation



5. Tank commissioning



6. Cover installation



7. Secondary liner installation



8. Primary liner installation

Figure 24: Wastewater tank construction steps

3.9.3.1 Hydrotest water management

Groundwater will be utilised to perform hydrotesting on each of the wastewater tanks to confirm the integrity of the primary liner and rectify any leaks prior to storing flowback wastewater. Hydrotesting involves the filling of each tank to approximately 75% capacity for a period of 24 hours.

Once a tank has been hydrotested, the groundwater in the wastewater tank will be recycled to perform a hydrotest on the adjacent wastewater tank and will also be used for dust suppression. The majority of the water will be re-used, with any unused groundwater released through a controlled discharge to the area surrounding the well pad.

The quality of the hydrotest water is anticipated to be similar to the groundwater, with a pH of between 6.5 to 9, and an Electrical conductivity of less than 2000 us/cm. Releases will be undertaken in a manner that prevents erosion or the discharge of groundwater directly to surface waters (which are absent in the immediate vicinity of the Amungee NW and Velkerri 76 S2 locations).

3.9.4 Stimulation activities

Hydraulic Fracture Stimulation (HFS) will be undertaken upon completion of the drilling of the E&A wells. Stimulation is generally conducted during daylight hours, with wireline and coiled tubing support activities operating on a 24-hour basis.

HFS involves the injection of a slurry, primarily consisting of water and sand (proppant), plus a small percentage of chemicals at high pressure into the target section of the horizontal wellbore. Typically, 95% or higher of the total volume in stimulation fluids is a combination of fresh water and sand, with the remainder as fluid-conditioning additives. Chemicals used in HFS are designed to optimise stimulation outcomes and are commonly found in food and other household domestic products. The chemical composition of stimulation fluid is discussed further in section 3.11.

All fluid additives (water and chemicals) and sand are mixed on the surface in the frac spread mixer, which uses a portable containment bund. The mixture and pumping schedule (rates, volume and proppant) are based on modelling which determines the desired fracture attributes. The HFS model is completed prior to the commencement of stimulation activities and is underpinned by a Mechanical Earth Model (MEM). The MEM is generated from data collected during drilling, wireline logging, core analysis and DFIT tests. The stimulation fluid mixture and pumping schedule is continuously updated during and after each stage to ensure optimal outcomes are achieved. An example of the modelled fracture geometry for the Amungee NW-1H well is illustrated in Figure 25.

The stimulation fluid is pressurised by the high-pressure pumping units and directed downhole via a manifold to discrete target intervals along each of the horizontal wellbores (referred to as 'stages'). It is anticipated that 25 stages are proposed for each exploration well, with the final number of stages determined based upon the horizontal length of the well and commercial considerations. Each stage being isolated and perforated using a plug and perforation gun assembly deployed via wireline. As the pressure is sustained, the fractures propagate radially from the well, through the target rock. Once optimal fracture propagation has been achieved, the proppant (sand) is pumped down the well and into the open fractures. This process is repeated for each stage. The final number of stages pumped in each well is dependent on the useable length of the horizontal wellbore and in situ geological conditions. Once all stages are complete, the well is suspended awaiting completion and well testing activities.

It is anticipated that approximately 1.5ML of water and 180-250 tonnes of proppant (sand) will be used for each stage. This equals an approximate volume of 40ML of water and between 2,700-7,500 tonnes of sand per E&A well. Water will be sourced from the Gum Ridge Formation, as described in section 3.12. Proppant will be sourced from locations within Australia (such as South Australia) or imported from international sources.

Wellbore pressures of the E&A well which is being stimulated are monitored during each stimulation to ensure the operations have not compromised the integrity of the production casing or the cement barriers

of the well. Pressure monitoring is also completed on each of the casing strings being stimulated and on the adjacent wells to ensure any interference is identified and corrective actions implemented. An example of the monitoring of applied stimulation fluid pressure and annulus pressure monitoring is provided in Figure 26. The risk of a stimulation migrating into an adjacent wellbore is considered low, with conservative well spacing designed to prevent connection. If the stimulation zone of an E&A well were to become connected, the design of each well is sufficient to withstand any likely pressures encountered.

A Maximum Allowable Operating Pressure (MAOP) is an important parameter used to define the safe operating envelope of each E&A well. The Maximum Allowable Pumping Pressure (MAPP) is set below the MAOP to allow for uncertainty and provide an additional safety margin. The anticipated MAPP is 9,200psi and the MAOP is 10,000psi.

Two additional safety measures are set in place to ensure treating pressures do not exceed the MAOP of the system:

1. Each HFS pumping unit has an automated high-pressure shut-off control set at the MAPP or lower, and
2. A pressure relief valve will be installed on the surface treating line to instantaneously bleed-down pressures if the pressure exceeds the MAPP.

A coiled tubing unit is on standby, on location, in the event of contingent wellbore intervention operations, such as a wellbore screen-out. A screen-out occurs when the proppant in the stimulation fluid blocks the perforations or fracture network, creating a sudden and significant restriction to fluid flow, resulting in a premature termination of the stimulation operation.

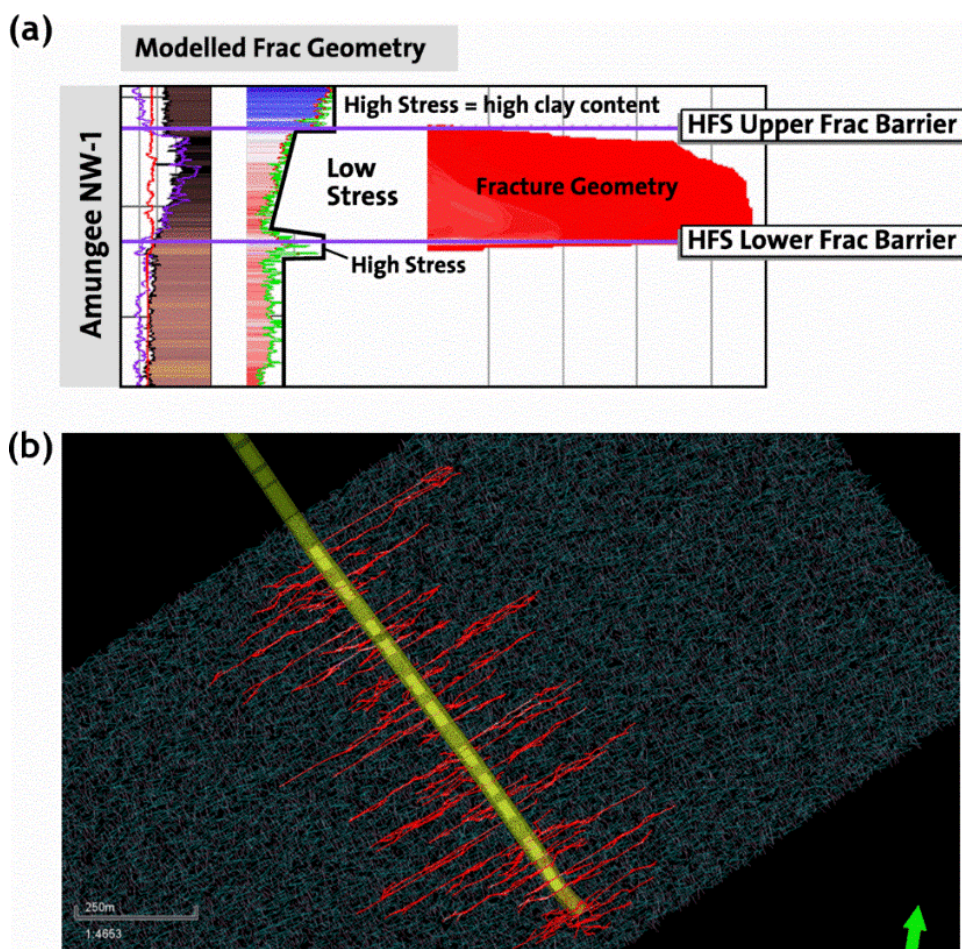


Figure 25: Example of visualised fracture geometry of Amungee NW-1

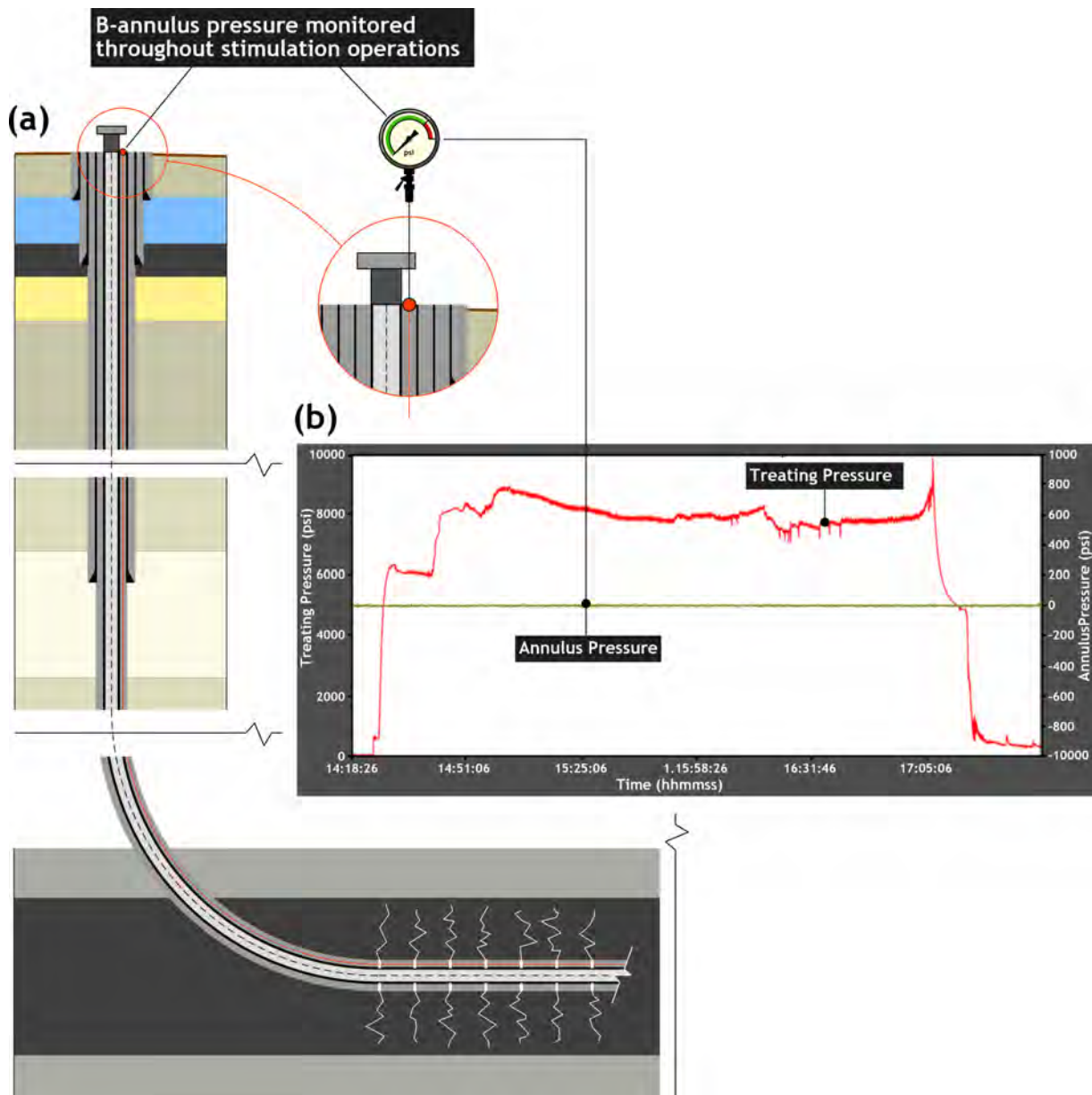


Figure 26: Well and wellhead schematic showing the “B Annulus” monitoring process, and an example from Stage 1 of the observed pressure of the B Annulus (0 psi) while high-pressure HFS operations were underway

3.10 Well completion and test program

Upon finalisation of HFS activities on both wells at each site, each of the new wells will be completed and the well testing phase initiated. The existing wells at Amungee NW (Amungee NW-1H) and Velkerri 76 S2 (Velkerri 76 S2-1) may also be brought online and tested at the same time. The well testing program is one of the most critical parts of the program, as information collected during this phase is used to understand the nature, quality, quantity and production performance of the resource. A key outcome of multi-well operations is to understand how the laterals interact with each other, to optimise lateral spacing and determine the number of wells that can be constructed on a development pad.

The well completion and testing program for each exploration well proposed under this EMP consists of:

- Completion activities for each wellbore include:
 - o preparing for downhole completion equipment
 - o installation of a production packer and production tubing

- o installation of production wellhead
- o underbalance wellbore to initiate production of hydrocarbons
- Well test activities include:
 - o flowback of fluids and hydrocarbons
 - o measurement and management of hydrocarbons
 - o ongoing sampling of flowback and hydrocarbons
 - o disposal of gaseous hydrocarbons via flare
 - o disposal of liquid hydrocarbons via flare or off-site transportation (including on-site temporary storage)

3.10.1 Completion and well testing activities

The site will consist of new and existing E&A wells and several associated, temporary facilities that will be brought on to assist with completion and testing activities. The Amungee NW and Velkerri 76 S2 sites will have the following equipment and infrastructure:

- Completion rig and associated equipment (which installs the production tubing)
- Well testing package, including:
 - o Test separator (separates hydrocarbons from flowback fluid)
 - o Vertical gas flare, a safe and accepted disposal method of volatile hydrocarbons
 - o Horizontal pit flare (for Velkerri 76 S2 only to manage condensate if encountered)
 - o Surface pipe work and manifolds
 - o Emergency Shut Down (ESD) valves
 - o Workshops and storerooms
 - o Communications and generator shacks
 - o Condensate tanks (at Velkerri 76 S2)
 - o Bunded diesel and oil storage areas
 - o Wastewater (flowback) fluid storage, open-top and covered
 - o Water transfer equipment
 - o A camp.

Each stimulated well will be completed to enable the flow of hydrocarbons and fluids. Completion activities involve the installation of downhole and surface completion equipment, including production packers and tubing and a wellhead.

To initiate the well testing phase, the well will be underbalanced to allow hydrocarbon and fluid production. It is anticipated that the wells will produce both gas (C1-C4 hydrocarbons), with liquids/condensate (C5+) at Velkerri 76 S2. Initially, the flowback will primarily contain HFS fluid. As the fluid and pressure within the reservoir is reduced, it is anticipated that gas rates will increase. To obtain a comprehensive understanding of the fluid recovery and gas production potential of the target reservoir, well testing may extend between one and six months for each well. The total time required to test each well will depend on several factors including the success of the well and observed depletion curve. Well testing activities may also be undertaken at multiple times during the activity to accommodate operational requirements (such as well maintenance, COVID-19 constraints or weather).

For example, a well may be tested for three months in year one and then three months in year two. Additional time may be required to account for unexpected issues or operational requirements. It is anticipated that where well testing above six months is required, the EMP would be revised to accommodate this activity.

All flowback fluids and hydrocarbons will be directed through a fully contained separator on-site. The separator will separate out the gases, fluids and solids so that they can be measured and managed.

Any liquid hydrocarbons will be separated from the flowback fluid and either combusted in the on-site flare, as discussed in section 3.10.2 and or stored within designated condensate storage tanks and transported off-site as per section 3.10.3. The decision to flare versus remove off-site is based upon site access (with limited access in January and February) and whether beneficial usage is allowed.

After the well test, the well may be shut-in to complete a pressure build-up test to further characterise the respective reservoirs for a period of up to 24 months. Upon finalisation of the build-up test, the well will be either suspended or plugged and rehabilitated.

An overview of the typical well testing equipment layout is provided in Figure 27.

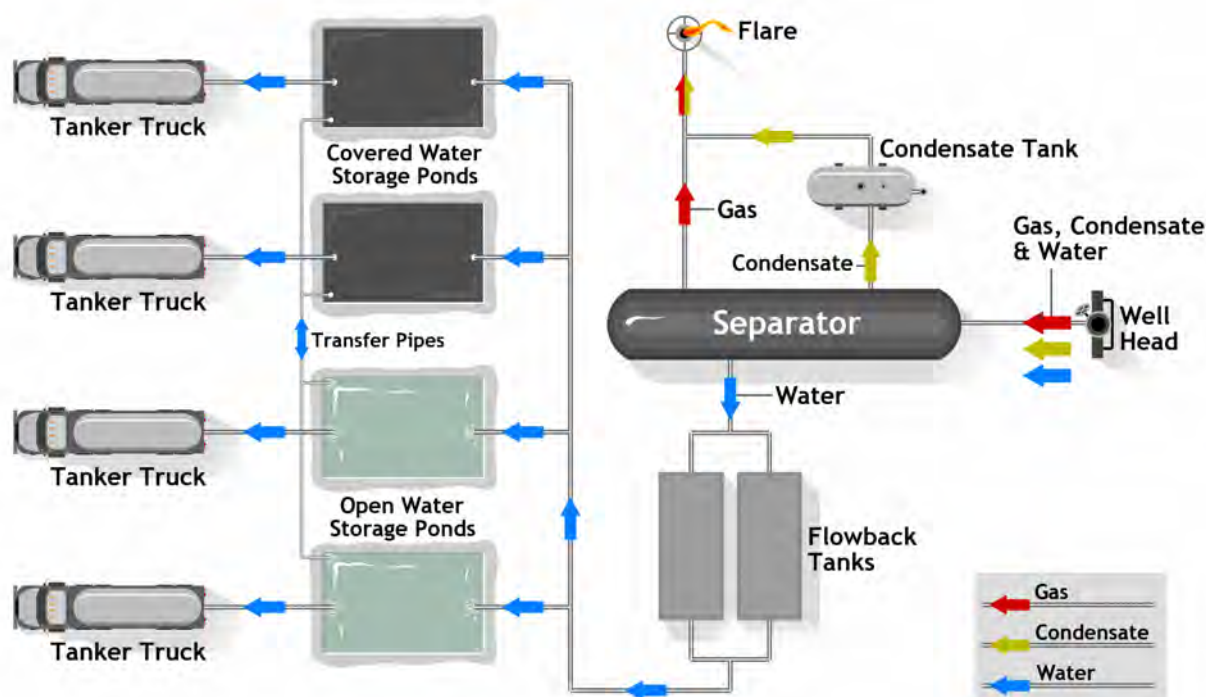


Figure 27: Sample well test schematic

3.10.2 Flaring

During well testing, produced gas and liquids will be separated to split out gas, condensate (if encountered) and flowback fluids. At Amungee NW, gas will be sent to a vertical flare for combustion while at Velkerri 76 S2 gas and wet gas may be sent to a vertical or horizontal flare. Where possible (and authorised under the Petroleum Act) any encountered condensate may be stored and transported off-site for beneficial use or disposal. Flowback fluids will be sent to wastewater storage tanks for management as described in section 3.13.3.

To minimise the potential GHG emissions and potential bushfire risk, the following controls will be utilised:

- The flares have been designed and will be operated in compliance with the US EPA 40 CFR § 63.11 control device and work practice requirements to achieve a 98% combustion efficiency

- The vertical flare s will be conservatively designed to manage the maximum anticipated gas production rates likely to be encountered. This is an order of magnitude higher than predicted gas production volumes
- The flare designs have capacity for the anticipated gas/liquid stream composition (net heating value) and maximum tip velocity (Vmax) to ensure the optimal flare efficiency The flares have been installed with a constant pilot flame and an autoignition system that provides electrical impulses to a spark plug continuously. If the flare was to extinguish, the autoignition system has been designed to reignite the flare within 1.3 seconds
- The flares are located at least 45m from the surrounding vegetation
- A bushfire management plan implemented outlining the controls and communication requirements (Appendix A).

The vertical flare at Amungee NW and Velkerri 76 S2 is an unassisted flare, with the anticipated gas composition likely to achieve the required combustion efficiency without any additional support. Refer to Figure 28 for an overview of the vertical flare.

Where liquids are encountered at Velkerri 76 S2, a horizontal flare will be utilised. The horizontal flare will be located within a 20 m x 10 m clay lined flume (to prevent damage to the liner from radiant heat) (see Figure 29) and is equipped with three independent nozzles, with two gas burners and one condensate burner. The flare unit will have a continuous flare pilot burner to ignite any gases and condensate that is sent to the flare during well testing. The pilot flame will be supplied with an independent propane fuel source located at least 45m from the flare.

The flare will have an autoignition system that provides electrical impulses to a spark plug continuously to generate a spark every 1.3 seconds. If a flare was to go out, the spark would ignite the flare within 1.3 seconds.

Condensate will be stored on-site and batch flared daily. The flare has a capacity of >10 Tj/day gas and 9,000 barrels/day of condensate. Based on anticipated condensate production volumes, the flaring of condensate is likely to be restricted to 0.5 hours to 1 hour per day.

During condensate flaring, a water curtain will be utilised to dampen the flare flame and reduce heat radiation. The water curtain water usage is anticipated to be between 7,500- 15,000 L per day. All water collected during this period will be collected in the flare flume and either re-used or periodically transferred into wastewater storage tanks on-site. The flare flume will be designed to overflow into the adjacent drilling sump if necessary.



Figure 28: Vertical flare schematic



Figure 29: Horizontal flare set-up (Note: the pit has a coletanche liner located ~500mm below the surface)

3.10.3 Condensate tanks

Based on indicative mud gas results of the Velkerri 76 S2-1 well, the proposed wells at Velkerri 76 S2 are likely to be liquids rich. Any produced condensate will be separated and stored in double skinned tanks compliant with Australian Standards 1692 Steel Tanks for flammable and combustible liquids. It is anticipated that up to four 500 barrel (80,000L) tanks will be utilised, depending on the volume of condensate encountered and factoring in previous well testing of the existing well. All tanks will have vents designed to reduce the risk of over pressurisation.

An example of a condensate tanks is provided in Figure 30. The Amungee NW wells are not expected to produce condensate.



Figure 30: Example of condensate storage tanks (image provided for indicative purposes only)

3.11 Chemical and fuel management

Tamboran will use a range of chemicals and hydrocarbons to support drilling, stimulation and well testing operations. All chemicals used in Australia must be approved for use by the Federal Government Department of Health and be listed on the Australian Inventory of Chemical Substances (AICS) which is maintained under the National Industrial Chemicals Notification and Assessment Scheme (NICNAS). Tamboran is also required to disclose all chemicals that are proposed to be used prior to undertaking any drilling and stimulation activities. The CAS number of all chemicals, including proprietary chemicals, is included in a chemical risk assessment which is undertaken by an independent third-party consultant. The final chemical risk assessment report is provided in Appendix E, Appendix E.1 and E.2.

The proprietary chemical CAS numbers are excluded from the final public submission to protect the intellectual property of chemical manufacturers. This approach ensures that all chemicals can be appropriately assessed, while protecting chemical companies from releasing commercially sensitive information.

3.11.1 Chemical types and quantities

Bulk chemicals and hydrocarbons will be utilised/generated during the drilling, stimulation and well testing activities. These are summarised in Table 17 and include the following chemical types:

- Acids and bases: controls pH and are used to clear perforations of debris prior to stimulation
- Biocides: controls or eliminates bacteria growth in the stimulation fluid to prevent introduction to target formation
- Viscosity regulators: increases or reduces the thickness of a fluid
- Clay control: prevents clays from swelling
- Friction reducers: reduces friction between the stimulation fluid and piping allowing the fluid to be injected further without pressure drop
- Corrosion inhibitors: prevents equipment from rusting
- Chemical inhibitors: such as iron or scale prevention
- Surfactants: reduces surface tension of the hydraulic fracturing fluid
- Bulk diesel: to fuel equipment and generate power
- Drilling muds and weighting agents: used to lubricate the drilling bit, return cuttings to surface, control clay swelling and inhibit formation inflows
- Synthetic based muds: mud used to drill within the intermediate and horizontal sections of a well, which are specifically engineered
- Typical workshop and maintenance chemicals including hydraulic oil, coolant, greases, paints, solvents and engine oils
- Degreasers and domestic cleaning chemicals
- Wastewater (discussed in section 3.13)
- Condensate (discussed in 3.10)
- Camp wastewater (sewage) (discussed in section 3.23)

The maximum chemical storage volume is generally restricted to the materials required for drilling and stimulation of two exploration wells at a time at each site.

Table 17: Anticipated chemical volume and storage used in the drilling and stimulation process

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Stimulation Chemicals							
Acetic acid - 60% pH control	3,000	9,000	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
BE-9 biocide	17,000	17,000	L	Stimulation chemical storage area	Tributyl tetradecyl phosphonium chloride	81741-28-8	AECOM, 2024 – Appendix
Caustic soda liquid - pH control / buffer	15,000	45,000	L	Stimulation chemical storage area	Sodium hydroxide	1310-73-2	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
DCA-11001 breaker activator	5,000	15,000	L	Stimulation chemical storage area	Diethanolamine	111-42-2	AECOM, 2024a – Appendix E
DCA-13002 breaker	300	900	kg	Stimulation chemical storage area	Sodium persulfate	7775-27-1	AECOM, 2024a – Appendix E
DCA-13003 breaker	10,000	30,000	L	Stimulation chemical storage area	Chlorous acid, sodium salt Sodium chloride	7758-19-2 7647-14-5	AECOM, 2024a – Appendix E
DCA-16001 clay stabiliser	42,000	126,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
DCA-17001 corrosion inhibitor	1,000	3,000	L	Stimulation chemical storage area	Diethylene glycol Cinnamaldehyde Amine oxides, cocoalkyldimethyl Methanol Benzaldehyde Alcohols, C12-16, ethoxylated Sodium iodide	111-46-6 104-55-2 61788-90-7 67-56-1 100-52-7 68551-12-2 7681-82-5	AECOM, 2024a – Appendix E
DCA-19001 crosslinker	600	1,800	kg	Stimulation chemical storage area	Disodium octaborate tetrahydrate	12008-41-2	AECOM, 2024a – Appendix E
DCA-19002 crosslinker	10,000	30,000	L	Stimulation chemical storage area	Ulexite Ethylene glycol Crystalline silica, quartz	1319-33-1 107-21-1 14808-60-7	AECOM, 2024a – Appendix E
DCA-23001 friction reducer	5,000	15,000	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
DCA-23003 friction reducer	18,000	54,000	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethoxylated branched C13 alcohol Sodium diacetate	64742-47-8 78330-21-9 126-96-5	AECOM, 2024a – Appendix E
DCA-25005 gelling agent	35,000	105,00	kg	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
DCA-30001 scale Inhibitor	15,000	45,000	L	Stimulation chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
DCA-32002 surfactant	15,000	45,000	L	Stimulation chemical storage area	Alcohols, C6-C12, ethoxylated propoxylated Alcohols, C10-C16, ethoxylated propoxylated	68937-66-6 69227-22-1	AECOM, 2024a – Appendix E
DCA-32014 surfactant	200	600	L	Stimulation chemical storage area	Hydrotreated light petroleum distillate Ethanol Fatty acids, tall-oil, ethoxylated C12-C15 Ethoxylated alcohols Amides, tall-oil fatty, N,N-bis(hydroxyethyl) Butyl alcohol Methanol	64742-47-8 64-17-5 61791-00-2 68131-39-5 68155-20-4 71-36-3 67-56-1	AECOM, 2024a – Appendix E
FE-2 buffer	200	600	kg	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024a – Appendix E
Hydrochloric acid - 32%	50,000	150,000	L	Stimulation chemical storage area	Hydrochloric acid (32%)	7647-01-0	AECOM, 2024a – Appendix E
Alcohols, C11-14-iso-, C13-rich, ethoxylated-surfactant	5,285	15,855	L	Stimulation chemical storage area	Alcohols, C11-14-iso-, C13-rich, ethoxylated	78330-21-9	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium (C14-16) olefin sulfonate - surfactant	4,658	13,974	L	Stimulation chemical storage area	Sodium (C14-16) olefin sulfonate	68439-57-6	EHS Support, (2023) – Appendix E.1
Diisobutyl glutarate - plasticiser	627	1,881	L	Stimulation chemical storage area	Diisobutyl glutarate	71195-64-7	EHS Support, (2023) – Appendix E.1
Diisobutyl succinate - plasticiser	209	627	L	Stimulation chemical storage area	Diisobutyl succinate	925-06-4	EHS Support, (2023) – Appendix E.1
Diisobutyl adipate- plasticiser	179	537	L	Stimulation chemical storage area	Diisobutyl adipate	141-04-8	EHS Support, (2023) – Appendix E.1
Sodium thiosulphate- stabilising agent	4,763	14,289	L	Stimulation chemical storage area	Sodium thiosulphate	7772-98-7	EHS Support, (2023) – Appendix E.1
Sodium sulphate stabilising agent	913	2,739	L	Stimulation chemical storage area	Sodium sulphate	7757-82-6	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Sodium sulphite stabilising agent	794	2,382	L	Stimulation chemical storage area	Sodium sulphite	7757-83-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Ethylene glycol-crosslinker Anti-freeze	8,416	25,247	L	Stimulation chemical storage area	Ethylene glycol	107-21-1	AECOM, 2024a – Appendix E EHS Support, (2023) –

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
							Appendix E.1 AECOM, 2024b – Appendix E.2
Choline chloride- clay stabiliser / clay swelling control (2-hydroxy-N,N,N-trimethylethan aminium chloride)	67,750	203,250	L	Stimulation chemical storage area	Choline chloride	67-48-1	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Glutaraldehyde-biocide	14,930	44,790	L	Stimulation chemical storage area	Glutaraldehyde	111-30-8	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Ammonium sulphate-breaker	4,479	13,491	L	Stimulation chemical storage area	Ammonium sulphate	7783-20-2	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Polyacrylamide-friction reducer	4,479	13,491	L	Stimulation chemical storage area	Polyacrylamide	25085-02-3	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Sodium polyacrylate-gelling agent	746	2,238	L	Stimulation chemical storage area	Sodium polyacrylate	9003-04-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Sodium bisulfite-stabiliser	149	447	L	Stimulation chemical storage area	Sodium bisulfite	7631-90-5	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Alkyl alcohol-surfactant	149	447	L	Stimulation chemical storage area	Alkyl alcohol	56-81-5	EHS Support, (2023) – Appendix E.1
2-Propenoic acid, homopolymer, ammonium salt- biocide	149	447	L	Stimulation chemical storage area	2-Propenoic acid, homopolymer, ammonium salt	9003-03-6	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Potassium persulfate-braker	149	447	L	Stimulation chemical storage area	Potassium persulfate	7727-21-1	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
2-Ethoxy-naphthalene-surfactant	149	447	L	Stimulation chemical storage area	2-Ethoxy-naphthalene	93-18-5	EHS Support, (2023) – Appendix E.1
Sodium gluconate-stabiliser	8,576	25,728	L	Stimulation chemical storage area	Sodium gluconate	527-07-1	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Boric acid-crosslinker	4,288	12,864	L	Stimulation chemical storage area	Boric acid	10043-35-3	EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Potassium hydroxide- pH control	10,745	32,235	L	Stimulation chemical storage area	Potassium hydroxide	1310-58-3	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Mannanase-crosslinker	2	6	L	Stimulation chemical storage area	Mannanase	37288-54-3	EHS Support, (2023) – Appendix E.1
Ammonium persulphate-breaker Diammonium peroxidisulphate – Oxidizing viscosity breaker	7,451	22,353	L	Stimulation chemical storage area	Ammonium persulphate	7727-54-0	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Talc- buffer/ Filler for encapsulate	384	1,152	L	Stimulation chemical storage area	Talc, Magnesium Silicate	14807-96-6	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b –

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
							Appendix E.2
Sodium bromate-breaker	50,441	151,323	L	Stimulation chemical storage area	Sodium bromate	7789-38-0	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Hepta sodium phosphonate-Emulsifier	3,176	9,528	L	Stimulation chemical storage area	Hepta sodium phosphonate	22042-96-2	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Distillates, hydrotreated light- friction reducer/slurry agent	54,231	162,693	L	Stimulation chemical storage area	Distillates, hydrotreated light	64742-47-8	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Guar gum-viscosity regulator	15,141	45,423	L	Stimulation chemical storage area	Guar gum	9000-30-0	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Poly-oxyethylene nonylphenol ether-surfactant	4,466	13,398	L	Stimulation chemical storage area	Poly-oxyethylene nonylphenol ether	9016-45-9	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite-biocide	4,466	13,398	L	Stimulation chemical storage area	Quaternary ammonium compounds, bis(hydrogenated tallow alkyl)dimethyl, salts with bentonite	68953-58-2	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
1,6-Hexanediol-cross linker	447	1,341	L	Stimulation chemical storage area	1,6-Hexanediol	629-11-8	EHS Support, (2023) – Appendix E.1
Hydrochloric acid- pH control	44,715	134,145	L	Stimulation chemical storage area	Hydrochloric acid	7647-01-0	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
N-Benzyl-alkylpyridinium chloride- pH control	28	84	L	Stimulation chemical storage area	N-Benzyl-alkylpyridinium chloride	68909-18-2	EHS Support, (2023) – Appendix E.1
Formic acid-corrosion inhibitor	2,001	6,002	L	Stimulation chemical storage area	Formic acid	64-18-6	EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Sodium erythorbate-scaler prohibitor/Reducing Agent	2,001	6,002	L	Stimulation chemical storage area	Sodium erythorbate	6381-77-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Citric acid- pH control	15,878	47,634	L	Stimulation chemical storage area	Citric acid	77-92-9	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Acetic acid- pH Buffer	15,878	47,634	L	Stimulation chemical storage area	Acetic acid	64-19-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Isopropanol- clay management	83	249	L	Stimulation chemical storage area	Isopropanol	67-63-0	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated C12-C16 alcohol - surfactant	57	171	L	Stimulation chemical storage area	Ethoxylated C12-C16 alcohol	68551-12-2	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Ethoxylated decanol - surfactant	19	57	L	Stimulation chemical storage area	Ethoxylated decanol	26183-52-8	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Cinnamaldehyde- biocide / Corrosion inhibitor	1,000	3,000	L	Stimulation chemical storage area	Cinnamaldehyde	104-55-2	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
							EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
Ethoxylated tallow alkyl amine - surfactant	9	27	L	Stimulation chemical storage area	Ethoxylated tallow alkyl amine	61791-26-2	EHS Support, (2023) – Appendix E.1
Methanol-corrosion inhibitor	2	6	L	Stimulation chemical storage area	Methanol	67-56-1	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Polyacrylamide - friction reducer	49,093	147,279	L	Stimulation chemical storage area	Polyacrylamide	9003-05-08	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 AECOM, 2004 – Appendix E.2
Polyethylene glycol trimethylnonyl ether - clay manager/ Emulsifier	748	2,243	L	Stimulation chemical storage area	Polyethylene glycol trimethylnonyl ether	127087-87-0	EHS Support, (2023) – Appendix E.1 AECOM, 2024 - Appendix E.2
Water in additive-stabiliser	66,804	200,412	L	Stimulation chemical storage area	Water in additive	7732-18-5	EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Potassium sorbate food grade-corrosion inhibitor	14	42	L	Stimulation chemical storage area	Potassium sorbate	24634-61-5	EHS Support, (2023) – Appendix E.1
Mannanase (Mannan endo-1,4-beta-mannosidase)-cross linker	2	6	L	Stimulation chemical storage area	Mannanase (Mannan endo-1,4-beta-mannosidase)	37288-54-3	EHS Support, (2023) – Appendix E.1
Nonoxynol-9-surfactant/Emulsifier	51	153	L	Stimulation chemical storage area	Nonoxynol-9	26571-11-9	EHS Support, (2023) – Appendix E.1 AECOM, 2024b – Appendix E.2
2-Ethylhexanol PO/EO polymer-stabiliser	9	27	L	Stimulation chemical storage area	2-Ethylhexanol PO/EO polymer	64366-70-7	EHS Support, (2023) – Appendix E.1
Corn oil- friction reducer	662	1,986	L	Stimulation chemical storage area	Corn oil	8001-30-7	EHS Support, (2023) – Appendix E.1
Proprietary – SCI-1F Scale inhibitor	19,357	58,071	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were PBT and calculated below the risk thresholds.	Proprietary	AECOM, 2024b – Appendix E.2
Proprietary – surface coating	44	131	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were	Proprietary	AECOM, 2024b – Appendix E.2

