Santos

Environment Management Plan: McArthur Basin Drilling Program

NT Exploration Permit (EP) 161

Date	Rev	Reason for Issue	Author	Checked	Approved
17/06/2019	3	Post-review Comments	MB	PW	DC
09/06/2019	4	Amendments	MB	PW	DC
15/07/2019	5	For Approval – Revisions to Table 8-1	MB	PW	DC
20/11/2020	6	Revision of EMP. STO2-6	MB	PW	AM
01/02/2021	7	Revision of EMP. STO2-6	MB	PW	AM

Executive Summary

Introduction and Scope

Santos QNT Pty Ltd (Santos) is the operator of Exploration Permit (EP) 161 which is located approximately 350 km south-east of Katherine in the Northern Territory (NT) (Figure ES-1). Santos has undertaken exploration activities in EP 161 since 2013, including acquiring 2D seismic, drilling two exploration wells, Tanumbirini-1 and Marmbulligan-1, development of a water bore drilling and monitoring program, and DFIT, fracture stimulation and testing of Tanumbirini-1.

Under the Petroleum (Environment) Regulations (the Regulations), interest holders in petroleum titles must prepare and submit an Environment Management Plan (EMP) for all proposed exploration activity.

Santos has prepared and submitted this revised EMP for the proposed Drilling Program at the Tanumbirini and Inacumba locations.

Description of the Activity

This EMP covers the Drilling Program at the Tanumbirini and Inacumba locations, which is expected to commence in Quarter 2 2021. It should be noted that elements of the overall work program proposed at EP 161 are covered in other EMPs including the McArthur Basin Civil and Seismic Program and the McArthur Basin Hydraulic Fracturing Program. In particular, the civil works required to prepare for the Drilling Program, including the upgrading of access tracks and creation of infrastructure at the lease pads, are covered in the Civils and Seismic Program EMP. Accordingly, this EMP covers no civil engineering works or land clearing. The relevant EMPs and their respective scopes of work are summarised in Table ES-1 below.

Table ES-1 also summarises the specific scope of work covered by this revised EMP (McArthur Basin Drilling Program) and further highlights those activities that have already been approved versus proposed additional scope that is the subject of this revision.

Table ES-1 Environmental Management Plans for EP 161

EP 161 EMPs	Scope Definition	Approved	Complete
McArthur Basin Civil and Seismic Program	Expansion of the Tanumbirini lease pad and construction of the Inacumba lease pad	June 2019	✓*
	Civil engineering activity – upgrading and creation of new roads and access tracks, clearing of laydown areas, borrow pits, campsites and tank pads	June 2019	✓*
	Acquisition of a 10km 2D seismic line	June 2019	✓
McArthur Basin Drilling Program	Drilling of Inacumba-1 pilot well	July 2019	✕
	Plug and decommission of the deepest section of the Inacumba-1 pilot well	July 2019	✕
	Drilling of Inacumba-1H horizontal well from the Inacumba-1 pilot	July 2019	✕

EP 161 EMPs	Scope Definition	Approved	Complete
	DFIT of Tanumbirini-1	July 2019	✓
	Drilling of Tanumbirini-2H well	July 2019	✗
	Well integrity monitoring	July 2019	✗
	Evaluation of Inacumba-1/1H and Tanumbirini-2H (including: mudlogging, wireline/LWD, DFIT, coring)	July 2019	✗
	Suspension and/or Plugging and decommissioning of Tanumbirini-2H and Inacumba-1/1H	July 2019	✗
	Rehabilitation of the Tanumbirini-1, Tanumbirini-2H and Inacumba-1H wells.	July 2019	✗
	Drilling of Tanumbirini-3H well	**No - scope change subject to this revision**	✗
	Drilling of Inacumba-2H well	**No - scope change subject to this revision**	✗
	Evaluation of Inacumba-2H and Tanumbirini-3H (including: mudlogging, wireline/LWD, DFIT, coring)	**No - scope change subject to this revision**	✗
	Suspension and/or Plugging and decommissioning of Inacumba-2H and Tanumbirini-3H	**No - scope change subject to this revision**	✗
	Rehabilitation of the Tanumbirini-3H and Inacumba-2H wells.	**No - scope change subject to this revision**	✗
McArthur Basin Hydraulic Fracturing Program	Hydraulic fracture stimulation (including fracturing diagnostics) at Tanumbirini-1	Oct 2019	✓
	Hydraulic fracture stimulation (including fracturing diagnostics) at Tanumbirini-2H	Oct 2019	✗
	Hydraulic fracture stimulation (including fracturing diagnostics) at Inacumba 1/1H	Oct 2019	✗
	Flow-back and appraisal (production) testing at Tanumbirini and Inacumba	Oct 2019	✗

** Ongoing civil works are required to maintain infrastructure.*

The Drilling Program will require a temporary campsite to be constructed at the Inacumba and Tanumbirini well lease pads. The existing landholder airstrip adjacent to the Tanumbirini homestead may be required for crew changes and emergency response evacuations.

The Drilling Program will involve the drilling of the Inacumba-1 vertical pilot well, the proposed Inacumba horizontal wells (contingent on results from the Inacumba-1 vertical pilot well), and the proposed Tanumbirini horizontal wells.

Wells will be drilled using a water-based mud to assist in effective drilling and to lift formation cuttings out of the hole. Formation cuttings will be transferred to the cuttings pit and drilling fluids will be stored in fit-for-purpose mud tanks and drill sumps.

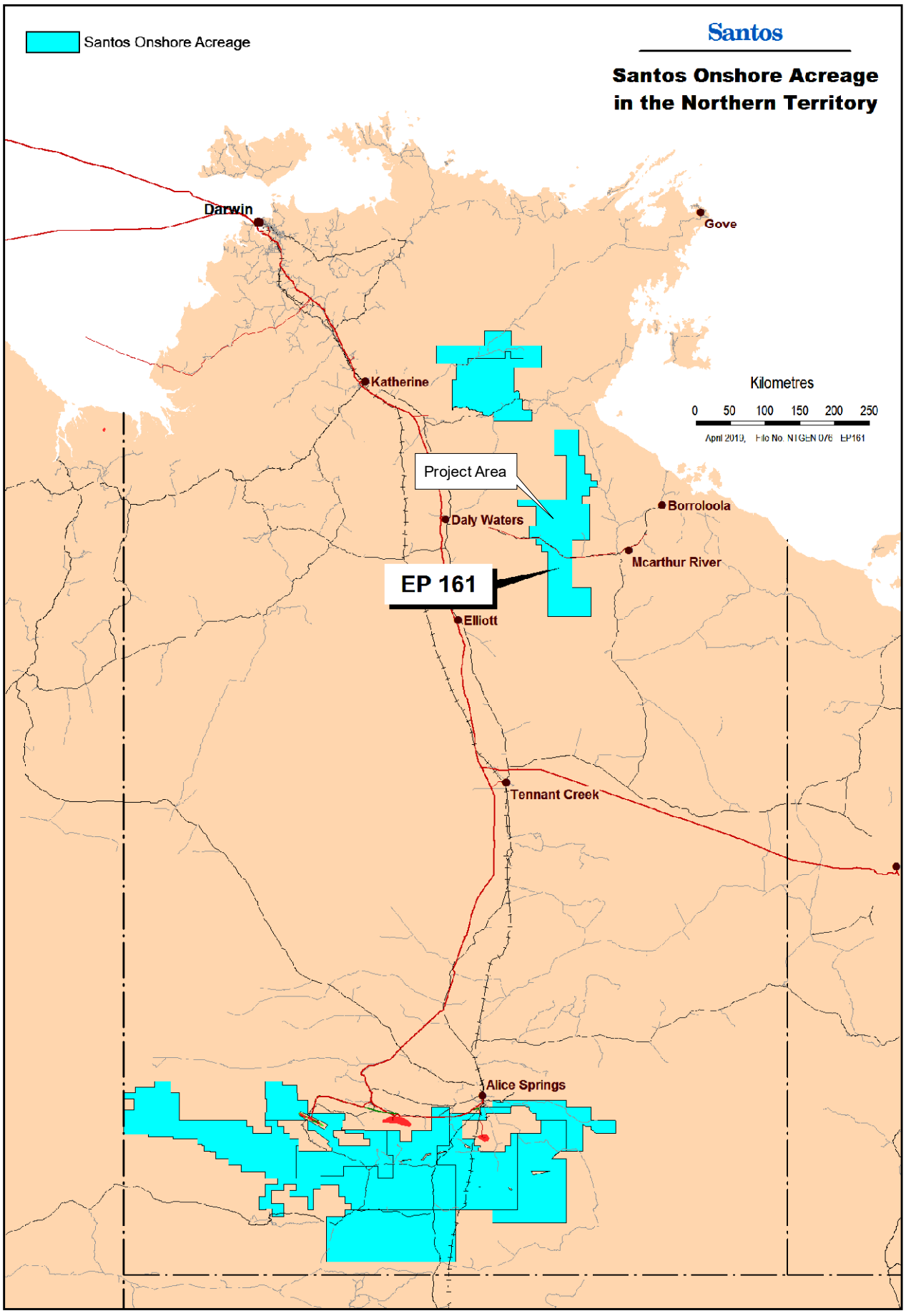
During and/or on the completion of drilling, well evaluation will be undertaken using a variety of techniques including mudlogging, logging while drilling, wireline logging, formation testing, core acquisition, fluid sampling, and open hole formation integrity testing. Drill cutting samples and/or core will be collected for geological assessment and analysis and wireline logs will be acquired over the open hole.

In a success case, following completion of the well drilling operations, the operator proposes to conduct a program of hydraulic fracture stimulations and flow testing of the Velkerri Formation in the Tanumbirini and Inacumba wells. It should be noted that these proposed activities will be the subject of a separate Environmental Management Plan.

On completion of well evaluation the wells will either be suspended for future re-entry, suspended on build-up, or decommissioned with permanent cement plugs. For suspended wells, wellbore barriers will be put in place and will be monitored through a Well Integrity Monitoring Plan; and the well and well-pad will be monitored and maintained. At the completion of operations all surface infrastructure will be removed and pits filled and stockpiled topsoil and vegetation will be spread to promote revegetation.

The Activity Location

The proposed activity will be undertaken in EP 161, which is located approximately 350 km south-east of Katherine in the Northern Territory (NT), as shown in Figure ES-1 below. The Project Area for the program is located on Tanumbirini Station, a 5000 km^2 cattle grazing property within NT Portion 701 of Arnold. The location and layout of the proposed project infrastructure is shown on Figure ES-2.



Not to scale

N

GHD

Santos
McArthur Basin
Environmental Management Plan

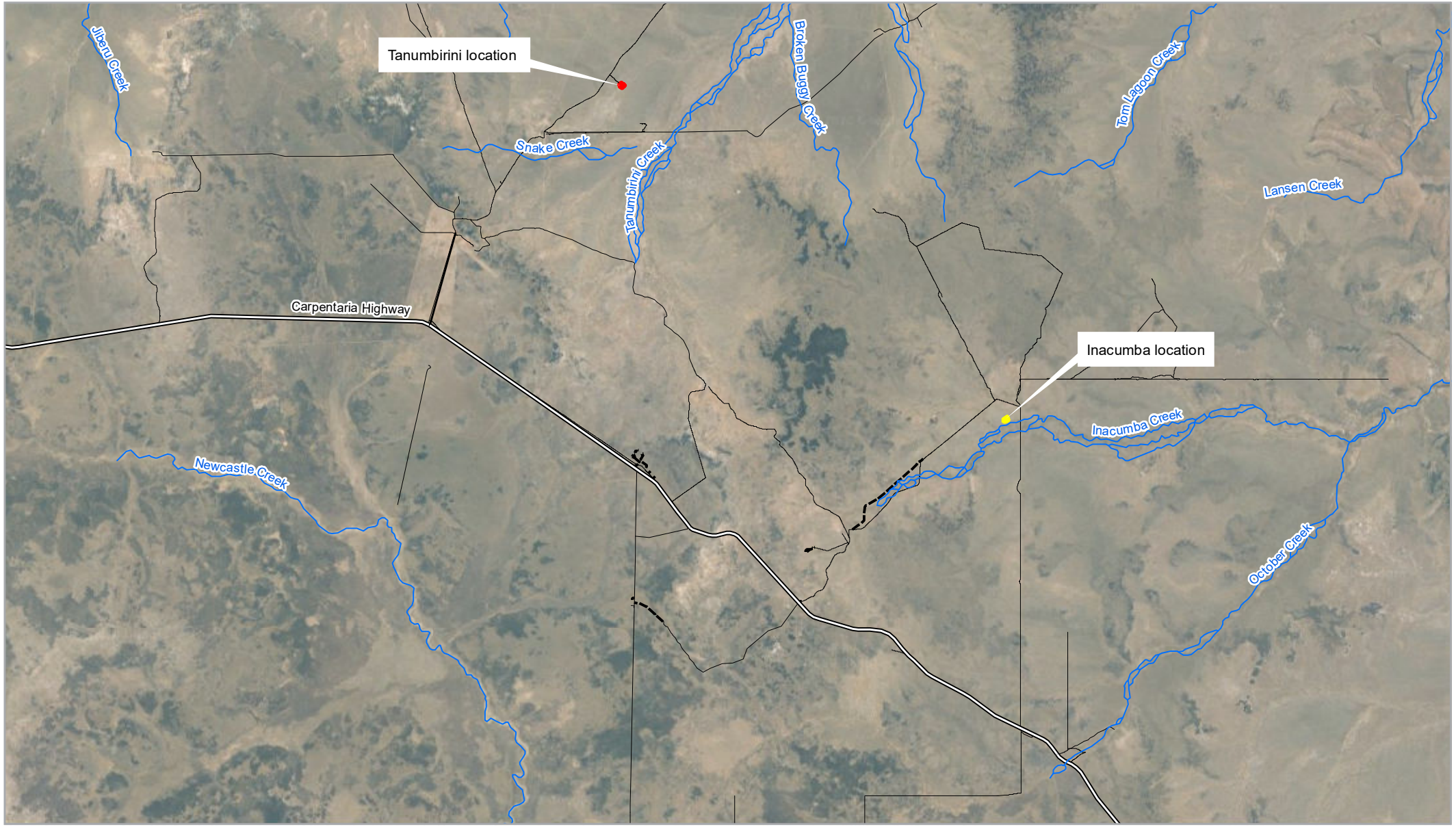
Project No. 12538768
Revision No. A
Date 05/02/2019

Santos's acreage in the NT

FIGURE ES-1

S:\Geospatial\43\12538768\GIS\Maps\12538768_002_SantosAcreage.mxd
Print date: 09 Nov 2020 - 11:17

Data source: Santos: Base map (2014). Created by: cmacgregor



Legend

- Existing Road
- New Road
- Major Waterways
- Principal Road
- Minor Road
- Inacumba Lease
- Tanumbirini Lease

1:260,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

GHD

Santos
McArthur Basin
Environmental Management Plan

Proposed Infrastructure

Project No. **12538768**
Revision No. **A**
Date **5/11/2020**

FIGURE ES-2

S:\Geospatial\43\12538768\GIS\Maps\12538768_003_ProposedInfrastructure.mxd
Print date: 05 Nov 2020 - 16:06

Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: Roads, Waterways (2015) Santos: Project Sites, Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, Borrow Pit, Seismic Line (2019) Created by: cmacgregor

Existing Environment

The proposed Drilling Program is located within two bioregions, the Sturt Plateau and Gulf Fall and Upland Bioregions. Plateaus, sandstone outcrops and undulating plains outline the landscape. The vegetation comprises tussock grasslands, eucalypt and acacia forests and woodlands. The climate is semi-arid and subtropical, and is influenced by the monsoonal weather in the north. The soils in this area comprise kandosols and rudosols, and the major water system in the vicinity is the Roper River Catchment. The main ground water resource is the Cambrian Limestone Aquifer (CLA). The Project Area is located in the Limmen Bight River catchment which drains towards the Gulf of Carpentaria.

There are 12 threatened species listed as potentially occurring within the region, these include a range of birds, mammals and reptiles. Eleven migratory species are known to inhabit parts of this region, and two weeds and nine invasive fauna species have been identified as potentially occurring within the region.

The environmental values and/or sensitivities with the potential to occur in the vicinity of the project are provided in Table ES-2.

Table ES-2: Summary of Environmental Values and Sensitivities

Environmental Factors	Environmental Values and Sensitivities	Summary
Terrestrial ecosystems	Sensitive or significant vegetation	Ecoz (2019) recorded riparian vegetation (a sensitive vegetation type) along the watercourses and drainage lines within the Project Area.
	Groundwater dependent ecosystems	There is a low potential for terrestrial GDEs and aquatic GDEs in the Project Area (BoM 2018b).
	Threatened fauna species and their habitat	The PMST and NT database searches identified 12 listed, threatened species have the potential to occur in the Project Area. Of these, the Gouldian Finch, Grey Falcon and Crested Shrike-tit have a medium likelihood of occurrence.
	Listed Migratory Species	The PMST search identified 13 EPBC listed migratory species that were potentially occurring in the Project Area. Of these, the Fork-tailed Swift had a medium likelihood of occurrence.
	Listed threatened flora species and ecological communities	There are no Threatened Ecological Communities (TECs) or threatened flora listed under the EPBC Act and/or TPWC Act known to occur within 10 km of the Project Area.
Terrestrial Environmental Quality	Soils	The Project Area has intact soils within ephemeral creeks and drainage lines maintain the stability of watercourse and reduce sedimentation when rainfall events occur.
Inland water environmental quality	Groundwater	The Cambrian Limestone Aquifer is a regional scale aquifer that provides groundwater resources for pastoral enterprises, domestic bores at homesteads and town water supplies at a number of small communities across the region. The groundwater resource in this area is understood to connect to the Roper River, where groundwater discharge supports aquatic, riparian and floodplain ecosystem function.