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					PBT and calculated below the risk thresholds.		
Sodium carbonate – pH buffer	78.5	236	L	Stimulation chemical storage area	Sodium carbonate	497-19-8	AECOM, 2024b – Appendix E.2
Proprietary – improves surface and interfacial tension	292	876	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were PBT and calculated below the risk thresholds.	Proprietary	AECOM, 2024b – Appendix E.2
Proprietary – surfactant	7,592	22,776	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were PBT and calculated below the risk thresholds.	Proprietary	AECOM, 2024b – Appendix E.2
Alkyl Pyridines Quat – Corrosion inhibitor	128	384	L	Stimulation chemical storage area	Alkyl Pyridines Quat	68909-18-2	AECOM, 2024b – Appendix E.2
Polymer/s - Isotridecanol, ethoxylated – Emulsifier	5,742	17,225	L	Stimulation chemical storage area	Isotridecanol, ethoxylated	69011-36-5	AECOM, 2024b – Appendix E.2
HCL-15B – Hydrochloric acid Blend – mineral acid	76,201	228,603	L	Stimulation chemical storage area	Hydrochloric acid	7647-01-0	AECOM, 2024b – Appendix E.2
Proprietary - Emulsifier	8,614	25,842	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health	Proprietary	AECOM, 2024b – Appendix E.2

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					and the environment. Chemicals were PBT and calculated below the risk thresholds.		
Didecyldimethyl -ammonium Chloride - Biocide	1,936	5,807	L	Stimulation chemical storage area	Didecyldimethyl -ammonium Chloride	7173-51-5	AECOM, 2024b – Appendix E.2
Benzalkonium Chloride – Biocide	1,936	5,807	L	Stimulation chemical storage area	Benzalkonium Chloride	8001-54-5	AECOM, 2024b – Appendix E.2
Proprietary – Improve surface and interfacial tension	1,022	3,066	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were PBT and calculated below the risk thresholds.	Proprietary	AECOM, 2024b – Appendix E.2
Proprietary – Improve surface and interfacial tension	341	1,022	L	Stimulation chemical storage area	Based on the CRA, the chemical is of low concern to human health and the environment. Chemicals were PBT and calculated below the risk thresholds.	Proprietary	AECOM, 2024b – Appendix E.2
Completion chemicals							
Sodium chloride-weighting agent	15,000	45,000	kg	Completion chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024a – Appendix E
ALDACIDE G biocide	500	1,500	L	Completion chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
OYXGON Oxygen scavenger	100	300	kg	Completion chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
BARACOR 100 corrosion inhibitor	2,000	6,000	L	Completion chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024a – Appendix E
Sodium Hypochlorite 10 – 30% cleaner	10,000	30,000	L	Completion chemical storage area	Sodium hypochlorite Sodium Hydroxide Water	7681-52-9 1310-73-2 7732-18-5	AECOM, 2024a – Appendix E
Drilling chemicals							
CON-DET wetting agent	50	150	kg	Drilling chemical storage area	Amides, coco, N,N-bis (hydroxyethyl) Benzenesulfonic acid, dimethyl-, sodium salt Isopropanol Potassium pyrophosphate Potassium hydroxide	68603-42-9 1300-72-7 67-63-0 7320-34-5 1310-58-3	AECOM, 2024a – Appendix E
SAPP- sodium acid phosphate cement treatment	50	150	kg	Drilling chemical storage area	DISODIUM PYROPHOSPHATE	7758-16-9	AECOM, 2024a – Appendix E
Bentonite-lubricant	3,000	9,000	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					Crystalline silica, cristobalite Crystalline silica, tridymite	14464-46-1 15468-32-3	
Caustic Soda-pH control	1,400	4,200	kg	Drilling chemical storage area	Sodium hydroxide	1310-73-2	AECOM, 2024a – Appendix E
EZ MUD DP or EZ MUD Liquid-drilling mud	2000	6,000	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
ALDACIDE G biocide	336	1,008	kg	Drilling chemical storage area	Glutaraldehyde Methanol	111-30-8 67-56-1	AECOM, 2024a – Appendix E
STOPPIT loss of circulation material	1,000	3,000	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024a – Appendix E
Soda Ash- drill mud conditioner	350	1,050	kg	Drilling chemical storage area	Sodium carbonate	497-19-8	AECOM, 2024a – Appendix E
BARACOR 100 corrosion inhibitor	250	750	kg	Drilling chemical storage area	Ethanol, 2,2'-oxybis-, reaction products with ammonia, morpholine derivatives residues Methanol Nitrilotriacetic acid, trisodium salt monohydrate	68909-77-3 67-56-1 5064-31-3	AECOM, 2024a – Appendix E
Sodium chloride (flossy salt)- weighting agent and formation inhibitor	96,000	288,000	kg	Drilling chemical storage area	Sodium chloride	7647-14-5	AECOM, 2024a – Appendix E
Barite- weighting agent	500	1,500	kg	Drilling chemical storage area	Crystalline silica	14808-60-7	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BARACARB loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024a – Appendix E
Citric acid- pH control	500	1,500	kg	Drilling chemical storage area	Citric acid	5949-29-1	AECOM, 2024a – Appendix E
BARADEFOAM HP drilling fluid/foam	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
Sodium bicarbonate- pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
PERFORMATRO L- polymer fluid system	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
SOURSCAV- mud additive treat H2S contamination	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
DRIL-N-SLIDE- casing lubricant	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					competent authority		
STEELSEAL- corrosion inhibitor	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
BARAZAN D or BARAZAN D PLUS- viscosity increaser	4,150	12,450	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
PAC Loss of circulation material	2,300	6,900	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
Potassium chloride- weighting agent and formation inhibitor	22,500	67,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
QUIK-FREE – drilling additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
BAROFIBRE, BAROFIBRE super fine and BAROFIBRE coarse loss of circulation material	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
BaraBlend-657 Loss of circulation material	500	1,500	kg	Drilling chemical storage area	Crystalline silica, quartz	14808-60-7	AECOM, 2024a – Appendix E
N-DRIL HT PLUS filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
DEXTRID LTE filtration control additive	4,600	13,800	kg	Drilling chemical storage area	Tetrahydro-3,5-dimethyl-1,3,5-thiadiazine-2-thione	533-74-4	AECOM, 2024a – Appendix E
BARABUF pH buffer	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
BDF 933 or BaraLube W-933 drilling lubricant	864	2,592	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
BAROLIFT sweeping agent	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					concentrations above cut-off values according to the competent authority		
OXYGON oxygen scavenger	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
ENVIRO-THIN filtration control additive	500	1,500	kg	Drilling chemical storage area	Contains no hazardous substances in concentrations above cut-off values according to the competent authority	Proprietary	AECOM, 2024a – Appendix E
Lime pH buffer	500	1,500	kg	Drilling chemical storage area	Calcium hydroxide	1305-62-0	AECOM, 2024a – Appendix E
Calcium chloride	37,000	111,000	kg	Drilling chemical storage area	Calcium chloride	10043-52-4	AECOM, 2024a – Appendix E
Sodium bromide	8,160	24,480	kg	Drilling chemical storage area	Sodium bromide	7647-15-6	AECOM, 2024a – Appendix E
Evolute TR	14,500	43,500	L	Drilling chemical storage area	Triethylene glycol, monobutyl ether 2-Butoxyethanol Diethanolamine	143-22-6 111-76-2 111-42-2	AECOM, 2024a – Appendix E
Radiagreen EME	4,800	14,400	L	Drilling chemical storage area	Fatty esters Specialities	Proprietary	AECOM, 2024a – Appendix E
Radiagreen EBL	4,800	14,400	L	Drilling chemical storage area	Fatty esters Specialities	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Polydrill	7,500	22,500	kg	Drilling chemical storage area	SULPHONATED ORGANIC POLYMER	Proprietary	AECOM, 2024a – Appendix E
Alpine spotting beads	1,000	3,000	kg	Drilling chemical storage area	Styrene	100-42-5	AECOM, 2024a – Appendix E
Barite-weighting agent	354,000	1,062,000	kg	Drilling chemical storage area	Barium sulfate Crystalline silica Mica-group minerals	7727-43-7 14808-60-7 12001-26-2	AECOM, 2024a – Appendix E
Bio-Paq high temp filtration control	1,134	3,402	kg	Drilling chemical storage area	Starch, carboxymethyl ether, sodium salt	9063-38-1	AECOM, 2024a – Appendix E
Brine-Pac XTS corrosion inhibitor	3,400	10,200	L	Drilling chemical storage area	2-methylbut-3-yn-2-ol	115-19-5	AECOM, 2024a – Appendix E
Calcium chloride - salinity	180,000	540,000	kg	Drilling chemical storage area	calcium chloride	10043-52-4	AECOM, 2024a – Appendix E
CF Desco deflocculant	2,270	6,810	kg	Drilling chemical storage area	Tannins, sulfo-methylated crystalline silica, respirable powder	68201-64-9 14808-60-7	AECOM, 2024a – Appendix E
Chek-Loss fibrous LCM	1,360	4,080	kg	Drilling chemical storage area	Cellulose	9004-34-6	AECOM, 2024a – Appendix E
Citric acid - pH control	1,360	4,080	L	Drilling chemical storage area	Citric acid	77-92-9	AECOM, 2024a – Appendix E
Ecco-Temp high temp extender	8,000	24,000	L	Drilling chemical storage area	Triethanolamine	102-71-6	AECOM, 2024a – Appendix E
Flowzan viscosifier	5,000	15,000	kg	Drilling chemical storage area	Contains no hazardous ingredients according to GHS.	N/A	AECOM, 2024a – Appendix E
KEN-SEAL™ PLUS - high temperature	4,000	12,000	Kg	Drilling chemical storage area	Copolymer, sodium salt, dimethylacryla	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
filtration control agent					mide, acrylamidomethyl propane, sulfonic		
Mil-Lime (Calcium hydroxide) alkalinity	1,361	4,080	L	Drilling chemical storage area	calcium dihydroxide	1305-62-0	AECOM, 2024a – Appendix E
Magnesium oxide pH buffer	7,500	22,500	kg	Drilling chemical storage area	magnesium oxide	1309-48-4	AECOM, 2024a – Appendix E
Mil-bio SEA 98 biocide	1,800	5,400	L	Drilling chemical storage area	THPS	55566-30-8	AECOM, 2024a – Appendix E
Mil-carb LCM / bridging	5,000	15,000	kg	Drilling chemical storage area	Limestone crystalline silica, respirable powder	1317-65-3 14808-60-7	AECOM, 2024a – Appendix E
Milstarch filtration control	5,000	15,000	kg	Drilling chemical storage area	Starch	9005-25-8	AECOM, 2024a – Appendix E
Navi-Lube lubricant	16,650	49,950	L	Drilling chemical storage area	Distillates, (petroleum), hydrotreated light Diethylene glycol monobutyl ether Benzene, mono-C10-13-alkyl derivatives, fractionation bottoms, heavy ends, sulfonated, sodium salts Petroleum distillates, hydrotreated heavy naphthenic Benzenesulfonic acid, C10-14-alkyl	64742-47-8 112-34-5 148520-82-5 64742-52-5 69669-44-9	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					derivatives, sodium salts		
New-Drill Plus shale stabiliser	1,000	3,000	kg	Drilling chemical storage area	2-Propenoic acid, polymer with 2-propenamide, sodium salt	25987-30-8	AECOM, 2024a – Appendix E
Noxygen XT oxygen scavenger	884	2,652	kg	Drilling chemical storage area	2,3-didehydro-3-O-sodio-D-erythro-hexono-1,4-lactone	6381-77-7	AECOM, 2024a – Appendix E
Ova Col 110 HC cloud point glycol	13,000	39,000	kg	Drilling chemical storage area	Glycol Ether	9004-77-7	AECOM, 2024a – Appendix E
Potassium chloride salt / shale stabiliser	41,000	123,000	kg	Drilling chemical storage area	potassium chloride	7447-40-7	AECOM, 2024a – Appendix E
Potassium hydroxide pH source	1,250	3,750	kg	Drilling chemical storage area	potassium hydroxide	1310-58-3	AECOM, 2024a – Appendix E
Pyro-Trol II HT filtration control	25	75	kg	Drilling chemical storage area	Copolymer of acrylamide and 2-acrylamide-2-methyl propane sulfonic acid	Proprietary	AECOM, 2024a – Appendix E
Pyro-Vis II HT viscosifier	1,400	4,200	kg	Drilling chemical storage area	t-Butyl alcohol	75-65-0	AECOM, 2024a – Appendix E
Soda ash pH and hardness control	1,000	3,000	kg	Drilling chemical storage area	sodium carbonate	497-19-8	AECOM, 2024a – Appendix E
Sodium bicarbonate pH and hardness control	1,000	3,000	kg	Drilling chemical storage area	sodium hydrogen carbonate	144-55-8	AECOM, 2024a – Appendix E
Sodium chloride - salt	54,400	163,200	kg	Drilling chemical storage area	sodium chloride	7647-14-5	AECOM, 2024a – Appendix E
W.O. defoam defoamer	600	1,800	L	Drilling chemical storage area	1-Hexanol, 2-ethyl-	104-76-7	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
Xan-Plex D viscosifier	3,000	9,000	kg	Drilling chemical storage area	Contains no hazardous ingredients according to GHS.	N/A	AECOM, 2024a – Appendix E
TEQ-LUBE II - lubricant	14,400	43,200	kg	Drilling chemical storage area	Poly(oxy-1,2-ethanediyl), α -hydro- ω -hydroxy-Ethane-1,2-diol, ethoxylated	25322-68-3	AECOM, 2024a – Appendix E
TEQ-LUBE II - lubricant	14,400	43,200	kg	Drilling chemical storage area	Poly(oxy-1,2-ethanediyl), α -(9Z)-9-octadecen-1-yl- ω -hydroxy-, phosphate	39464-69-2	AECOM, 2024a – Appendix E
NEW-THIN – Polymeric thinner	4,680	14,040	kg	Drilling chemical storage area	Contains no hazardous ingredients according to GHS.	N/A	AECOM, 2024a – Appendix E
LC-LUBE - lubricant (graphite)	9,090	27,270	kg	Drilling chemical storage area	Natural graphite	7782-42-5	AECOM, 2024a – Appendix E
MAX-GUARD EA	26,000	78,000	L	Drilling chemical storage area	Poly[oxy(methyl-1,2-ethanediyl)], α -(2-aminomethylethyl)- ω -(2-aminomethylethoxy)-	9046-10-0	AECOM, 2024a – Appendix E
					Acetic acid	64-19-7	AECOM, 2024a – Appendix E
MAX-GUARD PLUS	26,000	78,000	L	Drilling chemical storage area	Reaction mass of 7-azatridecane-1,13-diamine and hexamethylene diamine	Proprietary	AECOM, 2024a – Appendix E

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
					acetic acid	64-19-7	AECOM, 2024a – Appendix E
					hexamethylene diamine	124-09-4	AECOM, 2024a – Appendix E
					cyclohex-1,2-ylenediamine	694-83-7	AECOM, 2024a – Appendix E
MAX-GUARD PLUS A	26,000	78,000	L	Drilling chemical storage area	1,2-Ethanediamine, N-(2-aminoethyl)-	111-40-0	AECOM, 2024a – Appendix E
					acetic acid	64-19-7	AECOM, 2024a – Appendix E
SARALINE 185V	18,603	55,809	kg	Drilling chemical storage area	Distillates (Fischer-Tropsch), C8-26 - Branched and Linear	848301-67-7	AECOM, 2024a – Appendix E
Proppants*							
100 mesh sand-proppant	91,000	273,000	kg	Stimulation Chemical storage area	Sand	14808-60-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
Quartz or organophilic phyllosilicate-proppant	1,084	3,252	L	Stimulation Chemical storage area	Quartz or organophilic phyllosilicate	14808-60-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1
40/70 sand-proppant	1,650,000	4,950,000	kg	Stimulation Chemical storage area	Sand	14808-60-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1

Material name	Typical volume	Maximum volume	Unit	Storage area	Chemical composition	CAS Number	Chemical risk assessment report
30/50 sand-proppant	610,000	1,830,000	kg	Stimulation Chemical storage area	Sand	14808-60-7	AECOM, 2024a – Appendix E EHS Support, (2023) – Appendix E.1 as 20/40
Silicon dioxide (quartz/sand) 100 sand	4,757,614	14,272,842	kg	Stimulation Chemical storage area	Sand	14808-60-7	AECOM, 2024b – Appendix E.2
Silicon dioxide (quartz/sand) 40/70	5,435,287	16,305,860	kg	Stimulation Chemical storage area	Sand	14808-60-7	AECOM, 2024b – Appendix E.2
* Proppants are sand which is inert. They do not require special chemical bunding but are co-located in the stimulation chemical storage area, within the well pad bund. Residual proppant from a stimulation campaign is often used to assist with chemical spills on the well pad, where contaminated spill material is removed.							
Cleaning Chemicals and Spill Response							
Soda ash – sodium carbonate	3,750	11,250	kg	Stimulation Chemical storage area	Sodium carbonate - spill response in event acid spill	497-19-8	AECOM, 2024b – Appendix E.2
Flush fluid - distillates (petroleum), hydrotreated	1,500	4,500	L	Stimulation Chemical storage area	Distillates (petroleum), hydrotreated - equipment cleaning	64742-47-8	AECOM, 2024b – Appendix E.2

3.11.2 Chemical risk assessment

A chemical risk assessment was completed to evaluate the potential human health and environmental health effects of all compounds to be used during drilling and stimulation. The chemical risk assessment is provided in Appendix E.

The assessment methodology is based upon the following guidance documents:

- Northern Territory Department of Environment, Parks and Water Security (DEPWS) – Draft Guideline for the Preparation of an EMP under the NT Petroleum (Environment) Regulations, 2019 (herein referred to as NT 2019)
- Department of the Environment and Energy, Exposure Draft – Chemical Risk Assessment Guidance Manual: for chemicals associated with coal seam gas extraction, 2017 (herein referred to as DOE 2017)

- National Industrial Chemicals Notification and Assessment Scheme (NICNAS), National Assessment of Chemicals Associated with Coal Seam Gas Extraction in Australia, 2017 (herein referred to as NICNAS 2017)
- enHealth “Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards” 2012
- National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPM); Schedule B4, Site-specific health risk assessment methodology 2013.

The chemical risk assessment comprised the following tasks:

- Hazard assessment: An evaluation of the environmental and human health hazards of the chemical additives in the hydraulic fracturing fluid, based on their environmental persistence, bioaccumulation and aquatic toxicity properties.
- Exposure assessment: The exposure assessment comprises an evaluation of surface and sub-surface exposure pathways and reviews the effectiveness of the proposed controls in preventing a complete pathway.
- Screening and validation processes via Tier 1 and Tier 2 assessments to determine chemicals known to be of low concern and identify chemicals for further risk assessment:
 - Tier 1: Using published information about each chemical proposed to be used in the hydraulic fracturing activity.
 - Tier 2: A quantitative evaluation of the risks using toxicity values and quantitative estimates of chemical intake to provide an estimate of potential human health and environmental risk associated with the hydraulic fracturing activities, based on the identification of complete exposure pathways and hazard identification.

3.11.2.1 Results of risk assessment

The results of the chemical hazard and exposure analysis are provided in Appendix E, Appendix E.1 and Appendix E.2.

A Tier 1 assessment was undertaken on all chemicals except for light petroleum distillate (CAS# 64742-47-8). Certain chemicals (14 from Slick Water, 17 from Hybrid and 15 from High Velocity Friction Reduced) require standard flowback water and wastewater disposal controls to ensure the risk of management is low (Appendix E). These controls are consistent with the requirements outlined in the Code of Practice and summarised in section 6.5 of this plan. It must be noted that none of these chemicals were identified to be persistent and bioaccumulative.

An assessment of the potential valid environmental and human health exposure pathways is summarised in Table 18. The exposure pathways assessment considered the:

- properties of the chemicals
- site setting and physical separation distances between receptors (environmental and human) and the activity as outlined in section 3.1
- lack of protected flora and fauna and high conservation value areas in the vicinity of the activity as outlined in section 4.2
- description of the activity and summary of controls as provided in section 3 and section 6.5.

The exposure pathway assessment identified only one partially complete exposure pathway; the on-site release of particulates and vapour during chemical mixing and flowback evaporation. The limited number of valid pathways is consistent with the limited size and duration of the proposed activities.

A Tier 2 assessment was conducted on hydrotreated light petroleum distillate, which was classified as a bioaccumulative and toxic substance (see Appendix E) and glutaraldehyde (CAS number 111-30-8), which is identified in the Tier 1 assessment as having a potential avian wildlife exposure (see Appendix E.1). As per NICNAS 2017 and DOE 2017 guidance, the Margin of Exposure (MOE) approach was used to assess the health risk to workers. For each occupational activity scenario (i.e. transport and storage, mixing/blending of hydraulic fracturing chemicals, evaporation of flowback and cleaning and maintenance), an MOE was derived by comparing the point of departure (e.g. No Observed Adverse Effects Level [NOAEL]) for long-term health effects from the critical toxicological study to the estimated total human internal dose from all routes of exposure.

Based on the calculated MOEs, the chemical is of low concern for workers (refer to individual toxicity profile for further detail). A summary of the Tier 2 risk assessment is provided in Appendix E and Appendix E.1.

Table 18: Stimulation chemical exposure pathways

Pathway	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Off-lease release via spill – water	As per the Spill Management Plan (Appendix F) 1. All chemical storage and handling areas to have appropriate secondary containment. 2. Well pads are bunded to contain any major spill of flowback chemicals (capacity of 6ML at Amungee NW, 10ML at Velkerri 76 S2). 3. Offset distances from sensitive receptors (groundwater extraction bores, homesteads, culturally sensitive areas and communities). 4. Routine inspections (daily inspections during the wet season and weekly during the dry season) are completed to ensure any leaks or spills from chemical and waste storage are prevented or promptly identified.	Petroleum Code of Practice Part A – Surface Activities A.3.1 Site selection and planning A.3.2 Well pad site selection requirements 3.8 Containment of Contaminants C.7.2 Spill Management Plan American Petroleum Institute Standards API RP Recommended Practice 100-2 Managing Environmental Aspects Associated with Exploration and Production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing Australian Standards (AS) AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods	High – The use of secondary containment and bunding reduces the probability of an off-lease release via a spill down to ‘remote’.	High – The certainty around the use of secondary containment and bunding to prevent spills is well recognised within international spill containment standards and legislation.	Incomplete – Controls in place unlikely to result in any off-site releases.
On-lease release via spill – water	1. All chemical storage and handling areas to have appropriate secondary containment. 2. Routine inspections (daily during drilling weekly post drilling) are	Petroleum Code of Practice Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan	High – The use of secondary containment and bunding reduces the probability of releases.	High – The certainty around the use of secondary containment and bunding to prevent spills is well recognised within international spill	Incomplete – Controls in place unlikely to result in any exposure.

Pathway	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
	completed to ensure any leaks or spills are prevented, promptly identified and rectified. 3. Spill kits and clean up equipment available on-site.	American Petroleum Institute Standards API RP Recommended Practice 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing Australian Standards (AS) AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods		containment standards and legislation.	
Off-lease release via particulate during mixing and flowback evaporation – air	1. All chemical mixing on-site to comply with the Workplace Health and Safety guidelines for handling of chemicals. 2. Chemical transfer and mixing procedures deployed to avoid the generation of dust. 3. Chemical mixing location away from well site boundary, with a separation distance of 50m and within a portable containment bund. 4. Wind speed and direction sensors deployed with automatic cut-offs to prevent off-site drift from evaporation units.	Petroleum Code of Practice Part A – Surface Activities Containment of Contaminants American Petroleum Institute Standards API RP Recommended Practice 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing Managing risks of hazardous chemicals in the workplace Code of Practices 2013 Section 4— Controlling risk Australian Standards (AS)	High – Legislation controlling the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	High – The certainty around the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	Incomplete – The deployment of standard chemical handling procedures to minimise dust, combined with separation distance from the well site boundary, is likely to limit off-site releases.

Pathway	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
		AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods			
On-lease release via particulate – air	1. All chemical mixing on-site to comply with the NOHSC guidelines for handling of chemicals. 2. Chemical transfer and mixing procedures deployed to avoid the generation of dust. 3. Chemical mixing location away from well site boundary, with a separation distance of at least 50m and within a portable containment bund.	Petroleum Code of Practice Part A – Surface Activities Containment of Contaminants American Petroleum Institute Standards API RP Recommended Practice 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of fluids and Materials for Hydraulic Fracturing Managing risks of hazardous chemicals in the workplace Code of Practices 2013 Section 4 – Controlling risk Australian Standards (AS) AS/NZS 4452: The storage and handling of toxic substances AS1940: The storage and handling of flammable and combustible liquids AS 3780:2008: The storage and handling of corrosive substances AS/NZS 3833:1998: The storage and handling of mixed classes of dangerous goods	High – Legislation controlling the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	High – The certainty around the handling of chemicals is mature and standardised across Australia to limit exposure to employees and surrounding receptors.	Partially complete – On-site release of particulate chemicals during handling is potentially complete with human error.

Pathway	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
Off-site release via transport accident	1. All chemicals and waste products to be transported by licenced contractors in accordance with the NT Dangerous Goods (Roads and Rail) Regulations and <i>NT Waste Management and Pollution Control Act 1998</i>. 2. Legislation, regulations and national standards set out the requirements for the safe transport of chemicals, including for packaging, driver training, safety equipment and vehicle standards. These measures reduce the risk of a spill occurring, or of not being detected and cleaned up if it does occur. 3. Origin, and now Tamboran, have undertaken 100,000's of chemical transport movements without any major accidents causing environmental harm.	Petroleum Code of Practice Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan Transport of Dangerous Goods by Road and rail (National Uniform Legislation) Regulations 2011	High – Legislation controlling the transportation of chemicals and wastes is mature and standardised across Australia.	High – The certainty around the transportation of chemicals and wastes is mature and well understood across Australia. Origin, and now Tamboran, has undertaken 100,000's of chemical transport activities without major incident.	Incomplete – The probability of exposure via a transport accident is limited via the mature legislative framework in place.
Subsurface release of chemicals to aquifer	1. Code of Practice requiring multiple strings of casing and cement designed to protect aquifer. 2. Integrity validation of casing and cement barriers prior to completing stimulation. 3. Pressure monitoring during stimulation of both the formation and the B well annulus. 4. Physical separation distance of 1,400 m between aquifer and the target formation prevents any migration of stimulation fluid to aquifer units.	Petroleum Code of Practice Part B – Well Operations B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.10 Drilling fluids B.4.13 Hydraulic stimulation and flowback operations B.4.7 Primary cementing B.4.17 Groundwater monitoring B.5 BTEX Limit	High – The legislation and guidance notes relating to aquifer protection and well integrity are mature, with extensive industry experience.	High – High certainty around the effectiveness of controls around the protection of aquifers using industry standard practice.	Incomplete – The probability of contamination of an aquifer from release of stimulation fluid during stimulation is remote and therefore incomplete.

Pathway	Controls	Regulatory controls/guidelines	Effectiveness of controls	Scientific certainty	Pathway assessment
	5. 4km separation distance between exploration well and closest pastoralist extraction bores.				
Surface release of chemicals to aquifer	1. Secondary containment to be used to manage all chemicals and wastes handled on-site. 2. Code of Practice requires double-lined tanks with in-built leak detection. 3. Spill Management Plan and Wastewater Management Plan to be implemented. 4. Routine inspections to identify leaks (daily during drilling weekly post drilling). 5. 70m vertical separation between surface and underlying aquifer. 6. Closest groundwater extraction bore is 4km away.	Part A – Surface Activities 3.8 Containment of Contaminants C.7.2 Spill Management Plan American Petroleum Institute Standards API RP Recommended Practice 100-2 Managing Environmental Aspects Associated with Exploration and production Operations Including Hydraulic Fracturing Section 13.2: Storage and Management of Fluids and Materials for Hydraulic Fracturing	High – The controls managing the storage of chemicals and wastes are mature with secondary containment measures limiting potential pathways to receptors.	High – The certainty around the effectiveness of secondary containment in preventing groundwater contamination is mature.	Incomplete – The probability of contamination of an aquifer from release of stimulation fluid is remote and therefore incomplete.

3.12 Water supply and use

The extraction of water for all activities associated with stimulation is approved under the Water Extraction Licence (WEL) number GRF10285. This approval allows for an extraction of up to 175ML/year from the Gum Ridge Formation to cover all its proposed exploration until December 2024.

Water sourced for the EMP activities will be extracted from the existing Gum Ridge Formation bores at the sites, or from the proposed groundwater bores to be installed at Amungee NW. Any new bores constructed to support exploration activities will be registered and added to the WEL.

It is estimated that 110ML of water per site (220ML total) will be extracted from the Gum Ridge Formation at the Amungee NW and Velkerri 76 S2 sites to support the proposed E&A activities over two years. A water balance for the activity is provided in Table 19, noting that all estimates are estimates and subject to operational changes. The anticipated breakdown of groundwater take for the proposed exploration activities consists of the following breakdown per activity:

- 5 ML per E&A well for drilling (total 20 ML)
- 40 ML per well for stimulation (total 160 ML)
- 5 ML for camp activities per site (total 10 ML)
- 15 ML civil construction, groundwater bore drilling, dust suppression, water curtain and general activities per site (total 30 ML)

All groundwater take is metered with continuous flow meters and reported to DLPE as per the WEL conditions. Water take records will be kept and updated weekly during operations, to ensure the water take volumes are not exceeded. Predicted water take by period is provided in Table 19, demonstrating the available water under the WEL is sufficient to cover the proposed water take.

Groundwater will be used to supply potable water, with on-site water treatment used to provide water in accordance with the Australian Drinking Water Guidelines.

To reduce raw water take and minimise the storage and disposal of wastewater, flowback may be utilised in the stimulation make up fluid where technically feasible (i.e. due to fluid compatibility). Where flowback is used for make-up fluid, flowback will be managed in accordance with section 3.13.3

The cumulative impact associated with current and future groundwater takes were addressed in the Water Extraction Licence (WEL) GRF 10285 statement of reason. This WEL covered the anticipated (conservatively high) future water take for civil construction, drilling, stimulation and well activities over the foreseeable future. The WEL will be periodically renewed to ensure all required take is covered. The WEL statement of reason is provided in Appendix B and is available from DLPE Water Resources website at <http://www.ntlis.nt.gov.au/walaps-portal/report/current/gwel>.

Table 19: Predicted water use by year

Site	Predicted water use per year		
	2022	2023	2024
Amungee NW	108	2	0
Velkerri 76 S2	0	108	2
Total	108	110	2

3.13 Wastewater management

A project-wide Wastewater Management Plan (WWMP) has been developed to manage wastewater generated under this EMP. The WWMP has been developed in accordance with the Code of Practice and covers the following wastewater streams:

- drilling fluids, water-based drilling muds and drilling cuttings
- stimulation fluids
- completion and kill fluids
- produced fluids.

The WWMP covers the following information on the management of wastewater during Tamboran's exploration activities:

- storage, handling and disposal requirements for wastewater, including the requirement for flowback tanks
- spill management and response requirements
- prohibited reinjection or surface disposal of wastewater.

The following section provides an overview of the wastewater management strategy, with further information provided in the Wastewater Management Plan attached in Appendix G.

3.13.1 Wastewater management

A water balance has been prepared summarising the anticipated volumes of water to be used and volumes of wastewater that is expected to be generated, stored and disposed of off-site. This balance includes existing wastewater generated from the existing E&A wells and all proposed activities associated with the drilling, stimulation and well testing of under this EMP. Observed average monthly rainfall and evaporation rates for the region are used to calculate the rainfall inputs and evaporation outputs from open tanks.

The water balance includes the make-up water and wastewater generated from the main processes of drilling, stimulation, well testing, dust suppression and camp activity.

An overview of on-site water management is provided in Figure 31 and in Table 20 and Table 21.

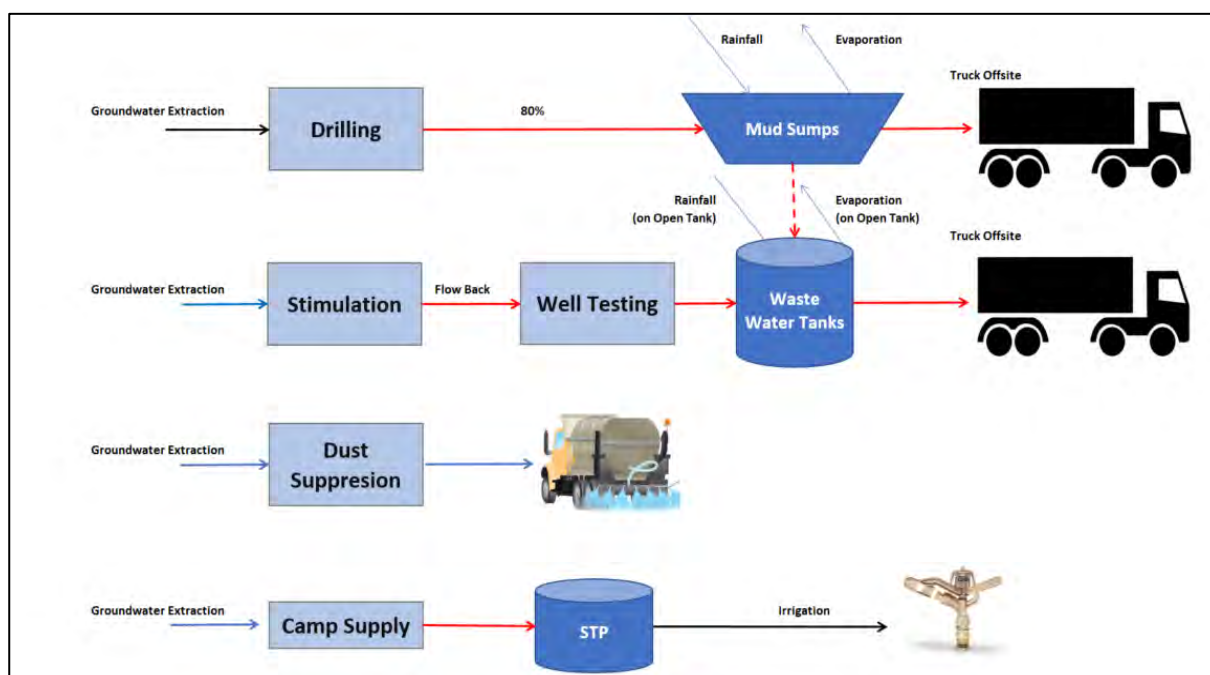


Figure 31: Site water management illustration

Table 20: Amungee NW site process water balance by activity

Summary			2022												2023											
Month	Total		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater water used per month																										
Drilling	ML	10.0	0.00	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stimulation	ML	80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Camp	ML	4.1	0.00	0.00	0.00	0.00	0.00	0.60	0.62	0.62	0.77	0.19	0.18	0.19	0.19	0.17	0.19	0.18	0.19	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Dust suppression	ML	2.0	0.00	0.00	0.00	0.00	0.00	0.15	0.16	0.16	0.15	0.16	0.15	0.16	0.16	0.14	0.16	0.15	0.16	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Total	ML	96.1	0.00	0.00	0.00	0.00	0.00	3.25	3.28	83.28	3.42	0.34	0.33	0.34	0.34	0.31	0.34	0.33	0.34	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater generated per month																										
Drilling	ML	4.0	0.00	0.00	0.00	0.00	0.00	1.25	0.75	0.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stimulation	ML	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	7.20	2.40	1.68	0.24	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater stored on-site per month (cumulative total which includes evaporation and rainfall)																										
Drilling wastewater	ML		0.00	0.00	0.00	0.00	0.00	1.25	0.75	0.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flowback wastewater on-site	ML		0.20	0.20	0.20	0.20	0.20	0.20	0.26	0.56	12.56	14.11	10.93	9.42	7.67	6.45	4.34	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total wastewater on-site	ML		0.20	0.20	0.20	0.20	0.20	1.45	1.01	1.31	13.81	14.11	10.93	9.42	7.67	6.45	4.34	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 21Table 21: Velkerri 76 S2 site process water balance by activity

Summary			2022												2023											
Month	Total		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Groundwater water used per month																										
Drilling	ML	10.0	0.00	0.00	0.00	0.00	0.00	2.50	2.50	2.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stimulation	ML	80.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	80.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Camp	ML	4.1	0.00	0.00	0.00	0.00	0.00	0.60	0.62	0.62	0.77	0.19	0.18	0.19	0.19	0.17	0.19	0.18	0.19	0.03	0.00	0.00	0.00	0.00	0.00	0.00
Dust suppression	ML	2.0	0.00	0.00	0.00	0.00	0.00	0.15	0.16	0.16	0.15	0.16	0.15	0.16	0.16	0.14	0.16	0.15	0.16	0.15	0.00	0.00	0.00	0.00	0.00	0.00
Total	ML	96.1	0.00	0.00	0.00	0.00	0.00	3.25	3.28	83.28	3.42	0.34	0.33	0.34	0.34	0.31	0.34	0.33	0.34	0.18	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater generated per month																										
Drilling	ML	4.0	0.00	0.00	0.00	0.00	0.00	1.25	0.75	0.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stimulation	ML	24.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	12.00	7.20	2.40	1.68	0.24	0.24	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wastewater stored on-site per month (cumulative total which includes evaporation and rainfall)																										
Drilling wastewater	ML		0.00	0.00	0.00	0.00	0.00	1.25	0.75	0.75	1.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Flowback wastewater on-site	ML		0.20	0.20	0.20	0.20	0.20	0.20	0.26	0.56	12.56	14.11	10.93	9.42	7.67	6.45	4.34	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total wastewater on-site	ML		0.20	0.20	0.20	0.20	0.20	1.45	1.01	1.31	13.81	14.11	10.93	9.42	7.67	6.45	4.34	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

3.13.2 Drilling fluids, muds, cuttings and cement returns

The following section provides an overview of the management summary associated with waste drilling fluids, muds, cuttings and cement returns.

3.13.2.1 Sump design

Except for synthetic based mud drilling fluid which will be recovered after use and reused, all drilling fluids, including cuttings, muds and cement returns, will be directed to the drilling sump on each site (the existing Velkerri 76 S2 sump and new Amungee NW sump). The drilling sump is designed to accommodate the drilling of multiple wells. Waste drilling fluids may also be transferred and stored on-site in wastewater tanks to ensure sufficient capacity is always in place to accommodate the freeboard requirements.

An overview of the drilling sump design is provided in Appendix D. The sump surface will be rolled and compacted, with a Coletanche liner. Coletanche is a composite liner consisting of five different layers:

1. A highly resistant anti-root film able to withstand puncturing by vegetation or rough substrates
2. Glass fleece which ensures dimensional stability
3. A non-woven geotextile reinforced structure which is highly resistant to tearing and puncturing
4. An elastomeric bitumen binder ensures that the geotextile is waterproof and resistant to ageing
5. A coating of sand ensures that workers can move on the surface in all weather conditions in order to carry out maintenance work. It also provides a rough surface which allows coverage of the membrane by soil.

The Coletanche liner product data sheet is provided in Appendix D. Coletanche was selected based upon the following:

- easily installed and shaped to fit sump geometry
- high resistance to tearing/puncturing and to hydrostatic pressures
- low water permeability, with a 6×10^{-14} m/s permeability
- can withstand high temperature fluctuations.

In some circumstances, a conventional HDPE liner may be utilised. Where a HDPE liner is utilised, the liner specification shall meet or exceed with the Code of Practice.

3.13.2.2 Volume and quality

It is anticipated that approximately 1500m³ (750m³ per E&A well) of waste drilling solids (cuttings, muds (water based) and cement returns) and approximately 4 ML (2ML per E&A well) of drilling and completion fluids will be generated at each of the Amungee NW and Velkerri 76 S2 sites. This estimate is based on engineering calculations and observed drilling waste volumes recorded during the existing wells at the sites. Drilling fluids and muds are saline, with sodium and potassium-based salts used as a weighting agent and formation inhibitor. Other compounds, such as barite (Barium Sulphate) and polymer-based compounds are also utilised during drilling process.

Drill cuttings waste will largely reflect the quality of the rock overburden and target shale formations. Drilling fluids and solids (cuttings, muds and cements returns) may be removed periodically from the sump between wells, or as required to maintain the safe operating level of the sump. Drilling fluids and solids may be transferred to lined tank/ pit (in accordance with section C.4.1.2 of the Code of Practice), disposed of in accordance with section 3.13.2.3 of this EMP.

3.13.2.3 Drilling muds, cuttings and cement returns disposal

It is anticipated that drilling material (except for SBM which are recovered and reused) may either be disposed of during operations (i.e. between the drilling each E&A well to accommodate storage volume requirements) or upon completion of drilling/well testing operations (with the potential for on-site storage of material in accordance with section C.4.1.2 of the Code of Practice).

Prior to the disposal of drilling waste material, a suitably qualified third-party will test the dried material and determine whether the material is suitable to be disposed of on the well pad (or within the approved disturbance area) using a 'mix, bury and cover' approach (as per C.4.1.2 of the Code of Practice). 'Mix, bury and cover' involves the mixing of dried drilling waste material with the soil located within the drilling sump batters to reduce the concentration of any potential contaminants to an acceptable level. The material is then track-rolled and approximately 300mm of clean material placed over the top. An additional 150mm of topsoil is added to the sump upon remediation of the entire well site. DLPE will be consulted if on-site disposal is proposed.

If the material is unsuitable for on-site disposal (such as the moisture content is too high or the material is incompatible with surrounding soils or the analysis of the material indicates it is inappropriate for on-site disposal (as per C.4.1.2 of the Code of Practice)), the material may be left in-situ across the wet season to allow for the material to dry during the subsequent dry season or be transported off-site. If on-site disposal is not feasible, all solid material 3000m³ of waste from the four (4) proposed E&A wells (4 wells @750m³/well) will be transported off-site to an alternative suitable exploration location (such as Kyalla 117 N2) or a licenced facility. Off-site disposal will be undertaken in accordance with the NT Waste Management and Pollution Control Act 1998.

All fluids collected in the sumps will either be evaporated in the sump or transferred to wastewater tanks for storage and evaporation. The use of evaporation is the main mechanism used to reduce the volume down to as low as possible. The residual concentrated liquid waste stream will be disposed of off-site at a licenced facility in accordance with the NT Waste Management and Pollution Control Act 1998.

The sumps will be operated with sufficient freeboard available to accommodate the total rainfall anticipated based on a 1:1000-year Average Recurrence Interval (ARI) for the duration the sump is in operation. As per the calculations within the wastewater management plan (WWMP) (Appendix G), this equates to a 1.3m wet season freeboard and a 0.3m of dry season freeboard. Any rainwater that has come into contact with contaminants in the sump will be collected and disposed of in accordance with the WWMP.

3.13.2.4 Monitoring

Wastewater volumes within the mud sumps will be monitored daily during operations. Once drilling has finished, sump levels will be monitored weekly during the dry season and daily during the wet season. Monitoring may be undertaken via physical inspection, remote cameras or sensor. The wastewater balance and storage curves will be updated weekly to ensure sufficient freeboard in compliance with the Code of Practice.

Drilling mud and cuttings will be sampled prior to disposal and characterised in accordance with requirements set out in section 3.26.

3.13.3 Flowback

The anticipated flowback will be composed of formation reservoir hydrocarbons only, with an absence of movable indigenous water from the reservoir. The absence of water is due to a combination of the extremely low reservoir permeabilities and clay adsorption effects.

3.13.3.1 Volume

Tamboran anticipates that a potential load fluid recovery of 30% of injected stimulation fluid over the testing duration based upon previous Amungee NW-1H results. Tamboran estimates a flowback wastewater production volume of approximately 12 ML per E&A well. The majority (80% of encountered volume of flowback) is anticipated to be generated in the first 60 days of the well test.

The predicted maximum volume of flowback stored at each of the sites are:

- Amungee NW – 14.11 ML
- Velkerri 76 S2 – 14.91 ML

An overview of the site wastewater balance is provided in section 3.13.1.

3.13.3.2 Quality

The quality of flowback at both sites is expected to be similar to that encountered during the Amungee NW-1H well test. A summary of the flowback monitoring results is provided in Table 22.

Geogenic chemicals requiring careful management, with salt the main contaminate of concern (predominantly sodium chloride). The flowback is likely to be elevated in some metals (primarily barium) and hydrocarbons. BTEX, phenolic compounds and polycyclic aromatic hydrocarbons (PAHs) are either not anticipated, or likely to be present at low concentrations.

Additional information on flowback quality of the Amungee NW-1H well and other petroleum wells in the Beetaloo are available here [Flowback fluid monitoring results | Department of Lands, Planning and Environment](#).

Table 22: Flowback quality based on Amungee NW-1H flowback results

Parameter	Flow back levels
BTEX compounds	Total BTEX levels are anticipated to be low. Total BTEX in the Amungee NW-1 flowback ranged between 2 and 15 µg/L
Total nitrogen (as N)	Maximum value of 62.1 mg/l observed within flowback
Salinity (TDS)	Saline with total dissolved solids level exceeding 49,000 mg/L
pH	Slightly acidic with a median value of 6.74
Major ions	Flowback predominantly Na and Cl dominated
Dissolved metals	All detected dissolved metal concentrations within the flowback were low, with the exception of Barium 54.5 mg/L and Boron (80.1 mg/L)
Polycyclic Aromatic Hydrocarbons	All values in the flowback below laboratory Limit of Reporting (LOR)
Petroleum Hydrocarbons	All fractions of TPH are anticipated to be elevated
Phenolic Compounds	Low level of phenolic compounds detected in flowback
Radionuclides	Maximum Gross Alpha Activity and Gross Beta Activity of 12.4 Bq/L and 18.3 Bq/L encountered in the flowback, the anticipated source is likely to be Radium-226

3.13.3.3 Flowback storage

On-site wastewater management will be an adaptive process, with enclosed tank and treatment capacity adjusted (added or removed) to meet operational requirements (including meeting mandatory Code of Practice requirements).

During the wet season, enough enclosed capacity will be on-site to store all flowback wastewater as the risk of recording a significant rainfall event is considerably higher than the dry season. During this period, both the Amungee NW and Velkerri 76 S2 site will have approximately 5 x 5.3ML enclosed tanks (26.5ML to capacity), which will be sufficient to manage the anticipated 24L of produced flowback per site. Open treatment tanks will also be utilised during the wet season, with 5 x 5.3ML open tanks (1.3ML of available storage, accounting for freeboard) installed on-site. Total available open and enclosed wet season flowback storage on each site (excluding freeboard) is anticipated to be 33ML, 137% of the predicted flowback generated per site. The tank set-up is provided in Table 15.

During the dry season, the risk of receiving a significant rainfall event is considerably lower. Flowback stored during the dry season will be treated in open treatment tanks to reduce the wastewater volume as much as possible. It is anticipated that both the Amungee NW and Velkerri 76 S2 sites will have approximately 8 x 5.3 ML open tanks (34.4 ML of available storage minus freeboard), which will be utilised to treat the predicted 22 ML of produced flowback per site. Enclosed tanks will be constructed on-site with enough capacity to store the 1:1000ARI dry season freeboard for all open flowback wastewater tanks operating on-site. This will be achieved through the construction of 2x 5.3 ML enclosed tanks (10.6 ML total capacity), which is greater than the sum of the dry season freeboards of all open tanks (8 ML). The total available dry season open, and enclosed wastewater tank storage volume (accounting for freeboard) is 45ML, almost double the anticipated 24 ML of flowback anticipated to be generated per site. The tank set-up is provided in Table 16.

To manage flowback volume across the basin, trucking of wastewater may be undertaken periodically to provide additional storage capacity on-site for weather events and unexpected volumes of water. This includes trucking to off-site approved disposal locations and Tamboran's existing approved exploration sites within the Basin (such as between Velkerri 76 S2 and Amungee NW and Kyalla 117 N2).

A picture of the enclosed tanks currently installed on the Kyalla 117 N2 site is provided as an example (Figure 32).



Figure 32: Example of covered water storage tank located on the existing Kyalla 117 N2 site

3.13.3.4 Wastewater operating strategy

The operating plan for the working evaporation tanks is provided in the WWMP (Appendix G). The wastewater treatment tanks will be operated in accordance with the following philosophy:

- During the dry season, all flowback wastewater will be treated in open tanks to maximise. Sufficient enclosed flowback wastewater storage will be available to manage the sum of all open tank freeboard volume on-site.
- During the wet season, enough covered flowback wastewater storage capacity will be on-site at all times to manage all stored flowback wastewater volumes
- Open tanks will be periodically converted to enclosed tanks as the volume of flowback water on-site increases (i.e. prior to commencement of wet season)
- Flowback wastewater levels and the interstitial space between each of the tank liners are monitored continuously with electric probes to prevent overtopping and leaks
- Where sufficient enclosed tank capacity is unavailable, the well will be shut in to ensure compliance with the Code of Practice wastewater management guidelines and prevent overtopping of the tanks. Wastewater levels must be reduced to below the enclosed tank capacity before recommencing operations
- Mechanical enhanced evaporators will be utilised within the evaporation tanks to maximise evaporation rates
- All flowback wastewater stored within open working evaporation tanks will be transferred to enclosed storage at least eight hours before the onset of a significant rainfall event (defined as a 300mm rainfall event predicted over four days as per the WWMP)
- All open tanks will be operated with enough freeboard to manage the entire rainfall from of an entire 1:1000 ARI wet or dry season (i.e. the entire seasons rainfall and not just one single event), as specified in the WWMP, this equates to a minimum 1.3 m of freeboard for the wet season and 300 mm for the dry season
- Wastewater may be transferred between approved sites within the basin, which includes wastewater taken to/from the Amungee NW and Velkerri 76 S2 site for storage.

Mechanical enhanced evaporators will be utilised in each wastewater treatment tank to enhance natural evaporation. It is anticipated that up to three to five evaporator units will be deployed on each tank, with a combined water treatment rate of up to 1,000 L/minute. Based upon the results from the existing Kyalla 117 N2-1 well, evaporation rates above 100 barrels (16,000 L) per day have been observed, which aligns with the estimate evaporation rates used in the wastewater balance.

The evaporator units have an estimated diesel consumption of 21L/hour will be required while the units are in operation. To mitigate the drift of wastewater outside of the tank, the units will have an automated wind speed and direction cut-off mechanism to stop operations during periods of moderate wind (11-16 knots as defined by the BOM (refer to <http://www.bom.gov.au/marine/knowledge-centre/reference/wind.shtml>)). The exact wind speed cut-off will be determined during the installation of the units and tested with fresh water. This proposed approach was used successfully during the flowback operations at the Amungee NW-1H well and Kyalla N2-1H well.

Other technology, such as brine crystallisers and thermal combustion treatment systems may be utilised to further reduce wastewater on-site. Such systems will be utilised to generate solid/ semi solid brines to minimise off-site transportation. These systems will be located on the well pad, be fully bundled and use either diesel or gas fired (from the on-site wells) power generation. All water treatment systems will either be zero liquid discharge or produce a freshwater compliant with Table 23 that will be irrigated into the surrounding area.

Where a significant rainfall event is predicted (defined as a 300 mm rainfall event predicted over four days as per the WWMP), the total volume of flowback stored on-site will be transferred to the covered storage tanks 8-hours prior to the onset of the event. The Bureau of Meteorology's 4-day total rain forecast (<http://www.bom.gov.au/jsp/watl/rainfall/pme.jsp>) will be reviewed daily to identify periods of significant rainfall. This forecast provides an 8-day look ahead, which will be able to identify periods of significant rainfall several days before its onset.

Tamboran will have up to 6 x 6-inch transfer pumps on-site capable of transferring up to 23 ML/day each. The on-site pumping capacity is significantly more than the total worst-case volume of wastewater that will be stored on-site. Commencement time to begin transferring the flowback fluid will be selected to ensure that it is completed at least eight 8-hours prior to the predicted commencement of the significant rainfall event.

In the event of a catastrophic failure of a tank, all wastewater will be contained within the bunded site. The earthen bund around the Amungee NW site has the capacity to manage approximately 6ML of wastewater and the existing Velkerri 76 S2 site has a bund capacity of 10ML (minimum 300 mm bund around the entire site) to accommodate 110% of the volume of the largest tank on-site if the tank were to fail. Where a tank fails, water will be pumped from the bund into the available waste storage tanks on-site. In such a case, the exploration well would be shut in and the regulator notified as per the SPMP. A site assessment and rehabilitation strategy would be developed in alignment with Schedule A of the National Environmental Protection (Assessment of Site Contamination) Measure.

3.13.3.5 Wastewater monitoring

The following wastewater monitoring strategies will be implemented during extended production testing and wastewater storage:

- Each wastewater tank will be equipped with level sensors to monitor the fluid volumes in real time
- Alarms are set below the freeboard level (referred to as the maximum operating water level) to trigger a management response if exceeded
- Automated cut-off sensors will also be deployed to ensure wastewater tank levels do not exceed the safe operating level and 1:1000 ARI freeboard requirements (for open tanks) during operations
- Weekly tracking and storage forecasting will be undertaken to ensure freeboard requirements are not exceeded
- Weekly wastewater tank integrity inspections to identify any liner or tank defects
- Monitoring of flowback quality will be undertaken in accordance with Section 3.26

3.13.3.6 Flowback disposal

When the tanks are decommissioned, the associated residual solids, brines, sludges and liners are removed, transported by road and disposed of at a licensed waste disposal facility. It is anticipated that associated residual solids, brines, sludges and liners will be sent interstate to the Westrex waste facility in Jackson, Queensland as the default location. Options for alternative authorised facilities are under review and if they become available during the disposal of flowback materials they may be used. All interstate transfers of controlled wastes will require an interstate/territory consignment authority to authorise the movement of waste between administrative boundaries.

It is anticipated that the operational strategy will reduce residual flowback volumes from a peak of approximately 14.11ML at Amungee NW to approximately 0.6ML by April 2023. At this point, approximately 20 B-Triples will transport the residual flow back to an approved disposal location.

Flowback volumes at Velkerri 76 S2 are anticipated to be reduced from a peak of 14.91ML, down to below 0.5ML by May 2024. Approximately 20 B-Triples will transport the residual flow back to an approved disposal location.

It should be noted that the above volumes and timelines are indicative and is subject to change based upon operational requirements.

3.13.4 Fauna and bird access

Previous operations at the Amungee NW and Kyalla 117 N2 site have not identified any significant interaction of fauna with open wastewater storages. This is supported by various pieces of literature which highlight the role of the salinity in deterring birds and fauna from consuming/interacting with wastewater (Bartholomew and Cade 1963; Ohmart and Smith, 1970; ANZECC, 1992; Griffiths et al, 2009).

The Amungee NW-1H and Velkerri 76 S2-1 flowback wastewater is hypersaline, with total dissolved solids (TDS) > 50,000mg/L, and is indicative of the flowback water anticipated under this EMP. It is well documented that birds, insects and mammals are unable to drink hypersaline water greater than 46,000 mg/L TDS (Bartholomew and Cade 1963; Ohmart and Smith, 1970; ANZECC, 1992; Griffiths et al, 2009). The TDS of the wastewater is likely to reduce the palatability of the wastewater, thus reducing the potential exposure of fauna, including birds to wastewater. This has been documented within the gold industry, where studies have identified links between the hyper salinity of wastewater to reduced bird mortality associated with cyanide ecotoxicity (Adams et al. 2013, Adams et al. 2008, Griffiths et al. 2009a and Griffiths et al. 2009b).

Monitoring of flowback storages and surrounding areas for fauna mortality will be implemented as per section 3.26.

3.13.5 Stormwater

The Amungee NW and Velkerri 76 S2 sites will be operated in a manner that minimises the contamination of stormwater and overland flow. Stormwater is typically characterised by low electrical conductivity (<100 µs/cm) and will contain sediment sourced from the cleared well pad surface. The following describes how stormwater is managed on the site:

- the well pad has been designed to divert stormwater around the well pad to prevent contamination
- the wastewater storage areas will be bunded from the rest of the well site and designed to divert stormwater to prevent contamination
- a stormwater retention basin within the wastewater storage areas will allow collected stormwater to be tested prior to release/re-use/ disposal in accordance with section 3.26
- clean stormwater that meets the quality outlined in Table 22 will be discharged off-site in controlled manner or re-used for dust suppression
- where the water is visibly turbid, a sediment sock will be used to remove sediment from the release.
- all stormwater above the specified limit will be treated as wastewater and managed accordance with section 3.13.3.6
- once all work on the site has ceased and all contaminant sources have been removed from the well pad, the site will be left in a stable, non-polluting state with appropriate erosion and sediment controls in place.
- Erosion and sediment control plan (Appendix H) implemented.

Table 23: Stormwater quality

Monitoring parameter	Release limit	Limit basis
Off-site release and dust suppression		
Amenity	•No visible oil, grease or other hydrocarbons •No visible foams caused by surfactants and detergents •No visible abnormal discolouration	
Electrical conductivity	1,300 $\mu\text{S}/\text{cm}$	The limit of 1,300 $\mu\text{S}/\text{cm}$ was chosen as it aligns with the EC of the Gum Ridge formation (the main source of water used on proposed sites) and the ANZECC short term irrigation guideline value for moderately sensitive crops (Table 9.2.5 of the ANZEC Guidelines (2000) Volume 3, Chapter 9, Primary industries). The proposed EC limit is underpinned by modelling designed to assess the changing soil salinities and the potential for impact on the receiving vegetation types, including Eucalyptus, Acacia, Melaleuca species and native grasses which are common to the area. Many of these species have been shown to have a moderate to high tolerance to salinity. The results of the modelling indicates the maximum root zone salinity will be in the order of 1.6 dS/m (for a sandy loam) to 1.7 dS/m (for a clay). This is below the likely vegetation root zone salinity of the vegetation types in the area. Also, the sodium adsorption ratio (SAR) for the Gum Ridge Formation was calculated at 2, which when combined with the EC values, indicates that the release of stormwater based on the revised release criteria is unlikely to cause soil structural issues. The adopted discharge criteria are widely used by Tamboran at its other operational sites on EP 117, EP 98 and EP 76, with no negative effects on soil properties or native vegetation.
pH	5.2-9.0	The minimum pH is reflective of observed regional rainfall pH levels, with pH levels of 5.24 observed at Daly Waters on March 20, 2024. Tamboran has observed pH levels on its enclosed tank lids and sediment basins around the pH of 5 level. Given the large volume of rainwater that falls on a site in a very short period, the pH in the sediment basin is anticipated to be low, before increasing as they interact with the receiving soils. This has been observed in sediment basins onsite, with pH increasing from 5.2 to 6.5 over several hours after a rainfall event due to the low buffer capacity of rainwater. Given the existing pH of rainwater is approximately 5.2, we believe this to be an appropriate release limit for storm water

3.14 Routine site maintenance

Civil maintenance will be performed periodically to ensure the site remains functional, safe and non-polluting. Activities to be completed periodically include:

- Vegetation management on the well pad, camp pad and access tracks
- Firebreak maintenance
- Access track resurfacing and maintenance
- Well pad and camp pad resurfacing
- Water extraction bore maintenance
- Erosion and sediment control maintenance and repair
- Weed management.

3.15 Ongoing monitoring and well integrity management

The ongoing monitoring and well integrity management of the Amungee NW-1H, Amungee NW-2H, Amungee NW-3H, Velkerri 76 S2-1H, Velkerri 76 S2-2H and Velkerri 76 S2-3H wells is illustrated in Figure 33. Tamboran's Operations team manage the ongoing integrity of the well through the Well Integrity Management Plan (WIMP). The WIMP defines monitoring, maintenance and integrity testing requirements and frequencies and well integrity assurance activities, this ultimately forms a part of the Well Operation Management Plan (WOMP). The WIMP and WOMP are both designed to satisfy the Code of Practice to ensure the integrity of a well throughout its life.

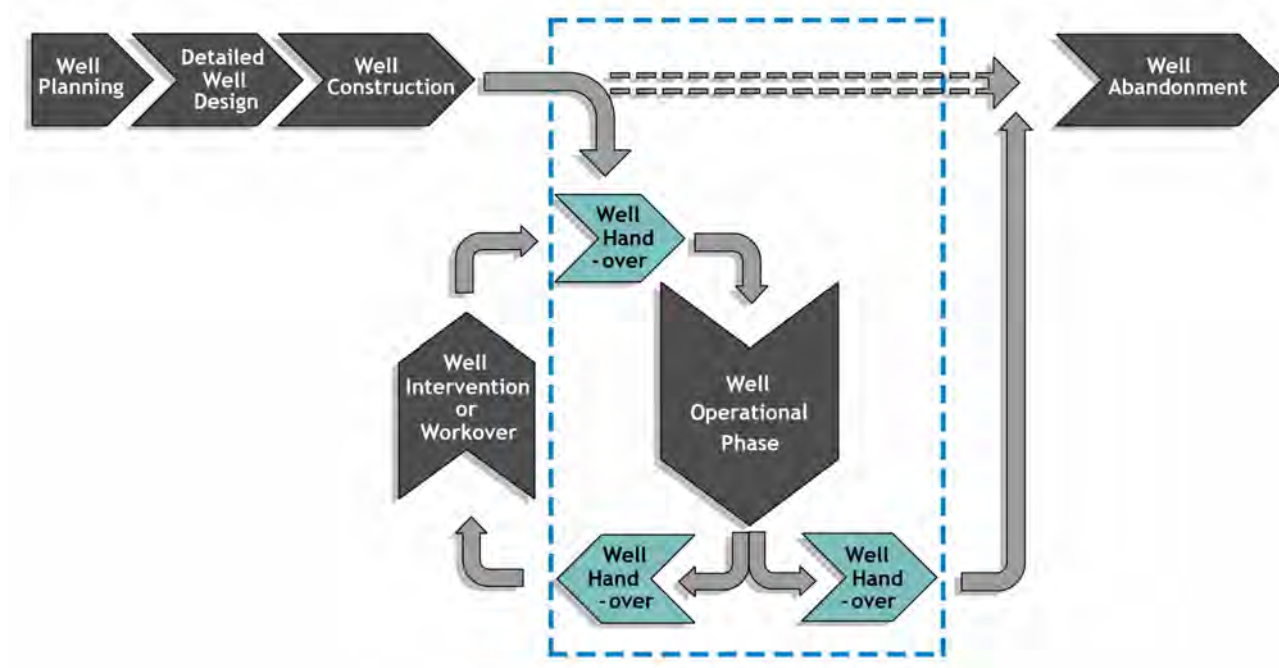


Figure 33: Well lifecycle with operational phase highlighted where well integrity monitoring is a key activity

Information from all Tamboran wells is gathered and stored in a database and made available to key technical staff via a software tool – Well Integrity Management System (WIMS). WIMS contains information such as wellhead and production valve maintenance results, annular and tubing pressures, well operating windows, key well information and historical well integrity data and maintenance. WIMS is used in the identification and assurance of the integrity of each individual well and also outlines the well integrity status for each well.

Well barriers are tested and pressures monitored regularly to ensure their performance over the lifecycle of the well. Remediation of well integrity anomalies could include well integrity barrier replacements, i.e. valves, tubing, and/or barrier remediation, such as casing patches and cement squeezes to ensure pressure isolation. If remediation does not prove to be a feasible option, plugging and decommissioning operations will be considered to ensure well integrity.

Additional routine maintenance and diagnostic testing under this EMP includes:

- Wellhead Maintenance – Truck and 4WD with about 3 people to do 1-2 days of work on pressure testing, and maintaining the wellhead
- Completion Rig – a small rig with 6-7 trucks to pull tubing and potential recompleted the well if required
- Wireline/Slickline – 1 truck to either set a plug downhole or run additional logs.

3.16 Well build up testing, suspension and decommissioning

Once all drilling, stimulation and testing has been completed, each E&A well will either be put on build up test, suspended or plugged and decommissioned. The fundamental difference between the three options is as follows:

- **Build up test:** each well or a subset of wells may be shut in at the surface with pressure monitoring undertaken. This may be undertaken for a period of 12 months (or longer) and is used to understand the performance of the reservoir.
- **Well suspension:** the well is suspended with (at a minimum) cemented casing and a wellhead so that it can be re-entered later for further down-hole activities. While the well is suspended, pressures on the well will be continuously monitored as per Tamboran's Well Integrity Management System (WIMS) to confirm well integrity is intact.
- **Well abandonment:** where a well is to be decommissioned, cement plugs will be installed as permanent barriers to flow prior to cutting off the wellhead. The cement plugs will be set and tested as per Tamboran Standards and Section B.4.15.2 of the Code of Practice. In some circumstances, such as a loss of the bottom hole assembly or hole stability issues, the entire well or a specific section of a well may need to be plugged and abandoned with a new well drilled or the well side-tracked around the affected area. Such an activity is undertaken to ensure the operational integrity of the well and ongoing.

3.17 Geohazards and seismicity

Major faults are avoided as they can represent hazards to both drilling and stimulation operations. Risks associated with geohazards are assessed and managed via the following steps:

- **Locating E&A wells:** Tamboran has more than 9,500 km of 2D data available which is used to screen for large scale, regional faults or structures prior to the finalisation of any exploration well location. The data for Tamboran's broader Beetaloo exploration area indicates there are very few major faults present and that the strata within the Basin (i.e. away from the steep flanks) are relatively gently dipping.
- **Geohazard assessment post drilling:** Prior to completing stimulation, geological data is analysed to determine the presence of minor and major faults which may pose a hazard to stimulation activities. Where faulting is encountered during the drilling of the horizontal section of the well, a risk assessment is undertaken to determine whether stimulation activities can occur safely. In some instances, location of stimulation stages along the wellbore may need to be moved/removed, to isolate the feature encountered (such as encountered during the original Amungee NW-1H well where a casing deformation occurred).
- **Real-time monitoring of pressure during stimulation:** Pressure data provides a tool to prevent fault activation and fluid/pressure communication out of the target interval. If anomalous pressure behaviour is observed, stimulation operations can be ceased immediately. This prevents any substantial volume of fluid or proppant from being pumped into an open geological structure.

Preliminary drilling results from the existing E&A wells has confirmed the absence of major structural features or faults. A casing deformation event within the Amungee NW-1H horizontal (i.e. within the Velkerri shale) was recorded during stimulation, however this was not considered a major hazard. This event resulted in poor production outcome (i.e. the production casing within the horizontal well installed within the Velkerri shale became damaged) and not an environment risk (i.e. no risk of interconnectivity with surface aquifers). The risk of induced seismicity is consistent with the current assessment level of low.

Monitoring of seismic events will be undertaken using the Geoscience Australia's Waramanga seismic array. It is likely that any material seismic events will be detected via this array if they occur.

An additional traffic light system is currently being developed by the NT in response to the NT Inquiry recommendation. This system is likely to be in place, prior to any full-scale development occurs.

A well plan summary is provided to DME outlining any known geohazards, structural features or faults prior to stimulation.

3.18 Greenhouse gas emissions

The worst case 180 day well test emissions associated with the proposed activities are summarised in Table 23. The emissions from the activities are estimated to total 273,030 tCO₂-e over a 3-year period. Emissions are predicted to peak in 2023, with 177,596 tCO₂-e predicted. A breakdown of the total greenhouse gas (GHG) emissions generated during exploration activities are summarised in Table 24, Table 25 and Table 26.

Table 24: Greenhouse gas summary for proposed activities based on the worst case 180 day well test

Location	2022 Emissions Forecast [tCO ₂ -e]	2023 Emissions Forecast [tCO ₂ -e]	2024 Emissions Forecast [tCO ₂ -e]	Total emission
Amungee NW	32,363	109,815	0	142,178
Velkerri 76 S2	2,805	67,781	60,266	130,852
TOTALS	35,168	177,596	60,266	273,030

Both these estimates assume material gas is encountered at consistent rates for each E&A well. The total greenhouse gas emissions are small when compared to the total annual greenhouse gas emissions for the NT (20,650,000 tCO₂ and for Australia (518,900,000 tonnes) (Department of Industry, Science, Energy and Resources, 2020).

Over 90% of the anticipated emissions are associated with flaring. Flaring of produced hydrocarbons is required under exploration tenure to evaluate the commercial viability of a resource.

Greenhouse gas emissions generation will be mitigated through adoption of the Code of Practice and implementation of a Methane Emission Management Plan (MEMP) (Appendix I). Mandatory requirements include:

- Restrictions on venting (D.5.9)
- Use of a Reduced Emissions Completion (REC) (D.5.9)
- Condensate to be beneficially sold where permissible (D.5.1.2)
- Six monthly routine leak detection and repair program to detect, repair and report leaks to be implemented (D.5.3)
- Pressure and gas testing all in service equipment to ensure any leaks are identified and fixed prior to commissioning (D.5.9)
- Flanges, valves and fittings are all API compliant and gas tight (D.5.9)
- Equipment is appropriately sized and regularly maintained to minimise diesel wastage. (D.5.9)

RECs involve the capture and combustion of hydrocarbons in a flare; a standard practice that has been used by Tamboran for all exploration activities. The combustion of gases produced will reduce the emissions generated by flaring by 94% when compared to venting.

In addition to monitoring emissions from drilling, stimulation and well testing activities, baseline assessments have been completed by CSIRO in the vicinity of the well pad as per the Code of Practice.

Table 25: Greenhouse gas summary for the proposed activities on Amungee NW

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
Amungee NW				
Diesel combustion - transport	118KL of diesel per well	640	640	Diesel estimated using forecasted usage estimates multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Diesel combustion - horizontal drilling	11,200 KL of diesel per well per day	4,188	4,188	Diesel estimated using forecasted drilling estimates multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Diesel combustion- Drilling and stimulation camp	0.5 KL per day	366	366	Diesel consumption estimated from historical data and multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Fugitive methane emissions – drill cuttings	0.906t of methane per well	50	50	Estimate by engineer based on gas saturation and core volume multiplied by NGERs Global Warming Potential (GWP) of 28 tCO₂e/tCH₄.

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
Fugitive emissions – completion (venting)	51.8t of methane per completion	2,901	2,901	2 completion days anticipated per well. Table 5-23 Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; American Petroleum Institute (API), 2009 NGERS completion factor of 25.9 tonnes of methane per day multiple by NGERS Global Warming Potential (GWP) of 25tCO ₂ -e/tCH ₄
Fugitive emission-wastewater storage	11.25ML of flowback per well	69	69	11.25ML/ well wastewater (assumes 25 stages, 1.5ML per stage and a recovery of 30%). Emissions multiplied by Table 5-10 produced saltwater tank methane flashing emission factors - Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; American Petroleum Institute (API), 2009 emission factor of 0.11tCH ₄ /ML (assuming 2% salinity, 250 psi separator pressure) multiplied by NGERS Global Warming Potential (GWP) of 28tCO ₂ -e/tCH ₄ . Assumes 50% of injected flowback is returned to the surface.
Well testing-flared natural gas emissions	1.2TJ per day of natural gas for the existing Amungee NW-1H E&A well (21.02t CH ₄ per day) 5 TJ per day of natural gas per additional horizontal E&A well (175.57t CH ₄ per day)	65,523	131,046	Flared estimate using forecasted P50 success case production rates multiplied by NGER Determination: Subdivision 3.3.2.2—Oil or gas exploration and development (emissions that are flared) section 3.44 Method 1—oil or gas exploration and development item 1: CO ₂ Factor 2.8 tCO ₂ -e/ t unprocessed gas CH ₄ Factor 0.933 tCO ₂ -e/ t unprocessed gas N ₂ O Factor 0.026 tCO ₂ -e/ t unprocessed gas
Well testing-stationary sources (diesel combustion)	500L per day	366	732	Diesel consumption estimated from historical data and multiplied by NGERS emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO ₂ Factor 69.9 kgCO ₂ -e/ GJ of diesel CH ₄ Factor 0.1 kgO ₂ -e/ GJ of diesel N ₂ O Factor 0.2 kgCO ₂ -e/ GJ of diesel
Land clearing for site preparation	10 ha land clearing (77t CO ₂ -e/ha)	770	770	Assume 10 ha of land clearing for well pad extensions and 90 ha of land clearing in CY22 for seismic exploration activities. TAGG 2013 Appendix I vegetation clearing methodology, Table 6, assumed maximum potential biomass class = 1.