Environmental Factors	Environmental Values and Sensitivities	Summary
	Surface water	There are ephemeral creeks and drainage lines present in the Project Area. In significant rainfall events, these drain into larger rivers eventually in to the Gulf of Carpentaria. Eighty km downstream of the works area the rivers traverse the Limmen Bight NP.
Hydrological processes	Supply and quantity of water	Ephemeral creeks adjacent to the Project Areas are located in the headwaters of the Limmen Bight river catchment and feed into the Limmen Bight River during significant rainfall events
Culture and Heritage	Cultural heritage, sacred sites	All activities proposed in this EMP will be supported by an AAPA Authority Certificate. An application for an AAPA Authority Certificate was submitted to AAPA in January 2019. Authority Certificate C2019/043 was issued on 13 May 2019 and covers all activities in this EMP.
Human health	People and communities	There are a number of pastoral properties with livestock and infrastructure in the vicinity of the Project Area. The nearest dwelling is Tanumbirini Homestead, located approximately 8.5 km southwest of theTanumbirini-1 well.

Environmental Impacts and Environmental Risks of the activity

An environmental risk assessment was undertaken a summary of the Environmental Factors and key risks are given below in Table ES-3.

Table ES-3 Summary of risk assessment

Environmental Value	Risk Sources
Terrestrial ecosystems	• Vehicle and plant movements generating dust • Vehicle movements and drilling equipment activities at night, including flaring generating light. • Noise and vibration from project activities • Vehicle movements and drilling activities / equipment use at night, and entrapment in open pits • Plant and vehicles carrying weeds from outside the Project Area • Project activities spreading weeds inside the area of activity • Ignition sources from plant and machinery, including flaring • Waste stored inappropriately attracting fauna
Terrestrial Environmental Quality	• Compaction of soils due to vehicle and equipment movement • Erosion of soil due to loss of vegetative cover • Inappropriate storage or handling of drilling muds, fuel and hazardous substances including drilling muds • Poor refuelling or fuel transfer practices
Inland water environmental quality	• Inappropriate storage or handling of hazardous substances • Poor refuelling or fuel transfer practices • Inappropriate drilling mud design the passing aquifer units • Well blow-out • Overflow and migration of cuttings or flare pits • Leaching and migration of fluids from cuttings pit • Increased wastewater storage volume required for the additional horizontal wells • Increased volume of chemicals required for the additional horizontal wells • Increase in transport of chemicals and waste to and from site

Environmental Value	Risk Sources
	• Potential interference between horizontal wells
Hydrological processes	• Use of groundwater for project activities
Air quality atmospheric processes	• Emissions from vehicle and plant • Fugitive Emissions
Communities and economy. Culture and heritage.	• Vehicle and plant movements generating dust • Vehicle movements and drilling activities at night, including flaring generating light • Noise and vibration from project activities • Use of groundwater for project activities • Vehicle and plant movements within the activity area disturbing stakeholders • Vehicle movements and drilling activities / equipment use at night • Plant and vehicles carrying weeds from outside the Project Area • Project activities spreading weeds inside the activity area • Ignition sources from plant and machinery, including flaring
Human health	• Vehicle and plant movements generating dust

Environmental Outcomes in Relation to the Activity

Through implementation of control measures, the residual risk ranking for most risks or impacts have been reduced to two (risk is acceptable provided ALARP has been achieved and demonstrated) or one (risk is acceptable and it is assumed that ALARP has been achieved).

The environmental outcomes achieved by this EMP are:

- Dust emissions minimised.
- The risk of impact on terrestrial flora and fauna as a result of vehicle and plant movements generating dust is minimised.
- Noise generation and vibration risks to flora and fauna are minimised.
- The risk of impact from vehicle and plant movements generating noise and vibration is minimised.
- Risk of disturbance to native fauna minimised through management of light emissions.
- The risk of disturbance, injury or death to terrestrial fauna due to vehicle movements, drilling activities and entrapment in open pits is minimised.
- No introduction of new species of weeds or plant pathogens as a result of project activities.
- No increase in abundance of existing weed species as a result of project activities.
- Risk of fire ignition sources is managed as a result of project activities.
- Risk of waste storage areas attracting fauna is managed.
- No disturbance outside designated areas
- Storage or handling practices for hazardous substances minimises the likelihood and consequence of spills on the terrestrial environmental quality.
- The likelihood and consequence of impacts to soils from overflowing pits is minimised.
- The availability and quantity of groundwater has not been effected.
- The supply and quantity of water in surface water and groundwater features not impacted from project activities.
- No adverse impacts to groundwater resources in the area.
- No adverse impact to air quality due to increased inefficient vehicle and plant emissions.

- No adverse impact to air quality due to loss of fugitive emissions.
- No public nuisance/visual amenity impacts from dust generated by project activities.
- Noise complaints from vehicle movements and drilling activities minimised.
- Amicable resolution of complaints.
- Disturbance, injury or death to livestock from vehicle movements and drilling activities minimised through active stakeholder engagement.
- Disturbance to landholders from vehicle movements and drilling activities minimised.
- No public health concerns resulting from ingesting dust.

Stakeholder Engagement

Santos seeks to establish and maintain enduring and mutually beneficial relationships with the communities of which it is a part; thereby ensuring that Santos' activities generate positive economic and social benefits for and in partnership with these communities.

Stakeholder identification was undertaken prior to commencing drilling works at Tanumbirini-1 in 2014. The relevant stakeholder groups were identified and engaged such that they could be informed of the proposed activities and the associated risks, build an understanding as to why and how Santos operates and have any objections or claims considered and addressed. The key stakeholders identified and engaged include:

- Owners of Tanumbirini Station
- Station Manager for Tanumbirini
- Northern Land Council (NLC)

A full list of the relevant stakeholders is provided in Table G-1 List of Relevant Stakeholders.

Santos has continued to engage with these key stakeholders on an ongoing basis since initial identification, specifically with regard to this project and development in the Northern Territory generally. This includes providing detailed information, presentations and mapping to key stakeholders. Government and industry stakeholders are updated through regularly scheduled industry and governmental joint meetings and one off conferences.

Other stakeholder engagement primarily involves engagement with landholders/managers. Landholders have been consulted with regard to the proposed activities on a number of occasions and have been directly involved in an on-ground inspection of proposed infrastructure locations. Land Access and Compensation Agreements (LACA) have been progressed and all LACAs will be in place prior to the Drilling Program commencing.

Stakeholder engagement records detailing who, when, type of engagement, method of delivery and maters raised, have been provided within Table G-2 Stakeholder Engagement Records.

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Tables

Figures

Appendices

Abbreviations and Units

Acronym / Abbreviation	Description
ALARP	As low as reasonably practicable
ALRA	Aboriginal Land Rights Act
AAPA	Aboriginal Areas Protection Authority
APPEA	Australian Petroleum Production and Exploration Association
CLA	Cambrian Limestone Aquifer
Code	Code of Practice
CPESC	Certified Professional in Erosion and Sediment Control
DEPWS	Department of Environment, Parks and Water Security
DAWE	Department of Agriculture, Water and Environment
DFIT	Diagnostic Fracture Injection Test
DITT	Department of Industry, Tourism and Trade
DPIR	Department of Primary Industry and Resources
D&C	Drilling and Completions
EC	Electrical Conductivity
EMP	Environmental Management Plan
EP	Exploration Permit
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EPS	Environmental Performance Standards
ERA	Environmental Risk Assessment
ESD	Ecologically Sustainable Development
ha	Hectares
GHG	Greenhouse Gas
GISERA	Gas Industry Social and Environmental Research Alliance
km	Kilometre
LACA	Land Access Compensation Agreement
LWD	Logging While Drilling
NLC	Northern Land Council
m	Metres
MD	Measured Depth
MoC	Management of Change
NRM	Natural Resource Management
NT	Northern Territory
NT EPA	Northern Territory Environmental Protection Authority
NVIS	National Vegetation Information System
Panel	Independent Scientific Panel
PL	Petroleum Lease

Acronym / Abbreviation	Description
PMST	Commonwealth Protected Matters Search Tool
PPL	Petroleum Pipeline Licence
SEAAOC	South East Asia Australia Onshore Conference
SMS	Santos Management System
SSCC	Sacred Site Clearance Certificate
TOC	Total Organic Content
TPWC Act	Territory Parks and Wildlife Conservation Act 2014
TVD	True Vertical Depth
TVDSS	True Vertical Depth referenced to sea-level (Australian Height Datum)
WOMP	Well Operations Management Plan
WoNS	Weed of National Significance

1.0 Introduction

1.1 Background and Purpose

Santos QNT Pty Ltd (Santos) is the operator of Exploration Permit (EP) 161 which is located approximately 350 km south-east of Katherine in the Northern Territory (NT) (Figure 1-1). Santos has undertaken exploration activities in EP 161 since 2013, including acquiring 2D seismic, drilling two exploration wells, Tanumbirini-1 and Marmbulligan-1, the development of a water bore drilling and monitoring program, and DFIT, fracture stimulation and testing of Tanumbirini-1. Table 1-1 lists the existing plans and approved activities within the EP 161 permit block.

Santos proposes to commence the Drilling Program covered by this EMP in Quarter 2 2021. Santos will request approval to undertake additional exploration activities following the completion of the activities covered under this EMP (which would require further EMP and other regulatory approvals and are not covered by this EMP). The purpose of exploration and appraisal activity is to increase our understanding of the prospectivity or potential of the EP 161 permit area. Our objective whenever undertaking such activity is to minimise our impact on the environment, including any activities of Traditional Owners and pastoral lessees

Measures to ensure the proposed Drilling Program are compliant with the Code have already commenced. In November and December 2018 two separate EMPs were approved for the construction of lease pads and installation of groundwater monitoring bores at the Tanumbirini and Inacumba locations. These control monitoring bores have been installed and baseline monitoring in compliance with the Guideline and the Code has commenced. Well lease layouts for the Drilling Program showing the locations of the monitoring bores are provided in Figure 3-2 and Figure 3-3.

Table 1-1 Environmental Management Plans for EP 161

EP 161 EMPs	Scope Definition	Approved	Complete
McArthur Basin Civil and Seismic Program	Expansion of the Tanumbirini lease pad and construction of the Inacumba lease pad	June 2019	✓*
	Civil engineering activity – upgrading and creation of new roads and access tracks, clearing of laydown areas, borrow pits, campsites and tank pads	June 2019	✓*
	Acquisition of a 10km 2D seismic line	June 2019	✓
McArthur Basin Drilling Program	Drilling of Inacumba-1 pilot well	July 2019	✕
	Plug and decommission of the deepest section of the Inacumba-1 pilot well	July 2019	✕
	Drilling of Inacumba-1H horizontal well from the Inacumba-1 pilot	July 2019	✕
	DFIT of Tanumbirini-1	July 2019	✓
	Drilling of Tanumbirini-2H well	July 2019	✕

EP 161 EMPs	Scope Definition	Approved	Complete
	Well integrity monitoring	July 2019	✕
	Evaluation of Inacumba-1/1H and Tanumbirini-2H (including: mudlogging, wireline/LWD, DFIT, coring)	July 2019	✕
	Suspension and/or Plugging and decommissioning of Tanumbirini-2H and Inacumba-1/1H	July 2019	✕
	Rehabilitation of the Tanumbirini-1, Tanumbirini-2H and Inacumba-1H wells.	July 2019	✕
	Drilling of Tanumbirini-3H well	**No - scope change subject to this revision**	✕
	Drilling of Inacumba-2H well	**No - scope change subject to this revision**	✕
	Evaluation of Inacumba-2H and Tanumbirini-3H (including: mudlogging, wireline/LWD, DFIT, coring)	**No - scope change subject to this revision**	✕
	Suspension and/or Plugging and decommissioning of Inacumba-2H and Tanumbirini-3H	**No - scope change subject to this revision**	✕
	Rehabilitation of the Tanumbirini-3H and Inacumba-2H wells.	**No - scope change subject to this revision**	✕
McArthur Basin Hydraulic Fracturing Program	Hydraulic fracture stimulation (including fracturing diagnostics) at Tanumbirini-1	Oct 2019	✓
	Hydraulic fracture stimulation (including fracturing diagnostics) at Tanumbirini-2H	Oct 2019	✕
	Hydraulic fracture stimulation (including fracturing diagnostics) at Inacumba 1/1H	Oct 2019	✕
	Flow-back and appraisal (production) testing at Tanumbirini and Inacumba	Oct 2019	✕

** Ongoing civil works are required to maintain infrastructure.*

1.2 Scope of this EMP

Revision 5 of this EMP received approval notice from the NT Environment minister on the 15th of July 2019, some of the approved petroleum activities were undertaken during 2019/2020 and others deferred. A revised drilling program has been reflected in this EMP. The revised EMP has been submitted pursuant of part 2 section 17 of the Petroleum Environment regulations (2016). These state;

Revision required for new or increased environmental impact or environmental risk

(1) This regulation applies if there has been:

(a) a new environmental impact or environmental risk not provided for in the current plan for the activity; or

(b) an increase, not provided for in the current plan for the activity, in an existing environmental impact or environmental risk

Santos proposes to undertake a Drilling Program at the Tanumbirini and Inacumba locations. This EMP covers these proposed works. Table 1-1 above summarises the specific scope of work covered by this revised EMP (McArthur Basin Drilling Program) and further highlights those activities that have already been approved versus proposed additional scope that is the subject of this revision. A full description of the activities covered in this EMP is provided in Section 3.0.

It is not anticipated that the horizontal section of any of the four horizontal wells would exceed 3,000m. However, the absolute limit of any horizontal well would remain within the area surveyed and cleared under Authority Certificate C2019/043, issued to Santos on 13 May 2019, which is a 5,000m radius from the Tanumbirini pad.

Drilling operations have been scheduled to be undertaken outside of the wet season period (Oct to April inclusive) as defined by the Code of Practice. However, if wet season operations are required to be undertaken risk controls have been added to this revision.

Activities covered in this EMP are limited to drilling activities. Activities covered do not include hydraulic fracturing of any petroleum exploration wells.

1.3 Titleholders Details

Table 1-2 provides details of the permit titleholder and titleholder nominated liaison person.

If there is a change in the titleholder, the titleholder's nominated liaison person or a change in the contact details for the titleholder or liaison person, Santos will notify and provide the updated details to the Department of Industry, Tourism and Trade (DITT) and the Department of Environment, Parks and Water Security (DEPWS).

Table 1-2 Details of Titleholder and Nominated Liaison Person

Titleholder Details	Liaison Person Details
Name: Santos QNT Pty Ltd Address: 60 Flinders Street, Adelaide, SA 5000 Phone: 08 8116 5000 ACN: 083 077 196	Name: Angus McIntyre Position: Manager – Onshore New Ventures Company: Santos Ltd Address: 60 Flinders Street, Adelaide, SA 5000 Phone : 08 8116 7353 Email: Angus.McIntyre@santos.com

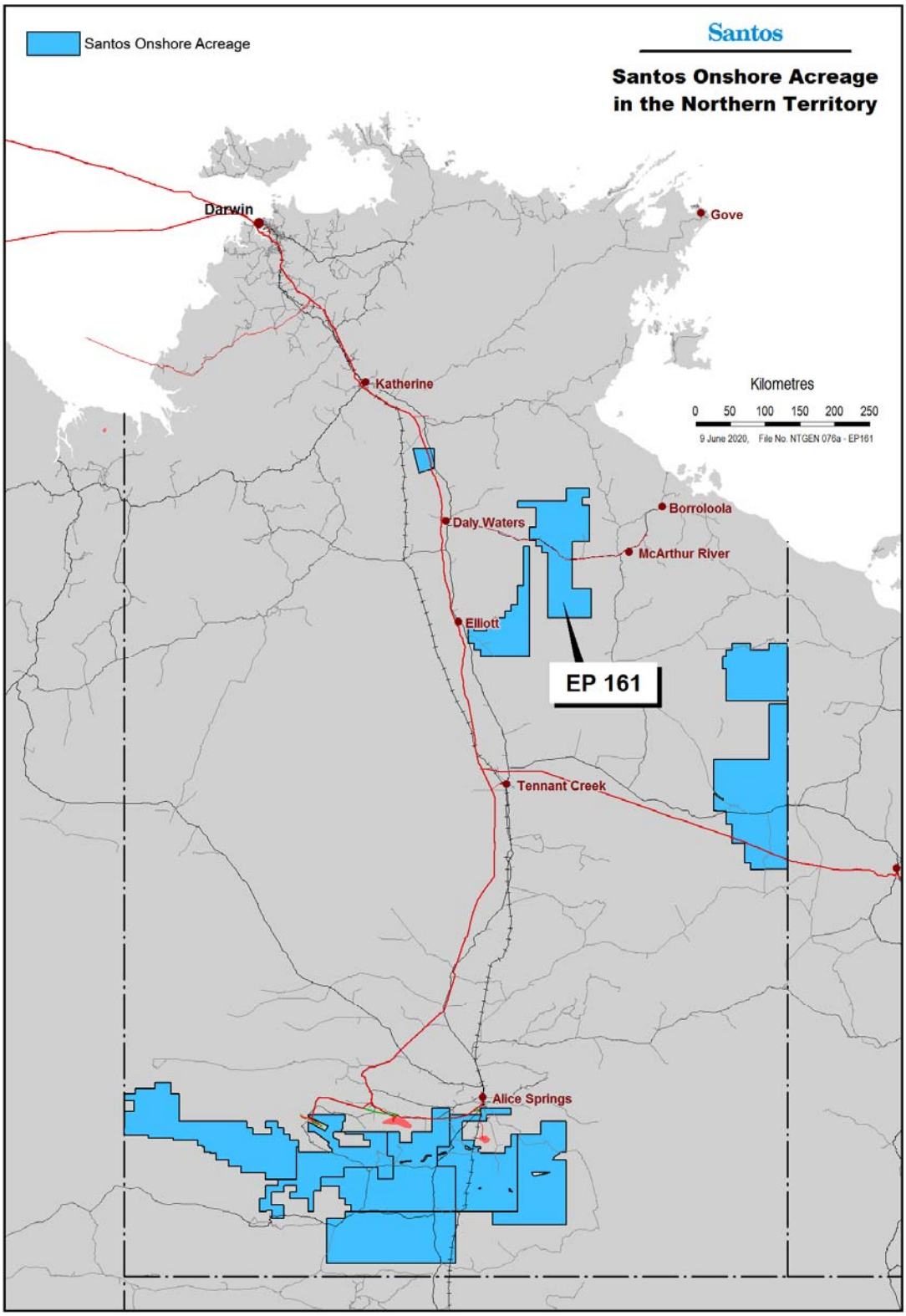


Figure 1-1 Santos' Acreage in the Northern Territory

2.0 Environmental Legislation and Other Requirements

2.1 The Petroleum Act 2016 (NT)

The *Petroleum Act 2016* (NT) is the governing legislation for onshore petroleum activities in the NT and the Petroleum (Environment) Regulations (the Regulations) govern environmental management. The objectives of the Regulations are to ensure that:

- Onshore oil and gas activities are carried out in a manner consistent with the principles of ecologically sustainable development (ESD); and
- Environmental impacts and risks associated with onshore oil and gas activities are reduced to a level that is as low as reasonably practicable (ALARP) and acceptable.