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
Well stimulation – stationary sources (diesel combustion)		1,416	1,416	Diesel consumption estimated from historical data and multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO ₂ Factor 69.9 kgCO ₂ -e/ GJ of diesel CH ₄ Factor 0.1 kgO ₂ -e/ GJ of diesel N ₂ O Factor 0.2 kgCO ₂ -e/ GJ of diesel
Total		76,289	142,178	

^ Based on Global Warming Potential (GWP) of 25tCO₂-e/tCH₄ (Clean Energy Regulator 2016)

* https://www.api.org/~media/files/ehs/climate-change/2009_ghg_compendium.ashx

Table 26: Greenhouse gas summary for the proposed activities on Velkerri 76 S2

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
Velkerri 76 S2				
Diesel combustion – transport	118KL of diesel per well	640	640	Diesel estimated using forecasted usage estimates multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO ₂ Factor 69.9 kgCO ₂ -e/ GJ of diesel CH ₄ Factor 0.1 kgO ₂ -e/ GJ of diesel N ₂ O Factor 0.2 kgCO ₂ -e/ GJ of diesel
Diesel combustion – horizontal drilling	11,200KL of diesel per well per day	4,188	4,188	Diesel estimated using forecasted drilling estimates multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO ₂ Factor 69.9 kgCO ₂ -e/ GJ of diesel CH ₄ Factor 0.1 kgO ₂ -e/ GJ of diesel

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
				N ₂ O Factor 0.2 kgCO ₂ -e/ GJ of diesel
Diesel combustion-camps (drilling and stimulation)	0.5 KL per day	366	366	Diesel consumption estimated from historical data, assuming 270 days per CY and multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Fugitive methane emissions – drill cuttings	0.906t of methane per well	25	25	Estimate by engineer based on gas saturation and core volume multiplied by NGERs Global Warming Potential (GWP) of 28 tCO ₂ e/tCH ₄ .
Fugitive emissions – completion (venting)	51.8t of methane per completion	2,901	2,901	2 completion days anticipated per well. Table 5-23 Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; American Petroleum Institute (API), 2009 NGERs completion factor of 25.9 tonnes of methane per day multiple by NGERs Global Warming Potential (GWP) of 25tCO₂e/tCH₄
Fugitive emission-wastewater storage	11.25ML of flowback per well	69	69	11.25ML/ well wastewater (assumes 25 stages, 1.5ML per stage and a recovery of 30%). Emissions multiplied by Table 5-10 produced saltwater tank methane flashing emission factors – Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Gas Industry; American Petroleum Institute (API), 2009 emission factor of 0.11tCH₄/ML (assuming 2% salinity, 250 psi separator pressure) multiplied by NGERs Global Warming Potential (GWP) of 28tCO₂e/tCH₄. Assumes 50% of injected flowback is returned to the surface.
Well testing-flared natural gas emissions	0.3TJ per day of natural gas per vertical E&A well (5.27t CH₄ per day) 5 TJ per day of natural gas per horizontal E&A well (175.57t CH₄ per day)	60,258	120,515	Flared estimate using forecasted P50 success case production rates multiplied by NGER Determination: Subdivision 3.3.2.2—Oil or gas exploration and development (emissions that are flared) section 3.44 Method 1—oil or gas exploration and development item 1: CO₂ Factor 2.8 tCO₂-e/ t unprocessed gas CH₄ Factor 0.933 tCO₂-e/ t unprocessed gas N₂O Factor 0.026 tCO₂-e/ t unprocessed gas
Well testing-stationary	500L per day	366	732	Diesel consumption estimated from historical data and multiplied by NGERs emission factor from

Activity	Anticipated volume	90-days Well Test [tCO ₂ -e]	180-days Well Test [tCO ₂ -e]	Estimate methodology and assumptions
sources (diesel combustion)				NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Well stimulation – stationary sources		1,416	1,416	Diesel consumption estimated from historical data and multiplied by NGERs emission factor from NGER Determination: Division 2.4.2 Method 1 emissions of carbon dioxide, methane and nitrous oxide from liquid fuels other than petroleum-based oils or greases, section 2.41 Method 1—emissions of carbon dioxide, methane and nitrous oxide and Part 3—Fuel combustion—liquid fuels and certain petroleum-based products for stationary energy purposes item 40: Energy Content Factor (GJ/kill) 38.6 CO₂ Factor 69.9 kgCO₂-e/ GJ of diesel CH₄ Factor 0.1 kgO₂-e/ GJ of diesel N₂O Factor 0.2 kgCO₂-e/ GJ of diesel
Total		70,229	130,852	

3.18.1 GHG cumulative emissions

The total worst case (180 day well test both sites) cumulative annual emissions for Tamboran's current approved, proposed and potential activities are anticipated to be between 45,297 and 177,780 tCO₂-e, peaking in 2023 (Table 27). The potential emissions of Tamboran's activities represent between 0.22% and 0.86% of the total NT GHG emissions for 2019 or 0.009% to 0.034% of Australia's total emission.

Based on Tamboran's current approved tenure commitments, it is anticipated that annual greenhouse gas emissions will be above 100,000 tCO₂-e/year for the 2023 period. This is above the NGER safeguard mechanism, which is triggered when an emitter produces above 100,000 tCO₂-e/year during a financial year.

Although a full-scale shale development is beyond the scope of this EMP, if a shale development were to occur in the future (post E&A phase), the emissions intensity per well is likely to be significantly lower than during exploration. All development wells will be flowed inline, negating the need to undertake flaring activities at the wellhead. The selection of infrastructure, equipment and operational practices will be specifically focused on eliminating emissions.

Based upon the life cycle assessment analysis of a similar (but different) unconventional gas development in Australia completed by the Gas Industry Social and Environmental Research Alliance (GISERA) (Heinz 2019), the current net climate benefits of using natural gas in replacing coal for electricity generation is up to 50% less emissions (Heinz 2019).

It is anticipated that a future shale gas development will be net zero scope 1 and 2 emissions, through the utilisation of world's best practice emission reduction technology, such as field electrification, flare minimisation strategies, use of renewable energy sources and procurement of emission offsets. Scope 3 emissions will also be reduced through investigation in low emission technologies, such as carbon capture and sequestration (CCS) enable blue ammonia/ hydrogen and electricity export. This would further reduce the emission intensity of a future gas developments and highlights the role of natural gas as a transition or 'firming' fuel to support the roll out of large-scale renewables in the future. This is reflected by Tamboran's ongoing commitment to invest in both renewable energy sources and firming fuels such as natural gas.

Table 27: Greenhouse gas summary for the proposed activities on Velkerri 76 S2

Activity	2022	2023	2024	Comments
Approved EMPs				
Kyalla 117 N2 water bores	0	0	0	No material emissions are anticipated
Kyalla 117 N2 civil construction	0	0	0	No material emissions are anticipated
Kyalla 117 N2-1H drilling, stimulation and well testing ²	46	46	46	No material emissions are anticipated
Kyalla 117 N2 multi-well EMP	0	0	0	No material emissions are anticipated
Amungee NW-1 EMP	46	46	46	No material emissions are anticipated
Beetaloo w-1 EMP	46	46	46	No material emissions are anticipated
Velkerri 76 S2 water bores	0	0	0	No material emissions are anticipated
Velkerri 76 S2 civil construction	0	0	0	No material emissions are anticipated
Velkerri 76 S2-1 drilling, stimulation and well testing ³	1,945	0	0	Based on revised vertical stimulation and 30 day well test @0.3TJ/day
Proposed (this EMP)				
4 total E&A wells with associated water bores, civil construction and drilling, stimulation and 3 months well testing (this assumes ongoing E&A success)	35,168	177,596	60,266	Most activities from 2022-24 will be covered under this EMP.
Potential (neither approved, or proposed, but potential)				
EMP for potential seismic surveys and well maintenance	8,046	46	46	No other wells are currently proposed. Kalala S1 maintenance emissions included for completeness
Total annual emissions	45,297	177,780	60,450	

3.18.2 Residual emissions offsets

In the absence of broader industry engagement and as a starting point, Tamboran proposes the following targets within the GGAP:

- That residual emissions be offset using credible carbon credit units approved by the Commonwealth Clean Energy Regulator.
- Minimum offset levels shall increase year-on-year by 3.7% (based on a baseline financial year of 2023) to result in a linear decrease in residual emission levels to net zero by 2050 as per the following schedule:
 - o Financial year 2023: 3.7% of total emissions offset
 - o Financial year 2024 7.4% of total emissions offset
 - o Financial year 2025: 11% of total emission offset

² Assumes a total of 9 months of well test

³ Based on revised vertical stimulation and 30 day well test @0.3TJ/day

- o Financial year 2026 14.7% of total emissions offset
- o Financial year 2027 18.4% of total emissions offset
- Actual emission levels produced during a financial year must be estimated in accordance with the National Greenhouse and Energy Reporting Scheme (NGERS) reporting methodology.
- Offsets volumes shall be calculated retrospectively, by multiplying the actual emission volumes generated during a financial year with the corresponding financial year offset % requirement level.
- Offsets shall be secured and retired within 6 months of the end of a financial year.
- An appropriately qualified independent person with extensive carbon accounting experience shall verify the actual emission levels generated, the procurement and retirement of the required offset volumes for emission generated in the specified financial year.
- A report from the appropriately qualified independent person shall be provided to DLPE by January 31 each year verifying the actual emission levels estimated and confirming the required offset for the previous financial year have been acquired and retired.
- That the GGAP is updated annually based on actual emissions from the preceding year to ensure currency.

3.19 Naturally occurring radioactive material

A detailed assessment of Naturally Occurring Radioactive Material (NORM) was undertaken during the Amungee NW-1H well drilling and testing in 2016. The assessment collected data on the drill cuttings, gas and flowback water, with the results considered applicable to the drilling on Amungee NW and Velkerri 76 S2 proposed under this EMP.

The observed radionuclide level within flowback and gas samples observed from Amungee NW-1H are at the lower end of those observed in the USA shale developments (Kibble et al. 2013).

The analysis concluded the following:

- **Drill cuttings:** X-Ray Fluorescence (XRF) data was collected at regular intervals (average 5m), providing an estimate of up to 48 elements (including uranium, thorium and potassium) present in the formations being drilled. This data was analysed by a third-party contractor. Analysis determined that the Uranium and Thorium (primary sources for mineral contained NORM) content of the geological formations drilled was well within the ranges of normal geological rocks. In addition, a study commissioned by Origin Energy in 2016 with the company 'Radiation Professionals' analysed drill cuttings samples from four (4) wells drilled by Origin Energy (Kalala S-1, Amungee NW-1, Amungee NW-1H, Beetaloo W-1). Results concluded that none of the samples provided exceeded limits provided in the 'Radiation Protection Regulations, 2012 (NT) Regulations 7' or the 'National Directory for Radiation Protection, Part B, section 3.2'. Given the distribution of the wells across the tenure and the geological continuity of the Roper Group formations, the risk of NORMs is considered low. The assessment of NORMs potential will be able to be accurately assessed and screened using a combination of well site wireline natural gamma and post drilling XRF analysis on cuttings samples to detected analogous samples with high radioactive producing elements such as Uranium and Thorium. If levels approaching the Radiation Protection Regulations are detected, a more thorough evaluation will be conducted. Furthermore, NORMs assessments of drilling muds are required under the Petroleum Code of Practice and will be completed as per section 3.13.1.
- **Flowback:** NORMs samples of flowback were collected weekly during the well testing of Amungee NW-1H. An assessment of the results indicated that for the flowback to breach the regulatory limit of 1 mSv/year, a person would have to consume greater than 80 litres of flowback fluid. Given fluid is strictly managed in accordance with the Code of Practice and correlating Wastewater Management Plan, this scenario is considered highly unlikely.

- **Gas:** Results for the raw gas analysis from Amungee NW 1 indicated that at the observed radon level of 225 Bq/m³. An exposure above 1mSv/m³ from raw natural gas is considered remote, as a person would need to be continuously exposed to raw gas on a long-term basis (years). This exposure scenario is not deemed a credible pathway, as there are stringent requirements within the Code of Practice which prohibit unnecessary venting and requires operators to conduct ongoing leak detection and repair program. Furthermore, the observed levels of radon are:
 - well below the maximum radon level limit for natural gas of 600Bq/m³. These limits are imposed by the Australian Energy Market Operation (AEMO) and outlined in the Australian Standard AS4564 Specification for general purpose natural gas (AEMO 2017) to protect the safety of the end domestic user of gas.
 - an order of magnitude lower than many shale radon level in the US; including the Marcellus (Cassman et al. 2016) which has been deemed safe to use for domestic purposes.
 - consistent with the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) recommendation that radon levels should not exceed 200 Bq/m³ in households and 1000Bq/m³ in workplaces (ARPANSA 2019). The exposure of a pastoralist to unventilated gas is considered remote, based on the separation distance between the well and the inherent controls that limit venting. The potential exposure to workers is also considered a low risk, based upon the radon levels being within the ARPANSA workplace guidelines and Code of Practice controls.

Risk controls have been implemented to manage the risk of exposure to personnel, including eliminating raw gas exposure and preventing access to drilling material and wastewater. The risk of exposure from NORMs generated during shale exploration activities is considered low. Testing of the drilling cuttings, gas and flowback water will be undertaken during this campaign, as described in Section 3.26.

Further information on the NORMs level encountered was provided to the Inquiry as part of Origin's submission (<https://frackinginquiry.nt.gov.au/?a=424843>).

3.20 Wet season operations

Drilling, stimulation, well testing and wastewater storage and treatment operations are anticipated occur over the wet season. Where wet season operations are undertaken the following risk controls will be implemented:

- All chemicals, fuels, equipment, tanks and materials required for ongoing operations will be stored on-site prior to the onset of the wet season
- All equipment required to respond to emergency situations will be on-site; this will be dictated by a pre-wet season risk assessment (based on the nature of activities underway) and include earth moving equipment, vacuum trucks, wireline rigs, cementing equipment etc. and equipment and material to deal with well control issues, spills and other emergency events
- All chemicals storage areas will be bunded, with covers used (where safe and appropriate) to prevent rain ingress and bund overflows
- Enclosed tanks will be utilised as the primary measure to store wastewater with enough enclosed tank capacity to store all wastewater on-site
- Enclosed wastewater storage volume will be sufficient to manage all wastewater stored on-site
- Open working evaporation tanks and mud sumps will have enough freeboard to manage an entire 1:1000 ARI wet season event (not just one rainfall event but an entire season's rainfall total)
- Helicopters will be used to transport people and supplies into and out of the site when access is restricted

- No transportation of wastewater or chemicals will be undertaken during the wet season unless a risk assessment is undertaken that demonstrates the risk is ALARP and acceptable (as per the Code of Practice)
- Well pad is bunded, which will prevent all off-site release of chemicals and stormwater
- All stormwater will be retained on-site via the sediment retention pond and tested prior to release
- Overland flow will be diverted around well pads
- Where wastewater is stored on-site, each sites will either be manned or have remote monitoring within regional manning to respond to any emergencies.

3.21 Helicopter operations

If access to the site is prevented during operations, helicopters will be utilised to move people and supplies into and out of the site. Helicopter activities are an existing, approved activity at the sites. Helicopter activities ensures the site can be manned during all activities, regardless of the season.

The use of helicopters in the NT for transportation is a standard activity and ensures that personnel and material can be moved to and from the site during periods of wet weather or in emergencies.

All helicopter movements will be managed under an aviation journey management plan. This plan addresses the risk associated with vehicle selection, maintenance, flight routes and flight procedures.

Audits are completed prior to the engagement of a helicopter service provider and at least annually. This ensures all aircraft are being appropriately maintained and operated to reduce the risk of accident.

3.22 Waste management

Waste management methods for the proposed exploration program are summarised in Table 28. Waste is managed in accordance with the internationally accepted guide for prioritising waste management practices, with the objective of achieving optimal environmental outcomes. Waste will be managed in accordance with the following hierarchy principals:

1. **Avoid:** eliminate the generation of wastes through design modification
2. **Reduce:** reduce unnecessary resource use or substitute a less resource intensive product or service
3. **Re-use:** reuse a waste without further processing
4. **Recycle:** recover resources from a waste
5. **Treatment:** treat the waste to reduce the hazard of the waste prior to disposal
6. **Disposal:** dispose of waste if there is no viable alternative

Waste transfer certificates will be retained and provided to DLPE upon completion of the project.

Drilling, stimulation and well testing wastewater is managed in accordance with Section 3.13.

Table 28: Waste and disposal methods

Activity	Disposal method
Sewage, grey and stormwater	Treatment: Grey water and sewage treated and disposed of on-site in an approved, portable treatment system accordance with Department of Health Code of Practice for small on-site sewage and sullage treatment systems and disposal for reuse of sewage effluent. Sewage treated will be surface irrigated to a dedicated, fenced area. The area will be left vegetated, with no clearing required. Sludge removed from site and disposed of at an appropriately licenced facility. Uncontaminated stormwater will be tested (refer section 3.11.5) and either released off-site or re-used for dust suppression.
Food waste, paper and plastic	Disposal: Collected in dedicated waste bins for back-loading to an approved landfill
Glass and cans	Recycled: Collected in separate waste bins for recycling at an off-site facility
Chemical bags and cardboard packaging materials	Recycled: Compacted and collected at rig site for transport to a licenced recycling centre
Scrap metals	Recycled: Collected in designated skip for recycling at an approved location
Used chemical and fuel drums	Recycled: Collected in designated skip for recycling at an approved location
Chemical wastes	Re-use/Disposal: Collected in approved containers for disposal at approved landfill or returned to supplier or recycled
Timber pallets (skids)	Recycled: Recycled at an approved facility
Vehicle tyres	Disposal: Disposed of at an approved landfill
Oily rags, oil-contaminated material, filters and any hydrocarbon material	Recycled/Disposal: Oil from machinery or encountered during drilling. Collected in suitable containers for disposal at approved landfill or recycled at an approved recycling facility
Flowback	Treatment and Disposal: Highly saline wastewater collected in a series of open and closed tanks. Evaporated on-site using mechanical evaporators and then disposed of off-site at a licenced facility interstate. On-site treatment could potentially include other mechanical treatment options, such as brine crystallisers and thermal combustion units.
Exploration well drill cuttings, muds and fluids	Treatment and Disposal: Saline fluids and solids stored within a lined sump. Fluids segregated from muds and cuttings. Solids dried out, with liquids evaporated. Solids tested and disposed of on-site or off-site depending on hazard. Fluids transported off-site to a licenced facility interstate.
Groundwater extraction bore drilling cutting and muds (cuttings mixed with drilling fluids)	Disposal: Freshwater cuttings and drilling muds with low hazard. Disposed of on-site in accordance with the Minimum Construction Requirements for Waters Bores in Australia for water bore drilling practices.
Spill contaminated soils and water	Disposal: All contaminated material (solids and liquids) will be disposed of off-site at a licenced facility.
Stormwater	Discharged/Recycled/Disposal: All stormwater will be collected on-site in a designated sediment retention system. Stormwater will be tested and either released off-site or recovered and either recycled within the drilling process or disposed of at a licenced wastewater treatment facility in accordance with the <i>NT Waste Management and Pollution Control Act 1998</i> .
Waste sand	Re-use/Disposal: Waste and returned sand from stimulation activities will be re-used or disposed of in the drilling sumps with the residual cuttings and muds.

3.23 Camps

Two camps will be utilised for E&A activities at each of the sites. The main camp located on-site will be designed to house up to 70 people. The camp will support two crews that will work 12-hour shifts, plus the camp staff, supervisory staff and service company personnel on an as-required basis. The main camp includes:

- accommodation
- ablutions and septic(s) waste treatment and irrigation
- recreation room
- kitchen and mess
- freezer unit
- site office
- generator and diesel storage
- water tank.
- water treatment facility (reverse osmosis plant).

A drilling mini-camp will be set-up on the exploration well pad during activities. The mini-camp will house up to eight people and will support the 24-hour drilling activities.

Each camp has its own sewage treatment plant and wastewater treatment plant. A notification of installation of wastewater management system outside a building control area will be submitted to the Department of Health after the installation of each system with a capacity above 2000L/day. Treated water is dispersed via drainage away from the camp to the designated irrigation area. The designated irrigation areas are located adjacent to the camp pad and exploration well pad. These areas are approximately 50x50m and are within the broader well site area fence, which will exclude livestock access.

The existing camp infrastructure is temporary and portable and powered by diesel generators. The potable water supply for the camps is sourced from groundwater bores established for drilling activities and treated to the appropriate drinking water standards (2011 NHMRC Australian Drinking Water Guidelines). A temporary reverse osmosis water treatment plant is utilised, which produces approximately 10KL of potable water per day. Approximately 2,000L of RO reject is likely to be produced per day, which will have an Electrical Conductivity of approximately 1,500-2,000 $\mu\text{S}/\text{cm}^3$. This water will be re-used or blended (diluted) with raw water at a 4 to 1 ratio and used for dust suppression.

All camp kitchens have been registered under the NT Food Act 2004 and comply with all food hygiene requirements.

The domestic solid waste generated by camp activities will be removed by a waste contractor in accordance with the NT WMPCA.

3.24 Traffic

The periods of highest traffic generated from exploration and appraisal activities will generally occur over a short duration and are generally associated with the mobilisation and demobilisation of equipment. The peak maximum anticipated traffic flow increase associated with the activity is conservatively estimated at approximately 44 vehicles per day during the demobilisation of equipment from site.

To assess the potential impact on pastoralist and tourism amenity and experience, a Traffic Impact Assessment (TIA) is discussed below. This assessment includes heavy equipment mobilisation to and from site and is a suitable conservative scenario to assess the potential associated traffic impacts.

The TIA involved the following steps:

- Identification of project traffic movements including approach and departure direction
- Existing traffic levels and road Level of Service
- Assessment of total traffic levels and potential impacts
- Determine required impact-mitigating treatments.

The results of the TIA are discussed below.

3.24.1 Identification of project traffic movements

Access to the Amungee NW site is via the Carpentaria Highway, off the Stuart Highway near Daly Waters. Access to Velkerri 76 S2 is via access tracks off the Stuart Highway. The Carpentaria Highway is a 110km/hour posted speed limit in the vicinity of the project two-lane, two-way road with a sealed width of 7 metres and unsealed or grassed shoulders varying between 2.5 and 5 metres in width. The Stuart Highway has a 130km/h posted speed limit in the vicinity of the project and is generally a two-lane, two-way road with a sealed width of 7 metres and unsealed or grassed shoulders varying between 2.5 and 5 metres in width.

The peak maximum anticipated traffic flow increase associated with the activity will be approximately 44 vehicles per day, during rig and heavy equipment demobilisation from site.

At each site, peak movements are likely to be restricted to a two-week period during mobilisation and a two-week period during the final rig demobilisation. Average daily traffic additions during the operational phase (drilling, stimulation and well testing) of the period are likely to be 10-15 movements per day for the first three-six months, reducing to three-four movements for the remainder of the period. Daily transport volumes have largely been reduced through the use of on-site camps, with busses used to facilitate crew change overs.

3.24.2 Existing traffic levels, road capacity and level of service

Existing traffic figures were obtained from the DIPL Annual Traffic Report 2019 showing Average Annual Daily Traffic (AADT) figures for the Carpentaria and Stuart Highway. The data from 2019 was used over 2020 due to the impacts of COVID likely impacting on vehicle volumes.

The total daily traffic flows on the Stuart Highway (20km north of Elliot) are in the order of 460 vehicles and 76 vehicles on the Carpentaria Highway (2km east of the Stuart Highway). On both highways, the total traffic flows are effectively split evenly between north and south bound (refer Figure 34). Traffic rates during the dry season are likely to be substantially higher than the average figures, with peak dry season traffic observed to be up to 50% higher than the average volumes (GHD 2013). Therefore, a revised figure of 690 vehicles per day on the Stuart Highway and 114 vehicles per day on the Carpentaria Highway is considered a representative worst-case traffic volume.

AUSTROADS guidelines (Austroads 2017) were used to determine the typical capacity that would be expected by traffic on the Stuart Highway to maintain a free-flow Level of Service (LOS). The Stuart Highway in the project location is a two-lane, two-way road. The capacity of roads is based on the maximum rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of lane or roadway during a given time period. The Level of Service relates to the operating conditions encountered by traffic as defined in the AUSTROADS guidelines (Austroads 2017). This data was then used to determine the capacity of the Stuart Highway to maintain a Category A (free flowing) LOS for the site. A conservative 700-1,000 vehicle/hr/lane figure was used to determine the vehicle movement capacity of both the Carpentaria and Stuart Highway.

In an urban situation it can be assumed that the peak hour volumes will be about 10% of the daily traffic volumes. However, the remoteness of this site means that a peak hour is not realistic and has not been considered. Due to the low anticipated volumes that are likely to be spread over the duration of the day, this is considered appropriate.

Road Name / Location	ADT Station	Direction	Units	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Buntine Highway 1km South of Top Springs	RKVDP005	Inbound	Veh	33	34	35	32	33	33	46	34	32	38
		Outbound	Veh	32	35	35	32	33	32	33	33	32	39
		Both	Veh	65	69	70	64	66	65	79	67	64	77
Carpentaria Highway 2km East of Stuart Highway	RKVDP008	Inbound	Veh	23	22	33	36	34	36	35	34	33	39
		Outbound	Veh	26	36	41	37	36	37	33	32	31	37
		Both	Veh	49	58	74	73	70	73	68	66	64	76
Stuart Highway 20km North of Elliott	RTVDC020	Inbound	Veh	225	211	210	225	222	229	223	280	262	233
		Outbound	Veh	221	195	197	205	213	213	222	271	247	227
		Both	Veh	446	406	407	430	435	442	445	551	509	460

Figure 34: Traffic flows on the Stuart Highway approx. 30km south of the proposed site access point and Carpentaria Highway near the Daly Waters on the Stuart Highway

3.2.4.2.1 Assessment of total traffic levels and reduction to road capacity and level of service

The total anticipated peak traffic volume for the project has been determined at 734 vehicles per day on the Stuart Highway and 158 vehicles per day on the Carpentaria Highway. This consists of an additional peak project vehicle movement level of 44 vehicles per day in addition to the existing peak dry season traffic volumes of 690 vehicles per day (Stuart Highway) and 114 vehicles per day (Carpentaria Highway).

The total volume of traffic is considerably lower than the capacity of the Stuart and Carpentaria Highways, with any reduction in LOS from the volume of project traffic considered extremely unlikely.

Traffic LOS may also be impacted through changes in traffic compositions, with the volume of trucks affecting the road capacity greater than light vehicles. To assess the changes in traffic composition, vehicle category data obtained from the DIPL Annual Traffic Report 2019 were assessed against expected total project traffic figures. These figures were increased by 50% to represent peak dry season traffic volumes. The assessment is provided in Table 29 and Table 30.

Table 29: Traffic impact summary for the Stuart Highway – existing versus proposed additional

Vehicle category	Existing vehicles per day (vpd) and % (approx.)	TAM1-2 and TAM2-2 additional vpd	3D Seismic additional vpd	Total vpd during activity and % (approx.)
Short (light vehicles)	306 vpd (44.32%)	12 vpd	318 (43.32%)	306 vpd (44.32%)
Medium (heavy vehicles or short towing)	259 vpd (37.55%)	0 vpd	259 (35.28%)	259 vpd (37.55%)
Long (heavy vehicles)	41 vpd (5.9%)	5 vpd	46 (6.26%)	41 vpd (5.9%)
Medium combination (heavy vehicles)	23 vpd (3.32%)	0 vpd	23 (3.13%)	23 vpd (3.32%)

Vehicle category	Existing vehicles per day (vpd) and % (approx.)	TAM1-2 and TAM2-2 additional vpd	3D Seismic additional vdp	Total vpd during activity and % (approx.)
Large combination (heavy vehicles)	62 vpd (8.92%)	27 vpd	89 (12.12%)	62 vpd (8.92%)

Table 30: Traffic impact summary for the Carpentaria Highway – existing versus proposed additional

Vehicle category	Existing vehicles per day (vpd) and % (approx.)	TAM1-2 and TAM2-2 additional vpd	3D Seismic additional vdp	Total vpd during activity and % (approx.)
Short (light vehicles)	84 vpd (73.26%)	12 vpd	96 (60.75%)	84 vpd (73.26%)
Medium (heavy vehicles or short towing)	22 vpd (19.28%)	0 vpd	22 (13.92%)	22 vpd (19.28%)
Long (heavy vehicles)	3 vpd (2.35%)	5 vpd	8 (5.06%)	3 vpd (2.35%)
Medium combination (heavy vehicles)	2 vpd (1.86%)	0 vpd	2 (1.26%)	2 vpd (1.86%)
Large combination (heavy vehicles)	4 vpd (3.25%)	27 vpd	31 (19.62%)	4 vpd (3.25%)

The results in Table 29 and Table 30 demonstrate that there are minimal changes in traffic composition associated with the project, with an additional 3.2% to 16.37% of large combination vehicles (the vehicle class considered the highest potential risk to local road users) when compared to the total volume composition. This percentage is unlikely to significantly impact upon the road's capacity and LOS.

3.24.3 Traffic risk management strategies

The management of risks of injury to staff, contractors and the community is a key focus of every Tamboran activity. To reduce the risks associated transport, all vehicle movements undertaken as a part of Tamboran activities must comply with the Tamboran Land Transport Directive. Mandatory controls include:

- Avoiding vehicle movements where possible (such as the use of buses and aircraft)
- Requirement for all vehicles to be fitted with an in-vehicle monitoring systems (IVMS) to monitor speed limits, seat belt usage, harsh breaking and acceleration, and fatigue
- Driving at night to be avoided
- Defensive driver training for all employees and contractors performing work
- Zero alcohol and drug policy – with all staff breath tested when on-site and random drug tests completed
- Fatigue management policy – with mandatory breaks required for every 2- hours and maximum 10- hours in a single 24-hour period working hours (unless the driver of a fatigue regulated heavy vehicle, where the driver must then comply with the applicable law for fatigue management where the vehicle is operated)
- Chain of responsibility training for all logistics/supply chain roles to ensure they understand their obligations to ensure the safety of their transport activities under the Heavy Vehicle National Law
- Journey management is undertaken in accordance with Tamboran's Land Transport Procedure.
- Requirements to comply with the National Transport Code Load Restraint Guide

- Contractor and employee driver performance tracking and reporting, with all breaches investigated, formally documented and disciplinary actions taken

In addition to the above requirements, Tamboran has also implemented the following additional controls:

- Current use of the access track Stuart Highway intersection is approved by DIPL with traffic management in place where required. Ongoing engagement with DIPL is underway covering all future exploration activities
- Large loads to have their own journey management plan outlining proposed controls, including fatigue management, route selection, load constraint, speed restrictions, pilot requirements etc.
- Communication with pastoralists when heavy/multiple transports are likely to occur
- Peak transport period to be restricted to the demobilisation of the rig, with the majority of mobilisations occurring via internal access tracks from the existing approved Velkerri 76 S2 site
- The use of camps reduces vehicle movements between the site and local communities

Other potential risks and controls associated with traffic are discussed further in section 6.6.

3.25 Cumulative impact summary

This section provides a summary of the cumulative impacts associated with the proposed activity in accordance with Section 3b of the NT Petroleum (Environment) Regulations 2016. These include cumulative impacts associated with groundwater extraction, flora and fauna, greenhouse gas generation, traffic and social impacts. The assessment of cumulative impacts is summarised in Table 31.

Table 31: Summary of cumulative impacts addressed within the EMP

Aspect	Summary	EMP section
Water	Groundwater extraction cumulative impacts assessed under the Water Extraction Licence GRF 10285. This includes water use for Tamboran's future exploration program, adjacent petroleum operators and surrounding users. No material impacts on surrounding users expected.	Section 3.12
Flora and fauna	Additional clearing required at Amungee NW to extend the existing well pad to up to 10 ha, camp pad to 1.2 ha, helipad 1 ha, laydown 1 ha and fence line 4 ha. No clearing at Velkerri 76 S2. Impacts associated with weed introduction are managed through the weed management plan. All other petroleum operators and pastoralists required to have a weed management plan.	Section 4.2
Greenhouse gases	Cumulative emissions from all of Tamboran's 2022-2024 activities has been provided. Emission levels are mainly attributed to flaring. In a development scenario, gas production is likely to have 50% less emissions than coal, thus playing an important role as a transition or firming fuel to support large scale renewable energy supply.	Section 3.18
Traffic	Impacts of traffic are anticipated to be minor, with no reduction in level of service of the Stuart Highway. Maximum peak traffic level assessment considers cumulative user traffic load, with project movements anticipated to be 44 movements per day during demobilisation.	Section 3.12

Aspect	Summary	EMP section
Social	Risk associated with increased competition for labour from exploration activities, including other petroleum operators is low and well within the capacity of existing service providers. Ongoing engagement with local and regional businesses is underway, providing information and updates on the status of any future projects. Increased industrialisation of landscape resulting in a loss of amenity and tourism value considered low due to limited extent of petroleum activities, including from other petroleum or mining operators.	Section 4.4

3.26 Monitoring

A series of monitoring programs has been developed under this EMP to:

- monitor and detect changes in environmental values associated with Tamboran's activities
- characterise waste streams to understand the nature of the waste and determine the disposal requirements
- characterise the quality of the produced hydrocarbons
- report on rehabilitation progress.

An overview of each of the monitoring programs is provided in Table 32.

3.26.1 Groundwater Monitoring

Baseline monitoring data has been collected from the control monitoring bores in accordance with condition B.4.17.2(b) of the code of Practice. Monitoring data can be accessed via the DLPE website located at [Groundwater monitoring results | Department of Lands, Planning and Environment](#).

3.26.2 Water sampling methodology

Water samples will be collected in accordance with Table 33. All samples will be collected by appropriately qualified personnel, with all meters calibrated in accordance with the manufacturer's instructions before use. Samples will be collected in laboratory-supplied sampling containers and placed in chilled eskies and transported under Chain of Custody (COC) procedures. Analysis will be performed by laboratories with National Association of Testing Authorities (NATA) accredited analysis methodology. Each sample will have a unique identifier that is cross-referenced to the monitoring location and time of sampling. Where there are no NATA accredited laboratories for a specific analyte or substance, then duplicate samples must be sent to at least two separate laboratories for independent testing or evaluation.