The Regulations achieve these objectives by requiring interest holders to have an approved EMP in place before a 'regulated activity' can be undertaken. An EMP will be approved when the Minister for Primary Industry and Resources (the Minister) is satisfied that approval criteria have been met.

Under the Regulations, interest holders in petroleum titles must prepare and submit an Environment Management Plan (EMP). Approval of an EMP is necessary for all activities that have an environmental impact or risk and is only one of several approvals required for the activity to proceed. An approved EMP is a statutory document that is enforceable

The approval criteria for an EMP are provided in Section 9 of the Petroleum (Environment) Regulations:

9. Approval criteria for plan

(1) The approval criteria for an environment management plan are that the plan must:

(a) include all the information required by Schedule 1; and

(b) be appropriate for the nature and scale of the regulated activity to which the plan relates; and

(c) demonstrate that the activity will be carried out in a manner by which the environmental impacts and environmental risks of the activity will be reduced to a level that is:

(i) as low as reasonably practicable; and

(ii) acceptable.

(2) When considering whether an environment management plan meets the approval criterion mentioned in sub-regulation (1)(c), the Minister must take into account:

(a) the principles of ecologically sustainable development; and

(b) if an environmental report or statement has been prepared, or is required to be prepared, in relation to the regulated activity to which the plan relates – each environmental assessment recommendation in the assessment report made about the activity.

(3) In this regulation:

environmental report or statement means a public environmental report or environmental impact statement mentioned in section 7(2) of the Environmental Assessment Act.

The requirements of Schedule 1 of the Petroleum (Environment) Regulations are listed in Table 2-1

Table 2-1 Requirements of this EMP

Part	Section	Requirement	Section in this Plan
1	Description of a regulated activity	A plan must give a comprehensive description of the regulated activity to which it relates and include: (a) the location (or locations) of the activity; and (b) general details of the construction and layout of any facility associated with the activity; and (c) an outline of, and proposed timetable for, the operational details of the activity.	Section 3.0
2	Description of existing environment	A plan must include: (a) a description of the existing environment that may be affected by the regulated activity described in the plan; and (b) details of any particular values and sensitivities of that environment relevant to the activity; and (c) details of any uncertainties or lack of understanding in relation to that environment	Section 4.0
3	Assessment of environmental impacts and environmental risks	(1) A plan must include: (a) details of all environmental impacts and environmental risks of the regulated activity described in the plan and an assessment of those impacts and risks; and (b) details of all environmental impacts and environmental risks of the regulated activity described in the plan and an assessment of those impacts and risks; and (c) a description of the process used to assess the environmental impacts and environmental risks. (2) The assessment mentioned in subclause (1)(a) must be of: (a) all the environmental impacts and environmental risks arising directly or indirectly from: (i) all aspects of the regulated activity; and (ii) potential emergency conditions, whether resulting from an incident or any other reason; and (b) the cumulative effects of those impacts and risks when considered with each other and in conjunction with any other activities or events that occurred or may occur in or near the permit area for the regulated activity. o Example for clause 3(2)(b) of other activities or events Activities or events associated with: o (a) other exploration for, or production of, petroleum; or o (b) the exploration for, or extraction of, minerals or extractive minerals.	Section 5.0
4	Environmental outcomes and Environmental Performance Standards	A plan must specify: (a) the Environmental Outcomes in relation to the regulated activity described in the plan; and (b) the Environmental Performance Standards against which the performance of the interest holder in achieving the Environmental Outcomes can be measured; and (c) the measurement criteria to be used to ensure the Environmental Outcomes and Environmental Performance Standards are met.	Section 6.0

Part	Section	Requirement	Section in this Plan
4A	Chemicals used in the course of hydraulic fracturing	If the activity is hydraulic fracturing, a plan must specify the following information in relation to any chemical or other substance that may be in, or added to, any treatment fluids to be used in the course of the activity: (a) the identity of the chemical or other substance; (b) the volume of the chemical or other substance; (c) the concentration of the chemical or other substance; (d) the purpose of the chemical or other substance; (e) details regarding how the chemical or other substance will be managed; (f) details regarding how the chemical or other substance will be transported on-site; (g) details regarding any action proposed to be taken to prevent a spill of the chemical or other substance; (h) the requirements in relation to the management of the chemical or other substance of the prescribed chemical legislation. Note for clause 4A(e) Managed includes handling, collecting and storing any chemical or other substance.	Not applicable
5	Requirement for implementation strategy	A plan must include an implementation strategy, in accordance with this Part, for the regulated activity described in the plan.	Section 8.0
6	Details of systems, monitoring, tests etc.	(1) An implementation strategy must provide for: (a) ongoing monitoring and review of the strategy; and (b) monitoring, recording, audit and management of non-conformance with the plan and review of the interest holder's environmental performance. (2) The implementation strategy must give details of: (a) the specific systems, practices and procedures to be used to ensure that the Environmental Outcomes and Environmental Performance Standards in the plans are met, and (b) the following, as relevant to the regulatory activity described in the plan: (i) the monitoring of its environmental impact, (ii) the monitoring of emissions and discharges (whether occurring during normal operations or otherwise) (iii) the carrying out and recording of the monitoring mentioned in this paragraph in a manner that is accurate and can be audited against the Environmental Performance Standards and measurement criteria specified in the plan, and the intervals at which each type of monitoring will be carried out; (iv) tests to be carried out to assess the performance and accuracy of the equipment used for the monitoring mentioned in this paragraph, and the intervals at which the tests are to be carried out.	Section 8.2 Section 8.9
7	Personnel	An implementation strategy must:	Section 8.2

Part	Section	Requirement	Section in this Plan
		(a) establish a clear chain of command, including during emergencies or potential emergencies; and (b) set out the roles and responsibilities of personnel in relation to the implementation, management and review of the plan; and (c) specify measures to ensure that each employee or contractor working on, or in connection with, the regulated activity described in the plan: (i) is aware of his or her responsibilities or potential emergencies, and (ii) has the appropriate competencies and training.	Section 8.3
8	Emergency contingency plan	An implementation strategy must include: (a) a contingency plan that specifies arrangements for the response to emergencies or potential emergencies, and (b) provisions for the implementation and maintenance of the contingency plan.	Section 8.5
9	Stakeholder engagement	(1) A plan must include information about the stakeholder engagement carried out by the interest holder that includes the following: (a) a list of the stakeholders and the stakeholder's contact details; (b) a copy of the information provided to the stakeholders by the interest holder; (c) if written responses have been received from stakeholders – a summary and copy of each response; (d) an assessment of the merits of any objection or claim made by a stakeholder about the anticipated environmental impact of the proposed regulated activity; (e) a statement of the interest holder's response, or proposed response, to each objection or claim made by a stakeholder; (f) a record of communications with stakeholders that is not mentioned in paragraph (b), (c) or (e), (for example, telephone discussions); (g) details of changes the interest holder made as a result of the stakeholder engagement. (2) A plan must also include information about future stakeholder engagement to be carried out by the interest holder.	Section 9.0
10	Legislative requirements	A plan must: (a) specify any legislative requirements applicable to the regulated activity described in the plan that are relevant to the practices and processes used to manage the environmental aspects of the activity; and (b) demonstrate how those requirements will be met.	Section 2.0
11	Recording, monitoring and reporting	(1) A plan must specify arrangements for: (a) recording, monitoring and reporting information about the regulated activity to which the plan relates in a manner that will enable the Minister to determine whether the Environmental Outcomes and Environmental Performance Standards in the plan are being met; and (b) giving the Minister a report about the matters mentioned in paragraph (a), at approved intervals, but not less often than annually. (2) the information mentioned in subclause (1) includes information required to be recorded, monitored or reported under these Regulations or any other law in force in the Territory applying to the regulated activity.	Section 8.9 Section 8.10

Part	Section	Requirement	Section in this Plan
12	Notifying commencement of construction, drilling or seismic survey	A plan must specify arrangements for the interest holder to notify the following persons before the proposed date of commencement of construction, drilling or seismic surveys: (a) the Minister; (b) the occupier of the land on which the activity is to be carried out; (c) the owner of the land on which the activity is to be carried out (unless the owner is also the occupier).	Section 8.6

Other legislation, agreements and codes of practice relevant to the project, which are detailed below.

2.2 Scientific Inquiry into Hydraulic Fracturing In the Northern Territory

On 14 September 2016, the Chief Minister of the Northern Territory, the Hon. Michael Gunner MLA, announced a moratorium on hydraulic fracturing of onshore unconventional shale gas reservoirs in the NT. The Chief Minister also announced that he would appoint an independent scientific panel (Panel) to investigate the impacts and risks associated with hydraulic fracturing.

The Terms of Reference are required the Panel to assess and determine:

- the nature and extent of the risks associated with hydraulic fracturing of onshore unconventional shale gas reservoirs and its associated activities on the environmental (aquatic, terrestrial and atmospheric), social, cultural and economic conditions of the NT;
- whether these risks can be mitigated to an acceptable level;
- if they can, by what methodology or methodologies can these risks be mitigated; and
- whether the existing regulatory framework is sufficient to implement these methodologies, and if not, what changes need to be made.

Results of the inquiry determined that, provided that all of the recommendations made in the Final 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. In developing tools to ensure risks can be mitigated to an acceptable level, the panel recommended that codes of practice be developed for, among other things, well integrity and well decommissioning.

2.3 Summary of Legislative Requirements

A summary of legislative requirements and associated project approvals relevant to environmental management, and Santos's actions and intent for each are provided in Table 2-2.

Table 2-2 Summary of Legislative Requirements

Relevant Legislation	Administrator	Proposed Action
Northern Territory		
Aboriginal Land Act 1978	DIPL	Santos and the Northern Land Council are parties to a Cooperation and Exploration Agreement. Multiple consultations and sacred site avoidance surveys completed 2013 – 2019. Refer to Section 4.3.
Biological Control Act 1984	DITT	Santos has an obligation to prevent and manage the spreading of weeds. A weed management plan has been prepared, refer to Appendix E. All mitigation measures will be implemented during this activity.
Bushfires Management Act 2016	Bushfires NT, DEPWS	Assessment and mitigation of risks associated with this activity are found in section 6 and 7.2 f the EMP. No permits have been sought as part of this activity. Firebreaks and fire control zones are incorporated into worksite planning.
Control of Roads Act 1953	DIPL	No road permit to work are required for this activity, any increase in traffic is assessed through this EMP.
Dangerous Goods (Road and Rail Transport) Act 2012	NT WorkSafe	Santos will ensure a dangerous goods vehicle licence is held by Santos or contractor if applicable.
Environment Protection Act 2019 and Environment Protection regulations 2020	NT EPA and DEPWS	Petroleum activities that could reasonably be considered to be capable of having a significant effect on the environment are referred to the NT EPA, pursuant to Section 48 of the Environmental Protection Act (EP Act). Using the guideline "Referring a proposed action to the NT EPA: Environmental impact assessment guidance for proponents" (Draft for consultation NT EPA 2020), a detailed review of and assessment against each prescribed Environmental Objectives for each Environmental Factor was conducted in relation to the proposed Drilling Program. This EMP does not constitute any material change of use requiring referral and formal environmental assessment. Santos therefore considers it unnecessary to refer the activity for assessment. Refer to Section 6.2.2.
Heritage Act 2011	Department of Territory Families, Housing and Communities	A survey has been completed and no archaeological sites were identified. As a result, Santos does not anticipate a work approval will be required. Reporting obligations are noted if disturbance of sites was to occur.
Northern Territory Aboriginal Sacred Sites Act 1989	AAPA	Santos and the Northern Land Council are parties to a Cooperation and Exploration Agreement. Multiple consultations and sacred site avoidance surveys completed 2013 – 2019. Refer to Section 4.3.
Northern Territory Aboriginal Sacred Sites Act 2013	AAPA	All activities proposed in this EMP will be supported by an AAPA Authority Certificate or Authority Certificate Variation. Application made in January 2019 (awarded on 13 May 2019 as Authority Certificate C2019/043, as a variation to C2014/053). Santos understands that no activity can commence until a valid Authority Certificate is obtained.

Relevant Legislation	Administrator	Proposed Action
Petroleum Act 1984	DITT	Santos is the registered holder of the exploration permit EP 161. Operations for the drilling of a well or for a seismic survey cannot commence unless notice is given to the Minister and the Minister's approval is obtained.
Petroleum Regulations 2020	DITT	A valid land access agreement between Santos (the interest holder of EP 161) and the designated person of the relevant land is required before commencement of any operations.
Petroleum (Environment) Regulations 2020	DEPWS	The activity will not proceed without an approved Environmental Management Plan. Schedule 1, item 10(2) of the Regulations give legislative effect to the *Code of Practice: Petroleum Activities in the Northern Territory (Northern Territory Government, 2019)* (the Code). The Code applies to all activities involved in both conventional and unconventional oil and gas exploration, appraisal, development and production and ancillary activities in the Northern Territory. The Code covers all petroleum activities including all petroleum well types including exploration, appraisal, development, monitoring, injection and production wells.
Petroleum Act Stakeholder Engagement Guidelines Land Access 2016	DITT	Existing Land Access and Compensation Agreement (LACA) are in place for ongoing work at Tanumbirini-1 location and water monitoring bore construction and sampling. Santos will ensure LACAs are in place for all activities proposed in this EMP prior to commencing activities.
Schedule of Onshore Petroleum Exploration and Production Requirements 2019 (under the Petroleum Act)	DEPWS	The EMP has been compiled in accordance with the code of practice and the regulations.
Public and Environmental Health Act 2011	Department of Health (DoH)	Wastewater treatment systems are subject to requirements of the Act. Sewerage plants need to meet the NT Code of Practice for Small On-site Sewage and Sullage Treatment Systems and the Disposal or Reuse of Sewage Effluent.
Territory Parks and Wildlife Conservation Act 1976 (TPWC Act)	DEPWS	The activities are unlikely to impact on listed threatened species or places listed in this act.
Waste Management and Pollution Control Act 1998 (WMPC Act)	NT EPA, DEPWS	Licenced contractors will be engaged for the removal and disposal of listed waste. Pollution prevention measures and reporting requirements are built into the Santos management system.
Water Act 1992 and Water Legislation Amendment Act 2018	DEPWS	Application for a groundwater extraction licence associated with NT Portion 701 accepted in February 2019.
Weeds Management Act 2001	DEPWS	Santos has an obligation to prevent and manage the spreading of weeds. A weed management plan has been prepared, refer to Appendix E. All mitigation measures will be implemented during this activity.

Relevant Legislation	Administrator	Proposed Action
Work Health and Safety (National Uniform Legislation) Act 2011 and Regulations	NT WorkSafe	All activities described in this EMP are subject to *Work Health and Safety (National Uniform Legislation) Act 2011* and Regulations
Commonwealth		
Aboriginal and Torres Strait Islander Heritage Protection Act 1984	DAWE	Santos and the Northern Land Council are parties to a Cooperation and Exploration Agreement. Multiple consultations and sacred site avoidance surveys completed 2013 – 2019. Refer to Section 4.3.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	DAWE	The *Environmental Protection and Biodiversity Conservation Act 1999* provides for the protection of the environment and conservation of biodiversity, particularly MNES. Referral of the project to the Department of Agriculture, Water and the Environment is required if the proposed action will have, or is likely to have a significant impact. Santos does not consider the scope of the EMP likely to have any significant impacts on matters of environmental significance and will not be referring the activities for assessment at this stage. Refer to Section 6.2.1. Australia is party to many international agreements to protect and conserve migratory species and their habitat. Migratory species listed on the annexes to these Agreements are placed on the migratory species list under the EPBC Act. The Ramsar Convention's broad aims are to halt the worldwide loss of wetlands and to conserve, through wise use and management, those that remain. Ramsar wetlands within Australia are listed as a MNES and protected under the EPBC Act.
National Greenhouse and Energy Reporting Act 2007	Clean Energy Regulator	Santos is obligated and registered to report all emissions under the National Greenhouse and Energy Reporting Scheme (NGERS).
Native Title Act 1993	Prime Minister and Cabinet	Traditional owners under the *Native Title Act*, and Aboriginal owners under the *Aboriginal Land Rights Act* (ALRA) are given the opportunity to negotiate an agreement about how petroleum activities must occur in accordance with statutory processes described in each Act. The agreement, Co-operation and Exploration Agreement - Exploration Permit Application EP (A) 161, Northern Territory, executed on 4 April 2012, is a legal agreement between Tamboran Resources Pty Ltd and the Northern Land Council (NLC) (the body corporate representing the Traditional Owners). The agreement is referred to by Santos as 'the NLC Agreement'.
National Environment (National Pollution Inventory) Protection Measure 1998	DAWE	Santos must report pollution data to the NPI annually if any of the NPI thresholds are triggered.

2.4 Relevant Agreements and Operating Consents

Santos will ensure that prior to commencement of the new works proposed in this EMP, necessary consents and approvals have been identified, obtained and are in place and the work will be undertaken in accordance with the terms and conditions as detailed in the NLC Agreement.