Table 32: Monitoring program summary

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Flowback monitoring	Characterise flowback quality Field chemistry	Post separator before entering into flowback tank	Field Chemistry: pH, Dissolved Oxygen, temperature and electrical conductivity	Field Chemistry: Daily during the first four- weeks and weekly thereafter Analytical Suite: Weekly for the first 12-weeks of flowback and monthly thereafter	N/A	Code of Practice C.5.4
	Characterise stimulation fluid – laboratory analysis	Exploration well pre-injection	Field Chemistry: pH, Dissolved Oxygen, temperature and electrical conductivity Analytical suite: Appendix J including NORMS	Each fluid system used during injection (one of each in total)	N/A	Code of Practice C.5.4 and C.5.3
Drill cuttings, fluid and muds characterisation	Characterise the quality of drill cuttings, fluids and muds to determine disposal options	Drilling sump – as determined by a suitably qualified third-party	Table 10 of the Petroleum Code of Practice (NORMs), Particle size distribution, bulk density	Prior to disposal	N/A	Code of Practice C.5.2
Gas composition and isotopes	Characterise produced gas	Post-separator	Gas composition (Nitrogen, Oxygen, Carbon Dioxide, C1-C10+, H ₂ S) Isotopes (C ¹³ (CO ₂ and CH ₄) and H ² (CH ₄ , C ₂ H ₆ +). Radon and radioactivity.	Monthly – internal characterisation program	N/A	N/A

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Groundwater monitoring	Detect changes in groundwater as a result of drilling and stimulation activities	Amungee NW: RN040894 and newly constructed impact monitoring bores Velkerri 76 S2: RN041133, RN041134 and proposed impact monitoring bores (to be drilled)	Level	Quarterly measurements with real-time (continuous) level logging before, during and 1 month after stimulation	+/-1m water level change observed at the impact monitoring bore	Code of Practice B.4.17
			Temperature, electrical conductivity, pH	Quarterly commencing 6 months prior (baseline) and three-monthly after stimulation and then annually for 3 years	EC >200µs/cm change pH >1 unit change	
			Appendix J	Quarterly commencing 6 months prior (baseline) and three-monthly after stimulation	BTEX and Dissolved Methane - outside of the control bore and baseline interquartile range	
	Pastoralist bore monitoring	Pastoralist bores within 10km of an exploration well	Level	Baseline collected 3 months prior to stimulation and 12 months after stimulation	1m sustained water level decline against baseline	N/A
			Temperature, electrical conductivity, pH	Baseline collected 3 months prior to stimulation and 12 months after stimulation	+/- 20% compared to pre-stimulation reading	N/A

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
			Appendix J	Baseline collected 3 months prior to stimulation and 12 months after stimulation	BTEX and Dissolved Methane – outside of baseline interquartile range	N/A
Groundwater take	Groundwater volume	Each groundwater extraction bore	Litres	Continuous flow meter	Total extraction <220ML	NT Water Act
Stormwater	Manage stormwater collected within bunds during activities	Sediment basin release point	Field EC and pH	Prior to release	Off-site release and dust suppression limits: pH 5.2-9.0 EC 1,300 µS/cm	N/A
Erosion and sediment control	To detect the presence of erosion and sedimentation from infrastructure	Inspection of all disturbed areas, including well pads, access tracks, gravel pits, laydown yards, camp pads etc.	Visual inspection of infrastructure and erosion and sediment controls	Visual inspections pre- and post-wet season	Visible erosion or failure of erosion and sediment control	Tamboran's Approved Erosion and Sediment Control Plan (NT-2050-15-MP-0019)
Fauna – routine inspections	Collect data on fauna interactions with wastewater	Wastewater tank and sump inspections	Inspection records	Daily during operations	>7 per week for two (2) consecutive weeks or >1 threatened fauna species	Field Guide to NT Fauna
Weeds	Identify weeds potentially introduced or spread by Tamboran's activities	Inspection of all disturbed areas, including well pads, access tracks, gravel pits, laydown yards, camp pads etc.	Visual inspection	Visual inspections post-wet season	Positive confirmation of the detection of a weed of national significance species within Tamboran's disturbance footprint An increase in existing weed density and spatial extent	Tamboran's WMP (Appendix C)

Monitoring program	Purpose	Monitoring points	Parameters	Frequency	Investigation thresholds	Reference document
Methane emission monitoring program	To identify and remediate gas leaks	Each exploration well	Methane (PPM)	6 monthly	>500PPM	Methane Emissions Management Plan (Appendix I)
Post rehabilitation	Monitor ongoing rehabilitation success	Inspection of all rehabilitated areas, including well pads, access tracks, gravel pits and camp pads	Visual inspections of: - Stem count - Vegetation cover % - Species diversity - Erosion	Annually	Decline in rehabilitation criteria value compared to previous year results	Section 7.5

Table 33: Monitoring program methodologies

Program	Sampling Methodology
Drilling sump characterisation	- National Environment Protection (Assessment of Site Contamination) Measure - AS4482.1:2005. Guide to the investigation and sampling of sites with potentially contaminated soil
Flowback monitoring	- Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC Guidelines). - AS/NZ5667.1: 1998. Water Quality Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples
Groundwater monitoring	- AS/NZ5667.11: 1998. Water Quality Sampling Part 11: Guidance on Sampling of Groundwaters - AS/NZ5667.1: 1998. Water Quality Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples - Tamboran Groundwater purging and sampling procedure CDN/ID8212543 - Geoscience Australia 2009: Groundwater Sampling and Analysis

3.26.3 Investigation and response framework

Where an exceedance of a monitoring program investigation trigger is observed from one of the monitoring programs outlined in Table 32, an investigation and response will be implemented as summarised in Figure 35.

The investigation and response process will be divided into the following components:

- Verification – is the result real?
- Evaluation – is the result related to petroleum activities?
- Remediation or management – what is the potential impact?
- Ongoing monitoring.

The initial step in the process is *verification* of the measurement. This process begins with a check on integrity of the measurement, including a review of the protocol used to collect the measurement, calibration of equipment and the integrity of the monitoring infrastructure itself (such as the integrity of a monitoring bore). If the original data point is found to be correct, then a risk-based (appropriate to the scale and nature of the exceedances) investigation of the results is conducted, and an evaluation phase is initiated.

The *evaluation* phase will have two major goals; to identify the origin or source of the trigger exceedance and characterise the potential effects on environmental factors to reduce or eliminate negative consequences. This phase of investigation is conducted in a manner consistent with the type of threshold exceedance observed. Simple exceedances of water quality triggers during stormwater releases for example, may require simple investigations into the procedures and processes contributing to the event. Groundwater threshold exceedances may require more detailed assessment, whereby a comprehensive set of information is accessed and utilised, including a review of operational activities, the influence of other regional activities (e.g. mining or pastoral activities), changes in climatic conditions etc. Detailed investigation may include the identification of knowledge and/or data gaps and collection of additional data to fill these gaps and bring the issue into proper context.

If the *evaluation* phase of the investigation identifies the issue as being natural or not associated with petroleum activities, then the result is documented, and monitoring continues. This may lead to the revision of a trigger or threshold. However, if the results indicate an influence of a petroleum activity, an assessment of risks is undertaken to assess the potential impact on environmental factors. This will involve a more in-depth evaluation or characterisation of the affected area and potential source. Regulatory notification may be required in accordance with section 8.6.

If the *evaluation* phase of the investigation indicates the influence of a petroleum activity, then mitigation measures may need to be implemented to prevent ongoing impacts to an environmental factor. These mitigation measures will be appropriate to the nature of the incident and will be based upon a risk assessment and technical feasibility assessments. Such mitigation measures may include:

- Stopping the activity and/or
- Modifying the activity to directly address the source of harm (i.e. additional procedures, training, ceasing or redesigning an activity) and/or
- Implementation of mitigation measures to reduce the potential effects (i.e. make good agreements, direct removal and treatment of contaminants etc.).

Upon implementation of mitigation measures, further *evaluation* through increased monitoring is undertaken to determine the success of the mitigation measures. If a positive result is observed, and trends begin to stabilise or reverse, then the result is documented and a return to regular monitoring occurs. If not, then the continued operation of the identified activity or activities causing the effected may need to be reviewed and adjusted in consultation with the regulator and other affected parties.

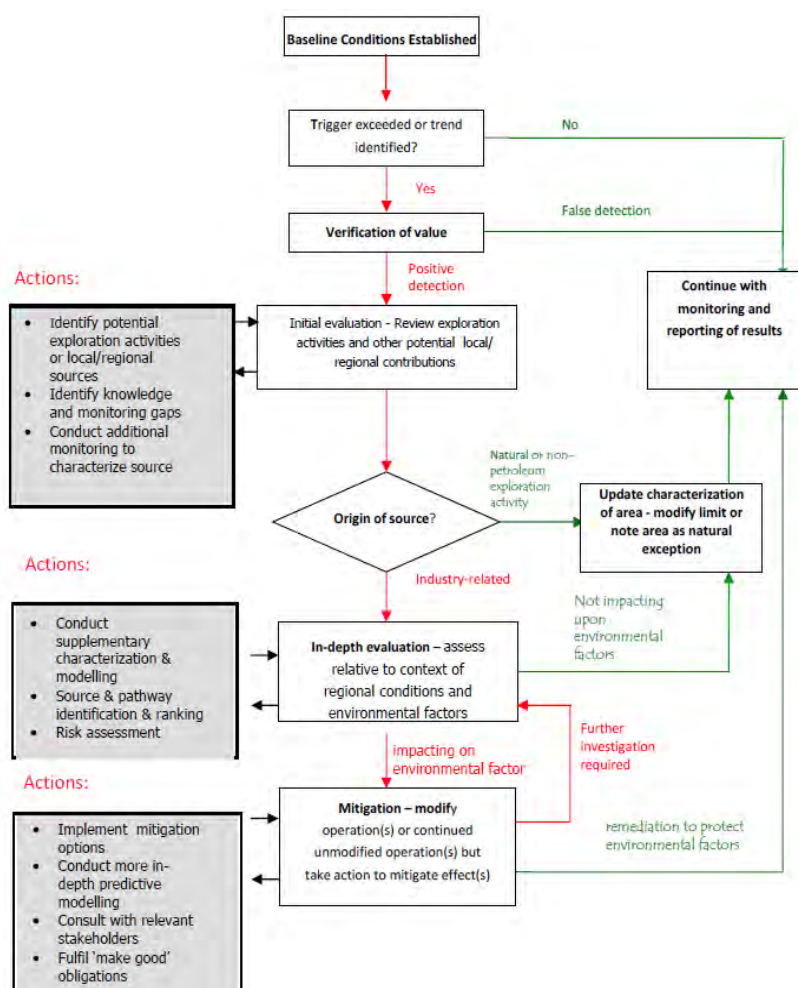


Figure 35: Investigation and response process

4 Description of the existing environment

4.1 Physical environment

4.1.1 Climate

The climate of the permit areas is arid to semi-arid, with rainfall decreasing in frequency and quantity from north to south. The climate is monsoon influenced, with a distinctive wet summer between October and March, and a dry winter season between May and August. September and April are transitional months with occasional rainfall.

Rainfall in the north of the Beetaloo exploration area is recorded at 681mm at Daly Waters. The southern portion of the permit area records an average annual rainfall of 536mm at Newcastle Waters and 602mm at Elliott. Approximately 90% of the rainfall occurs during the wet season.

The area is characterised by a net precipitation deficit of between -1,800 to -2,150 mm per year.

4.1.2 1:1000 wet season annual re-occurrence interval calculations

Monthly rainfall totals were analysed from the Scientific Information for Land Owners (SILO) data to interpolate rainfall data from 1900 to the present day. Consistent with industry accepted methodology associated with practices (such as dam risk assessments which calculates the wet season based on your geographical location) a 3-month time period was determined applicable.

The highest 3-month rainfall period during the wet and dry seasons was predicted for every year from 1900 till 2018. These values were then used to fit a Log Pearson III distribution to the data to allow us to extrapolate to the 1,000 year, 3-month duration wet season (Figure 36) and 3-month dry season (Figure 37). This method is consistent with the Australian Rainfall & Runoff methodologies. The median 1 in 1,000-year 3-month wet season is 1,289 mm and 3-month dry season is 300 mm. These figures do not include any evaporation and are therefore considered extremely conservative.

Based on the assessment, a 1,300 mm wet season and 300mm dry season freeboard will be applied to all open sumps and tanks.

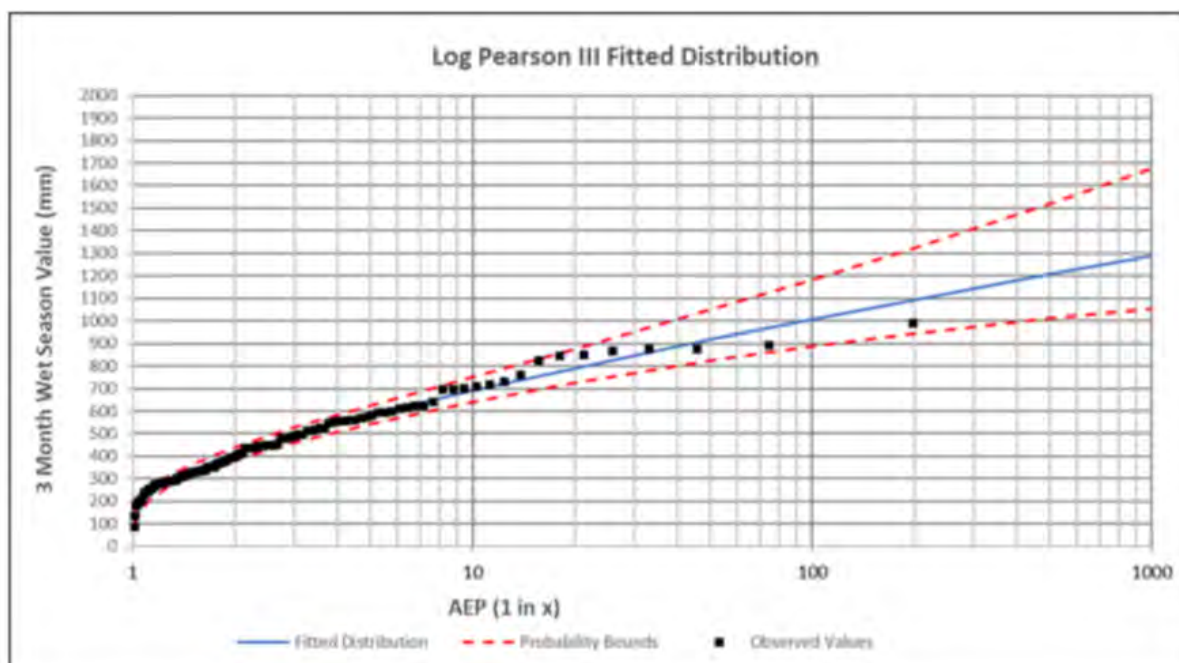


Figure 36: Log Pearson determination of 1:1000 wet season ARI

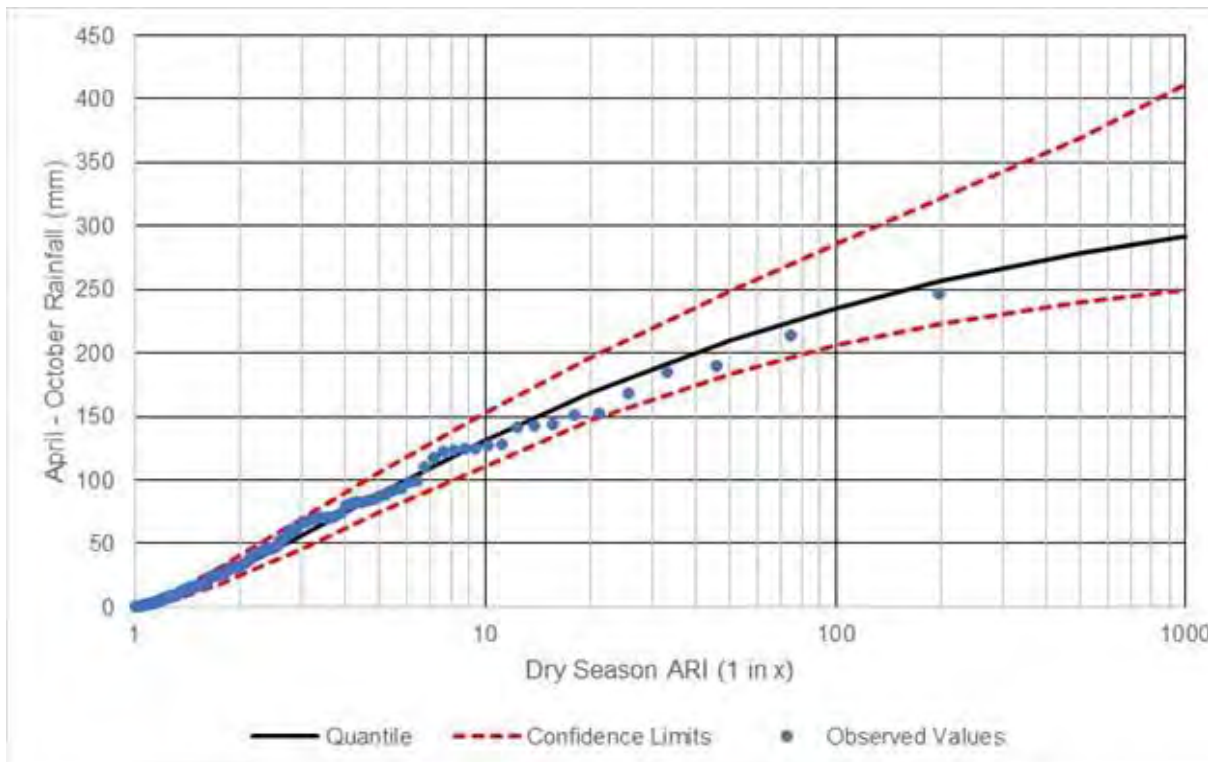


Figure 37: Log Pearson determination of 1:1000 dry season ARI

4.1.3 Geology

The Beetaloo Sub-basin comprises a thick sequence of mudstone and sandstone formations (Roper Group) that were deposited approximately 1,500-1,300 million years ago (Ma). The Roper Group is estimated to reach in excess of 5,000 m in thickness in the centre of the Sub-basin and estimated to be thinner outside the formally defined Beetaloo Sub-basin. The Roper Group is overlain unconformably by the yet to be formally defined Neoproterozoic Group. Unconformably overlying the Neoproterozoic group is the Georgina Basin (Cambrian) sedimentary package, which includes widespread extrusive flood basalts and a thick limestone sequence that forms the Cambrian Limestone Aquifer (CLA), a significant water supply aquifer. The Georgina Basin is capped unconformably by a thin section of Cretaceous mudstone and sandstone (Albian aged ~100-113 Ma) and recent alluvial and laterite deposits.

The proposed wells will be completed in the Velkerri formation. Organic richness within the Velkerri formation is generally confined to three to four main shale intervals, the A, A-B, B and C shales. The existing Amungee NW-1H and Velkerri 76 S2-1 wells have been completed in the Velkerri B shale. The proposed Amungee NW-2H and Amungee NW-3H wells and Velkerri 76 S2-2H and Velkerri 76 S2-3H wells will also likely be located in the Velkerri B Shale, although ongoing evaluation of the Velkerri 76 S2 1 core and log data may result in another of the shales (A, A-B or C) being targeted.

The Velkerri Formation Amungee Member is overlain with thick series of low permeability units (mudstone, siltstones, tight sandstone and Volcanic units) which include the Velkerri Formation Wyworrie Member, Kyalla Formation, Hayfield Formation, and Antrim Plateau Volcanics. These formations provide thick and multilayered effective geological barriers, with the Gum Ridge Formation separated from the target formations by >1500m. The effectiveness of geological barriers to fracture height growth will be assessed prior to stimulation with geomechanical data from core analysis, wireline log data and modelling.

4.1.4 Soils

The Sturt Plateau bioregion covers an area of 103,857 km² and comprises undulating plains on sandstones, with mostly neutral sandy red and yellow earth soils (ANRA, 2008; SREBA, 2022).

The soil types located within the plateau range from the very strongly leached lateritic soils of the Tertiary land surface to the calcareous desert soils and desert loams in the southern drier areas.

The lateritic plains, located with the permit area, are classed as very strongly leached soils of the Tertiary land surface. The three main soil types located within the permit area, include:

- **Tertiary Lateritic Red Earths:** which occur on the gently undulating topography. The soil profile can be described as:
 - **A-Horizon** Grey-brown sandy loam
 - **B-Horizon** Reddish-brown sandy clay loam
 - **C-Horizon** Red-brown to red light clay, overlying heavy ferruginous gravel and massive laterite
- **Tertiary Lateritic Red Sands:** which occur on gently undulating to undulating topography of the Tertiary Lateritic Plain, formed from sandstones and complex parent materials of the deep sandy soils. The soil profile can be described as:
 - **A-Horizon** Grey-brown to brown sand
 - **B-Horizon** Brown sand
 - **C-Horizon** Red-brown to yellow-brown sand overlying pisolitic ferruginous gravel and massive laterite. Altered colouring of highly siliceous parent sandstone is only evident in the mottled and pallid zones
- **Tertiary Lateritic Podzolic Soils:** formed on the gently undulating topography over a variety of rocks. These soils are located in the northern section of the Barkly Basin. The soil profile can be described as:
 - **A-Horizon** Grey sand
 - **B-Horizon** Yellowish-grey sand
 - **C-Horizon** Yellow-grey sandy loam with ferruginous gravel overlying massive laterite, mottled and pallid zones

Table 34 presents the erosion risk rating based on average monthly rainfall using the rating system provided in the IECA (2008) Table 4.4.2 for Daly Waters. All construction activities are anticipated to be undertaken on the well pad which has a stormwater sediment basin. No additional clearing or major civil construction activities are planned for the wet season. The overall risk of erosion is considered very low.

Table 34: Erosion risk rating based on average monthly rainfall at Daly Waters

Item	Jan	Feb	Mar	Apr	May	June	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	165.4	165.4	120.1	23.6	5.0	5.6	1.5	1.7	4.9	22.5	59.4	110
Erosion Risk*	H	H	H	VL	VL	VL	VL	VL	VL	VL	M	H
* ■ = Extreme (>225 mm); ■ = High (100+ to 225 mm); ■ = Moderate (45+ to 100 mm); ■ = Low (30+ to 45 mm); ■ = Very Low (0 to 30 mm)												

4.1.5 Seismicity

Large earthquakes are relatively rare in Australia with an earthquake exceeding magnitude 7 on the Richter scale occurring somewhere in Australia every 100 years (SRC 2017). Earthquakes are comparably rare in the NT, aside from limited areas around Tennant Creek and west of Alice Springs (Figure 38) where several earthquakes with a magnitude of 6.2-6.4 occurred in a 12-hour period. Thousands of aftershocks have occurred since and whilst the rate has decreased, it has not yet returned to its pre-1987 level (McCue 2013).

In the Beetaloo, there have been no earthquakes over magnitude 3 measured since records began. The area is not prone to seismic activity and there is no evidence of recent earthquake activity as most faults and the major subsurface structure are confined to Cambrian or older strata.

The issue of induced seismicity from HFS activities has gained increasing exposure due to some high magnitude events in Oklahoma. However, the United States Geological Survey has stated very clearly that HFS is not causing most of the induced earthquakes and has pointed out that wastewater disposal via reinjection is the primary cause of recent earthquakes in the Central USA (USGS 2017b). Davies et al. (2013) illustrates that induced seismicity directly attributed to HFS operations is of such low occurrence that the documented cases are statistical anomalies rather than commonly occurring phenomena.

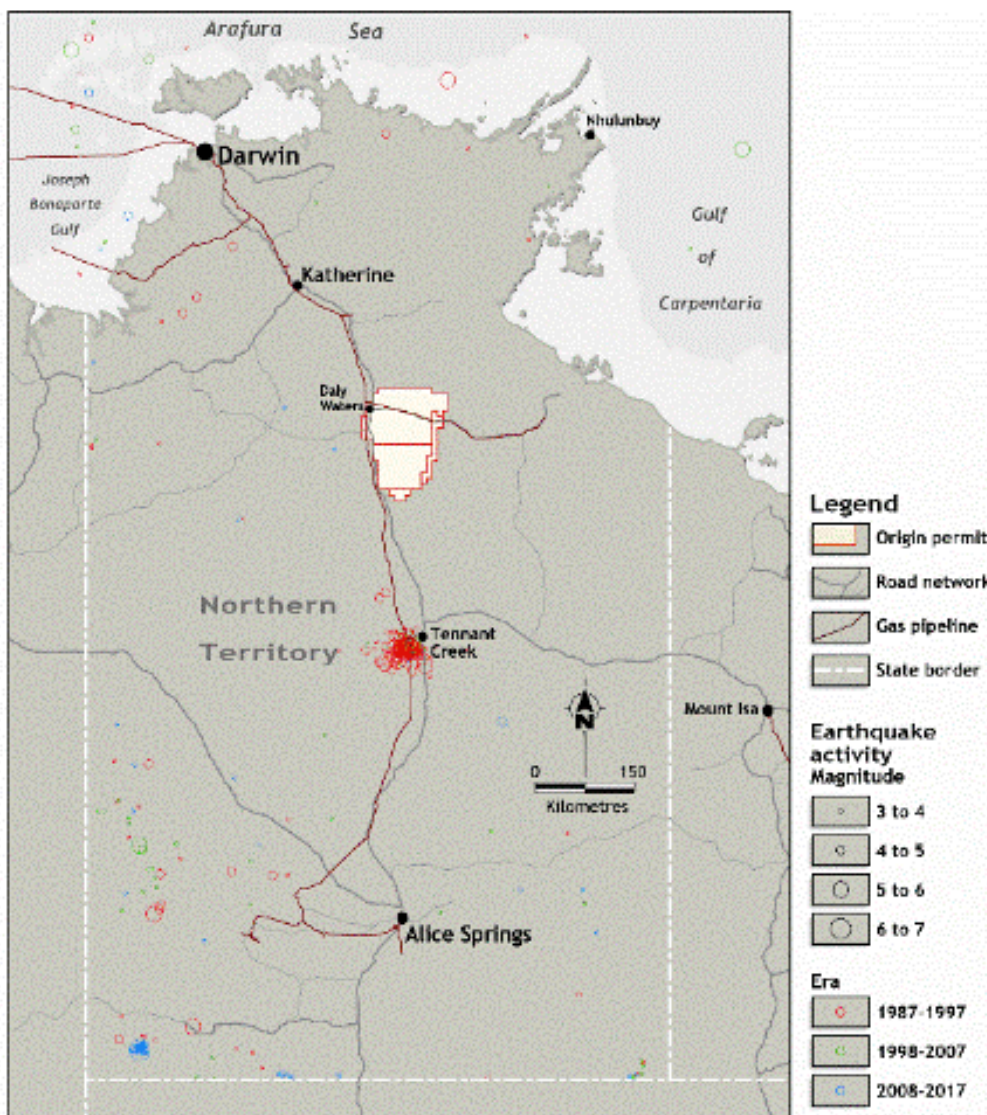


Figure 38: Earthquakes greater than magnitude 3 from 1987 to 2017 across the NT showing an absence of seismic activity in the Beetaloo area

4.1.6 Hydrology

The existing Amungee NW and Velkerri 76 S2 sites fall within the Wiso River Basin. The Wiso River Basin covers the southern half of EP98 (south of the Carpentaria Highway) and the majority of EP76 and EP117 and is internally drained by Newcastle Creek and several small ephemeral creeks.

Newcastle Creek (Stream Order 4) is approximately 85km to the south of the Amungee NW well pad and 13 km south of Velkerri 76 S2. Newcastle Creek ultimately flows into Lake Woods, which is located south of the Newcastle Waters Station. Lake Woods covers an area of inundation of approximately 50,000 ha in normal rainfall years, extending to 80,000 ha in exceptionally wet years, after which it can retain water for several years (HLA, 2005). Lake Woods is described as a major quasi-permanent surface water body and is listed on the NT Government Sites of Conservation Significance and on the Directory of Important Wetlands in Australia (HLA, 2006b). Some semi-permanent and many ephemeral waterholes are located across the permit area (HLA, 2006b)

The closest creek to any site Newcastle Creek, which is 13 km from the Velkerri 76 S2 site. Ephemeral streams (Stream Order 1 and 2) are located over 20 km from Amungee NW and along the existing Velkerri access tracks. The streams are overland flow paths that only flow for a short period during the wet season, with waterholes forming at the beginning of the dry season. Due to the separation distance from the sites to the closest watercourse, these features are unlikely to be directly impacted by the activities proposed under this EMP.

During the wet season, it is likely the broader region could experience widespread periodic surface flooding, to a depth of 30cm, which has previously been identified by debris being collected on fence lines (HLA, 2005). However, the Amungee NW well site is likely to remain dry as it is higher than surrounding areas at 261 mAHD and is considered a low risk from regional flooding. Flood modelling indicates the Velkerri 76 S2 site may be inundated with 700 mm during a Q100 flood event, however the site is bunded to reduce this risk.

4.1.7 Hydrogeology

Within the Beetaloo exploration area, groundwater use is primarily from the Cambrian Limestone Aquifer (CLA) with minor, localised use from formations where shallower groundwater is intersected, where the CLA is too deep, or where the CLA is absent from erosion. This includes:

- overlying Cretaceous sediments where it is saturated in the central-south of the Beetaloo Sub-basin
- Antrim Plateau Volcanics in the north-west
- Bukalara Sandstone in the north-east.

Table 35 summarises the encountered stratigraphy confirmed during the Amungee NW-1H and Velkerri 76 S2-1 well drilling.

Table 35: Summary hydrostratigraphy in the Beetaloo Basin at the Amungee NW and Velkerri 76 S2 sites

Province	Period/Age	Formation		Aquifer status	Encountered Depths (approx. top and bottom) (m)		Regional Yield (L/s)	Avg regional EC (µs/cm)
					Amungee NW Site	Velkerri 76 S2 Site		
CARPENTARIA BASIN	CRETACEOUS	Undifferentiated		Regional aquifer- Not saturated at location	0-87	-55	0.3-4	1,800
GEORGINA BASIN	CAMBRIAN	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Formation	Regional aquifer	Not Present	55-197	1-10	766 (Velkerri 76 S2)
			Gum Ridge Formation	Regional aquifer	87-221	197-300	>20 at both sites	1,180 (Amungee NW1) 857 (Velkerri 76 S2)
		Antrim Plateau Volcanics		Regional aquitard	221-306	300-448	0.3-5	900
		Bukalara Sandstone		Local aquifer	306-418	448-485	0.3-5	1,000
Undefined – Under NTGS Review	NEO PROTEROZOIC	Hayfield Formation		Regional Aquitard	418-869	Not Present	ID	32,000
		Jamison Sandstone		Local saline unit	869-948	485-678	ID	138,000
BEETALOO SUB-BASIN (ROPER GROUP)	MESO PROTEROZOIC 1,300-1,500 Ma	Kyalla Formation		Regional aquitard	948-1349	678-907	ID	ID
		Moroak Sandstone		Local saline unit	1349-1668	907-1298	0.5-5	131,000
		Velkerri Formation		Regional aquitard	1668-Well TD	298 – Well TD	-	-

Province	Period/Age	Formation	Aquifer status	Encountered Depths (approx. top and bottom) (m)		Regional Yield (L/s)	Avg regional EC (µs/cm)
				Amungee NW Site	Velkerri 76 S2 Site		
		Bessie Creek Sandstone	Local aquifer (not regionally connected)	Not Penetrated – Inferred to be present from 2D seismic interp.	Not Penetrated – Inferred to be present from 2D seismic interp.	0.5-5	-

The CLA, comprising the Gum Ridge Formation and the Anthony Lagoon Beds, is an extensive regional aquifer system that forms the principal water resource in the Beetaloo Sub-basin.

In the vicinity of the Amungee NW site, the Anthony Lagoon Formation is interpreted as being eroded by the Base Cretaceous unconformity. At Amungee NW the Gum Ridge Formation is the upper water bearing aquifer unit with a standing water depth of approximately 106 m below ground level.

At Velkerri 76 S2, the Anthony Lagoon Beds forms the upper water bearing aquifer with the groundwater level at approximately 89 m below ground level.

The limestone in the Gum Ridge Formation is commonly fractured and cavernous with bore yields of up to 100L/s having been recorded from this aquifer. At both Amungee NW and Velkerri 76 S2, yields in excess of 20L/sec were achieved with minimal (<1 m) aquifer losses.

Approximately 80% of groundwater bores drilled in the basin screen the CLA and the aquifer supplies water for the pastoral industry and local communities including Elliot, Daly Waters, Larrimah and Newcastle Waters. The CLA contains a significant but largely undeveloped groundwater resource with the sustainable yield from the Georgina Basin estimated to be in the order of 100,000 ML/year (NALWTF, 2009). Existing groundwater use in the Beetaloo Sub-basin is estimated at 6,000 ML/year, primarily used for agricultural production (Foulton and Knapton 2015).

The Antrim Plateau Volcanics conformably underlies the CLA in the north and central part of the Beetaloo Sub-basin. Across much of the Basin it consists of sequences of massive basalt flows with negligible primary porosity. In the north-west of the Basin, where the formation is shallow and fractured, it forms a marginal aquifer, however, reported use is primarily from a sandstone sequence at the contact with the Gum Ridge Formation. There is no reported use within the three petroleum exploration permits held by Tamboran.

The Bukalara Sandstone forms a fractured and weathered aquifer where it outcrops beyond the north-east margin of the Beetaloo Sub-basin. The formation consists of quartz sandstone with shale interbeds and probable enhanced permeability in these areas due to jointing within the sandstone. No use is reported from the formation away from the north-east margin of the Beetaloo Sub-basin where it is at considerable depth. This unit, if present, will be protected through intermediate casing and cement.

The regional groundwater flow direction in the CLA is north-west toward Mataranka, where the aquifer discharges into the Roper River and supports significant groundwater dependent ecosystems (aquatic, riparian and floodplain) including the Roper River at Elsey National Park and Red Lily/57 Mile Waterhole. These discharge features occur around 100 km north-west of the Beetaloo Sub-basin. Dry season flow in the Roper River has been gauged at 95,000-126,000 ML/yr and provides an estimate of the magnitude groundwater discharge from the CLA. Large decadal changes in the discharge to the Roper River suggest that most recharge input occurs close to the discharge zone (i.e. beyond the Beetaloo Sub-basin region). Groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and preferential recharge through soil cavities.

Limited information exists on the hydrogeological characteristics of the deeper Roper Group and undefined Neoproterozoic group sequence as it occurs at depth within the Beetaloo Sub-basin. This unit lies below the Georgina Basin which contains the CLA and other important aquifers. The deeper sandstone dominated formations may behave as aquifers, however, drilling results suggest these formations have limited potential as groundwater resources due to their depth and very high salinity. Groundwater in the Roper Group and undefined Neoproterozoic group is highly saline (>100,000 mg/L chlorides) and contrasts with the shallower, utilised aquifers of the Georgina Basin sediments in which groundwater is generally of drinking water quality.

4.1.7.1 Groundwater monitoring results

Baseline monitoring data has been collected from groundwater bores located at the Amungee NW site since commencing in 2016 until present. Baseline monitoring data has been collected from the two control monitoring bores located at the Velkerri 76 S2 site since monitoring commenced in late-2019.

A summary of the baseline monitoring data is provided in Table 36 and Table 37. Additionally, data collected during Tamboran's Beetaloo exploration program can be accessed via the DLPE website located at: [Industry-compliance-and-reporting/groundwater-monitoring-results](#).

Table 36: Summary of groundwater monitoring results collected at the Amungee NW site, within the Gum Ridge Formation

Analyte	Unit	Reporting limit	RN040894			RN039896			RN038493	
			# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.
Alkalinity (Bicarbonate) as CaCO ₃	mg/L	1	5	405	382	8	422	390	1	426
Alkalinity (Total) as CaCO ₃	mg/L	1	5	405	382	9	432.2	395	1	426
Anions Total	meq/L	0.01	5	13.7	13	8	14.3	13	1	13.8
Calcium						2	119			
Calcium (Filtered)	mg/L	1	5	122	117	7	123	116	1	129
Cations Total	meq/L	0.01	5	13.5	13	8	14.4	13	1	13.7
Chloride	mg/L	1	5	101	87	9	144	103	1	91
Electrical Conductivity (Lab)	µS/cm	1	5	1160	1136	8	1340	1209	1	1170
Fluoride	mg/L	0.1	5	0.6	0.54	5	1.2	0.64	1	0.5
Methane	mg/L	0.01	0	ND	0.005	1	0.002	0.0041	0	<0.001
pH (Lab)	pH	0.01	5	7.45	7.3	7	8.11	7.7		
Potassium						2	12			
Potassium (Filtered)	mg/L	1	5	10	9.8	7	11	10	1	11
Sodium						2	77			
Sodium (Filtered)	mg/L	1	5	72	68	7	103	76	1	67
Sulphate as SO ₄						1	127			
Sulphate as SO ₄ (Filtered)	mg/L	1	5	139	136	8	142	131	1	132
Total Dissolved Solids	mg/L	10	5	728	705	7	848	761	1	759
Barium	mg/L	0.001	5	0.106	0.087	5	0.196	0.11		
Barium (Filtered)	mg/L	0.001	5	0.105	0.079	4	0.1	0.076	1	0.046

Analyte	Unit	Reporting limit	RN040894			RN039896			RN038493	
			# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.
Strontium	mg/L	0.001	5	0.706	0.67	1	0.709050667			
Strontium (Filtered)	mg/L	0.001	5	0.683	0.63	1	0.661			

Table 37: Summary of groundwater monitoring results collected at the Velkerri 76 S2 site control monitoring bores

Analyte	Unit	Reporting limit	RN041134 Gum Ridge Formation			RN041133 Anthony Lagoon Beds		
			# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.	Average Conc.
Alkalinity (Bicarbonate) as CaCO ₃	mg/L	1	6	380	359	8	377	351
Alkalinity (Total) as CaCO ₃	mg/L	1	6	380	359	8	377	351
Anions Total	meq/L	0.01	6	9.94	9.3	8	13.5	8.5
Calcium (Filtered)	mg/L	1	6	88	78	8	100	74
Cations Total	meq/L	0.01	6	9.6	9	8	13.3	8.2
Chloride	mg/L	1	6	43	41	8	162	34
Electrical Conductivity (Lab)	µS/cm	1	6	897	857	8	1220	766
Fluoride	mg/L	0.1	6	0.4	0.4	8	1.5	0.5
Methane	mg/L	0.01	6	ND	0.005	7	0.03	0.021
pH (Lab)	pH	0.01	6	7.83	7.6	8	7.83	7.6
Potassium (Filtered)	mg/L	1	6	9	8.2	8	46	13
Sodium (Filtered)	mg/L	1	6	38	33	8	104	20

Analyte	Unit	Reporting limit	RN041134 Gum Ridge Formation			RN041133 Anthony Lagoon Beds		
			# of Results	Maximum Conc.	Average Conc.	# of Results	Maximum Conc.	Average Conc.
Sulphate as SO ₄ (Filtered)	mg/L	1	6	57	49	8	137	25
Total Dissolved Solids	mg/L	10	6	494	462	8	668	412
Barium	mg/L	0.001	6	0.058	0.054	8	0.572	0.2
Barium (Filtered)	mg/L	0.001	6	0.057	0.051	8	0.596	0.2
Strontium	mg/L	0.001	6	0.334	0.3	8	0.778	0.22
Strontium (Filtered)	mg/L	0.001	6	0.302	0.29	8	0.756	0.22

4.2 Biological environment

The description of the biological environment of the Amungee NW well site has been described previously in the Beetaloo Sub-basin, EP98 and 117 Exploration Drilling EMP ([NT-2050-35-PH-0018](#)) and the Beetaloo Sub-basin Amungee NW-1H EMP ([ORI7-2](#)).