2.5 Codes of Practice and Relevant Guidelines

In addition to the Code, contractors undertaking activities will be required to comply with the following environmental standards, guidelines and codes of practice:

- Santos Management System (SMS).
- Australian Petroleum Production and Exploration Association (APPEA) *Code of Environmental Practice* (2008).
- Draft Guideline for the preparation of an Environmental Management Plan under the Petroleum (Environment) Regulations (draft Guidelines) (Northern Territory Government, 2019).
- NT EPA Environmental Factors and Objectives (NT EPA, 2018)
- Code of Practice: Petroleum Activities in the Northern Territory (expected 2019)
- NORSOK D-010, Rev 4 (2013)
- Code of Practice for the construction and decommissioning Coal Seam Gas and petroleum wells and Associated Bores in Queensland Version 1, 1 (2018)

The following ISO/API standards have been adopted for the selection of materials for use in the EP161 for this project:

Table 2-3 ISO/API Standards for Material Selection

Component	Applicable Standard
Casing	ISO 11960: Steel pipes for use as casing or tubing for wells.
Couplings	ISO 13679 Procedures for testing casing and tubing connections.
Cement and Additives	API RP 10B-2 Recommended Practice for Testing Well Cements
Drilling Fluids	ISO 10414-1: Recommended Practice for Field Testing Water Based Drilling Fluids. API 13B-1 and 13B-2 Recommended Practices
Well Control Equipment	API STD 53: Blow-Out Prevention Equipment Systems for Drilling Wells. API 16A (ISO 13533): Specification for drill through equipment. API 16D: Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment.
Wellheads	API 6A: Specification for Wellhead and Christmas Tree Equipment. ISO 10423: Petroleum and Natural Gas Industries - Drilling and Production Equipment - Wellhead and Christmas Tree Equipment

3.0 Project Description

Santos QNT Pty Ltd (Santos) is the operator of exploration permit (EP) 161 which is located approximately 350 km south-east of Katherine in the Northern Territory (NT)) (Figure 3-1). The Project Area for the program is located on Tanumbirini Station, a 5,000 km^2 cattle grazing property within NT Portion 701 of Arnold.

Santos proposes to undertake a Drilling Program to obtain sub-surface geological and petrophysical data. A location and infrastructure plan for the Drilling Program is shown in Figure 3-1 and well lease layouts for the Drilling Program are shown in Figure 3-2 and Figure 3-3. In addition, a detailed lease layout plan showing rig hardstand area, sump cross sections as well and infrastructure locations and dimensions is provided in Appendix A.

Key activities for the Drilling Program include:

- Drilling of Inacumba-1 pilot well
- Decommissioning of the deepest section of the Inacumba-1 pilot well
- Drilling of two horizontal wells from the Inacumba location
- DFIT of Tanumbirini-1 (completed)
- Drilling of two horizontal wells from the Tanumbirini location
- Well integrity monitoring
- Evaluation of exploration wells (including: mudlogging, LWD, wireline, DFIT, coring)
- Suspension and/or Decommissioning of exploration wells
- Rehabilitation of the exploration wells.

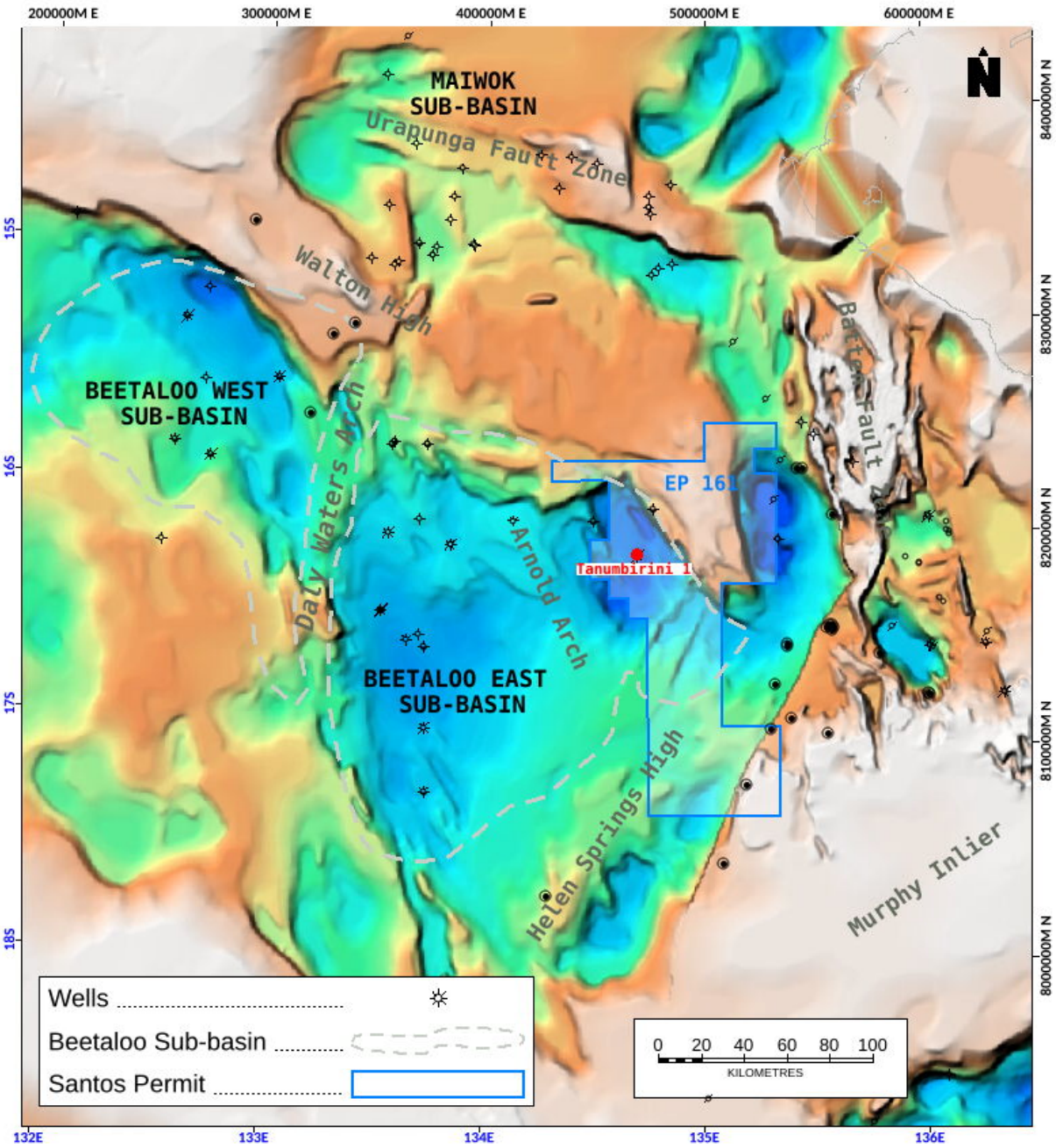
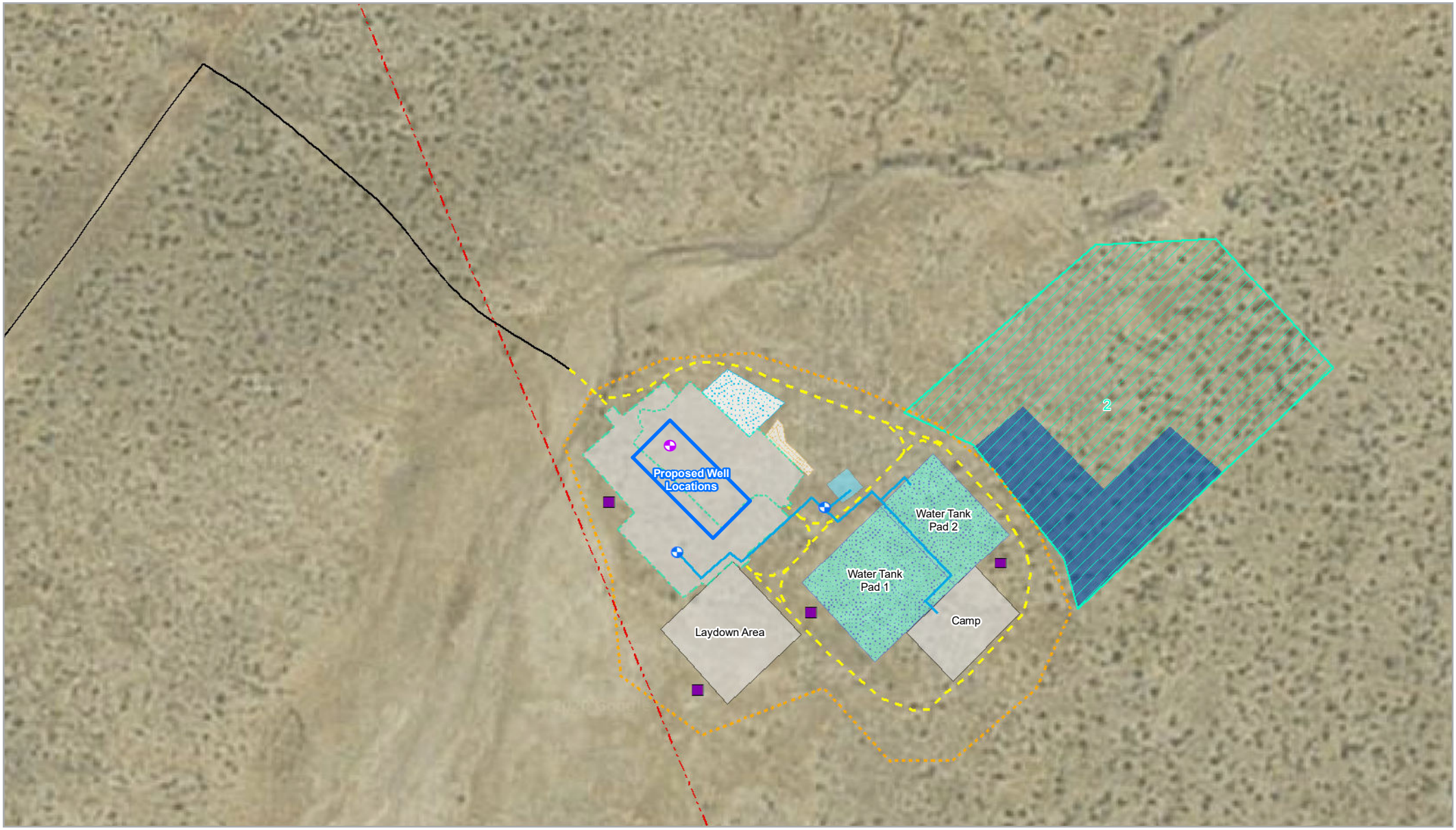


Figure 3-1 Location of the Project Area



Legend

- Existing Tanumbirini 1 Well
- Water Bore
- Proposed Topsoil Area
- Proposed Access Road
- Existing Access Road
- 2D Seismic Line
- Waterline
- Fire Control Area
- Cuttings Pit
- Existing Topsoil Area
- Borrow Pit
- Proposed Facilities
- Tanumbirini 1 Lease
- Tanumbirini 2 Lease
- Water Tank
- Dam
- Proposed Irrigation Area
- Proposed Well Locations

1:5000 @ A4

0 50 100 150 200

Metres

N

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

GHD

Santos
McArthur Basin
Environmental Management Plan

Infrastructure located in accordance with civil and seismic EMP Proposed well locations

Project No. **12538768**
Revision No. **B**
Date **16/12/2020**

FIGURE 3-2

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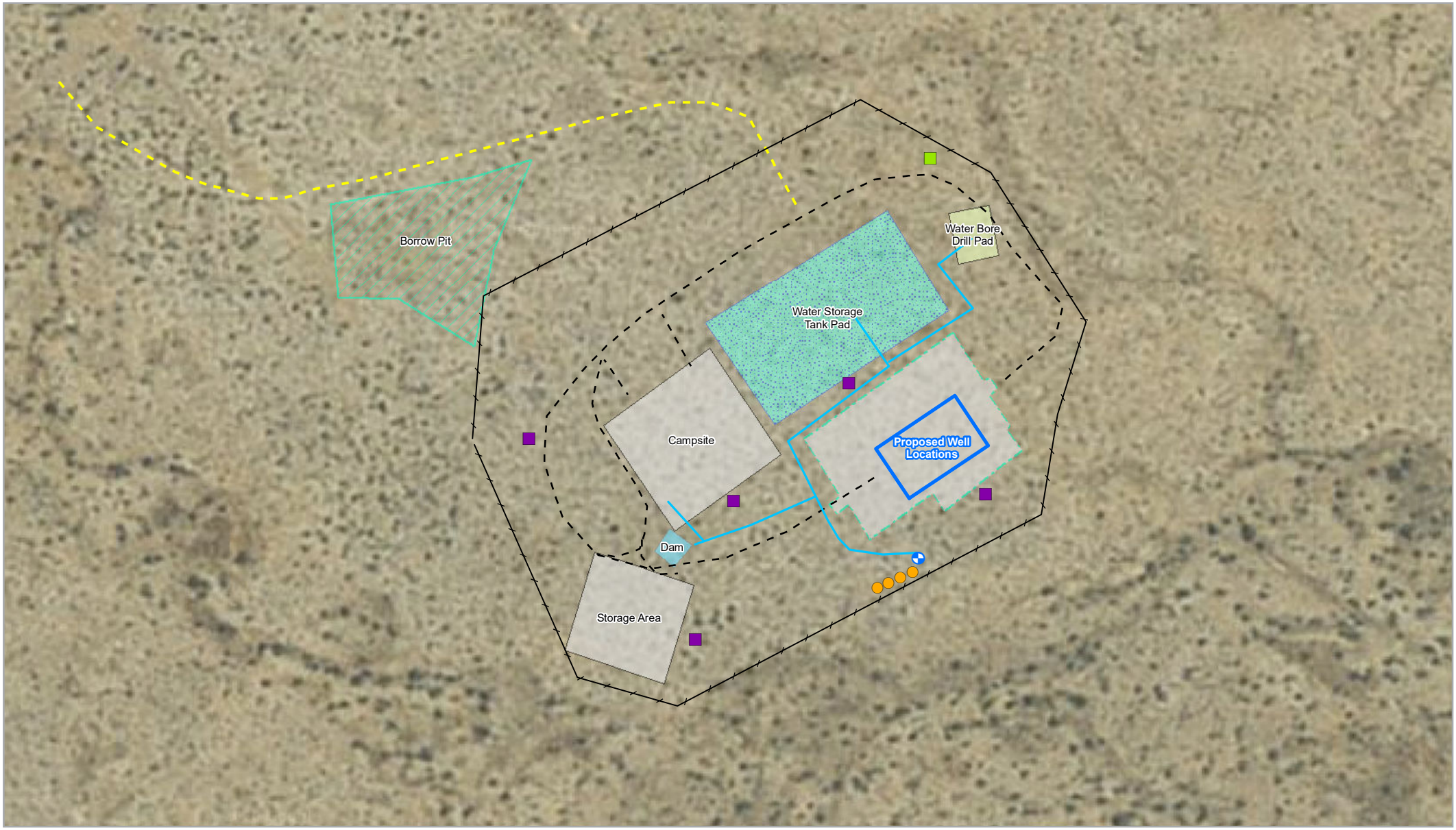
Print date: 16 Dec 2020 - 13:51

Data source: Google Earth: imagery (Jun 2016, captured Mar 2017) . Santos: Water Bores, Wells, Drilling Opportunities, Valves, Access Roads (existing and proposed), Waterline, Seismic Line, Fire control Area, Leases, Facilities, WaterTanks, Dam, Borrow Pit, Overburden (2019); GHD: Irrigation Area, Proposed Topsoil (2019). Created by: cmacgregor



Legend

- 30,000L Tank
- Water Bores
- Soil Stockpile
- Vegetation Stockpile
- Loop Road Access
- Water Flowline
- New Access Road Option 1
- Fence
- Proposed Well Locations
- Water Bore Drill Pad
- Inacumba Lease
- Borrow Pit
- Facilities
- Dam
- Water Tank Pad

1:5000 @ A4

0 25 50 75 100 125 150

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

GHD

Santos
McArthur Basin
Environmental Management Plan

Infrastructure located in accordance with civil and seismic EMP modification Proposed well locations

Project No. **12538768**
Revision No. **C**
Date **17/12/2020**

FIGURE 3-3

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Data source: . Google Earth: imagery (Jun 2016, captured Mar 2017). Santos: Water Bores, Wells, Drilling Opportunities, Valves, Access Roads (existing and proposed), Waterline, Leases, Facilities, WaterTanks, Dam, Borrow Pit (2019). GHD: Proposed Topsoil Area (2019). Created by: cmacgregor

3.1 Timing and Personnel

An indicative project schedule and personnel requirements are provided in Table 3-1. Estimated commencement date for activities is in April 2021.

Table 3-1 Indicative project schedule

Activity	Original Estimated Duration	Revised Estimated Duration	Personnel Required	Estimated commencement
Mobilisation of drilling equipment	4 weeks	4 weeks	20-50	April 2021
Drilling and well evaluation	15-25 weeks	36-52 weeks	35-65	May 2021
DFIT of Tanumbirini 1	4 weeks	11 weeks	10-15	Completed in 2019
Demobilisation of equipment	2-4 weeks	2-4 weeks	40-60	October 2021
Well Suspension and/or Decommissioning	4 weeks	4 weeks	15-30	To be determined
Rehabilitation post well suspension	1-2 weeks	1-2 weeks	5-15	To be determined
Rehabilitation post-decommissioning of wells	2-4 weeks	2-4 weeks	5-20	Commence within 12 months of decommissioning
Post-rehabilitation monitoring	2 weeks per monitoring event	2 weeks per monitoring event	1-2	• Immediately after well completion • Immediately after rehabilitation works completed post decommissioning • Following first wet season • Three years after decommissioning

3.2 Civil works

The civil works required to prepare for the Drilling Program including the upgrading of access routes, the creation of well pads, water storage pads, dams and campsites as well as any civils required to maintain existing and approved infrastructure are covered by the McArthur Basin Civil and Seismic Program EMP, approved June 2019.

3.3 Wet season operations

Drilling operations have been scheduled to be undertaken outside of the wet season period (Oct to April inclusive) as defined by the Code of Practice. However, if wet season operations are required to be undertaken the following risk controls will be implemented:

- Open drill rig mud tanks will be monitored daily during drill operations with multiple sensors and visual inspection to ensure safe operating fluid levels are maintained (ref. Code clause C.5.5 (b)).
- Fluid balance will be controlled by transferring to mud sumps which will have enough freeboard to ensure a minimum of 1500mm freeboard is maintained to accommodate a 1 in 1000 average recurrence interval (ARI) rainfall rate using Australian Rainfall & Runoff methodologies.
- Transportation of wastewater or chemicals will NOT be undertaken on unsealed roads during the defined wet season period unless a risk assessment is undertaken that demonstrates the risk is ALARP and acceptable (ref. Code clause A.3.8 (b)).
- Sufficient fuels, chemicals, equipment, tanks and materials required for ongoing operations will be stored on-site for continuous operations.
- All equipment required to respond to emergency situations will be on-site e.g., equipment and material to deal with well control issues, spills and other emergency events.
- Any hazardous chemicals or those that may cause environmental harm are to be stored within secondary containment will be stored in portable bunds sufficient capacity to hold 100% of the volume of the largest container stored in the area plus 10% or within tankers equipped with safety features such as double-skin. Spill kits available on all spill potential areas as well as drip trays for refuelling operations. (ref. Code clause A.3.8 (g)).
- Helicopters will be used as appropriate to transport people and supplies into and out of the site when access is restricted (ref. this EMP section 4.1.7.1. Flood Modelling).

To ensure safe operating parameters are maintained during any wet season operations a detailed weather forecast for the local area will be utilised to allow sufficient time to prepare locations for a significant rainfall event. The Bureau of Meteorology's (Business Solutions, Energy & Resources) four-day total rain forecast will be reviewed daily to identify periods of significant rainfall. This forecast provides an eight-day look ahead, which will be used to identify periods of significant rainfall several days before its onset. The forecast report also includes current river conditions at relevant locations.

3.4 Drilling and Completion

3.4.1 Drilling Program

The wells will be drilled to proposed true vertical depths of approximately 3,500 mTVD and 3000 mTVD at Tanumbirini and Inacumba respectively, and an estimated maximum total depth of 6,000 metres Measured Depth (mMD). The wells will be drilled using an appropriately sized rig to drill to the proposed maximum depth e.g., 1500HP Triple drilling rig (Figure 3-4).

Figure 3-4: 1500HP (horse-power) triple drilling rig

The proposed locations and target intervals of at Tanumbirini and Inacumba locations are shown in Figure 3-5 and Figure 3-6 respectively.

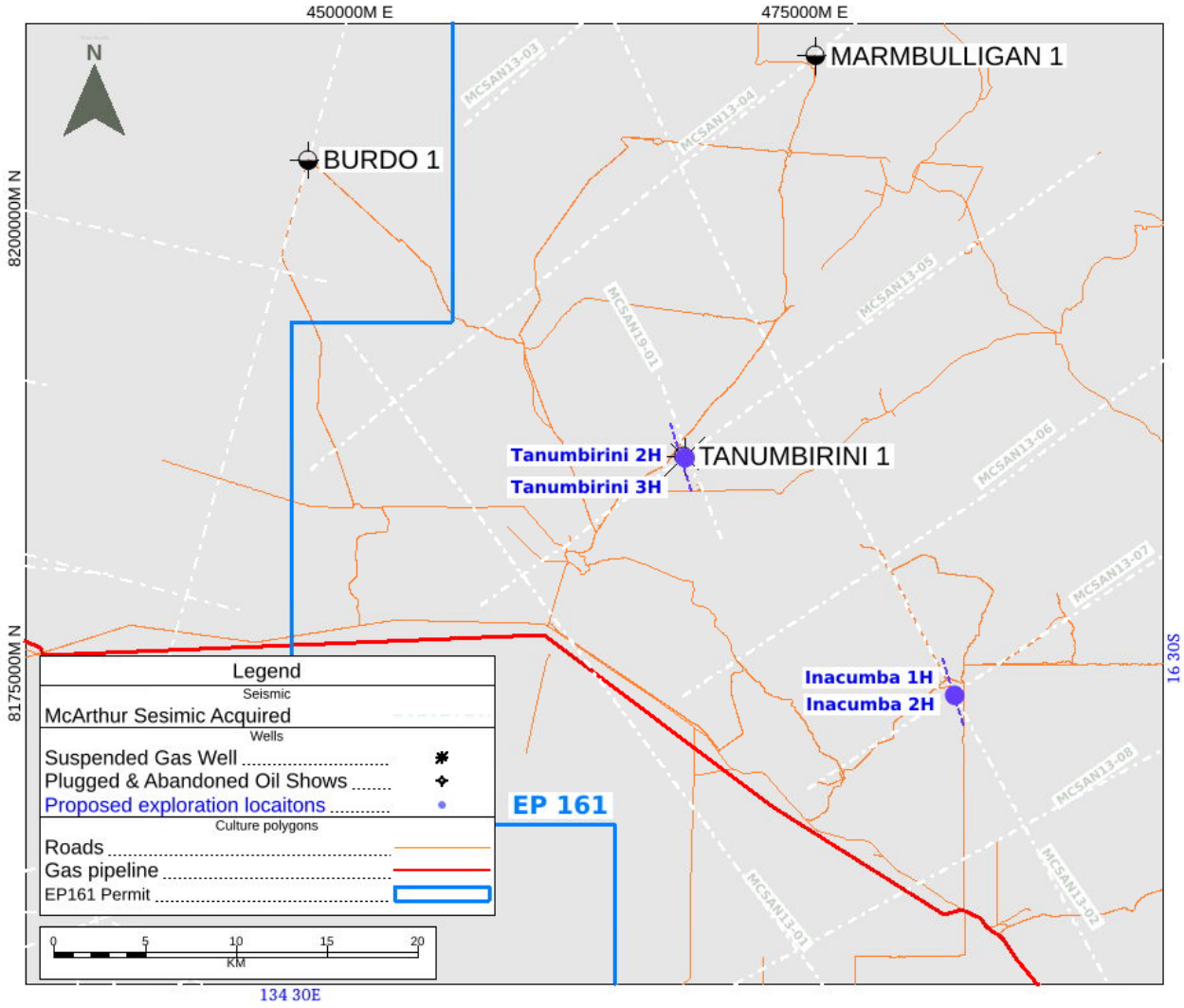


Figure 3-5: Map showing location of proposed wells

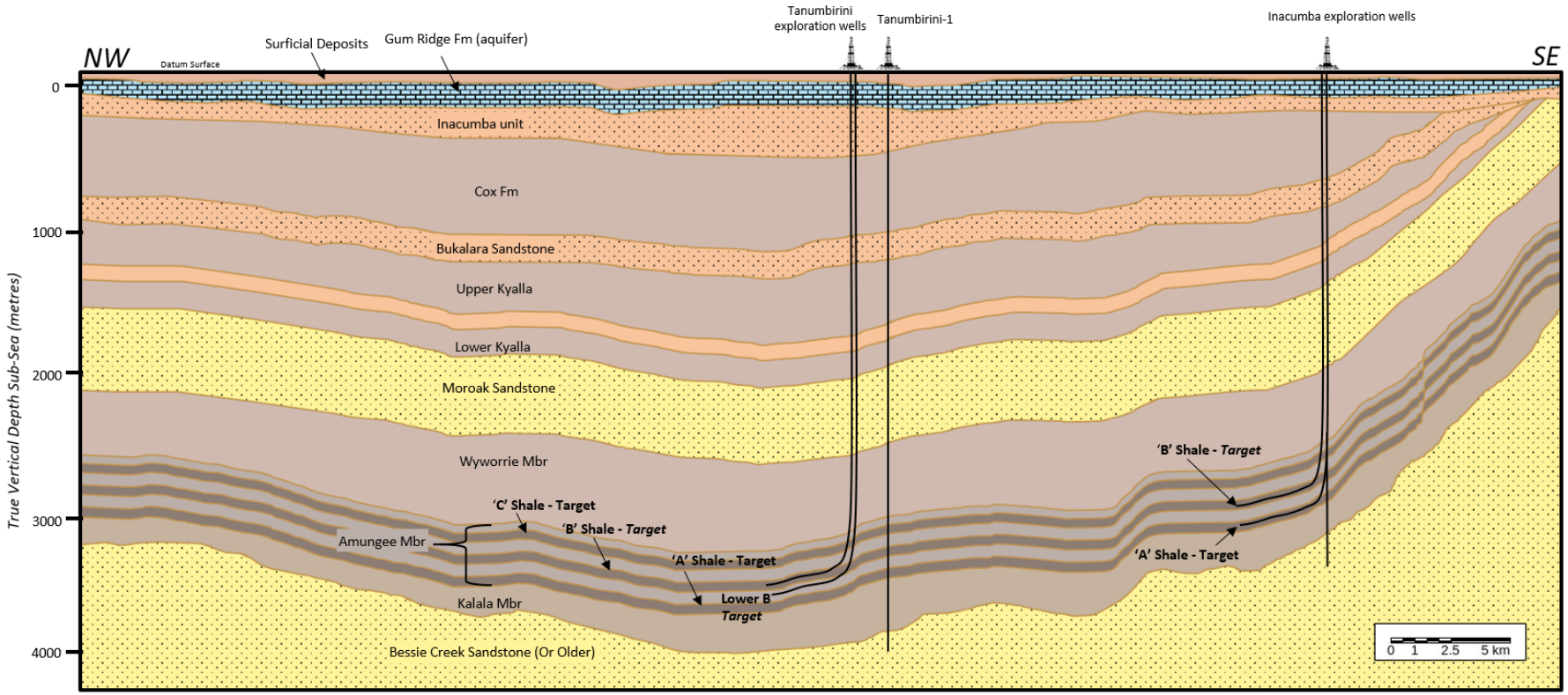


Figure 3-6: Illustrative section through the Beetaloo Sub-basin showing proposed target intervals of conceptual exploration wells relative to the deepest aquifer

3.4.1.1 Inacumba exploration wells

The proposed Inacumba-1 pilot and subsequent Inacumba horizontal wells will appraise the south-eastern flank of the eastern extension of the Beetaloo Sub-basin approximately 20km south-east of Tanumbirini-1. Table 3-2 outlines the expected formations and depths that will be intersected with a brief description of the general lithology of each formation/member.

The pilot has been proposed as a vertical well that will reach an approximate total depth (TD) of approximately 3,250 mMD before being plugged back with cement to a kick-off point (KOP) to facilitate the subsequent drilling of the horizontal wells towards the north-west or south-east from the vertical pilot hole. The B Shale unit of the Amungee Member of the Velkerri Formation is the anticipated target for horizontal drilling; however, a decision to target the A Shale, Lower B Shale, B Shale or C Shale will be finalised following evaluation of the vertical pilot hole (there is no change in geological hazard or environmental risk related to the final horizontal target selection). The proposed horizontal wells have been planned to be approximately 10m apart at surface i.e., wellhead to wellhead, and the lateral sections planned to be 500m apart (Figure 3-8). The horizontals will target separate shale intervals and be vertically separated with a minimum spacing of approximately 50mTVD. After being completed with casing/tubing, the wells will also be monitored with pressure gauges to detect communication during operations. The preferred direction for the proposed horizontal wells will be towards the north-west, and geosteered using real-time Logging While Drilling (LWD) tools to remain in the optimum target zone defined by the Inacumba-1 pilot well. The horizontal wells are conceptually planned to reach a total depth of approximately 5,400 mMD / 3,000 mTVD.

The interval targeted by the horizontal section of the well will be confirmed once the results of the vertical pilot well are known, but the shallowest possible target is considered to be the Amungee Member C Shale. The top of this unit is prognosed to be intersected at 2,460 mTVD in the vertical pilot well. The deepest aquifer at this location, based on offset well data (including water bores), is expected to be the Inacumba aquifer (currently an un-named formation).[1] The base of this unit is prognosed to be intersected at 300 mTVD. Therefore, a minimum offset of 2,160m is expected between the base of the deepest aquifer and the top of the shallowest primary target of the horizontal section of the well (Figure 3-7). This significantly exceeds the minimum offset, of more than 600m, between top target zone and base aquifer as mandated by the Code of Practice.

[1] For information on this formation see: *Tickell, S. J. (2020). Identification of the new Inacumba aquifer at Tanumbirini Station, Technical Report 20/2020, Department of Environment and Natural Resources, Northern Territory Government, Darwin, NT*.

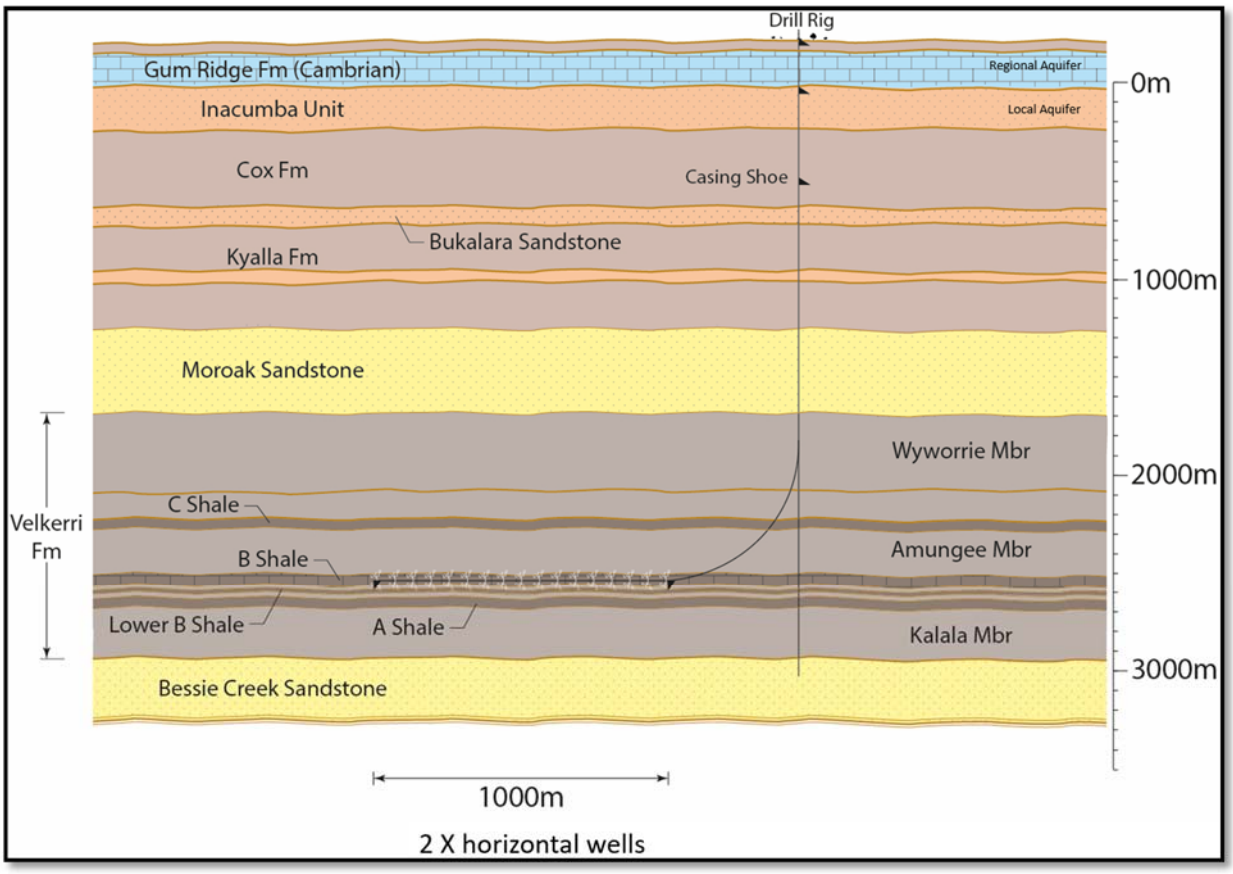


Figure 3-7: Schematic diagram illustrating offset between top of target interval and base of shallowest aquifer at Inacumba