The existing biological environment for Velkerri 76 S2 was described in the Beetaloo Basin Velkerri 76 S2 Civil Construction EMP ([ORI4-1](#)) and the Beetaloo Basin Velkerri 2019-2024 Drilling, Stimulation and Well Testing Program Velkerri 76 S2 EMP ([ORI5-4](#)).

All previously approved EMPs are available at [NT Onshore-gas/Approved-EMPs](#).

The environmental land condition reports are presented in Appendix K.1 and Appendix K.2.

4.2.1 Bioregions

The Amungee NW, Amungee NW2 and Velkerri 76 S2 sites falls within the Stuart Plateau Bioregion. The bioregion is characterised by undulating plains on sandstone with predominantly neutral sandy red and yellow earth soils. Dominant vegetation associations included extensive areas of Lancewood (*Acacia shirleyi*), Bullwaddy (*Macropteranthes kekwickii*) vegetation and associated fauna, including the Spectacled Hare-Wallaby (*Lagorchestes conspicillatus*). Land condition in the bioregion is moderate to good but is threatened by impacts from weeds, feral animals, pastoralism and changed fire regimes.

4.2.2 Vegetation communities

Vegetation communities within the permit areas have been ground-truthed during baseline assessments in 2004, 2006 (HLA, 2006; 2006c), 2010, 2014, 2016 and in August 2018 (AECOM, 2011; 2014; 2016 and 2018). Surveys at the existing Amungee NW site, including proposed disturbance areas, were most recently completed in August/September 2021(AECOM, 2021).

The Amungee NW, Amungee NW2 and Velkerri 76 S2 sites have been evaluated through detailed habitat assessments which included identification of vegetation community, dominant flora species at each strata, habitat condition, disturbance factors (fire, weeds, erosion, feral fauna species), and fauna attributes (e.g. tree hollows, logs, grass cover, mistletoe abundance). The areas are largely characterised as open *Corymbia* woodland.

The existing Amungee NW well site and Amungee NW2 water bore pad are situated within areas of *Corymbia* spp. open woodland. This vegetation community also makes up most of the well site expansion area, with only a small area on the north-east boundary falling within a patch of Lancewood/Bullwaddy open forest. The existing access track is also located in a small section of Lancewood open forest/*Corymbia* spp. open woodland, with the remaining in *Corymbia* spp. open woodland.

At Velkerri 76 S2, the existing infrastructure is mainly located within *Corymbia* low woodland/*Terminalia* (mixed) sparse shrubland/*Chrysopogon* (mixed) low tussock grassland. The access track to the well site is characterised by the same vegetation unit, with patched of Bullwaddy and Lancewood.

The vegetation communities are considered regionally extensive and not subjected to extensive clearing. A summary of the survey of the existing sites is shown in Table 38, Table 39 and Table 40.

Table 38: Summary of existing environment and surrounds at Amungee NW

Site ID	Amungee NW	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	-16°20' 38.17, 133°53' 2.76		
Landform and soil	Two types: laterite, ferruginous rubble, some red soil and sandy and loamy soil with some lateritic material on undulating plain		
Habitat type	Open eucalypt woodland		
Vegetation Community	Open woodland with dense shrub cover and grass cover. This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Upper Stratum <i>Corymbia ferruginea</i>		
	Mid Stratum <i>Petalostimga pubescens</i> , <i>Hakea arborescens</i> , <i>Teminalia canescens</i>		
	Ground Stratum <i>Sorghum timorense</i> and <i>Chrysopogon fallax</i> , <i>Themeda avenacea</i>		
Habitat Condition	Previous exploration activities (Amungee NW-1H). Habitat disturbances include grazing and prior clearing. Moderate evidence of fire. No evidence of erosion. The weed Hyptis suaveolens present on access track. Evidence of cattle from wet/early dry season. Tree hollows, mistletoe and flowering plants absent. Scattered fallen logs and shallow litter. Termite mounds common.	Hydrogeology Groundwater resources and use is from the Gum Ridge Formation. A seasonal perched shallow alluvium system has also been locally identified but is not utilised as a groundwater resource. The Anthony Lagoon formation and undifferentiated Cretaceous are unsaturated.	
Weeds	No weeds of national significance or NT declared weeds present. <i>Hyptis suaveolens</i> present on access tracks		
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch		

Table 39: Summary of existing environment and surrounds at Amungee NW2

Site ID	Amungee NW2	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	-16°20' 38.17, 133°53' 2.76		
Landform and soil	Two types: laterite, ferruginous rubble, some red soil and sandy and loamy soil with some lateritic material on undulating plain		
Habitat type	Open eucalypt woodland		
Vegetation Community	Open woodland with dense shrub cover and grass cover. This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Upper Stratum <i>Corymbia ferruginea</i>		
	Mid Stratum <i>Petalostimga pubescens</i> , <i>Hakea arborescens</i> , <i>Terminalia canescens</i>		
	Ground Stratum <i>Sorghum timorense</i> and <i>Chrysopogon fallax</i> , <i>Themeda avenacea</i>		
Habitat Condition	Previous exploration activities (Amungee NW-1H). Habitat disturbances include grazing and prior clearing. Moderate evidence of fire. No evidence of erosion. The weed <i>Hyptis suaveolens</i> present on access track. Evidence of cattle from wet/early dry season. Tree hollows, mistletoe and flowering plants absent. Scattered fallen logs and shallow litter. Termite mounds common.	Hydrogeology	
		Groundwater resources and use is from the Gum Ridge Formation. A seasonal perched shallow alluvium system has also been locally identified but is not utilised as a groundwater resource. The Anthony Lagoon formation and undifferentiated Cretaceous are unsaturated.	
Weeds	No weeds of national significance or NT declared weeds present. <i>Hyptis suaveolens</i> present on access tracks		
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch		

Table 40: Summary of existing environment and surrounds at Velkerri 76 S2

Site ID	Velkerri 76 S2	Habitat survey photos of the vegetation/habitat of the surrounding environment	
Location	-16°50'29.01, 133°39'0.16		
Landform and soil	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products, sandy and earth soils.		
Habitat type	Corymbia low woodland		
Vegetation Community	Corymbia low woodland/Terminalia (mixed) sparse shrubland/Chrysopogon (mixed) low tussock grassland This vegetation community is considered regionally extensive and not subjected to extensive clearing.		
Dominant flora species	Upper Stratum <i>Corymbia dichromophloia</i> , <i>Eucalyptus setosa</i>		
	Mid Stratum <i>Acacia ancistrocarpa</i> , <i>Alphitonia pomaderroides</i> , <i>Brachychiton paradoxus</i>		
	Ground Stratum <i>Triodia bitextura</i> .		
Habitat Condition	Good condition with evidence of recent grazing. Vegetation appeared to have been heavily burnt in recent years. No evidence of hollow bearing trees and logs. Habitat contained moderate to high refuge opportunities in the form of dense leaf litter, tussock grass cover, and woody debris. Good continuous cover adjoining adjacent woodland habitat and regionally extensive. No evidence of weeds or feral animals.		
Weeds	No Weeds of National Significance present. Hyptis suaveolens present at camp and wastewater irrigation area.		
Potential listed threatened species (SREBA 2023)	Grey Falcon, Northern Shrike-tit, Plains Death Adder, Gouldian Finch		

4.2.3 Flora

A total of 805 plant species have been recorded within the Beetaloo exploration area, and during the most recent August 2018 survey, 28 dominant flora species were identified. As the survey was conducted during the late dry season, grasses and other annual species were difficult or impossible to identify due to the lack of inflorescence or because they had already died-back.

The region supports fragmented stands of Bullwaddy, which is listed under the TPWC Act as 'Least Concern', which refers to species that are either widespread or common and cannot be categorised as Critically Endangered, Endangered, Vulnerable, Near Threatened or Data Deficient. However, Bullwaddy is significant in terms of the habitat it provides for a range of native species. The extent of Bullwaddy in the area is more extensive in the Beetaloo exploration area than that indicated by the NT Herbarium records.

No Commonwealth or NT threatened plant species were identified as occurring within a 15km buffer of Amungee NW and Velkerri 76 S2 by the PMSR or NT NR Maps search. One species, the prostrate, herbaceous vine *Ipomoea argillicola*, is listed as Near Threatened under Section 29 of the *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) and could potentially occur in the wider exploration area. The species has been recorded on the NT Significant Flora database within 20 km of the Amungee NW well site and in the Bullwaddy Conservation Reserve, however it has not been identified in previous and current field surveys.

4.2.4 Weeds

[Regional Weed Strategies and Plans](#) have been developed for areas of the NT, with the Barkly and the Katherine RWMP overlapping Tamboran's Beetaloo Sub-basin exploration tenure.

The weed species of high risk of introduction or spread through Tamboran's activities are listed in Table 41. These high-risk weeds have been determined through consideration of the following criteria:

- Weed species that has been confirmed in the area within the relevant [Regional Weed Strategies and Plans](#), or through field surveys
- Weed species listed in a statutory plan that are near Tamboran tenure
- Weed species that are at risk of introduction using machinery sourced from other regions in the NT or from other states.

Weed baseline surveys were completed by AECOM in August 2018 covering the sites and access tracks. Further surveys have been completed every 6-months since the original 2018 baseline exercise, with the latest survey conducted August/September 2021. These surveys have been completed with the DLPE Weed Officer.

Since the 8 July 2024, there are now five classes of weeds under the NT *Weed Management Act 2001*. The classes are described as:

- a. *it is necessary to eradicate the plant*
 - b. *it is necessary to prevent the growing and spreading of the plant*
 - c. *it is necessary to prevent the introduction of the plant into the Territory or a part of the Territory*
 - d. *it is necessary to prevent the plant being spread by the actions of persons*
- Unclassified. Declared but not classified as A, B, C or D.*

Table 41 provides a list of weed species that are known to occur or likely to occur within the Shenandoah South 3D seismic program area based on a desktop review of the following sources:

- Mapping data provided by the Weed Management Branch, DLPE.
- Guidelines for the Management of the Weeds of Beetaloo 2018 (DLRM & CDU, 2018).

- Department of Climate Change, Energy, the Environment and Water (DCCEEW) EPBC Act Protected Matters Report database.
- Previous data collected by AECOM in the permit area.

Table 41: NT listed weeds known or likely to occur within Shenandoah South 3D seismic program area

Scientific Name	Common Name	Category of priority	Status*
<i>Alternanthera pungens</i>	Khaki Weed	4	Declared, Class B and C
<i>Andropogon gayanus</i>	Gamba Grass	1	Declared, Class A and C, WoNS
<i>Azadirachta indica</i>	Neem	2	Declared, Class B and C
<i>Calotropis procera</i>	Rubber Bush	1	Declared, Class B and C (south of 16°30' S latitude)
<i>Cenchrus ciliaris</i>	Buffel Grass	3	Declared, Unclassified
<i>Cenchrus echinatus</i>	Mossman River Grass	3	Declared, Class B and C
<i>Datura ferox</i>	Fierce Thornapple	3	Declared, Class A and C
<i>Mesosphaerum suaveolens</i>	Hyptis	4	Declared, Class B and C
<i>Jatropha gossypifolia</i>	Bellyache Bush	1	Declared, Class A/B and C, WoNS
<i>Parkinsonia aculeata</i>	Parkinsonia	2	Declared, Class B and C, WoNS
<i>Sida acuta</i>	Spinyhead Sida	4	Declared, Class B and C
<i>Sida cordifolia</i>	Flannel Weed	4	Declared, Class B and C
<i>Sida rhombifolia</i>	Paddy's Lucerne	4	Declared, Class B and C
<i>Tamarix aphylla</i>	Athel Pine	2	Declared, Class A/B and C, WoNS
<i>Themeda quadrivalvis</i>	Grader Grass	5	Declared, Class B and C, WoNS
<i>Tribulus terrestris</i>	Caltrop	4	Declared, Class B and C
<i>Vachellia nilotica</i>	Prickly Acacia	1	Declared, Class A and C, WoNS
* All Class A and B weeds are also Class C weeds.			

Hyptis suaveolens (Hyptis) has been identified previously within the Carpentaria Highway corridor, along the existing Amungee NW access track, at the Amungee NW camp pad and well pad and at the Velkerri 76 S2 camp and wastewater irrigation areas. Annual mission grass (*Cenchrus pedicellatus*) was also identified at the Velkerri 76 S2 site, with rubber bush (*Calotropis procera*) found along the Velkerri 76 S2 access track.

Hyptis is a Class B (growth and spread to be controlled) and Class C (not to be introduced) weed in the Northern Territory. The Hyptis found at the sites is under active management, with 6-monthly treatments applied to individual weeds identified.

Parthenium hysterophorus, a declared Class A weed species, has been identified in the broader region. Areas of known parthenium outbreaks will be actively avoided.

Additional information on the full list of weeds and control measures for the development are provided in the Beetaloo Weed Management Plan (Appendix C).

4.2.5 Fauna

Previous surveys and database searches indicate that the broader Beetaloo exploration area is an important area for a diverse array of fauna. The NT Fauna database provides records for the following fauna species (excluding migratory birds): 32 species of mammal, 198 species of birds, 96 species of reptiles and 19 species of frogs. Surveys undertaken elsewhere within the region have recorded:

- 78 bird, 33 reptile, 11 mammal and 6 frog species in the Bullwaddy Conservation Reserve (PWCNT, 2005)
- 148 bird, 47 reptile, 21 mammal and 6 frog species in the Junction Stock Reserve and nearby Newcastle Waters (Fleming et al. 1983)
- 157 bird species within the project area as determined by a search of the Birds Australia bird atlas database (Birds Australia, 2010)

The Eucalypt/Corymbia woodland of the region in the vicinity of the sites provides habitat for a range of species. The areas have high native grass cover and include numerous species suitable for granivorous birds (seed eaters). Dense leaf litter and numerous logs provide suitable refuge and foraging sites for fauna such as reptiles. Many of the sites have a high density of hollow-bearing trees that provide important habitat for many fauna species. Although most of the species found in this vegetation type are widespread in the tropical savannas of the Northern Territory, some such as the threatened Northern Shrike-tit (*Falcunculus frontatus whitei*) are rare and known to utilise this habitat (DAWE, 2014, Ward, 2008).

In the broader area, Savanna grasslands and open woodland provide suitable habitat for species such as Emu (*Dromaius novaehollandiae*) and Australian Bush Turkey (*Ardeotis australis*). Drainage lines and seasonally inundated grasslands may also provide habitat for migratory species during the wet season and are breeding areas for frogs.

Incidental fauna surveys at Amungee NW in 2021 identified 13 fauna species, including one species of reptile and 12 bird species.

4.2.6 Significant fauna

The PMSR and searches of the NT NR Map fauna database, and records from the Atlas of Living Australia (ALA) of the Beetaloo exploration area indicate the potential presence of 20 fauna species listed as threatened under the EPBC Act and/or the TPWC Act. These included 10 birds, 8 mammals and 2 reptiles.

The likelihood assessment of species occurrence is based on the availability of suitable habitat within the permit area, records in the vicinity and distributional data. Therefore, many of the threatened and migratory fauna species indicated in databases as 'occurring' or 'likely to occur' have been assessed as 'unlikely to occur' within the exploration areas (AECOM, 2021).

No core habitat for threatened fauna has been identified in areas surrounding the Amungee NW and Velkerri 76 S2 sites. However, some species may possibly occur and are known to occur in the wider landscape. Threatened species that may possibly occur include:

- Gouldian Finch *Erythrura gouldiae* (E-EPBC Act, VU-TPWC Act)
- Northern Shrike-tit *Falcunculus frontatus whitei* (VU-EPBC Act, NT-TPWC Act).

Research has shown that critical components of suitable habitat for the Gouldian Finch include suitable nesting trees during the breeding season (particularly *E. tintinnans*, *E. brevifolia* or *E. leucophloia*), a water source and a diverse range of favoured annual and perennial grasses (DoE, 2015). No suitable nesting habitat is located in close proximity to the sites and it is unlikely this species breeds in close vicinity to the activity. During the wet season, Gouldian Finches move from breeding habitat on hillsides with suitable trees down to lower lying areas where they forage on perennial grasses such as *Triodia* sp., *Alloteropsis semialata*, and *Chrysopogon fallax* (Palmer et al. 2012).

Some of the perennial grasses were recorded during recent surveys so potential foraging habitat is present; however, the level of available habitat across the basin is extensive, with the Gouldian finch likely only to be using a small percentage of those previously occupied (National Recovery Plan for the Gouldian Finch). It is therefore considered unlikely for the finch to travel more than the reported 17kms from their dry season nesting locations in the wet season (National Recovery Plan for the Gouldian Finch).

Although there is potential wet season foraging habitat, the high level of water availability regionally is likely to remove the driver to access the Amungee NW and Velkerri 76 S2 sites and the Gouldian Finch is unlikely to be encountered throughout the year. This is confirmed by the fauna monitoring results, which have not thus far, detected the Gouldian Finch.

The Crested Shrike-tit lives in dry Eucalypt forests and woodland where it feeds on insects from the canopy and under bark (Ward, 2008). It has been recorded in wet Melaleuca open woodlands, woodlands dominated by Nutwood (*Terminalia arastrata*), Bloodwoods with flaky bark and Ironwood (DoE, 2014, Ward, 2008). In the NT, nesting has been recorded from September through to January and nests are built in terminal branches at the top of trees (Ward *et al.* 2009). The stronghold of this species is north of this location and only one old record exists near Borrooloola. Although it is possible this species may be present in the area, it is unlikely to represent an important area for this species and the impact of the proposed activities, given their size, would be small.

The Grey Falcon (*Falco hypoleucus*) is a widespread species listed as Vulnerable in the NT that is considered likely to be present in the study area. The Painted Honeyeater (*Grantiella picta*) has been known to occur in the study area, however, given it does not breed in the NT it would only be present intermittently for foraging. Based on the field assessment there was no breeding habitat recorded, and depending on grass seed and water availability, it is unlikely the study area comprises core habitat for this species.

The Yellow-spotted Monitor (*Varanus panoptes*) is listed as Vulnerable in the NT and is considered possible to occur given that it occurs across northern Australia where it occupies a variety of habitats, including grasslands and woodlands (AECOM, 2021). Most records of this species are from the Top End, though it has been recorded in the Barkly Tablelands. A small population of the species may occur across the Beetaloo project area; however, core habitat does not occur and impacts from proposed activities will be minimal.

The Common Brushtail Possum (*Trichosurus vulpecula arnhemensis*) is listed nationally as Vulnerable. According to the 2021 Commonwealth conservation advice the Brushtail Possum occurs discontinuously from the Gulf of Carpentaria hinterland near Borrooloola, NT westward to the Kimberley, Western Australia. Most of the current population appears to be in the NT, with limited sightings recorded in WA⁴.

Recent surveys for the Strategic Regional Environmental and Baseline Assessment (SREBA) have detected Brushtail Possums on the adjoining Kalala Station, which is approximately 45 km from the proposal area. As habitat is largely contiguous through the landscape there is potential for the species to also occur within EP98 and/or EP76. Given the relatively small area to be cleared compared to the area of remaining available habitat that would remain post disturbance, impacts from proposed activities will be minimal.

4.2.6.1 Feral and pest animals

Feral animals known to occur within the region include:

- Pig (*Sus scrofa*)
- Wild dog (*Canis lupus familiaris*)
- Feral cat (*Felis catus*)
- Cane toad (*Bufo marinus*)

⁴ Commonwealth Threatened Species Scientific Committee Conservation Advice *Trichosurus vulpecula arnhemensis* Northern Brushtail Possum, 11 May 2021: <http://www.environment.gov.au/biodiversity/threatened/species/pubs/83091-conservation-advice-11052021.pdf>.

- Horse (*Equus caballus*)
- Donkey (*Equus asinus*)
- Water buffalo (*Bubalus bubalis*)
- Camel (*Camelus dromedarius*)
- Black rat (*Rattus rattus*)
- Domestic cattle (*Bos Taurus*).

Cattle grazing occurs regularly in the areas across the Beetaloo Basin. Based on records and observations from sites in the broader permit Beetaloo exploration area, many species such as dogs/dingo, pigs and cane toads will be present in the vicinity of the sites. The disturbance from cattle varies depending on the season, with the level of disturbance at the proposed sites likely to have resulted in less than 5%.

4.2.6.2 Fire regime

Fire is a natural occurrence in most Australian ecosystems and plays an important role in their ecology. Fire is generally excluded from Mitchell grasslands by pastoral management in order to maintain forage throughout the dry season (HLA, 2005), whereas fire is more frequent in the Stuart Plateau.

A fire event occurred during the operation of the Amungee NW-1H appraisal well during late 2016. There was negligible evidence of the fire present during the 2018 survey, however with fires occurring in 2019, the most recent survey in 2021 (AECOM, 2021) noted 'moderate' fire disturbance around the site (Figure 39).

NR Maps Fire Scars mapping shows the most recent fire occurred in the areas around Velkerri 76 S2 in 2018 and ecological surveys have noted evidence of fire at an Intensity 1 (minor scars on some trees/shrubs and height <1 m). Regrowth and recovery were evident at the site.

A Bushfire Management Plan (BMP) has been developed to manage bushfire risks associated with the Amungee NW and Velkerri 76 S2 sites. This plan provides the hazard reduction strategies, resources and response to bushfire emergencies. The BMP is provided in Appendix A.

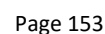


Figure 39: Fire frequency map of Tamboran's active sites within the Beetaloo Sub-basin

4.2.6.3 Groundwater dependent ecosystems

A search of the National Groundwater Dependent Ecosystems (GDE) has been conducted for Amungee NW and Velkerri 76 S2. The dataset expresses the potential for groundwater interaction/use for river/spring/wetland ecosystems across Australia. It shows the ecosystems that rely on groundwater that has been discharged to the surface, such as baseflow or spring flow.

A known aquatic GDE, the Strangways River (a tributary of the Roper River), was identified as occurring within 50km of the Amungee NW site. Eleven other locations were identified as having moderate aquatic GDE potential, including the Bull Creek, Hodgson River, Red Ochre Creek, Arnold River, Cow Creek and Crumby Creek river systems in the Roper River region.

Within 50 km of Velkerri 76 S2, the Woonalyaria Waterhole and four unnamed lakes located along Newcastle Creek were shown as a high potential aquatic GDE, with Williams Creek (Roper River region) and Yaroo Creek, Buloonungroo Creek, Gravel Creek and Newcastle Creek (Victoria River-Wiso region) shown as moderate potential GDEs.

The 50km buffer search identified one known terrestrial GDE, riparian vegetation *Melaleuca leucadendra*, *M. viridiflora* woodland in the Roper River region, and one moderate potential GDE, *Melaleuca citrolens*, *M. minutifolia* low woodland in the Victoria River-Wiso region. *Melaleuca citrolens*, *M. minutifolia* low woodland sites were identified a high and moderate potential terrestrial GDE within 50km of the Velkerri 76 S2 site.

All known and moderate potential GDE locations occurred at distances greater than 25km from Amungee NW and greater than 15 km from Velkerri 76 S2. The impact on these units from Tamboran's total water extraction across the Beetaloo exploration area was assessed during the granting of WEL GRF 10285.

Stygofauna are a form of GDE that inhabit the interstitial spaces of the cavities of alluvial, sedimentary and karstic aquifers. Limited information is available on the presence of stygofauna within the Beetaloo Sub-basin, with a Gas Industry Social and Environment Research Alliance (GISERA) program currently underway to identify and characterise stygofauna assemblages in the CLA units of the Beetaloo Sub-basin⁵. Data is available that can provide an indication of the likelihood of stygofauna presence, with Hose, GC., et al (2015) outlining the following factors affecting the distribution of stygofauna:

- **Formation type:** Stygofauna are predominantly found in aquifers with large (mm or greater) pore spaces, which is more common for alluvial, karstic and some fractured rock aquifers.
- **Depth below ground level:** The abundance and diversity of stygofauna typically decreases with depth below ground, with fauna rarely found more than 100 m below ground level (Hose, GC et al 2015).
- **Proximity of exchange and recharge:** Stygofauna are more abundant in areas of surface water-groundwater exchange, compared to deeper areas or those further along the groundwater flow path remote from areas of exchange or recharge.

Based upon the above, Stygofauna are anticipated to be absent in CLA in the vicinity of the Amungee NW site, where the Anthony Lagoon Formation is unsaturated and the depth to water is greater than 100 metres. The depth and limited extraction draw down predicted and observed concludes that impacts to stygofauna from extraction are considered highly unlikely.

Changes in groundwater quality may also result in impacts to stygofauna. Impacts to aquifers are mitigated through the following controls:

- Well design and construction to isolate aquifers

⁵ Further information is available on the GISERA website: <https://gisera.csiro.au/project/characterisation-of-the-stygofauna-and-microbial-assemblages-of-the-beetaloo-sub-basin-nt/>

- Low toxicity drilling fluid systems utilised
- Groundwater monitoring bores are located within 500m of the Amungee NW and Velkerri 76 S2 which will be used to detect changes in groundwater quality.

Based upon the above information, the presence of significant assemblages of stygofauna in the area is considered limited and impacts considered unlikely.

4.3 Environmental and cultural sensitivities

4.3.1 Native Title

Three native title determinations have been finalised across the SS 3D seismic program area with the most relevant being NTD21/2010 and NTD26/2010 (Table 42).

Table 42: Native Title and IULA Agreements current for the permit areas

Type	Site	Name	Summary
Native Title	Velkerri 76 S2 Access Track	NTD21/2010 Shenandoah Pastoral Lease	Native Title exists in parts of the determination area and is held by the Kinbininggu and Bamarrngganja groups
Native Title	Amungee NW Velkerri 76 S2	NTD17/2010 Amungee Mungee Pastoral Lease	Native title exists in parts of the determination area and is held by The Karranjini group; the Bamarrngganja group

The Native Title Petroleum Exploration Agreement between Tamboran and the NLC includes clauses for the protection of sacred sites, objects and sensitive areas related to Aboriginal activities in the area, including cultural, hunting and foraging activities. Site clearance will occur prior to any on ground activities. The Native Title Agreement also includes clauses for the protection of the environment and site rehabilitation.

4.3.2 Archaeology assessment

Archaeological assessments of E&A sites have been completed by AECOM in August 2014 for the Amungee NW and August 2017 for Velkerri 76 S2. The assessment involved a desktop review of existing heritage data from the Australian Heritage Database, the NT Heritage Branch and the AAPA, previous archaeological survey reports prepared for the local area, as well as consultation with traditional owners of the study area and a field inspection.

The field surveys of both sites were conducted by AECOM Archaeologist, Luke Kirkwood. The archaeological surveys involved either a vehicle survey (2014), helicopter survey (2017) and pedestrian survey of the proposed exploration area and access tracks. The project boundaries for the surveys included a 3.5 km diameter buffer surrounding the proposed drill site and associated access track, with corridors up to 700 m wide.

During the 2014 field survey, the AECOM Archaeologist was assisted by representatives of the traditional owners and the NLC. During the inspections, notes were taken on landform, ground surface visibility and areas of exposure. The aim of the field surveys was to identify any surface expressions of Aboriginal archaeological and cultural heritage values within the exploration area. Photographic records were taken at each location.

The inspection results of the sites are provided in Table 43.

Table 43: Well site inspection results

Location	Survey date	Easting (mE)*	Northing (mN)*	Ground surface visibility (GSV)	Ground surface integrity (GSI)	Surface archaeology	Subsurface potential	Impact potential
Amungee NW	August 2014	380868	8192258	Good	High	None identified	Low	Low to no impact
Velkerri 76 S2	August 2017	435488	8136321	Good	High	None identified	Low	Low to no impact

* GDA94 Zone 53

A search of the NT Heritage Register identified 41 Aboriginal archaeological sites within the Beetaloo Basin, however no sites were located within 15 km from the Amungee NW or Velkerri 76 S2 site.

A search of the Australia Heritage Database identified that no statutory listed heritage places were present within the proposed impact areas.

An unexpected finds protocol has been developed to respond to any potential artifact or sacred site finds during Tamboran's activities; provided in Appendix L.

4.3.3 Areas of cultural significance

Sacred sites in the study area are primarily associated with drainage lines; natural landform features and stock routes, but there are also concentrations of sites nearby to old homesteads. The distribution of these sites may reflect historical patterns of Indigenous movements along drainage lines and subsequent development of stock routes on old Indigenous walking trails, or they may merely be indicative of the site clearance work undertaken along roads and tracks in the area. It is suspected that there will be a range of other sites also within the area, either not yet recorded, or known but not reported for cultural reasons.

AAPA certificate C2020/003 has been granted covering all activities covered under this EMP for the Amungee NW site and the Velkerri 76 S2 site. A Restricted Work Area (RWA) is located at a waterhole over 8km from Amungee NW and at a complex of water holes located 7 km south of the Velkerri 76 S2 well site. There is also a segment of existing access track which intersects RWA 4 on the way to the Velkerri well site. The middle point of this segment of the track is 12 m (either side) from the RWA.

AAPA certificate C2022/02 has been granted covering the extraction of gravel at the proposed new Amungee NW gravel pit and Amungee NW2 control monitoring bore covered under this EMP.

No access or works will be undertaken within 500 m of the Sacred Site RWA and Tamboran has committed to comply with conditions as prescribed by AAPA for the duration of the program.

4.3.4 Natural resources

During the 2018 Sacred Site clearance and avoidance survey, representatives of the Traditional Owners identified several natural resources of importance to the Aboriginal people in the Beetaloo exploration area Table 44.

Table 44: Natural resources of importance in the permit areas

Scientific name	Common name	Usage
<i>Grewia retusifolia</i>	Emu-berry/Dog's Balls, Turkey Bush and Diddle Diddle	Fruit eaten. Leaves can be boiled, and body bathed in the liquid for treatment of several ailments

Scientific name	Common name	Usage
<i>Marsdenia australis</i>	Bush Banana/Gillibi	Bush 'fruit' eaten when young, as it matures 'fruit' seeds becomes feathery for dispersal in the wind and are not eaten
<i>Pterocaulon</i> sp.		Used for treating flu
<i>Acacia</i> sp.	Acacia	Leaves boiled and used to treat flu
<i>Acacia holosericea</i>	Soapbush Wattle or strap wattle	Leaves used for washing
	Termite (unknown species)	Mounds pulverised and mixed with water, used to treat diarrhoea

4.3.5 Non-indigenous heritage

In 1860, explorer John McDougall Stuart was the first European to penetrate the area now known as the 'Centre'. The first written descriptions of the area come from Stuart during his second attempt to cross the continent from south to north (HLA, 2005).

Development in the area began as pastoral lands with an increased interest in land settlement following the completion of the Overland Telegraph Line in 1873. Most attempts were unsuccessful with the Lancewood-Bullwaddy vegetation found to be impenetrable and the lack of surface water making the land unsuitable for cattle. Daly Waters was thus recognised as one of the last watering stops on the Murrarji Stock Route.

It wasn't until the 1930s to 1950s, that the area saw regional economic growth with Daly Waters becoming a significant hub of air and mail services into the Northern Territory. The wartime years saw this role increase with Daly Waters again playing a major role in cross country transport and communication. This role continued until the early 1970s when the airport was closed to commercial traffic. The town and surrounding areas subsequently reverted to a primarily agriculture-based existence following the decline of air travel, but in recent times has seen commercial interest from the exploration for gas in the Beetaloo Sub-basin and the growth of the 'grey nomad' tourism market.

4.3.6 Historic heritage assessment

A search of relevant historic heritage registers identified several historic heritage sites within a 125 km x 125 km area that encompasses the full proposal area. Frew Ponds, a reserve paying tribute to the building and joining of the Overland Telegraph Line is located 28km west south-west of the Velkerri 76 S2 well site and approximately 16 km south of the access track turn into the Velkerri 76 S2 access track from the Stuart Highway.

4.3.7 Protected or conservation areas

There are no conservation reserves, national parks, world heritage places, Commonwealth land, heritage places or critical habitat areas listed under the EPBC Act located within or adjacent to the proposed exploration area.

The closest area is the Bullwaddy Conservation Reserve, which is located 40 km from the Amungee NW. The EBC Listed Lake Woods is located approximately 160 km from the Amungee NW and is listed on the National directory of important Wetlands.

The risks to these receptors through aquifer contamination, spills, sediment release, habitat destruction have been addressed in the risk assessment presented in Appendix M. The main mitigation measures/factors include:

- As the proposed sites are 30-40 km away from the Bullwaddy Conservation Reserve and over 160 km (direct) from Lake Woods, contamination is not likely to reach the area at any undiluted impactable state.
- Surface water flow is to the south into a tributary of Newcastle Creek which flows into Lake Woods via Newcastle Waters. Any spill would need to exceed the capacity of the site bund and travel over 160 km to reach Lake Woods. A spill cannot impact the Bullwaddy Conservation Area as it is not in the overland flow path from either of the site.
- Groundwater depth throughout the Bullwaddy Conservation Reserve and the proposed conservation area is generally 70 m of depth with vegetation not being able to access groundwater at this depth. The flow path (north-west) is generally not in alignment with these two protected places.
- All access tracks are to the south of the Bullwaddy Conservation Reserve with vehicles and workers not interacting with flora and fauna from the site.

4.4 Social environment

4.4.1 Social context

The proposed EMP activities will occur within the Barkly Regional Council area, which covers 323,514 km². The approximate population is estimated for the Barkly Region of 6,091 people (Primary Health Network, 2020).

The potential social and economic effects associated with the proposed exploration activities are minor and predominantly positive.

The closest neighbouring regional towns and communities identified as being within proximity to Tamboran's activities include:

- Dunmarra
- Tennant Creek
- Elliott
- Daly Waters
- Newcastle Waters
- neighbouring pastoral leases of Beetaloo Station, Tanumbirini Station and Hayfield Shenandoah Station.

In 2014, the Tennant Creek Regional Economic Development Committee (REDC) released the Tennant Creek and Barkly Region Strategic Action Plan (2014-2016) which identified social and economic development within the region, including mineral and gas development. Tamboran is in ongoing consultation with REDC.