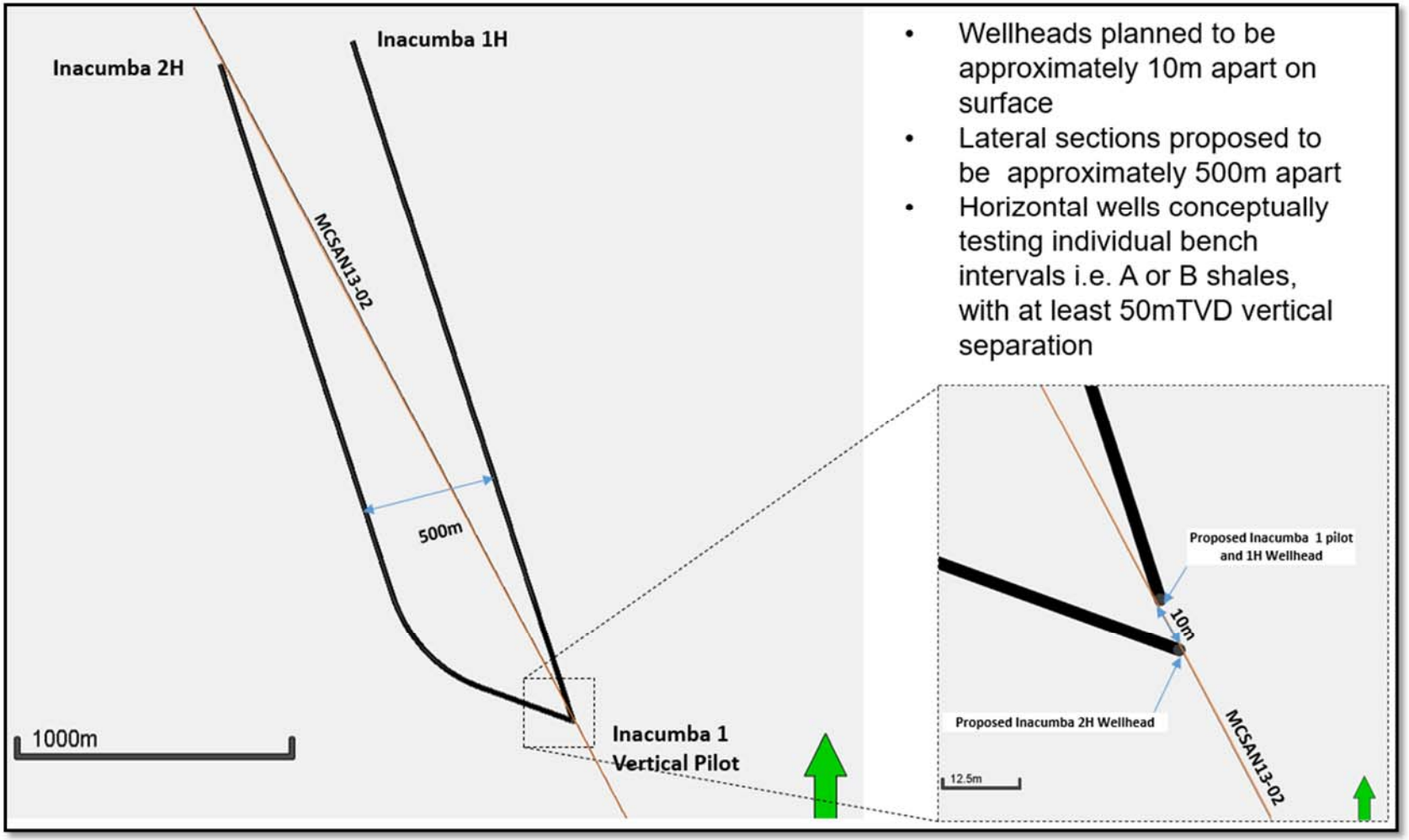


Figure 3-8: Well spacing parameters at Inacumba

Table 3-2 Inacumba-1 pilot prognosed formation depths

Formation			Depth (m-MD)	Depth (m-TVD)	Depth (m-TVDSS)	Description
Surficial Deposits						Claystone, siltstone and minor sandstone.
Gum Ridge Formation			60	60	175	**Regional Aquifer.** Minor grey brecciated limestone, pink to pale brown cryptalgal laminite
Inacumba Aquifer/Un-named Sandstone			110	110	127	**Local Aquifer.** Fine to very coarse grained, friable quartz to lithic sandstone with minor shale beds and basal pebbly sandstone to conglomerate
Cox Formation			307	307	-70	Thinly interbedded siltstone, laminated siltstone to claystone and very fine-grained sandstone
Bukalara Sandstone			827	827	-590	White, light grey to brown, fine- to coarse-grained quartz sandstone with lesser fine-grained micaceous sandstone
Upper Kyalla			957	957	-720	Interbedded siltstone, mudstone and very fine grained quartz sandstone
Lower Kyalla			1197	1197	-960	Fine- to coarse-grained quartz sandstone, with interbedded siltstone, mudstone
Moroak Sandstone			1507	1507	-1270	Medium to fine quartz sandstone
Velkerri Formation	Wyworrie Member		1937	1937	-1700	Interbedded and interlaminated mudstone and siltstone
	Amungee Member		2317	2317	-2080	Thinly interbedded, dark grey to brown-black organic-rich to -poor claystone, pale grey siltstone and rare, light grey fine-grained sandstone
	Amungee Mbr	C Shale	2462	2462	-2225	Organic-rich carbonaceous with varying clay content shale
		B Shale	2737	2737	-2500	Organic-rich carbonaceous with varying clay content shale
		A Shale	2857	2857	-2620	Organic-rich carbonaceous with varying clay content shale
	Kalala Member		2927	2927	-2690	Interlaminated grey-green to dark grey, variably carbonaceous claystone and pale grey siltstone, minor fine-grained light grey sandstone
Bessie Creek Sandstone			3187	3187	-2950	Quartz sandstone: fine to medium and locally coarse grained

3.4.1.2 Tanumbirini exploration wells

The proposed horizontal exploration wells have been proposed to appraise the deep basin area of the eastern extension of the Beetaloo Sub-basin. Tanumbirini-1, located approximately 50m to the north-east, provides offset control, with the log data used as control for trajectory planning. Table 3-3 outlines the expected formations and depths that will be intersected with a brief description of the general lithology of each formation/member.

The proposed horizontal wells have been planned to be approximately 10m apart at surface i.e., wellhead to wellhead, and the lateral sections planned to be 500m apart (Figure 3-10). The horizontals will target separate shale intervals and be vertically separated with a minimum spacing of

approximately 50mTVD. After being completed with casing/tubing, the wells will also be monitored with pressure gauges to detect communication during operations. The horizontal wells will be geosteered to remain in the optimum zone of the selected A, B, Lower B or C Shale intervals using real-time LWD tools. Tanumbirini-1 source rock analysis for core and cutting samples have been used to confirm TOC and calibrate petrophysical models for future data acquisition and indicates that the proposed Tanumbirini horizontal exploration wells should intersect highly mature Velkerri shale intervals with an expected dry gas composition i.e. primarily methane. The horizontal wells are currently planned to reach a total depth of 5,900 mMD/3,500 mTVD.

The primary target for the horizontal section of the well comprises the Amungee Member B Shale (of the Velkerri Formation). The top of this unit is prognosed to be intersected at 3,425m TVD. The deepest aquifer expected at this location is the Gum Ridge Formation (also known as Top Springs Limestone). The base of this unit is prognosed to be intersected at 202m TVD. Therefore, a minimum offset of 3,223m is expected between the base of the deepest aquifer and the top of the primary target of the horizontal section of the well (Figure 3-9). This significantly exceeds the minimum offset, of more than 600m, between top target zone and base aquifer as mandated by the Code of Practice.

The Inacumba unit has not been penetrated by waterbores at Tanumbirini and has not been used to extract groundwater. The base of the Inacumba unit is prognosed to be intersected 582m TVD. Thus even if the Inacumba unit were regarded as an aquifer at this location, the offset to the top of the target interval (3,223m TVD) would still be 2,641m; which far exceeds the minimum offset required under the Code of 600m..

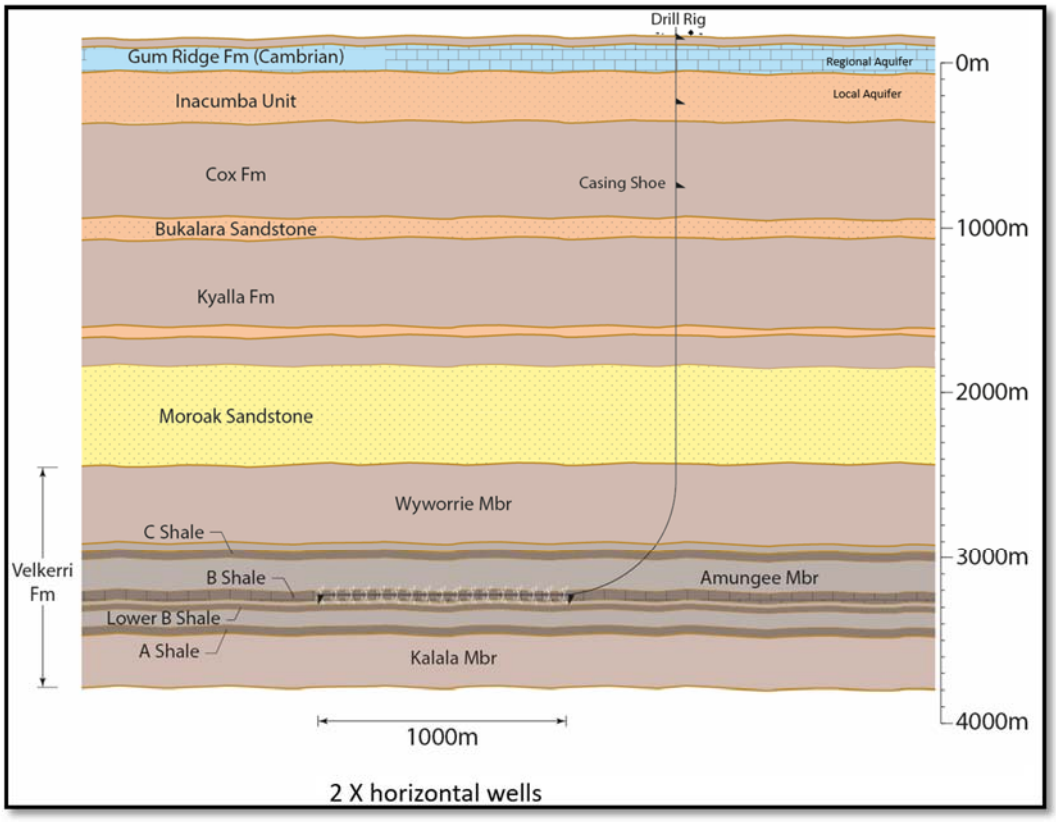


Figure 3-9: Schematic diagram illustrating offset between top of target interval and base of shallowest aquifer at Tanumbirini

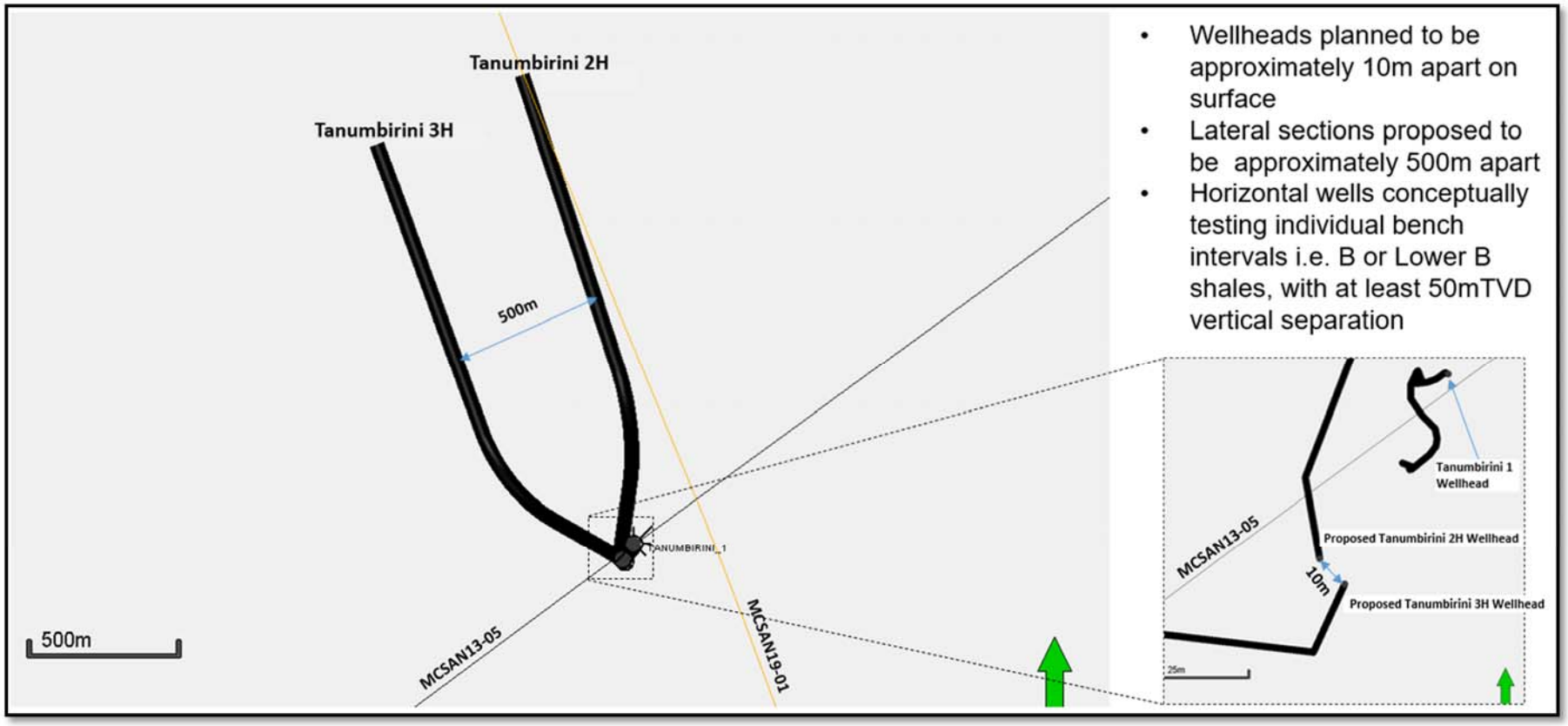


Figure 3-10: Well spacing parameters at Tanumbirini

Table 3-3 Tanumbirini exploration wells prognosed formation depths

Formation			Depth (m-MD)	Depth (m-TVD)	Depth (m-TVDSS)	Description
Surficial Deposits						Claystone, siltstone and minor sandstone.
Gum Ridge Formation			77	77	160	**Regional Aquifer.** Minor grey brecciated limestone, pink to pale brown cryptalgal laminite
Inacumba Unit/Un-named Sandstone			217	217	20	Fine to very coarse grained, friable quartz to lithic sandstone with minor shale beds and basal pebbly sandstone to conglomerate
Cox Formation			597	597	-360	Thinly interbedded siltstone, laminated siltstone to claystone and very fine-grained sandstone
Bukalara Sandstone			1167	1167	-930	White, light grey to brown, fine- to coarse-grained quartz sandstone with lesser fine-grained micaceous sandstone
Upper Kyalla			1312	1312	-1075	Interbedded siltstone, mudstone and very fine grained quartz sandstone
Lower Kyalla			1841	1841	-1604	Fine- to coarse-grained quartz sandstone, with interbedded siltstone, mudstone
Moroak Sandstone			2084	2084	-1847	Medium to fine quartz sandstone
Velkerri Fm	Wyworrie Mbr		2659	2659	-2422	Alternating, interbedded and interlaminated mudstone and siltstone
	Amungee Mbr		3155	3143	-2921	Thinly interbedded, dark grey to brown-black organic-rich to -poor claystone, pale grey siltstone and rare, light grey fine-grained sandstone,
	Amungee Mbr	C Shale	~3225	3205	-2983	Organic-rich carbonaceous with varying clay content shale
		B Shale	~3800	3425	-3203	Primary Target - Organic-rich carbonaceous with varying clay content shale
		Lower B Shale	~3900	3497	-3275	Organic shale with varying clay content and potentially favourable brittleness properties

3.4.1.3 Geological Hazard Assessment

A geohazard assessment (Table 3-4) has been performed to identify subsurface hazards that could create environmental risk. Hazards identified are assessed in Chapter 6 as part of the comprehensive Risk Assessment.

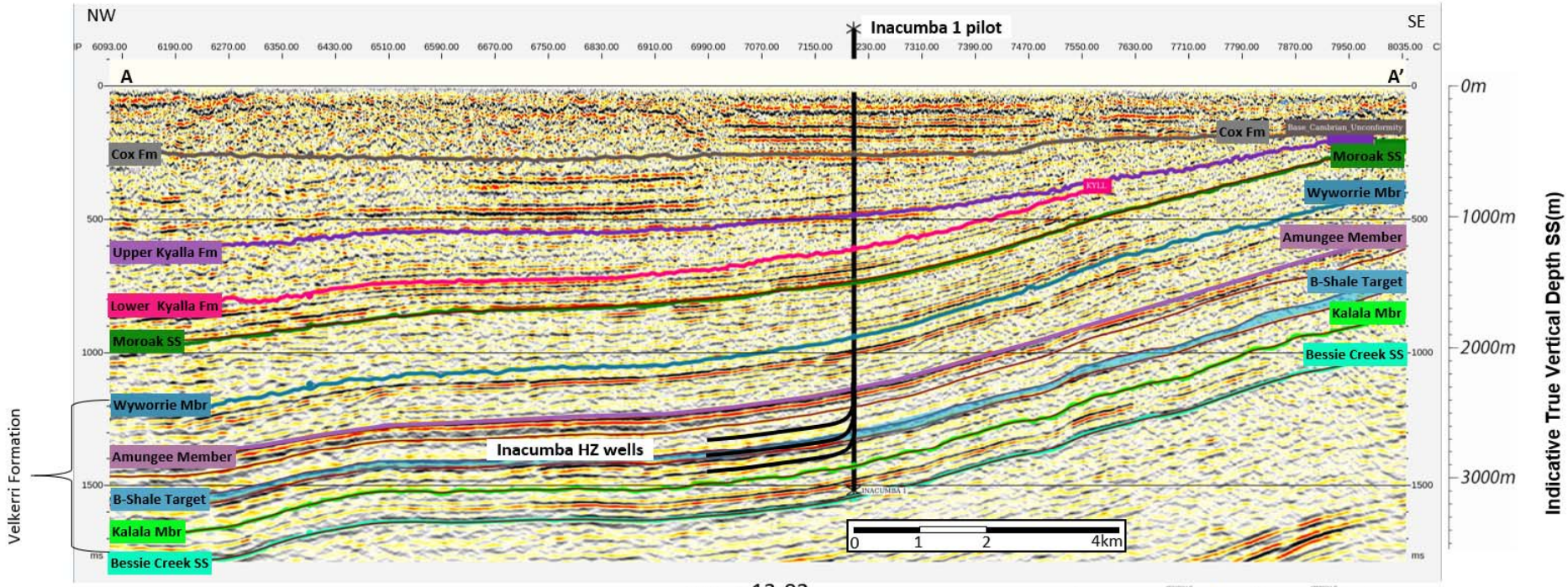
Table 3-4 Environmental Risk Geological Hazard Assessment

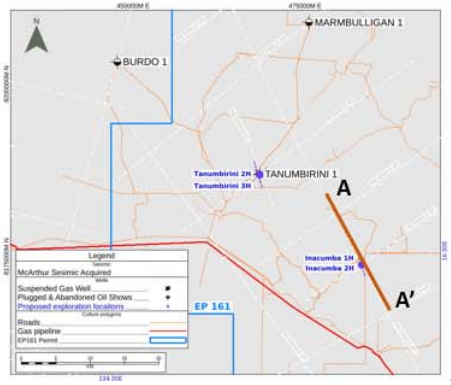
Hazard Type	Assessment/Observations
Shallow Gas	The proposed wells are deliberately targeted to avoid structural closures and are considered highly unlikely to encounter shallow gas in the Cambrian Limestone formations based on historical records of the thousands of penetrations. All formations below the Cambrian Limestone formations will be drilled overbalanced and have a large mud-weight stability window that would enable the control of even a strongly over-pressured formation.
Lost Circulation	The Cambrian Limestone formations typically do not allow circulation of drilling fluids due to the vuggy and karsted nature of the rocks. Drilling fluids through this interval is effectively fresh bore water with minimal biodegradable biocide, clays and minor chlorides (if required) to ensure no impact on the hydrological system.
Fault Penetrations	Wells have been located to avoid intersections with major fault zones based on available data. The proposed Inacumba horizontal wells are located approximately 10 km from the interpreted Sub-basin edge, however, there is no evidence of any major faults in the area of the Inacumba location. The Tanumbirini horizontal wells have been proposed for the central part of the Sub-basin where there are no significant structures evident.
Hazardous Gases	Hydrogen sulphide or other hazardous gases are unlikely to be observed based on mud gas data across the Sub-basin and the report gas composition from the Amungee NW-1H well testing results. Hydrogen sulphide detectors will be used throughout drilling operations as per best practice for exploration drilling.

Figure 3-11 and Figure 3-12 display the 2D seismic sections that intersect with the proposed wells at the Inacumba and Tanumbirini locations respectively. Figure 3-11 is a section from the MCSAN 13-02 seismic line oriented north-west to south-east and includes the approximate location of the proposed Inacumba-1 pilot well and the subsequent Inacumba horizontal wells. The horizontal sections of the proposed Inacumba wells have been proposed to be drilled down-dip at approximately 86 degrees following structure to remain within the primary target zone. An alternative scenario would be to drill the horizontal section in the opposite orientation: i.e. up-dip at approximately 97 degrees following the structure to remain in the primary target zone. No change to environmental risk will follow from the decision to drill up- or down-dip.

Figure 3-12 is a section from the MCSAN 13-05 line running south-west to north-east tied to Tanumbirini-1. The proposed Tanumbirini horizontal wells have been proposed to be drilled at a bearing of approximately 342 degrees. MCSAN 13-05 is oriented orthogonal to the proposed horizontal well azimuth, however, the seismic line has been used to assess the absence of major structures or faults in this area (supported by the results from Tanumbirini-1). MCSAN 19-01 2D seismic control line was acquired in July 2019 and provides further depth control and assessment of structural features.

The seismic sections have been reviewed and no major geohazards or faults have been identified at the proposed locations.





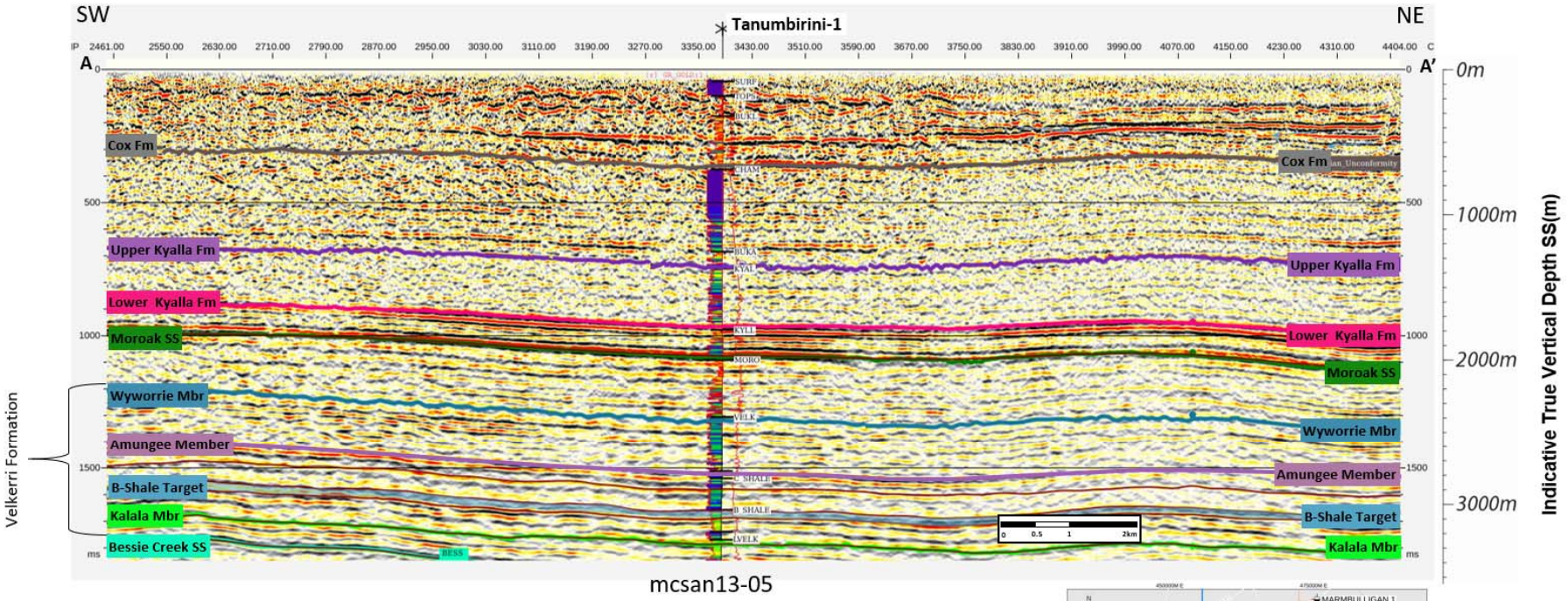
MCSAN 13-02 2D seismic line oriented SE-NW. Used as the control line for the Inacumba horizontal well paths (above).

Vertical exaggeration approximately 4 times.

The red line on the base map highlights the seismic section (right).

No major faulting identified in the area of the proposed wells.

Figure 3-11 2D seismic sections that intersect with the proposed locations at Inacumba



MCSAN 13-05 2D seismic line oriented SW-NE intersecting Tanumbirini-1 (above).

Vertical exaggeration approximately 4 times.

The red line on the base map highlights the seismic section (right).

No major faulting identified in the area of the proposed well.

Figure 3-12 2D seismic sections that intersect with the proposed locations at Tanumbirini

3.4.1.4 Drilling mud/fluid composition and Drill Cuttings

For a description of the drilling fluid and drill cuttings refer to the Wastewater Management Plan.

3.4.1.5 Associated Water

It is not anticipated that sizable volumes of water will be produced during the drilling campaign. The potential for associated water to come to surface will be minimised by using an overbalanced drilling fluid (water-based mud).

3.4.1.6 Environmental Controls for the Drilling Program

Santos employs a number of control measures to manage environmental risks associated with this drilling program. Drilling activities are conducted in compliance with the code, the controls manage the risk to the environment and aquifers are protected and managed to a level as low as reasonably practicable and acceptable. A full assessment of the project's environmental risks is provided in Section 6.0 assessment. A summary of specific environmental controls employed during drilling and completions is provided in Table 3-5 below.

Table 3-5 Drilling Program Environmental Controls

Activity	Environmental Controls	Detailed WOMP Controls
All	Prior to commencing well activities (including drilling, stimulation, completion, workover, well testing and decommissioning), a well operations management plan (WOMP) will be approved for those activities. Well control and BOP equipment will be installed and maintain and during all well activities The mechanical integrity of the well will be tested throughout the pressure testing prior to hydraulic stimulation or DFIT operations. The results of these tests will be provided to DITT. Regular annulus pressure monitoring will be conducted to provide assurance of the integrity of subsurface well barrier elements and their interface with the wellhead throughout the lifetime of the well. This will be included in the WOMP. Through casing design and cementing design any petroleum fluids produced from a well will not crossflow to any aquifer.	See below.
Fluid storage and spill management	Overbalanced water based mud system planned to provide primary well control and minimise environmental impact. Refer to the Wastewater Management Plan and Spill Management Plan for details.	None - Refer to the Wastewater Management Plan and Spill Management Plan for details

Activity	Environmental Controls	Detailed WOMP Controls
Drilling method and casing design	The well will be constructed, maintained and decommissioned so there are at least two verified well barriers between deep, saline bearing formations and potable aquifers and the surface. Aquifers will be isolated behind cemented concentric casing strings. Figure 3-13 and Figure 3-14 illustrate the proposed casing depths relative to stratigraphy (and the Cambrian Limestone Aquifer) for Inacumba and Tanumbirini respectively. Casing, tubing, downhole permanent barriers and wellhead components will be tested during installation to confirm the integrity of all barriers that bound each annulus. Casing will be pressure tested prior to drilling out for the next hole section. Casing setting depth will be selected to protect resources including aquifer systems. Water based drilling fluids planned for to minimise the risk of environmental impacts while drilling. Casing design and engineering assurance to meet internal Santos and relevant regulatory standards. Specifically the casing is designed to: • Maintain hole stability and withstand all planned life cycle well loading conditions without loss of well integrity • Allow the establishment of the well barriers required at various stages of the well life. • Ensure equivalent circulating density in the next hole section does not exceed the fracture propagation pressure while maintaining the required static overbalance. • Ensure the formation strength at the previous casing shoe or at a deeper zone will not be exceeded whilst circulating out a gas influx taken from the bottom of the open hole with the anticipated fluid weight and 0.5 ppg (60 g/l) kick intensity over prognoses formation pressure.	Shallow aquifers isolated from hydrocarbon bearing zones with more than 2 verified barriers. Aquifer (Gum Ridge Formation) isolated with cemented 13-3/8” Conductor 2 casing. The Inacumba Unit, isolated with cemented 9-5/8” surface casing. The cemented production casing string is planned to provide an additional barrier between producing hydrocarbon bearing zones and shallow aquifers. Offset waterbore drilling on pad de-risk any shallow gas hazards. (no Shallow Gas Encountered) Offset well review conducted, Antrim Volcanics not expected at ether location. First Gas anticipated in the Bukalara Fm based on offset wells. Casing shoe planned to be set above this depth. Kyalla Fm is the first potential hydrocarbon flow zone. Hole section will have standard hydrocarbon drilling controls in place as per the barrier schematic. Primary: Overbalance fluid in the hole Secondary: Wellhead and BOP’s installed on 9-5/8” (& 7” contingency liner if applicable) Casing Offset wells drilled with 10.2ppg MW successfully. DFIT conducted on T-1 cased hole to reduce pore pressure uncertainty. Low flow potential through reservoir shales pre stimulation. Casing design suitable for mud weights up to 13.5ppg if required. Chemicals on site sufficient to raise mud weight 1ppg or greater to kill the well. Cementing strategy would need to be reviewed if mud weights increase above 13.5ppg. In the remote likelihood that well control barriers fail at the intersection of the aquifers the following mitigations have been included in the WOMP. • Emergency and Well Control Response Plan • Contract in place with Well Control Response Specialists (CUDD) • Sister or equivalent rigs operating for Santos elsewhere in Australia could assist with a re-drill/intercept well operation if required.

Activity	Environmental Controls	Detailed WOMP Controls
Cementing design	All cement slurries to be appropriately engineered and laboratory tested for verify that the slurry is fit for purpose prior to use. Cement placement modelling conducted prior to use including but not limited to casing standoff, drilling fluid displacement, anticipated pressures and equivalent circulating densities. Good quality cement defined as: • Low permeability cement (permeability less than adjacent formation) • Free of contamination and channels or micro-annuli • Acceptable compressive strength • Resistant to attack from downhole fluids and temperature degradation. • Meets the goals of the cement plans in line with overall well design. Cement Bond Logs to verify cement placement and quality behind the production casing string. The top of cement for any intermediate and production casing strings must overlap with the shoe of the previous casing string by a minimum of 50m.	Cement Slurry Design, lab testing and placement modelling conducted by technical expert. Top of cement planned to be >200m of previous casing shoe. Rotation planned during the production cement job to improve mud displacement efficiency and avoid channelling. Gas-tight slurry selected to mitigate gas channelling. Ductile Slurry selected minimise cement damage during anticipated stimulation loads. Shallow aquifers isolated behind cemented Surface and conductor casing strings.
Critical acceptance criteria	Critical controls and hold points throughout the well construction process will need to be verified by a competent person prior to proceeding to the next operation.	The WOMP (Section 5) provides detailed Critical Acceptance Criteria (CAC) that will be conducted throughout Pre-spud, well construction and decommissioning stages.
Ongoing monitoring of barriers	Barrier verifications and monitoring throughout well construction, maintaining primary and secondary well control measures. Well schematic drawings of well barrier arrangements will be available for every phase of the well lifecycle. All new barriers or new operating envelopes will be verified, documented and reported prior to handover of well to production, suspension or decommissioning. This will be done by submission of updated Well Barrier Verification Form to DITT.	Aimed to be aligned with the NT Guideline for Monitoring, Inspection and reporting Requirements for Suspended (Dormant Wells) Table 1. Based on well risk evaluation the below monitoring requirements are anticipated. • Wellhead / Tree maintenance 2-3 Years • Annulus monitoring 2-3 Years • Periodic testing 2-3 Years

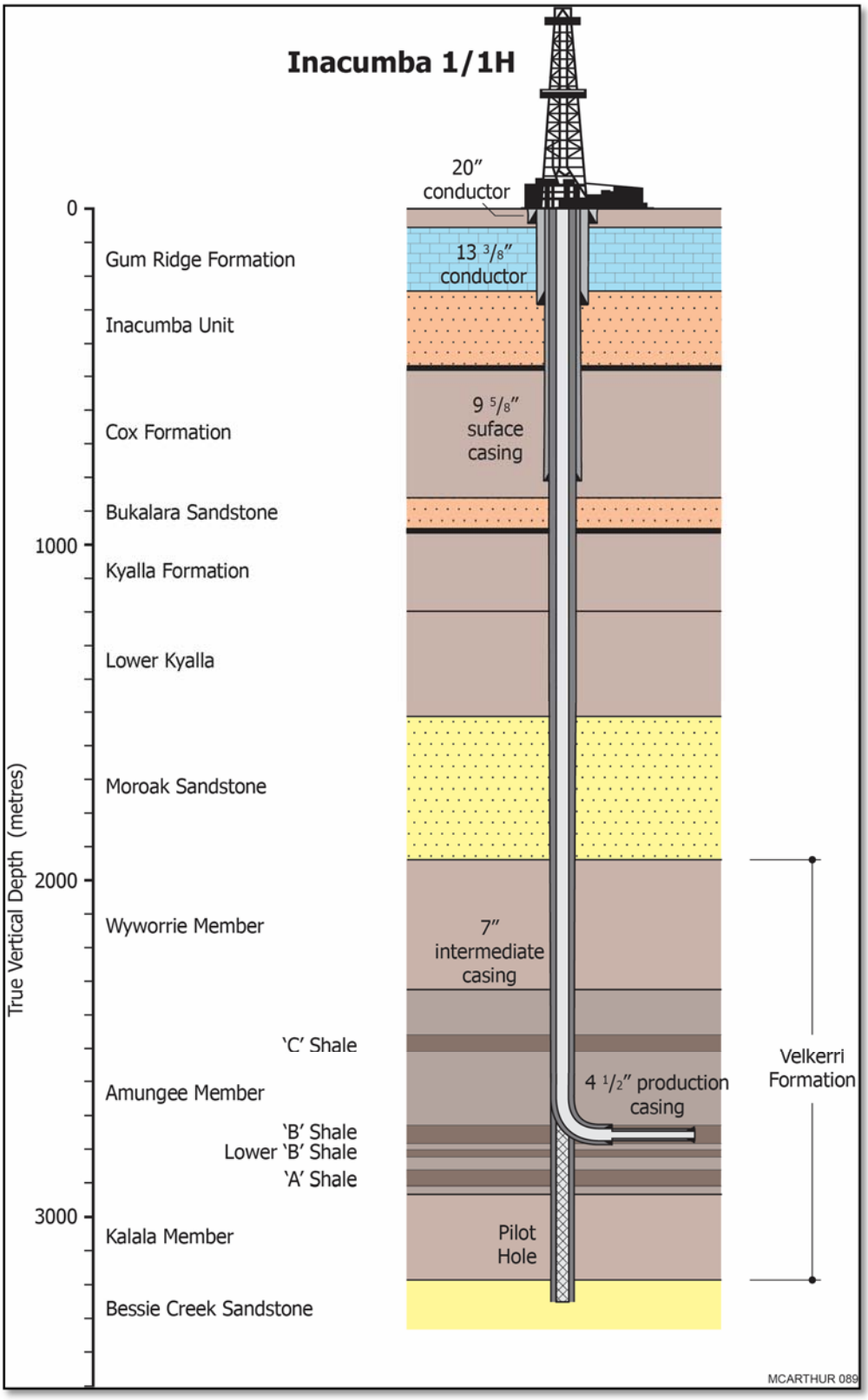


Figure 3-13: Schematic diagram illustrating locations of proposed casing shoes relative to stratigraphy (and Gum Ridge Formation and Inacumba aquifer) in Inacumba-1/1H (horizontal section not to scale).