4.4.2 Pastoral activity

Amungee NW and Velkerri S2 76 are located on the Amungee Mungee Station which is used for pastoral activities. Within the Tamboran's Beetaloo exploration permit area there are nine pastoral properties as shown in Table 45. All the land within the permit area is Leasehold Land. There is one small area of Aboriginal Freehold land known as Jingaloo on EP117.

Table 45: Pastoral properties in the permit area

Pastoral property	Permit areas			Contacts
	EP 76	EP 98	EP 117	
Amungee Mungee	✓	✓	✓	Adrian and Emma Brown adrian@bilbaholdings.com.au
Hayfield / Shenandoah / Shenandoah East		✓	✓	N/A
Kalala		✓	✓	
Tanumbirini	✓	✓		
Beetaloo	✓		✓	
Ucharonidge	✓		✓	
Tandyidgee	✓	✓		
Nutwood Downs		✓		
Newcastle Waters			✓	

The project area has been subject to pastoral activities for over 150 years (AECOM, 2021). The average size of a Station in the Barkly Region is 8,186 km² (Bubb, 2004), which is large by global standards.

4.4.3 Other land uses in the area

A range of other land uses exist in the permit area or in the larger region, including a range of public utilities and facilities. These include the following:

- **Tourism** – Tourism is an important regional industry with the Stuart Highway being a major thoroughfare for tourists travelling in the area during the dry season. The local townships of Daly Waters, Dunmarra and Elliot provide consumables (food, fuel etc.) and accommodation. Several heritage areas of importance to regional tourism are in the broader region, including Elliott, Newcastle Waters and other heritage listed homesteads.
- **Road networks** – The Stuart Highway and Carpentaria Highway will be used to access the sites. In addition, there are numerous gravel roads connecting properties, and internal property tracks. All properties also have firebreaks on their boundaries and internally.
- **Gas pipeline** – A gas pipeline runs to the west of the Stuart Highway, along the eastern boundary of EP117 and crosses the boundary of one part of EP98. It also runs parallel with the Carpentaria Highway to the Gulf of Carpentaria, through EP98 and EP76.
- **Alice Springs to Darwin Railway** – The railway line runs to the west of the gas pipeline and Stuart Highway and does not cross into any of the permit areas.
- **Townships** – The townships of Daly Waters and Dunmarra neighbour EP98 to the West.
- **Conservation areas** – including the Bullwaddy Conservation Reserve, which lies within EP98 and Lake Woods and the Junction Stock Reserve just outside the permit area.
- **Heritage** – There are seven (7) heritage sites within the exploration permit area and several heritage areas of importance to regional tourism located in the broader region, including Elliott, Newcastle Waters and heritage-listed homesteads.

- Archaeological sites – The permit areas have a long history of Aboriginal association, and 41 archaeological sites have previously been recorded within the permit areas, as well as registered sacred sites and areas of significance which are shown in the AAPA Abstract of Record.

5 Stakeholder engagement

5.1 Purpose and objectives

Tamboran's stakeholder engagement is focused on building respectful relationships with key stakeholders and developing a positive reputation founded on Tamboran's core values. Tamboran's consistent approach to stakeholder engagement has been to ensure that those persons and/or groups directly impacted/affected and/or influenced by permit commitments have received Tamboran's full attention. Tamboran views the social acceptance and informed consent of these primary stakeholders of critical importance and relevance during this stage of low impact and small-scale exploration activities.

A stakeholder engagement plan has been implemented, which guides the way Tamboran undertakes stakeholder engagement above and beyond the NT Petroleum (Environment) Regulations 2016. This plan has been developed based upon the International Association for Public Participation (IAP2) (2015) Quality Assurance Standard for Community and Stakeholder Engagement.

5.2 Identification of stakeholders

The NT Petroleum (Environment) Regulations 2016 defines stakeholder as meaning:

- a) *a person or body whose rights or activities may be directly affected by the environmental impacts or environmental risks of the regulated activity proposed to be carried out; or*
- b) *an agent or representative of a person or body mentioned in paragraph (a).⁶*

Tamboran's directly affected stakeholders have been, and will continue to be, consulted in a respectful, open and consistent manner. This has been the case since 2014, when the previous operator, Tamboran, assumed operatorship of EP 98, EP 117 and EP 76 and again in November 2022 when Tamboran assumed operatorship of EPs 98, 117 and 76.

For this EMP, Tamboran identifies its stakeholders, in compliance with the regulations as:

- **Host traditional owners** recognised as the native title holders and/or claimants and their representative, the NLC, as described in Exploration Agreements between the parties for EP 98, EP 117 and EP 76; and
- **Host pastoralists** recognised as the landholders of the nine pastoral stations (Table 45). With regard to this EMP for the Amungee NW and Velkerri 76 S2 location, the owners of the pastoral lease for Amungee Mungee Station are recognised as a pastoralist stakeholder directly impacted.

Stakeholder and community engagement for the proposed work program has been held with host pastoralists and traditional owners directly affected by the proposed activities. Activities performed on EPs will be conducted in a manner consistent with the Code, which Tamboran considers an appropriate regulatory instrument for ensuring Tamboran's activities are in line with community expectations and legislative requirements.

Tamboran also recognises and engages, where appropriate with other interested parties that are not classified as directly affected under the Regulations. These include government agencies, land councils, local and regional suppliers, non-government organisations, councils and peak industry bodies.

⁶ Refer section 7(3) of the Regulations.

5.3 Pastoralist stakeholder engagement

Tamboran has engaged with the pastoral stakeholders identified in Table 43 on an ongoing basis, including engagement with the leaseholder and/or representatives of the Amungee Mungee pastoral lease regarding the full range of exploration activities outlined in this EMP. Key engagement efforts Tamboran has undertaken include:

- Ongoing regular engagement with pastoralist about Tamboran's general activities.
- Providing the landholder with draft copies of a Stakeholder Engagement Pack (SEP) covering exploration activities and providing opportunity for the landholder to comment.

Appendix N summarises Tamboran's engagement with the leaseholders of Amungee Mungee Station as a relevant stakeholder and provide information in accordance with section 7(2)(a) of the NT Petroleum (Environment) Regulations 2016.

Appendix N provides the specific details of communication between Tamboran and the pastoralist regarding the proposed activities.

5.4 Host traditional owner(s) engagement

Tamboran, the previous operator completed detailed engagement with the host Traditional Owners through the Northern Land Council (NLC) to facilitate an ongoing relationship between Tamboran, now Tamboran, and their host Traditional Owners. Engagement efforts undertaken include:

- Complying with the Exploration Agreement(s) between Tamboran, Native Title holders and the NLC for EP117, EP98, EP76.
- Ongoing consultation regarding Tamboran work programs and proposed exploration activities, including the location(s) of all areas of disturbance and answering any questions or comments on the activity and its related impacts.
- In person consultation between Tamboran, host Traditional Owners and their statutory representative body, the NLC regarding the proposed exploration activities on 3 September 2018.
- Execution of Sacred Site clearance and avoidance surveys on the specific areas of land (~6 kms in radius) with the relevant Traditional Owners between 10 September and 19 September 2018. A formal NLC Sacred Site Avoidance and Anthropological Report was provided to the AAPA to assist with the issuing of an Authority Certificate in compliance with the Northern Territory's *Aboriginal Sacred Sites Act*.
- On country meetings held between NLC, Traditional Owners and the permit operator in April and May 2019 revisiting the work program submission from July 2018 and field surveys with Traditional Owners in September 2018. The on-country meetings concluded the engagement and consultation necessary with Traditional Owners prior to commencement of each years' activities.
- Kyalla 117 N2-1H NLC, Traditional Owners and the permit operator site tour in September 2020. The tour provided an overview of the Beetaloo exploration project and answered questions regarding hydraulic fracking activities underway.
- Ongoing communication between Tamboran and the NLC.
- Consultation and engagement with host Traditional Owners, to ensure their understanding of the nature and purpose of activities, is executed by the NLC in accordance with the *Land Rights Act*. The approved work program includes the installation of multiple vertical and horizontal E&A wells per well pad.
- Pursuant to the *Sacred Sites Act*, Tamboran has submitted to, and obtained approval from the AAPA for Authority Certificates to provide indemnity against prosecution in respect of the offences

under the *Sacred Sites Act* Tamboran holds AAPA Authority Certificate C2020/003 and C2022/02 and shall comply with the conditions in the Certificate to ensure compliance to the *Sacred Sites Act*.

The Traditional Owner stakeholder engagement summary is provided in Appendix N.

The NLC is the contact point for all native title holders:

Northern Land Council
45 Mitchell Street, Darwin, NT 0801
PH: (08) 8920 5100

5.5 Stakeholder activities

Key considerations when understanding the consequences to pastoral operations and traditional owners include:

- Understanding pastoralist operations and determined native title holder custodianship of the proposed area to ensure petroleum activities can sustainably co-exist.
- Provision of payments and/or benefits to the pastoral lessee(s) and native title holders for the impact of regulated activities on the proposed activity area in accordance with the relevant agreements.

A summary of the potential consequences of the activity on stakeholders' activities and mitigation controls is provided in Table 46.

Table 46: Potential consequences of Tamboran's activities on stakeholders' activities and control measures which are outlined in the SEPs sent to stakeholders

Activity	Potential consequence to activities	Mitigations
Land and stock		
Well pad (and E&A wells) and associated infrastructure	• Reduction in grazing area • Restricted access to well site and associated infrastructure during activity duration	• Exploration Agreement(s) with NLC and Native Title holders and/or claimants • Aboriginal Areas Protection Authority Certification (including RWAs and Work Instructions) • Short term use • Full fencing and bunding of well pad • Industry-proven coexistence of cattle and petroleum industry • End of life rehabilitation to return land back to pre-existing state • Code of Conduct agreed to by Tamboran and the pastoralists.
Existing access tracks	• Traffic along access track • Temporary access restrictions during rig mobilisations and heavy transport operations • Interference with stock	• Exploration Agreement(s) with NLC and Native Title holders and/or claimants • Aboriginal Areas Protection Authority Certification (including RWAs and Work Instructions) • Upgrade of the existing road to enable dual carriage • Main traffic movements limited to over a 2-week period 1-2 times per year • Code of Conduct agreed with Pastoral Lessee • Tamboran pastoral lease notification of large movements • Road remains shared use asset of pastoral lessee • Controls to be implemented regarding use of gates-including specific induction requirements, gate monitoring and signage.

Activity	Potential consequence to activities	Mitigations
Well sites	- Contamination of soils from activities - Impact to organic certification	- All activities must comply with Code of Practice for Petroleum activities in the Northern Territory, including spill management, wastewater management and waste management - Site to be rehabilitated back to pre-disturbance level with no harmful contamination permitted. - Sites fully bunded - Activity restricted to a small area, with no contaminants released to surrounding areas - Contaminants affecting organic certification for cattle or crops (agrichemicals, GMO, pesticides etc) are typically not associated with petroleum activities. - Exploration Agreement(s) with NLC and Native Title holders and/or claimants - Aboriginal Areas Protection Authority Certification (including RWAs and Work Instructions)
Water		
Groundwater	- Pastoral bores rates and/or quality - Reduction in groundwater availability	- Exploration Agreement(s) with NLC and Native Title holders and/or claimants (<i>Clause 9.2(n)</i>) - No hydrocarbon wells within 1 km of pastoral bore unless other wised agreed - Modelling supported extraction limits set by DLPE through extraction licence GRF 10285 - Monitoring of control and impact groundwater levels to detect and respond to water level declines >1 m as per section 3.26 - Baseline monitoring of local bores within 10 km of petroleum wells - Ongoing control and impact groundwater water monitoring - Aquifer protected through the use of multiple cement and steel casing barriers - Well integrity validated prior to completing stimulation.
Weeds		
Weed control	- Noxious weeds - Impacts to vegetation communities	- Exploration Agreement(s) with NLC and Native Title holders and/or claimants - Baseline weeds survey completed - Ongoing weeds surveys and NTG bi-annual monitoring - Vehicle and Equipment to be clean and have valid weed hygiene certificates prior to access - Weed identification training of key personnel - Weed management plans.
Air quality		
Dust	Dust	- Exploration Agreement(s) with NLC and Native Title holders and/or claimants - Short period of high-volume traffic movements - Equipment movements to consider time of day to reduce impacts on traffic - Dust suppression utilised during high volume traffic movements and around sensitive features (homesteads, cattle yards etc.).
Emissions	Increased emissions from flares and wells	Exploration Agreement(s) with NLC and Native Title holders and/or claimants

Activity	Potential consequence to activities	Mitigations
		- Flares are used to reduce the risk associated with vented hydrocarbons - Short period of operations and testing - Baseline emissions monitoring conducted and is ongoing - Emissions monitoring at all locations - No well pad within 20 km of a residence.
Light, noise and visual amenity		
Light and noise	- Interaction with stock - Reduction in amenity of surrounding site	- Exploration Agreement(s) with NLC and Native Title holders and/or claimants - Site location chosen to minimise impacts on pastoralist operations – including appropriate separation distances between sensitive receptors and activities - Short duration of drilling and stimulation activities.
Light, noise and visual amenity		
Visual amenity	Pastoral and Traditional Owner visual amenity	- Exploration Agreement(s) with NLC and Native Title holders and/or claimants - Site location chosen to minimise impacts on pastoralist amenity – including appropriate separation distances between sensitive receptors and activities - Short duration of drilling and stimulation activities. - Site not located in major thoroughfare and away from the majority of pastoralist activities.

5.6 Northern Territory business engagement

Broader engagement has occurred with local and regional business within the local communities of Daly Waters, Elliott, Katherine and the broader Northern Territory region.

Northern Territory businesses have been engaged on the scope of Tamboran's activities through information sessions and tender opportunities covering a range of material supply and support services, such as:

- people transport and logistics
- accommodation and food
- provision of temporary camps and camp services
- civil construction work
- freight and transport
- water bore drilling
- water carting and waste management
- site maintenance and inspections
- weed management and control
- equipment and materials storage
- oil country tubular goods
- environmental and civil consulting
- surveying and geotechnical assessments
- general provisions of goods and services (such as personal protective equipment and hire cars).

5.7 Ongoing stakeholder and community engagement

Tamboran is committed to continuing to engage with stakeholders regarding the exploration activities under EP 98, EP 117 and EP 76, and any associated environmental outcomes prior to, during and after performance of exploration activities.

Tamboran recognises the growing community interest in ensuring onshore natural gas development takes place in a safe and environmentally sound way and are committed to delivering operational excellence (which encapsulates our health, safety and environmental performance standards).

Tamboran has further committed to ongoing engagement with the relevant traditional owners, including annual work plan meetings and provision of draft work programs for future years of activity.

Detailed community and stakeholder engagement are underway, covering future exploration activities. This includes the following engagement activities:

- Pastoralists:
 - o Weekly-monthly engagement with host pastoralists for which activity is proposed within the immediate timeframe. With the engagement frequency agreed to with the pastoralist.
 - o Quarterly engagement with future host pastoralists for which activity is proposed within the preceding year.
 - o Annual consultation with all pastoralists, including surrounding pastoralists with no immediate proposed activities.
- Native title holders of the area in which the activity is occurring:
 - o Ad hoc updates for the NLC when required, informing them of progress of exploration activities underway.
 - o Quarterly project status updates to the NLC informing them of progress of exploration activities underway.
 - o Site visits by traditional owners during exploration activity so that traditional owners can have first-hand observation of key activities.
 - o Work program surveys conducted by traditional owners, with the support of the NLC, to review work programs and ensure protection of sacred sites and objects.
 - o Annual on country meetings with native title holders to discuss current work program status and future exploration activities.

Broader community engagement that is in addition to the requirements outlined in Reg 7 of the Regulations will continue.

6 Environmental risk assessment

6.1 Tamboran's risk management approach

Tamboran uses a robust risk management process for all its activities to achieve the following key outcomes:

- Risks are understood, eliminated or reduced and controlled to an acceptable level
- Controls are owned, assured and continuously reviewed for effectiveness
- All activities are compliant with regulatory standards and are guided by best practice
- Tamboran and its stakeholders are confident in the way activities are conducted to manage risks
- The approach aligns with the findings of the NT Inquiry Final Report and associated recommendations (as implemented via the Code or legislation).

Tamboran's risk assessment process is undertaken in accordance with section 5.4.3 of ISO 31000. Assessment of risk is completed using Tamboran's risk matrix (Figure 40) to assess and rate risks by assessing the combination of frequency of occurrence and the severity of the outcome of a potential event, including a worst-case scenario event. This allows quantification of a risk and determination can then be made about whether the risk can be accepted, or whether further mitigation is required.

Tamboran risk management processes require regular assessment of all risks once controls are applied, the effectiveness of controls (Table 47) and the likelihood and consequence of a risk event⁷. A residual risk is either accepted in accordance with strict delegations of authority or the activity does not proceed.

Tamboran also includes site specific controls for each identified risk, which further demonstrates how it achieves a residual risk that meets its ALARP and acceptable criteria. When applying the existing controls during the risk analysis (as per ISO 31000), there is very often little material change to most risk profiles identified in the risk register (Appendix M). This is a function of the comprehensive nature of the Code, which was designed to mandate a high level of environmental performance and minimise environmental risk.

Table 47: Risk assessment ratings

Rating	Explanation
Effective	• All controls are well designed and address the cause/s of the risk. • All controls operate to the required level. • Ongoing monitoring required.
Can be improved	• Majority of controls are well designed and address the cause/s of the risk. • Majority of controls operate to the required level. • Certain controls can be improved. • Ongoing monitoring required.
Must be improved	• Majority of controls are not well designed and do not address the root cause/s of the risk. • Majority of controls do not operate to the required level. • All the controls require improvement.

⁷ Includes applying existing controls, such as compliance with regulatory requirements which are mandatory (e.g. the Code, Regulations Schedule 1, etc),

RISK MATRIX

		IMPACT ON TAMBORAN			EXTERNAL RESPONSE		LIKELIHOOD						
		PEOPLE	ENVIRONMENT, HERITAGE & COMMUNITY	FINANCIAL (\$A)	STAKEHOLDER	LAWS, REGULATION AND CIVIL ACTIONS	1 REMOTE <1% chance of occurring within the next year. Occurs as a '100-year event' or less frequent.	2 HIGHLY UNLIKELY <10% chance of occurring within the next year. Could occur within decades.	3 UNLIKELY <30% chance of occurring within the next year. Could occur within the next few years.	4 POSSIBLE <60% chance of occurring within the next year. Could occur within months to years.	5 LIKELY <90% chance of occurring within the next year. Could occur within weeks to months.	6 HIGHLY LIKELY Likely to happen multiple times a year	
CONSEQUENCES	6 CATASTROPHIC	Multiple fatalities >4 or life-threatening illness or total permanent disability to a large, exposed group (≥10 people).	Extensive, permanent damage to the environment, including species, habitats, ecosystems or area/s of cultural significance. Long- term social unrest and outrage within community.	>\$100m	Multiple stakeholder groups taking coordinated action, as reflected in media channels with significant reach and influence (e.g. blockade/boycott negatively impacts substantial aspects of operations and are covered in media for more than 1 week).	Criminal charges against any director or senior executive involving jail or loss of right to manage the company. Public inquiry – requiring considerable resources and Executive Leadership time. Loss of licence to operate.	6 CATASTROPHIC	HIGH	HIGH	VERY HIGH	VERY HIGH	VERY HIGH	VERY HIGH
	5 CRITICAL	1 – 3 fatalities or life-threatening illness or total permanent disability to a small, exposed group (<10 people).	Extensive, long-term, partially reversible damage to the environment, including species, habitats, ecosystems or area/s of cultural significance. Prolonged community outrage.	>\$25-100m	Multiple stakeholder groups mobilising and encouraging others to act, as reflected in media channels with significant reach and influence with substantial negative influence (e.g. social media campaign calling for protest, escalating over several days).	Criminal charges against any director, senior executive or senior manager not involving jail or loss of right to manage the company. Prolonged major litigation – exposure to significant damages / fines / costs. Suspension / restriction to operate an asset.	5 CRITICAL	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH	VERY HIGH
	4 MAJOR	Injury or illness to one or more persons, resulting in permanent partial disability.	Long-term, reversible damage to the environment, including species, habitats, ecosystems or area/s of cultural significance. High levels of tension within the community.	>\$10-25m	More than one stakeholder group's opinion or view influencing other stakeholders, reported through media channels with some reach and influence (e.g. government comments in national media or in Parliament).	Criminal charges against any employee (not described above) Major litigation – exposure to damages / fines / costs.	4 MAJOR	MEDIUM	MEDIUM	MEDIUM	HIGH	VERY HIGH	VERY HIGH
	3 SERIOUS*	Injury or illness that requires treatment as an in-patient in a hospital OR immediate treatment for a serious injury OR medical treatment within 48 hours of exposure to a substance.	Serious, medium-term, reversible impacts to the environment, including species, habitats, ecosystems or area/s of cultural significance. Moderate levels of community tension.	>\$1-10m	More than one group offering an opinion or view, reported through media channels with reach and influence (commentary lasting one 24-hour media cycle across internet, print, television, radio).	Non-compliance with conditions of licence to operate an asset or to conduct an activity. Litigation and exposure to damages / fines / costs.	3 SERIOUS	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH
	2 MODERATE	Injury or illness to 1 or more persons resulting in medical treatment, up to 5 days lost time or alternative / restricted duties for up to 1 month.	Moderate short-term impacts to the environment, including species, habitat, ecosystems or area of cultural significance. Isolated examples of community tension.	>\$250k-\$1m	A single stakeholder group drawing attention to an incident, issue or approach, conveyed through media channels with potential reach and influence (e.g. some social media complaints or local media reports).	Moderate non-compliance with external mandatory obligations or breach of contractual or other legal obligations (not described above).	2 MODERATE	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM
	1 MINOR	Injury or illness requiring first aid to 1 or more persons, or a no treatment case.	Limited environmental or cultural heritage impact- readily dealt with and contained on site. Individual community member voicing concern.	<\$100k	A person or organisation signalling interest in an incident or event using channels with limited reach or influence (e.g. letter of complaint).	Minor non-compliance with external mandatory obligations or breach of contractual or other legal obligations.	1 LOW	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM

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Figure 40: Tamboran's risk matrix

6.2 ALARP

The risk management process requires risks to be managed to ALARP. A risk can be considered to have been reduced to ALARP when all reasonably practicable control measures (both preventative and mitigative) have been identified and implemented to reduce the risk of identified events. A key element of demonstrating ALARP is that good practice is followed, where good practice is defined as the recognised risk management practices and measures that are used by competent organisations to manage well understood hazards arising from their activities. This definition incorporates good practice as defined in codes and standards, and a consensus of good practice within the industry. ALARP is not a final position over the life of an asset or project.

The practicability and the reasonability of control measures can change over time due to changes in technology (that can make measures more readily available), industry standards (that can commoditise once-cutting-edge technology) and the socio-technical landscape (that can modify societal expectations).

In the NT context, ALARP and the definition of acceptable risk levels was a key feature of the NT Inquiry Final Report. For each aspect, acceptability criteria were defined, with recommendations outlined to reduce the potential risk to below the acceptable level. With the adoption of all recommendations by the NTG, the Code and associated regulatory changes provides a high level of inherent protection to ensure activities are undertaken in a safe and consistent manner.

Tamboran considers ALARP to be achieved where the residual risk is low, whereby any additional control measures applied will not reduce the risk any further.

If the residual risk of low is not achieved, Tamboran considers ALARP to be achieved where the following criteria have been met:

- the requirements of the Code have been met
- all reasonably practicable site-specific controls have been identified and implemented; and
- the cost of further reducing the risk is unreasonable compared to the environmental benefit gained from implementing the control measure.

6.3 Risk acceptability

Tamboran uses a series of criteria (Table 48) to determine the acceptability of a risk once all controls are identified / implemented. Each risk event and final risk rating outlined in Appendix M is assessed against these criteria to determine whether Tamboran believes it is acceptable.

Table 48: Risk acceptability criteria

#	Criteria	Tamboran's acceptance threshold
1	Risk level after treatments / controls are applied	Consistent with Tamboran's risk acceptance criteria: Very high risk – Not acceptable High risk – Residual risk may be conditionally accepted where the residual risk is ALARP and the risk is signed off by a General Manager with risk treatment applied to improve, control or further modify risk. Risk reviews are to occur annually with the intent to reduce the risk severity lower. Medium-low risk – Residual risk is accepted when ALARP is demonstrated
2	Legislative requirements and regional strategies and conservation plans	1. Consistent with legislative requirements, including Code 2. Consistent with regional strategies and conservation/threat abatement plans
3	Stakeholder expectations	Consistent with the commitments made in stakeholder engagement and/or agreements

#	Criteria	Tamboran's acceptance threshold
4	Industry guidelines and best practice	Is consistent with petroleum standards (such as API and the Oil and Gas UK standards), best practice and controls used in other NT industries
5	Scientific uncertainty in the data used to determine the environmental impact or risk	Low uncertainty: Accepted risks are well understood, and uncertainty is minimal. Moderate uncertainty: Accepted using well-established data and assessment methods. Some uncertainty exists, with routine monitoring and performance criteria in place to detect and respond to any impacts arising from a risk. High: Conditional acceptance – Significant uncertainty exists with data and assessment methodologies unproven. A precautionary approach will mean that uncertainty is replaced by conservative assumptions that will require additional control measures being implemented to prevent, detect and respond to any impacts arising from a risk.
6	ESD Principles	Risk is consistent with the principles of ESD as defined in section 2.1. This also includes weighting to consider the social and economic benefits of the project.

6.4 Assessment of scientific uncertainty

The Regulations require an assessment of uncertainty as a part of the risk assessment process. The assessment of potential impacts and effectiveness of controls must demonstrate that the activities are carried out in a manner consistent with the principles of ESD and the precautionary principle.

Impact and risk identification must include consideration of uncertainty regarding impacts and risks for the activity where a precautionary approach is appropriate. Uncertainty is high where confidence in the available information is low in identifying risk or the effectiveness of a management control. Additional baseline studies or other safeguards may be required to increase the accuracy of an assessment to determine the acceptability of a risk.

As per the EMP Guidelines, scientific certainty is qualitatively assessed using a generic means of ranking the data available in accordance with Table 49. Considerations of uncertainty have been included in the risk assessment discussed in section 6.5.

Table 49: Scoring system and ranking for scientific uncertainty (DEFRA, 2013)

Score	Description
Low (1)	- Comprehensive data with strong evidence in multiple peer reviewed data - Little disagreement between authors or experts - Considerable and consistent on-ground experience and/or monitoring
Medium (2)	- Some or incomplete data available - Evidence provided based on a small number of references - Authors or experts conclusions vary - Limited on-ground experience and/or monitoring
High (3)	- Scarce or no data available; evidence provided in unpublished reports - Few on-ground observations - Authors and experts conclusions vary considerably

6.5 Risk assessment outcomes

The environmental, heritage and social risks associated with the activities covered under this EMP have been assessed utilising the Tamboran risk assessment framework described in section 6.1. The detailed risk assessment presents the range of potential impact-causing activities, corresponding mitigation measures and residual risk ratings based on their assessed worst-case consequence and likelihood of occurrence. The assessment also cross-referenced the various risk assessment outcomes in the NT Inquiry Final Report, to ensure consistency.

Site specific conditions and cumulative impacts have also been considered during the assessment. Cumulative impacts have included the following:

- A total of five future Tamboran E&A wells for the 2020-2022 period as per the current approved tenure work plan (this includes the two covered under this plan).
- Existing land users (predominately pastoralists).

There were no residual risks above a 'Medium' risk ranking, with 23 risk scenarios. Within these risk scenarios, the assessment considered 72 risk sources which may potentially result in a risk occurring. Of the 72 risk sources, eight were ranked as 'Moderate' with the remaining ranked as 'Low'. The medium residual risks sources identified through the risk assessment include:

1. Loss in soil productivity and viability due to soil erosion from cleared areas (existing access tracks, well pad and camp pad)
2. Impact to fauna habitats and threatened flora and fauna through the introduction and spread of weeds in the area
3. Impact to fauna habitats and threatened flora and fauna through accidental ignition of fire from exploration activities (drilling, HFS, flaring, general access)
4. Disturbance of sacred site or culturally sensitive area and decline in environmental value of area used for cultural purposes through the accidental ignition of fire by site activities
5. Reduction in agriculture productivity through the introduction and spread of weeds in the area
6. Reduction in agriculture productivity through bushfire from accidental ignition by site activities or site personnel
7. Increased nuisance from dust emissions associated with the activities
8. Increased nuisance from dust due to accidental ignition of bushfire during the site activities.

The 'Medium' risks identified were consistent with standard construction or pastoralist activities carried out across the NT, being the potential spread of weeds, erosion and sediment control, and ignition of bushfires from the proposed activities. The reduced risk profile associated with stimulation activities (such as potential spills and groundwater contamination) is reflective of the stringent regulatory requirements within the Petroleum Code of Practice.

The level of uncertainty for each risk was also assessed. There was no uncertainty level above 'Low', which is consistent with the scale of the activity and the knowledge of impacts associated with shale exploration activities demonstrated in the Inquiry Final Report and through the various reports published by the US EPA (such as USEPA 2016- U.S. EPA. Hydraulic Fracturing for Oil and Gas: Impacts from the Hydraulic Fracturing Water Cycle on Drinking Water Resources in the United States (Final Report)).

Table 50 provides a count of the post-treatment environmental risks associated with this EMP. A copy of the risk assessment is provided in Appendix M.

Table 50: Count of environmental risks for the Shenandoah South 3D seismic program

	Environmental risk rating with applied controls			
	Low	Medium	High	Very high
Total - 26	22	4	0	0

6.6 Environmental outcomes, performance standards and measurement criteria

The following section provides the environmental outcomes, performance standards and measurement criteria of each environmental aspect, based on the risk assessment presented in Appendix M. Table 51 to Table 57 provide the environmental outcomes, performance standards and measurement criteria, based on the NT EPA's environmental factors and objectives, to demonstrate whether controls have been effective during the activity and that the stated environmental outcomes have been achieved.

6.6.1 Soils

Table 51: Environmental outcomes, performance standards and measurement criteria – Soils

Environmental performance measures – Soils				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant impact to the ecological function and productivity of surrounding soils as result of Tamboran's exploration activities.	S-1	No releases of contaminants (chemicals, hydrocarbon, drilling wastewater or flowback wastewater) outside of Tamboran's well pad	Weekly site inspections completed during chemical and wastewater storages confirm no releases of chemicals, hydrocarbons and wastewater outside of Tamboran's disturbance area.	Weekly records of site inspections retained Internal Management System (IMS) incidents of off-site releases retained
	S-2	No reportable spills, including wastewater tank/sump overtopping events, resulting from Tamboran's exploration activities.	Weekly site inspections during hydrocarbon, wastewater and chemical storage activities confirm no reportable spills.	Weekly records of site inspections retained IMS incidents of reportable incidents relating to spills
	S-3		Zero reportable incidents resulting from chemical or waste transportation accidents.	IMS incidents of reportable incidents relating to transportation accidents and spills
	S-4	Erosion and sediment control in place and working effectively.	6-monthly site stability inspections confirm ESC in place and working effectively. No erosion or sediment releases present that cannot be rectified during routine site maintenance.	ESC inspection records retained.
	S-5	Erosion and sediment control in place and working effectively.	Evidence of maintenance performed on all material erosion and sediment control events.	Maintenance records retained.
Risk sources	• Soil compaction from access tracks and leases (Risk ID 23) • Soil erosion from cleared areas (access tracks, well pads and camp pads) (Risk ID 24) • Spills/leaks from the on-site storing and handling of fuels (condensate, hydrocarbons, drilling additives, stimulation additives, drilling fluids, flowback fluid, solid wastes, storage and transportation of wastes) (Risk ID 25) • Drill sump and flowback tank overtopping (Risk ID 26) • Chemical and waste transportation accident (Risk ID 27) • On-site disposal of drill muds and cuttings (Risk ID 28) • Failure of a flowback tank (Risk ID 29) • Wastewater evaporation mist transported off-site during wastewater treatment (Risk ID 30) • Greywater and sewerage disposal (camps) (Risk ID 31).			

6.6.2 Surface water

Table 52: Environmental outcomes, performance standards and measurement criteria –Surface water

Environmental performance measures – Surface water				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant impact on surface water quality as a result of Tamboran's exploration activities.	SW-1	During chemical and wastewater storage activities, no off-site release of contaminants from chemical, hydrocarbon and waste storage.	All stormwater discharges monitored by operators prior to release, with results confirm stormwater is within the approved limits listed in Table 23.	Discharge monitoring results retained for each stormwater release.
	SW-2	No seismic events over Ml 3.5 attributable to Tamboran's activities.	No seismic events over Ml 3.5 recorded in vicinity of a hydraulic fracture operation measured at the Warramunga seismic monitoring station during period that hydraulic fracture stimulations have occurred resulting in surface subsidence and impacting surface hydrology.	Monitoring results available at https://earthquakes.ga.gov.au/
	SW-3	No reportable spills, including off-site releases of contaminants resulting from Tamboran's exploration activities.	Weekly site inspections completed during chemical and wastewater storages confirm no releases of chemicals, hydrocarbons and wastewater outside of the project areas	Weekly records of site inspections retained.
	SW-4	Erosion and sediment control in place and working effectively.	All material erosion and sediment control events are rectified as soon practicable upon identification.	IMS incident records of off-site releases retained. IMS incident records of reportable incidents relating to spills.
Risk sources	- Failure of flowback storage tank (Risk ID 14) - Overtopping of drilling sumps and flowback tanks (including wet season operations) (Risk ID 15) - Transportation accident releasing chemical or wastewater (drilling fluid and flowback) (Risk ID 16) - Storage and handling of drilling and stimulation chemicals and hydrocarbons (Risk ID 17) - Release of stormwater from activities to surface water (Risk ID 18) - Runoff from sewage treatment irrigation areas (Risk ID 19) - Infrastructure located on regional flow path resulting in changes to surface water flow (Risk ID 20) - Changes to terrestrial ground surface levels associated with seismic activity (Risk ID 21)			
Instrument calibration	Management of storm water: Instrument calibrated before use. pH probe calibrated with a two-point calibration using a pH buffer of 7 and 10. EC meter calibrated with a 1413µs/cm (or similar) standard.			

6.6.3 Groundwater

Table 53: Environmental outcomes, performance standards and measurement criteria – Groundwater

Environmental performance measure – Groundwater				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
Tamboran's exploration activities do not reduce the environmental values of the underlying groundwater resources.	GW-1	All regional aquifers isolated through cement and casing	Isolation of the Gum Ridge Formation and Anthony Lagoons Formation is confirmed through cement bond logs and casing pressure tests	Well completion report
	GW-2	No failure of wastewater tank secondary liner	All leak detection alarms investigated within 24 hour, with no incidents of secondary liner failure	Records of leak detection alarms and investigations retained on site
			All spills cleaned up immediately	Incidents of secondary liner failure documented in the IMS and reported to regulator.
	GW-3	No seismic events over Ml 3.5 attributable to Tamboran's activities	No seismic events over Ml 3.5 recorded in vicinity of a hydraulic fracture operation measured at the Warramunga seismic monitoring station during period that hydraulic fracture stimulations have occurred.	Monitoring results available at https://earthquakes.ga.gov.au/
	GW-4	No long-term (>12 month) reduction in quality of an impact groundwater monitoring bore that is attributable to Tamboran's activities. A decline is defined as a change in water chemistry that exceeds the ANZECC guidelines for Livestock (the primary Environmental Value) of groundwater in the region.	Quarterly groundwater monitoring data collected and analysed against baseline data demonstrates no material decline in groundwater quality.	Quarterly groundwater monitoring results retained.
	GW-5	No long term (>12 month) reduction in groundwater level observed in the impact monitoring bore that results in >1m decline in groundwater water level	Quarterly groundwater monitoring data collected and analysed against baseline data confirms no material (>1m) decline in groundwater level	Quarterly groundwater monitoring results retained
	GW-6		Total groundwater extraction volume below the Water extraction level of 175Ml/year	Groundwater take records retained

Environmental performance measure – Groundwater			
Environmental outcome	Environmental performance standards	Measurement criteria	Records
Risk sources	- Sub-surface loss of drilling fluids during drilling (Risk ID 1) - Sub-surface cross flow of formation through inappropriate well barrier design and construction (Risk ID 2) - Sub-surface crossflow through fracture growth into aquifer from stimulation activities allowing the migration of fluid and gas (Risk ID 3) - Stimulation activity induces seismic activity that enables cross formational flow between shallow aquifers (Risk ID 4) - Sub-surface migration of fluid and gasses via fractures intersecting with offset wells (including the adjacent horizontal wells) or intersecting an existing geohazard (Risk ID 5) - Crossflow/well integrity caused by the deviation of an E&A well into the adjacent well during drilling (Risk ID 6) - Leakage of either flowback, produced water, or hydrocarbons (liquid and gaseous) from suspended or abandoned wells (Risk ID 7) - Surface spills/contamination from the storage and disposal of drilling fluids, additives, muds and cuttings on-site (Risk ID 8) - Surface spills from the storage, handling and transportation of produced hydrocarbons (condensate) (Risk ID 9) - Surface spills from storage, handling and transportation of flowback water (Risk ID 10) - Surface spills from the storage, handling and transportation of chemicals, fuels and wastes (Risk ID 11) - Surface spills from the overtopping of drilling sumps and flowback tanks (including during wet season) (Risk ID 12) - Surface spills from the failure of flowback storage tank (Risk ID 13) - Over extraction of groundwater for exploration activities (Risk ID 22) - Cumulative impact from regional groundwater take exceeds the natural recharge rate of the Basin (Risk ID 68)		
Instrument calibration	Groundwater volume: N/A approved DLPE meter used with no calibration required.		

6.6.4 Ecology – flora, fauna and habitats

Table 54: Environmental outcomes, performance standards and measurement criteria – Ecology

Environmental performance measure – Ecology				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant impact to high valued habitats and threatened flora and fauna as a result of Tamboran’s exploration activities	EC-1	No releases of wastewater (drilling fluid and flowback) off the well site into the surrounding vegetation	Weekly site inspections confirm no loss of containment (structural failure, overtopping or major spills) resulting in off-site releases of wastewater	Weekly site inspection completed during wastewater storage
	EC-2	<7 individual fauna deaths per week for 2 consecutive weeks caused by flowback water storage	Daily checks of wastewater tanks for fauna mortality	Fauna interaction log retained
	EC-3		Weekly checks of area immediately surrounding well pad for fauna deaths	Fauna interaction log retained
	EC-4	<0 threatened fauna deaths caused by flowback storage	Daily checks of wastewater tanks for fauna mortality	Fauna interaction log retained
	EC-5		Weekly checks of area immediately surrounding well pad for fauna deaths	Fauna interaction log retained
	EC-6	No uncontrolled bushfires caused by Tamboran’s exploration activities	Zero reported incidents of uncontrolled bushfire caused by Tamboran’s activities	Fire incident data to be retained for all Tamboran’s unplanned fires
	EC-7	Weed surveys completed on all Tamboran disturbed areas	6-monthly pre and post-wet season weed surveys completed on all Tamboran controlled disturbed areas	Annual weed monitoring and management report
	EC-8	Year-on-year decline in the size and density of all weed infestations introduced as a result of Tamboran’s activities	Annual report demonstrates weed infestation size and density of weed outbreaks introduced by Tamboran’s activities are reducing each year	Annual weed monitoring and management report
	EC-10	No unauthorised clearing.	1. Total clearing levels within the authorised clearing levels stated in the EMP. No clearing outside of approved areas defined in the EMP.	Survey and spatial data collected confirms disturbance levels are within approved limits and areas.
	EC-11	Wetlands and riparian vegetation protected from clearing.	No clearing of riparian vegetation or wetlands recorded.	Global positioning system (GPS) survey data for disturbed areas retained.
	EC-12	Impacts to large trees (>25cm trunk @ 1.3 m) minimised during clearing.	All large trees proposed to be cleared are recorded, with justification as to why clearing could not be avoided.	Large tree clearing log to be retained including trees that were avoided.

Environmental performance measure – Ecology				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
	EC-13	No disturbance of Grey Falcon nesting sites	No clearing within 300 m of known Grey Falcon nesting sites.	Records of pre-clearance surveys retained documenting presence/ab
Risk sources	• Activity (vehicle and machinery) noise and lighting on well pads and access tracks (Risk ID 32) • Structural failure and overtopping of flowback storage tanks and drilling sump (Risk ID 33) • Introduction and spread of weeds in the area (Risk ID 34) • Accidental ignition of fire from exploration activities (drilling, stimulation, flaring and general access (Risk ID 35) • Poor rehabilitation of the site reduces regional habitat and promotes weed invasions (Risk ID 36) • Trapping and drowning of fauna in storage tanks and sumps (Risk ID 37) • Contaminants in water and soil pass through the food chain and bioaccumulate in fauna causing detrimental impacts to local species and communities (Risk ID 38) • Vehicle collisions with fauna – fauna mortality results in a localised decline in species abundance (Risk ID 39) • Encouragement of feral animals and other pest species increases leading to competition with native species. This includes the introduction of cane toads (Risk ID 40)			

6.6.5 Air quality and greenhouse gas emissions (GHG)

Table 55: Environmental outcomes, performance standards and measurement criteria – Air quality and GHG emissions

Environmental performance measures – air quality and atmospheric processes				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant impact on air quality and no excess greenhouse gas emissions resulting from Tamboran's exploration activities.	AQ-1	Venting to be eliminated as far as reasonably practicable	Daily reports confirm all technically recovered hydrocarbons sent to the flare is metered and recorded	Gas flow volumes recorded
	AQ-2	All greenhouse gasses reporting in accordance with NGERS requirements	All emissions related data (fuel use, flaring volumes etc.) reported in accordance with NGERS requirements	Emission related data (fuel use, flare volumes, etc.) retained
	AQ-3	All leaks detected and repaired in accordance with code of practice	6-monthly leak detection program completed on surface equipment.	Leak detection records retained
	AQ-4		Minor leaks rectified as per Code of Practice within 30 days	Leaks and management recorded in IMS
	AQ-5		A significant leak is repaired as per the Code of Practice within 72-hours	Leaks and management recorded in IMS

Environmental performance measures – air quality and atmospheric processes			
Environmental outcome	Environmental performance standards	Measurement criteria	Records
Risk sources	- Emissions from the combustion of diesel (Risk ID 58) - Air emissions from gas and condensate flaring (Risk ID 59) - Air emissions from chemical releases during drilling and stimulation activities (Risk ID 60) - Dust from truck movements, drilling operations, stimulation and well testing (Risk ID 61) - Bushfire from accidental ignition by site activities (civil works, drilling, flaring, grinding) or personnel (Risk ID 62) - Combustion of diesel for exploration activities (Risk ID 63) - Avoidable GHG generation through flaring of gas and condensate during well testing (Risk ID 64) - Uncontrolled release of gas encountered during drilling, stimulation, barrier failure, operator error or vehicle collision under a multi-well scenario (Risk ID 65) - Leak of gas from wells (Risk ID 66) - Uncontrolled release of gas from well due to sabotage (Risk ID 67))		
Instrument calibration	Identification and remediation of gas leaks: Gas detector calibrated monthly with a 10ppm (or similar) methane calibration gas.		

6.6.6 Community

Table 56: Environmental outcomes, performance standards and measurement criteria – Community - Lighting, noise, vibration and visual amenity

Environmental performance measures – Community				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant negative impacts to the community as a result from Tamboran's exploration activities.	CO-1	All valid community complaints of nuisance investigated and resolved	All valid community complaints responded to within 24 hours with actions to remedy nuisance implemented as soon as practicable (depending on the nature of the complaint)	OCIS records of community complaints and actions completed
	CO-2	>60% of addressable spend ⁸ to be from NT businesses	Project expenditure data confirms the NT business spend on the Beetaloo exploration project exceeds >60% of addressable spend ⁸ of the project	Data on NT business spend retained
Risk sources	• Industrialisation of landscape (Risk ID 45) • Increased traffic (Risk ID 46) • Light emissions impact on sensitive receptor (such as pastoralist) (Risk ID 47) • Influx of workers to region (Risk ID 48) • Noise emissions from activities (Risk ID 49) • Introduction and spread of weeds in the area (Risk ID 50) • Over extraction of groundwater (Risk ID 51) • Impact to surface hydrology reduces water capture (Risk ID 52) • Bushfire from accidental ignition by site activities (civil works, drilling, flaring grinding) or personnel (Risk ID 53) • Poor rehabilitation of exploration infrastructure (Risk ID 54) • Exploration activities compete with agricultural industry for resources (Risk ID 55) • Increased risk of vehicle accident (Risk ID 56) • Exploration activities compete with agricultural industry for resources (Risk ID 57)			

⁸ Addressable spend is defined as a service or material that can be reasonably provided by an NT business at similar quality, timeliness and cost.

6.6.7 Cultural heritage

Table 57: Environmental outcomes, performance standards and measurement criteria – Cultural heritage

Environmental performance measures – Cultural heritage				
Environmental outcome	Environmental performance standards		Measurement criteria	Records
No significant impact on sacred sites and environmental values as a result of Tamboran’s exploration activities.	CH-1	No non-compliances with Native Title Holder Exploration Agreements and AAPA certificate conditions.	No unauthorised work within Restricted Work Areas (RWA)	IMS incidents retained where unauthorised activities are identified
	CH-2		No impacts to sacred sites	IMS incidents retained where unauthorised activities are identified
	CH-3		Site inductions completed on all employees and contractors which include information on RWAs and approved activity areas	Records of inductions retained
Risk sources	• Sites disturbed directly by exploration activities (Risk ID 41) • Accidental ignition by site activities (civil works, drilling, grinding) or site personnel (Risk ID 42) • Flowback tank structural failure (Risk ID 43) • Personnel unauthorised access to sacred site (Risk ID 44)			

7 Management plans

The following section provides a high-level summary of the various management plans required to be implemented in accordance with the Code.

7.1 Wastewater management plan

A wastewater management plan (WWMP) has been developed to satisfy the requirements of the Code of Practice. The WWMP describes how Tamboran will store wastewater to minimise risks to the environment. A copy of the WWMP is provided in Appendix G.

7.2 Spill management plan

The use of secondary containment to prevent spills during the activities is a regulatory requirement embedded in national and state chemical handling legislation and guidelines. These requirements have been further covered in the Code of Practice.

A spill management plan (SPMP) has been developed covering Tamboran's proposed exploration activities. This SPMP is provided in Appendix F.

An example of bunding used for drilling and stimulation activities is provided in Figure 41.



Figure 41: Examples of spill mats used to contain potential wastewater transfer spills

7.3 Methane emissions management plan

A methane emission management plan (MEMP) is required to be developed to demonstrate how methane emissions will be managed. The MEMP describes how Tamboran:

- Mitigates the generation of methane emissions, such as the minimisation of venting and use of reduced emission completions.
- Outlines the required leak detection and repair programs.
- Summarises the leak reporting requirements.

A copy of the MEMP is provided in Appendix I.

7.4 Erosion and sediment control plan

An erosion and sediment control plan (ESCP) has been developed to outline how the Amungee NW and Velkerri 76 S2 well sites will be operated to minimise the risk of erosion and sediment release to the surrounding environment. The ESCP is provided in Appendix H.

7.5 Rehabilitation plan

Once a determination has been made to decommission an asset, a site-specific rehabilitation strategy will be developed for each disturbed area in consultation with DLPE. A specific strategy for each area is required to ensure the operational history of the site is considered during rehabilitation planning (such as spills etc.). As per the Code of Practice, rehabilitation will commence within 12 months of determining an asset is no longer required.

Each petroleum well will be plugged and decommissioned in accordance with the Petroleum Codes of Practice. All tanks, surface infrastructure and wastes will be removed from site and disposed of in accordance with the *Waste Management and Pollution Control Act 1998*.

All remaining assets with a residual beneficial use (such as water bores, laydown yards, gates, fences, fresh water tanks etc.) will be offered for transfer to the pastoralist, subject to DLPE approval and compliance with the Code of Practice. Prior to considering the transfer of ownership, Tamboran will:

- Undertake an assessment of the status of the asset and whether it can be beneficially used by the local pastoralist. Where a beneficial use is anticipated, identify works required to be undertaken to ready the asset for transfer (i.e. any repairs, site remediation, equipment removal etc.)
- Obtain written agreement from the pastoralist to take ownership of the asset and document any stipulated liabilities.

Where an asset cannot be beneficially utilised, the site will be rehabilitated to the pre-existing condition using assisted natural regeneration. This will include:

- Removal of all surface facilities
- Removal of all weeds and contaminated materials/wastes
- Re-spreading of stockpiled topsoil/windrows
- Reshaping the site to as close to natural form as possible
- Ripping or scarifying any compacted surface
- Spreading of stockpiled vegetation to aid in surface water flow control
- Spreading seed of suitable local native species which has been determined through analogue sites representative surrounding vegetation communities
- Source native seed supply and rehabilitation services from indigenous suppliers (where available).
- Undertake yearly monitoring of the rehabilitation success requirements to assess the rehabilitation status of a site and determine where additional remedial works are required.

The rehabilitation plan for Amungee NW, Amungee NW2 and Velkerri 76 S2 well sites is provided in Appendix O.

7.6 Weed management plan

Exploration activities are undertaken in accordance with Tamboran's Beetaloo Weed Management Plan (Appendix C). This plan has been developed in accordance with the *Weed Management Planning Guide: Onshore Shale Gas Developments Project*.

Weed surveys have confirmed the proposed area of activity has an extremely low presence of weeds. Efforts will therefore focus on both eliminating the potential introduction of weeds into the region and preventing the spread of existing weeds.

From a cumulative impact perspective, the risks of increasing weed pressure in the area is reduced through the mandated use of weed hygiene inspections/certification for all equipment and vehicles and routine weed monitoring and maintenance. Any weeds that are introduced into the activity areas will be promptly identified and managed, reducing the potential additional stress to the region.

7.7 Bushfire management plan

A Bushfire Management Plan (BMP) has been developed for each of the sites to outline the controls to prevent, detect and respond to fires associated with Tamboran's activities. Controls implemented include:

- Implementation and maintenance of firebreaks
- Monitoring during periods of high fire danger
- Flaring controls, including separation distances and cessation of flaring during total fire bans
- Fire response and reporting

A copy of the BMPs is provided in Appendix A.

7.8 Well operations management plan

A well operations management plan (WOMP) must be developed and submitted to the Minister for Mines and Energy (DME) for approval prior to the commencement of activities. The WOMP is a separate approval from the EMP and provides an operational description of how Tamboran plans to operate, suspend and decommission the proposed wells in a manner that ensures all risk to the environment are reduced to As Low as Reasonably Practicable (ALARP).

8 Implementation strategy

8.1 Environment, health and safety management system

Tamboran's activities are governed by a Health, Safety and Environment (HSSE) policy (Figure 42). Tamboran will implement a HSEMS, which ensures we conduct our business in line with all the elements of this policy, including but not limited to:

- Risk management and compliance
- Training and competency
- Contractor management
- Safety management and emergency response.



Health, Safety and Environment Policy

Tamboran Resources Corporation (**Tamboran**) is committed to operating in a manner that prioritizes the safety of our people and the community and places an emphasis on preventing unforeseen environmental harm.

Tamboran will achieve this through:

- Creating a culture of work where it is understood that no task is too important that time cannot be taken to ensure it is performed safely and efficiently.
- Empowering our workforce (including contractors) to “stop the job” whenever they believe a task is unsafe or there is an unacceptable risk to people, the environment, or the safe operation of assets.
- Implementation of a contractor management process to ensure alignment of HSE values and safe execution of work.
- Compliance with all applicable legislative requirements, company policies, plans and processes.
- The application of our risk management framework, ensuring that all risks are identified, controlled, or eliminated where practicable.
- Ensuring HSE considerations are an integral part of planning, design, and procurement processes.
- Developing and managing our assets in an environmentally responsible manner and in accordance with ecologically sustainable development principals.
- Ensuring our people are trained and competent for the work they are undertaking.
- Managing all HSE incidents through reporting, investigation and learning with the aim of preventing re-occurrence.
- Effective communication, consultation, and promotion of worker participation to encourage all personnel to be actively engaged in HSE matters.
- Setting objectives aimed at preventing serious harm and improving HSE performance.
- Monitoring and improvement of the HSE management system that supports our people and the way we work.

Tamboran’s Executive Leadership Team is committed to leading by example to influence our culture. By upholding health and safety as a core workplace value, Tamboran Resources will achieve positive outcomes for our people and the environment.

Authorised by

CEO
Joel Riddle

28 March 2024

COO
Faron Thibodeaux

28 March 2024

Governance – This policy will be reviewed every 2 years to ensure it remains relevant and effective for Tamboran Resources operations and risk profile. The Nomination and Governance Committee is responsible for undertaking this review.

Figure 42: Tamboran’s Health, Safety, Security and Environment (HSSE) Policy

8.2 Roles and responsibilities

Overall roles and responsibilities for the implementation of the regulated activities described in this EMP are outlined in Table 58. There are two primary streams of responsibility which sit under the Chief Operating Officer and the Executive Vice President, Strategy and Sustainability.

Table 58: Roles and responsibilities

Role		Responsibility
Stream 1	Chief Operating Officer	Tamboran employee responsible for the overall program.
	Senior Manager Geoscience and Technical Advisor.	Ensures all areas of the seismic acquisition are carried out in accordance with the EMP and work instruction(s).
	Manager Field Operations Senior HSE Manager Operating Company Representative Field HSE Advisor(s) Contract Administrator	Tamboran employees/consultants responsible executing operations in accordance with the EMP, Tamboran's HSEMS, contractual agreements and the exploration quality controls. These roles are ultimately responsible for ensuring all other parties are working within the HSE guidelines and provide guidance and advice to site personnel on: - Day-to-day management of the environment and implementation of this EMP, including reporting, monitoring compliance of operations of all regulated and associated activities. - Planning and implementation of Tamboran monitoring requirements including weeds, groundwater, soil and erosion, bushfire and emergency response
	Specialist contractors	Contractors engaged by Tamboran to deliver on elements of the seismic program. They are responsible for compliance with this EMP at all times during execution of their work.
Stream 2	Vice President- Environment and Approvals	Tamboran employee responsible for managing regulatory approvals and program changes and reporting and supporting operations (including HSE). Also responsible for notifying the responsible Minister(s) and the owner/occupier of the land on which the activity is to be carried out; and for communications with the regulator and key stakeholders.
	Cultural managers	NLC representatives to provide cultural clearances during clearing and grubbing activities to ensure activities are conducted to avoid areas of cultural significance.

8.3 Contractor management

Most of the work executed under this EMP is done via contractors with oversight from a Tamboran Representative. Assessing the level of capability and competency of the contractors is a major focus of the execution strategy.

The interfaces between Tamboran and contractors HSEMS are formalised and documented within the HSE bridging document. This is an operational document which is used on site to identify the systems / processes that take precedence during the execution of a work scope.

Figure 43 provides an overview of the EMP implementation process.

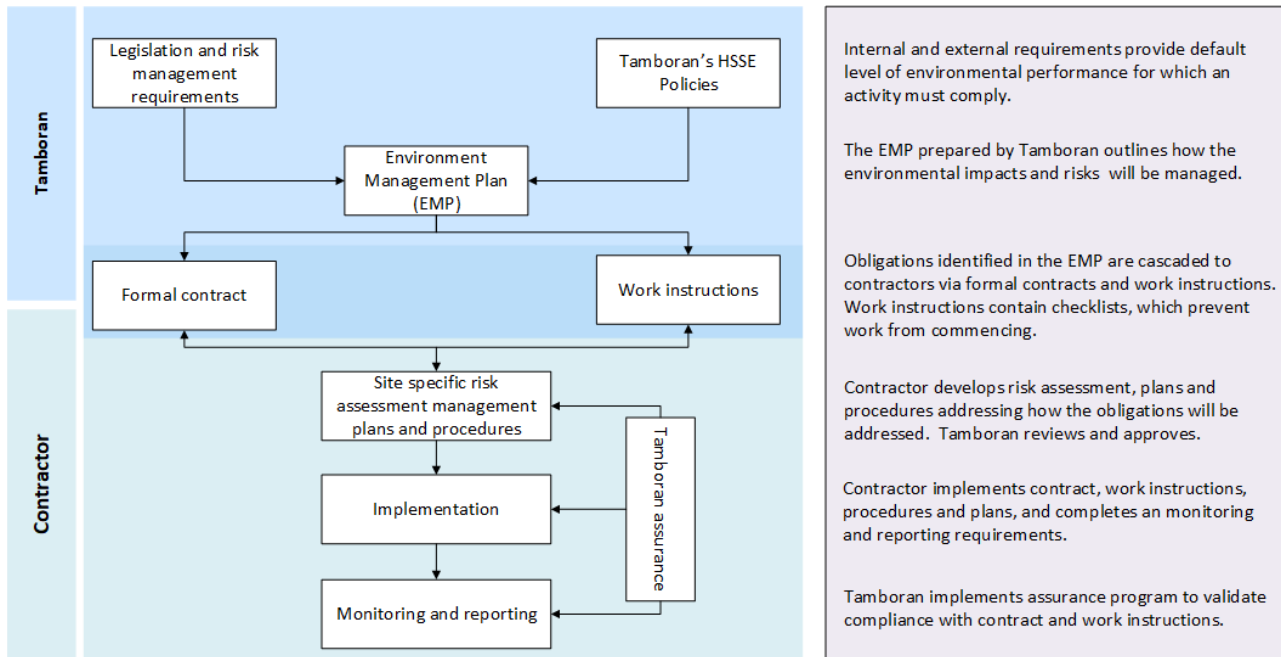


Figure 43: EMP implementation overview flowchart

8.4 Environmental commitment summary

The responsibility for general environmental monitoring rests with all personnel engaged on the project. More specifically, Tamboran's Drilling Completion Lead and Well Site Representatives are responsible for delivering the relevant components of this plan.

The program environmental commitments outlined in Appendix P are sourced from the risk assessment (Appendix M) and environmental outcomes, performance standards and measurement criteria tables (Table 51 to Table 57). The implementation and compliance against these risk controls will be assessed as part of the annual environmental report (refer in section 8.11).

Specific commitments will be to:

- Record information to track performance, including non-conformances and corrective actions.
- Inspect and monitor operational controls on-site via regular environmental monitoring.
- Assess the level of conformance with objectives and targets detailed in this EMP.
- The operating company representative/HSE advisor will undertake site inspections and direct such action as may be considered necessary to protect, minimise or rectify any environmental concerns.

8.5 Work instructions

An instrument referred to as a 'work instruction' is the mechanism used to cascade the relevant environmental commitments to Tamboran personnel and contractors. It outlines the minimum compliance requirements that must be implemented and includes:

- Key compliance and system documents.
- A list of compliance commitments with responsible parties allocated.
- A list of inspections, procedures and other tools required to implement the content of the EMP.
- Monitoring and reporting requirements.
- 'Hold Points' which require a deliverable to be completed prior to entry into a new activity phase (i.e. prior to mobilisation, operation and demobilisation)

- Maps illustrating the approved disturbance areas and any restricted work areas.

8.6 Incident reporting

All personnel working on site (including visitors) are required to report incidents and near-misses that have the potential to, or do, affect the environment.

All environmental incidents and near misses are managed as per Tamboran's Incident Management Procedure and tracked through an online incident management system (IMS). Incidents are investigated with the level of investigation and methodology (5 whys, ICAM etc) dependent on actual and potential consequence.

Personnel are also encouraged to submit hazard / observation cards to maintain a level of awareness of environmental risk and to ensure a cycle of continual improvement.

8.7 Incident reporting

Incident reporting and investigation provides the mechanism to prevent a recurrence. All personnel are required to proactively report all incidents, near-misses and identification of potential hazards.

Tamboran uses an online incident management and reporting system. Any environmental incident, near miss or observations are reported through the online incident management system (IMS). All personnel are encouraged to report minor events to act as an alert to environmental risks and to maintain a program of continual improvement.

8.8 Reportable environmental incident reporting

The Regulations define a reportable incident as an incident arising from a regulated activity that has caused, or has the potential to cause, material environmental harm or serious environmental harm as defined under the Petroleum Act. This also includes any potential or actual damage to a sacred site. Environmental offences and penalties that meet this criteria are defined in s. 117AAB of the Petroleum Act.

Tamboran will assess incidents as they occur to determine if they are reportable. Where an incident is reportable, DLPE will be contacted (this may be verbal or in writing) as soon as practicable but no later than two hours after the first occurrence of the incident or after the time the interest holder becomes aware of the incident.

The Regulations define a recordable incident as an incident arising from a regulated activity that:

1. Has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or
2. Has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or
3. Is inconsistent with an environmental outcome specified in the current plan for the activity; and
4. Is not a reportable incident.

Tamboran will notify (this may be oral or in writing) DLPE of a recordable incident as soon as practicable but no later than 15-days after the reporting period (agreed period or each 90-day period after the day on which the EMP is approved).

8.8.1 NT Waste Management and Pollution Control Act 1998 incident reporting

In accordance with the *NT Waste Management and Pollution Control (WMPC) Act 1998*, where contaminants or waste is not confined within the land on which the petroleum activities are undertaken (i.e. the approved disturbance areas where the petroleum activity is occurring), Tamboran has a duty to notify of incidents causing or threatening to cause pollution as soon as practicable, but no less than 24-hours after becoming aware of the incident.

A notifiable incident is defined as an incident that causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm.

A notification must include:

- a) the incident causing or threatening to cause pollution
- b) the place where the incident occurred
- c) the date and time of the incident
- d) how the pollution has occurred, is occurring or may occur
- e) the attempts made to prevent, reduce, control, rectify or clean up the pollution or resultant environmental harm caused or threatening to be caused by the incident
- f) the identity of the person notifying

Tamboran shall make all notification under the WMPA via the NT EPA Pollution Hotline 1800 064 567 and Petroleum Operations via the DLPE email: onshoregas.dlpe@nt.gov.au.

8.8.2 Gas leak reporting

Each gas leak shall be classified, repaired and reported in accordance with Table 59.

Table 59: Leak classification and remediation summary

Classification	Threshold	Notification	Comments
Minor Leak	>500ppm measured at the surface of the component	All minor leaks must be documented	A minor leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning
Significant Leak	>5,000 ppm (or 10% of the Lower Explosive Limit) when measured at 150 mm above the leak source or A Liquid Petroleum (condensate/oil) loss of containment that exceeds 200 L or The leak is too large or not safe to measure.	In the case of an emergency situation, DME must be notified within 24 hours via the emergency response hotline number 1300 935 250. Notification must include the date of identification, nature and level of the leak, infrastructure name, number and location as well as the initial actions to minimise the risk. The landowner or occupier of the property in which these leaks are occurring must be notified in the following circumstances: i) if the leak cannot be repaired immediately; and ii) if the leak is likely to affect any of the landowner's or occupiers facilities or activities. A written close-out report must be submitted within 5 business days of the remediation of the leak, specifying the date of identification, nature and level of	A significant leak is an unplanned release that does not occur during commissioning or bringing equipment back into service. These leaks should be corrected immediately as a part of commissioning

Classification	Threshold	Notification	Comments
		leak, location and name of the operating plant, and the rectification actions taken. If finalising the remediation is delayed more than 7 business days from the identification of the leak an update must be submitted on that day. The final close out report shall be provided when all work is completed. Where environmental impacts have occurred notification to DLPE is undertaken as described in section 7.7.1 or 7.7.2 as appropriate.	

8.9 Monitoring, assurance and non-conformance management

In addition to regular monitoring as set out in this document, audits assessing compliance with this EMP, and associated work instruction will be undertaken by Tamboran during the execution of the activity. System deficiencies/non-compliances arising from activities will have corrective actions agreed and assigned to the relevant personnel and may be the subject of a formal non-conformance. These non-conformances or corrective actions shall be logged, and remedial actions identified and implemented. The status of corrective actions will be tracked through to closure and reported in the annual environmental report.

Audits assessing the implementation of the EMP commitments will be completed for each activity (Table 60). The results will be included in the annual environmental report.

Table 60: EMP audit schedule

Audit Type	Scope of audit	Frequency	Responsibility
Operational assurance	Operational compliance checks to ensure risk management controls are implemented	Monthly	Tamboran HSE representative
Annual assurance	Compliance against EMP commitments and risk management controls	Annually	Tamboran HSE representative

8.10 Emergency response plan

An Emergency Response Plan (ERP) has been developed and supports all Tamboran's activities within the Beetaloo Sub-basin. The ERP provides the framework for managing emergencies (i.e. spills, bushfires, medical emergencies) to minimise the impacts to personnel health and safety, and the environment.

The ERP will be reviewed every three years to ensure the content is continually kept up to date. A copy of the ERP is provided in Appendix Q.

8.11 Reporting

Internal and government reporting on performance standards will be carried out by the Tamboran authorised representative, and distributed to Tamboran management and the DLPE, in accordance with Section 35 of the Regulations. Quarterly and annual reports will be completed to summarise the compliance with this EMP, whether the environmental outcomes and performance standards in the plan were met and the details of any recordable and reportable incidents (Table 61).

Table 61: EMP reporting schedule

Frequency	Report detail	Recipient
Prior to the commencement of construction and drilling	A commencement of construction or drilling activity notification	a) Minister for Lands, Planning and Environment (via DLPE) b) Occupier of the land in which the activity is carried out c) Owner for the land for which the activity is to be carried out
Only if required	Incident report summarising reportable incidents.	DLPE
Monthly	Monthly activity summary report.	DLPE
Quarterly	Quarterly incident report summarising recordable incidents during the period (during operational activities) and groundwater monitoring data.	DLPE
Annually	An annual environment performance report will be prepared and submitted to the Minister covering the following: • Summary of the works completed under the EMP during the reporting period. • Summary of performance against measurement criteria. • A summary of environmental incidents that occurred during the year (i.e. reportable and recordable incidents that occurred). • Any environmental studies or research associated with the activity. • Technical improvements. • Consultation undertaken. • Annual weed management performance reporting • Results of related research or of an ongoing monitoring program. • The relevant records outlined with section 8.12.	Tamboran management DLPE
Report about flowback fluid and produced water	A report regarding flowback and produced water is required within 6 months of the flowback commencing, in accordance with section 37A and 37B of the <i>NT Petroleum (Environment) Regulations 2016</i>	The Minister for Lands, Planning and Environment (via DLPE)
Geospatial information	As per A.3.5 of the Code, geospatial information must be provided to the Minister. Geospatial data of all areas cleared and rehabilitated will be provided annually as a part of the Annual Environmental Performance Report.	Minister for Lands, Planning and Environment (via DLPE)

8.12 Record keeping

The following records will be retained within Tamboran's document management system for a period of five years:

- Records linked to measurement criteria, commitments and statutory reporting requirements.
- Induction records.
- Waste records.
- Hazardous goods manifests.
- Fuel usage.
- Weed inspections.
- Non-compliances and corrective action records.
- Internal audits and inspection records.
- Management of change records.

To the extent these documents are 'prescribed records' for the purpose of the Regulations, they will be kept for the longer of five years following the period during which the petroleum interest is in force and 15-years after the record comes into existence.

8.13 Management of change

A management of change process will be implemented to ensure any changes to the regulated activities described in this EMP are assessed and communicated to ensure no new or unintended environmental risks or impacts are introduced. This allows adaptive management and the ability to use appropriate technologies.

It should be noted that changes can only be implemented to optimise environmental outcomes or to improve operational efficiency where no new regulated activity, risk (including risk level) or impact is introduced. Where a new regulated activity, risk (including risk level) or impact is introduced, then a Revision of the EMP is required under the PER's.

8.14 EMP review

Implementation of this EMP will be continually monitored and revised as required based on monitoring and audit results, complaints, employee and stakeholder feedback, change to the proposed work program or a material increase in risk level.

A formal review, update and resubmission of this EMP will be undertaken every five years.

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10 Acronyms and Abbreviations

Acronym	Meaning
°C	degrees Celsius
%	Percentage
AAPA	Aboriginal Areas Protection Authority
ABS	Australian Bureau of Statistics
ALA	Atlas of Living Australia
ALARP	as low as reasonably practicable
ANZECC	Australian and New Zealand Environment Conservation Council
ANRA	Australian Natural Resources Atlas
API	American Petroleum Institute
APPEA	Australian Petroleum Production and Exploration Association
ASRIS	Australian Soil Resource Information System
AS	Australian Standard
BoM	Bureau of Meteorology
BMP	Bushfire Management Plan
BPESC	Best Practice Erosion and Sediment Control
CE, E, V, or NT	Critically Endangered, Endangered, Vulnerable and Near Threatened
CLA	Cambrian Limestone Aquifer
CPESC	Certified Professional in Erosion and Sediment Control
Code	Code of Practice: Onshore Petroleum Activities in the Northern Territory
Cth	Commonwealth
CY	calendar year
DAWE	Department of Agriculture, Water and the Environment (Cth); now the Department of Climate Change, Energy, the Environment and Water
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DEPWS/DLPE	Department of Environment, Parks and Water Security; now the Department of Lands, Planning and Environment
DIPL	Department of Infrastructure, Planning and Logistics
DITT/DME	Department of Industry, Trade and Tourism; now the Department of Mining and Energy
DoH	Department of Health (NT)

Acronym	Meaning
EC	Electrical Conductivity
EIS	Environment Impact Statement
EO	Environmental Outcome
EMP	Environment Management Plan
EP	exploration permit (e.g. EP 76, EP 98 and EP 117)
EPA	Environment Protection Authority (NT)
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth)
EPS	Environmental Performance Standard
ERP	Emergency Response Plan
ESC	erosion and sediment controls
ESCP	Erosion and Sediment Control Plan
GDE	Groundwater Dependent Ecosystems
GHG	Greenhouse gas
GPS	Global Positioning Device
ha	hectare
HFS	Hydraulic Fracture Stimulation
HSE	Health, Safety and Environment
HSEMPs	Health, Safety and Environment Management Plans
HSEMS	Health, Safety and Environment Management System
IBA	Important Bird Area
IECA	International Erosion Control Association
ILUA	Indigenous Land Use Agreement
IMS	Integrated Management System
ISO	International Organisation for Standardisation
JV	Joint venture
km	kilometre
km ²	square kilometres
km/hr	kilometres per hour
LAG	Local Aboriginal Group

Acronym	Meaning
LOS	Level of Service
m	metre
Mya	millions of years ago
MD	measured depth
MEMP	Methane Management Plan
ML	megalitre
MI	Local magnitude
mm	millimetre
mMDRT	Meters measured depth below rotary table
MNES	Matters of National Environmental Significance
mTVDGL	metre True Vertical Depth below ground level
SDS	Safety Data Sheet
NAFI	Northern Australian Fire Information
NATA	National Association of Testing Authorities
NEPM	National Environmental Protection Measure
NGERS	National Greenhouse and Energy Reporting Scheme
NICNAS	National Industrial Chemicals Notification and Assessment Scheme
NLC	Northern Land Council
NORMs	Naturally Occurring Radioactive Materials
NPI	National Pollutant Inventory
NT	Northern Territory
NT Por	NT Portion (Parcel Reference Table)
NTG	Northern Territory Government
NVIS	National Vegetation Information System
OHS	Occupational Health and Safety
ppm	parts per million
PER	Public Environment Report
PPE	Personal Protective Equipment
PPL	Perpetual Pastoral Lease

Acronym	Meaning
RMP	Rehabilitation Management Plan
RUSLE	Revised Universal Soil Loss Equation
RWA	Restricted Work Area
SPMP	Spill Management Plan
SWL	Standing Water Level
tCO ₂ e	tonnes of carbon dioxide equivalent
TDS	Total Dissolved Solids
TIA	Traffic Impact Assessment
TMP	Traffic Management Plan
TO	Traditional Owner
TVDSS	True Vertical Depth from Surface Sea level
TPWC Act	<i>Territory Parks and Wildlife Conservation Act</i> (NTG)
TRH	Total Recoverable Hydrocarbons
TSS	Total Suspended Solids
VOCs	Volatile Organic Compounds
WBIV	Well barrier integrity verification
WEL	Water Extraction Licence
WIMP	Well Integrity Management Plan
WMP	Weed Management Plan
WOMP	Well Operations Management Plan
WoNS	Weed of National Significance
WWMP	Wastewater Management Plan