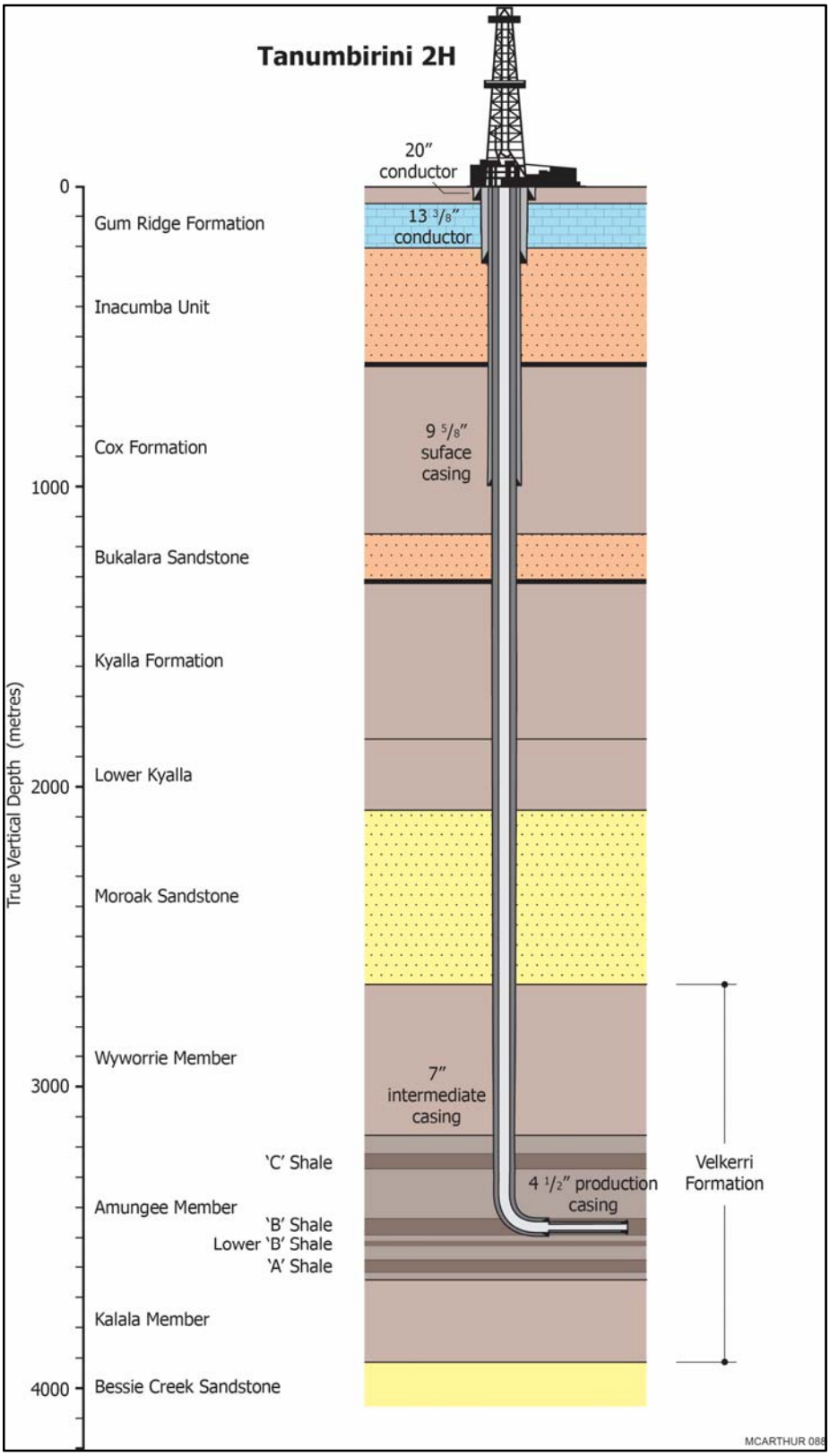


Figure 3-14: Schematic diagram illustrating locations of proposed casing shoes relative to stratigraphy (and Gum Ridge Formation aquifer) in Tanumbirini-2H (horizontal section not to scale).

3.4.2 Well Evaluation

3.4.2.1 Open hole evaluation, logging and testing

Well evaluation activities including mudlogging, LWD, wireline logging, formation testing, core acquisition, fluid sampling, open hole formation integrity testing (i.e. leak-off tests, formation integrity tests, or diagnostic fracture injectivity tests) and other standard oilfield evaluation techniques as deemed appropriate. Drill core and/or cutting samples will be collected for geological assessment and analysis and wireline logs will be acquired over the open hole section as per Santos and Northern Territory Government requirements.

3.4.2.2 Diagnostic Fracture Injection Test (DFIT)

Diagnostic Fracture Injection Tests (DFITs) will be conducted to evaluate the geomechanical and reservoir properties of the targeted formation to determine the suitability and capacity of these formations for potential gas extraction activities. Prior to the DFITs, a cement bond log will be run to determine the quantity and quality of the cement behind the production casing string. This will be followed by a pressure test to simulate the maximum pressure exerted on the casing string and wellhead during the DFIT. The above tests will confirm well bore integrity and zonal isolation between reservoir targets and aquifers.

As there is no flowback through the well to surface following a DFIT there will be no flowback fluid handling or storage required.

Following successful pressure testing and cement evaluation, the casing will be perforated using wireline perforating guns to provide communication between the well bore and the DFIT target.

The objective of the test is to calibrate the pre-DFIT mechanical earth model (MEM) and estimate formation characteristics such as breakdown pressure, fracture gradient, stress state and, potentially, permeability. A DFIT refers to the act of injecting small volumes of a water (approximately 5-10m^3 per DFIT) at low pumping rates to create a small fracture in the target interval. The well is shut-in and the pressure allowed to fall-off naturally. Monitoring the fall-off pressure over time allows information to be derived about the reservoir. The fluid does not contain proppant so that the fracture can relax and close naturally when pressure is released. The pressure changes are measured with high-accuracy gauges that are either placed deep in the wellbore or at surface on the wellhead. The analyses of fracturing pressure, during injection and after shut-in, provide powerful tools for understanding and subsequently informing the design for a future hydraulic fracturing process (not in this scope). The DFITs will provide information on fracture growth, fracture closure and permeability of the target formation(s), which are critical elements of the hydraulic fracture program design. The aim of the design is to maximise geomechanical understanding of the target formation to ensure optimal induced fracture network creation and the containment of the fracture network within the target formation.

3.4.3 Well suspension and decommissioning

The wells are part of an exploration program with uncertainty on reservoir outcome. The following activities may occur post well evaluation:

- The well will be suspended with cemented production casing and a 15 kpsi well-head for future re-entry; or
- The well will be decommissioned with permanent cement plugs installed in the well as per regulatory requirements.

As part of the well suspension process, wellbore barriers will be put in place as per Santos and the Code of Practice. A Well Integrity Monitoring Plan will be put in place for any suspended well for monitoring of wellbore barriers.

At completion of testing, a decision will be made on whether each of the wells will be suspended or decommissioned. All decommissioned wells will have cement plugs permanently placed in the well and the wellhead removed. If all wells on a lease pad are to be decommissioned leases and roads rehabilitated in accordance with Civils and Seismic EMP.

3.5 Operations Support Facilities for the Program

3.5.1 Traffic Management

Mobilisation of the drilling rig selected to complete the Drilling Program, accommodation camp and other supporting equipment will require a number of truck movements. The estimated operational trucking requirements during the Drilling Program are shown in Table 3-6. The mobilisation will follow with traffic management measures that meets the requirements of the Department of Infrastructure, Planning and Logistics and will be shared with relevant NT Government agencies and other stakeholders prior to mobilisation.

Table 3-6 Estimated operational trucking requirements

Drilling Operational Trucking Activities	Trucks	Frequency (per Week)	Truck on location per week.
Rig Support Trucking Package.	2	7	14
Food Truck Delivery	1	0.5	0.5
Rubbish and waste removal	1	1	1
Water Potable Trucking (if bore water isn't suitable)	1	2	2
Fuel Delivery	1	1	1
Mud Chemicals	1	1	1
Optimised Logistics support	1	1	1

The visual impacts of the project are negligible. The proposed activities approved under this EMP are unable to be seen from the Carpentaria Highway. Santos, in consultation with the Department of Infrastructure, Planning and Logistics completed a major upgrade to the intersection of the Carpentaria Highway and the main access to Tanumbirini Station. This intersection upgrade will enable a safer entry and exit to Tanumbirini Station and minimise gravel moving from the Tanumbirini Access Road onto the sealed Carpentaria Highway.

3.5.2 Accommodation Camp

A temporary camp will be constructed at each of the exploration well lease pads at Tanumbirini and Inacumba. Personnel numbers required for the duration of the drilling activities is provided in Table 3-1. Facilities at the camp include:

- Accommodation

- Workshop to allow for vehicle maintenance
- Ablutions and septic(s) waste treatment
- Kitchen and mess
- Freezer unit
- Site office
- Generator and diesel storage
- Water tank.

3.5.3 Airstrip

The landowner airstrip adjacent the Tanumbirini Homestead may be used for crew changes and emergency response evacuations. The 1,400 m airstrip is regularly used to deliver landowner mail and other private aircraft.

3.5.4 Waste Management

Refer to the Wastewater management Plan for details.

3.6 Project Water Use

The drilling crew will source water from potable water suppliers or utilise existing water bores, as shown in Figure 4-4. Santos intends to extract water from the multiple existing water bores in the vicinity of Tanumbirini and Inacumba locations. Water will be stored at the bore in the fenced holding ponds and then trucked to the wellsite pad where it will be stored in tanks before use in the drilling campaign.

A breakdown of the water use volumes is provided in Table 3-7. Water consumption and extraction amounts will be submitted to DITT and DEPWS upon completion of the drilling program. Water for dust suppression is required and will be sourced from the existing bores (See Figure 4-4). Volumes of water used for dust suppression will depend on the weather conditions and the potential for dust production.

Table 3-7 Estimated Water Use Volumes (ML)

Use	Scope	Q1	Q2	Q3	Q4	Total Use
Well drilling and maintenance	Drilling (1 vertical and 4 x horizontal wells)	2	8	8	2	20
	Camp Use	1.8	2	2	1.8	7.6
	Dust suppression	0	1	1	0	2.0
	Wash-downs	0.2	0.4	0.4	0.2	1.2
	Cementing	0	0.6	0.3	0	1.2
Operational Activities	Road and site maintenance at 1ML per month	2	2	2	2	8
Totals		**6**	**14**	**13.7**	**6**	**40**

Activities conducted to date have used approximately 3,000L for the DFIT.

Table 3-8 shows the Cumulative water use volumes for the Civils and Seismic and Drilling EMPs.

Table 3-8 Cumulative Water Use

Source of Water Use	Total ML Required
EMP: McArthur Basin Civils and Seismic Program	45.5
EMP: McArthur Basin Drilling Program	40
Cumulative water use by the project	**85.5**

Santos has two water licences that are used to provide water for this project. Water Licence GRF10280 is used to access the Gum Ridge Formation. This licence has a maximum water entitlement of 193.5 ML/year. This represents 22.7% of the 850ML/year in water licences accessing this formation. Water Licence U10335 is used to access the Inacumba Unit (local aquifer), a newly identified water resource estimated to be 300 GL (Tickle 2020). This water licence has a maximum water entitlement of 195 ML/year and is the only water licence accessing this formation.

3.7 Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions for the drilling EMP were estimated using tools developed for the National Greenhouse and Energy Reporting scheme. Emissions associated with fuel combustion were estimated using factors and formulas in the Emissions and Energy Threshold Calculator – 2018, based on the National Greenhouse and Energy Reporting (Measurement) Determination 2008 (NGER Determination) for the 2017-18 reporting year. Greenhouse gas emissions associated with fugitive emissions were calculated using shale methane saturation estimates and estimated cutting volumes. This is a conservative estimate as both free gas and sorbed gas is included. The total whole of project GHG estimates for drilling program is provided in Table 3-9 below.

Table 3-9 Greenhouse Gas Emissions for the drilling EMP

Source of GHG Emissions	Key Inputs	Assumptions	Total tCO2-e
Transport fuel combustion	15.5 kL Diesel oil (post-2004 vehicles)	General Transport - Diesel volumes estimated at 50L/day for 310 days. Estimate based on the Emissions and Energy Threshold Calculator – 2018.	42
Non-transport fuel combustion	1,879 kL Diesel oil	Average fuel consumption at Dukas 1 is 6,057L/day for 310 days = 1,878kL plus a 1kL for DFIT operations (1,879kL Non-transport fuel combustion). Estimate based on the Emissions and Energy Threshold Calculator – 2018.	5,092
Fugitive emissions from cuttings (4 horizontal wells and a pilot well)	2.85 tonnes of methane (CH4)	Based on Tanumbirini 1 gas saturation and the anticipated shale cutting volume. Includes free gas and sorbed gas Conversion of emissions factor from CH4 to CO2 (25 tCO2-e/CH4).	72
Total			**5,206**

Table 3-10 shows the cumulative GHG Emissions for the Civils and Seismic and Drilling EMPs. An estimated percentage contribution to the annual Northern Territory GHG emissions is also provided. This estimate assumes the whole of project emissions are distributed over 5 years. Overall, the total annual emissions from the drilling program represents approximately 0.007% of the total estimated annual GHG emissions for the NT (16 million tCO2-e for 2018, Department of Industry, Science, Energy and Resources, May 2020).

Table 3-10 Cumulative Greenhouse Gas Emissions

Source of GHG Emissions	Total tCO2-e	% of Estimated NT Emissions
EMP: McArthur Basin 2019 Civils and Seismic Program	11,714	0.015%
EMP: McArthur Basin 2019 Drilling Program	5,206	0.007%
Cumulative emissions	16,920	0.021%

3.8 Rehabilitation

Rehabilitation is discussed in the Rehabilitation Management Plan (Section 7.3).

4.0 Description of the Existing Environment

This section describes the physical, biological, cultural and socio-economic environment that may be affected by the proposed activity and identifies particular values and sensitivities of the environment that may be affected by the activity (referred as the 'Project Area'). The existing environment has been described using the Environmental Factors described in the 'Guidelines for Environmental Factors and Objectives' (NTG 2018).

The information has been sourced using Santos data, publicly available information, the Australian Government Protected Matters Search Tool (PMST) (Appendix B) and NT NRM Report (Appendix C).

4.1 Physical Environment

4.1.1 Climate

Exploration Permit EP 161 is located in a semi-arid, subtropical climatic region, under the influence of the monsoonal climate to the north where there is a distinctive wet and dry season. The majority of rainfall occurs during the summer months between November and March. Rainfall events are usually associated with intense thunderstorms or widespread monsoonal activity. The local area averages 50 days of rain per annum (NTG 2018). Little rainfall occurs during the remainder of the year when the climate is characterised by mild days and cool nights (Knapton and Fulton 2015).

EP 161 is situated between the Daly Waters Airstrip weather station (#014626) and the McArthur River Mine Airport weather station (#014704). There is also a weather station (#14628) located within the exploration permit at Tanumbirini Station capturing monthly rainfall data between 1970 and 2018 however, no other climate statistics have been recorded from the site. Table 4-1 shows climate averages data for Daly Waters, McArthur River and Tanumbirini Station.

The highest rainfall typically occurs during January and February. Tanumbirini Station's maximum rainfall occurs during January, with an average of 216.2 mm recorded between 1970 and 2018. The least amount of rainfall occurs during July and August across all three weather stations however, Tanumbirini Station receives more rain during the dry season on average than Daly Waters or McArthur River Mine (Table 4-1). The annual rainfall pattern varies between the three weather stations however, the overall mean annual rainfall increases towards the coast.

The minimum and maximum daily temperatures in Daly Waters is slightly less than McArthur River Mine throughout the year. The highest temperatures for both areas are experienced in November, with temperatures of 38.2 and 38.7 respectively. The lowest temperatures are experienced in July, with an average daily temperature between 12.0 and 12.7 at both stations. The average temperature increases closer to the coast (BoM 2018a).

Table 4-1 Average Climate at Daly Waters, Tanumbirini Station, and McArthur River Mine

Month	Daily maximum temperature (degrees C)		Daily minimum temperature		Mean monthly rainfall (mm)			Relative humidity 9 am (%)		Mean daily evaporation (mm)		Mean Wind speed 9 am (km/hr)	
	DW	MR	DW	MR	DW	TS	MR	DW	MR*	DW	MR*	DW	MR*
Annual rainfall					680.8	736.9	766.9						
Minimum	28.9	29.9	12.0	12.3	0.4	1.2	0.3	42	46	6.6	5.8	4.5	5.5
Maximum	38.2	38.7	24.4	25.0	180.7	216.2	220.7	74	75	10.5	9.8	7.8	9.4
Average	34.0	34.6	19.1	19.7				55	57	8.3	7.5	6.6	7.8

Legend: DW – Daly Waters, MR – McArthur River Mine Airport, TS-Tanumbirini Station

4.1.2 Topography

Tanumbirini Station is situated on the north eastern boundary of the Beetaloo Basin, approximately 250-280 metres above sea level at the Carpentaria Highway (Fulton and Knapton 2015). The station is situated on a drainage divide that separates inland drainage of the Sturt Plateau from the north east flowing streams that lead into the Gulf of Carpentaria.

To the west and south west are the gently undulating plain of the Sturt plateau, and to the north and east towards the Gulf of Carpentaria are the laterite plains. Formed by laterite capping on Cretaceous aged sedimentary rocks, the undulating terrain is characterised by scattered low, steep hills and dissected plateaux on exposed Proterozoic and Palaeozoic sedimentary rocks (Fulton & Knapton 2015).

The general elevation change across the Tanumbirini and Inacumba locations can be seen on Figure 3-2 and Figure 3-3

4.1.3 Geology

Gas exploration on EP 161 targets shale sequences within the Beetaloo Sub-basin, which forms part of the greater McArthur Basin (Figure 4-1). The Beetaloo Sub-basin comprises a thick sequence of flat-lying mudstone and sandstone formations (Roper Group) which is estimated to reach 5,000 m in thickness in the centre of the basin.

The Beetaloo Sub-basin is an ancient Proterozoic sedimentary basin that has been relatively tectonically quiescent throughout its long history, as evidenced by the lack of significant structural deformation (Figure 3-11 and Figure 3-12). The principle exploration target within the basin is the Velkerri Formation, which is thought to have been deposited ~1.4 billion years ago. This comprises intervals of high organic content fine-grained rocks (“shales”) contained within clay-rich and organically-lean layers. These clay rich, organically lean layers act as impermeable aquitards to fluid migration (as evidenced by the organic-enriched layers still containing gas hundreds of millions of years after it was generated). They also provide effective barriers to fracture growth during hydraulic fracture stimulation operations. Given the lack of major faults and structures across the deeper areas of the Beetaloo Sub-basin there is a low geohazard risk associated with through-going faults, therefore a low likelihood of the perceived risk of communication to shallow aquifers occurring.

The Velkerri Formation is overlain by other formations of the Roper Group (Maiwok Sub-group), including the Moroak Sandstone and the Kyalla Formation. These comprise a thick sequence of fine-grained siltstones and mudstones interbedded with sandstones, which provide excellent isolation between the target zones in the underlying Velkerri Formation and the overlying aquifer (Gum Ridge Formation).

The Roper Group sediments are unconformably overlain by Neoproterozoic basal sediments of the northern Georgina Basin, which constitute the Kiana Group including the Bukalara Sandstone and Cox Formation at this location. The Kiana Group is unconformably overlain by the Barkly Group, which includes the Gum Ridge Formation and the informally named Inacumba Unit. The Inacumba Unit has been recognised as a local aquifer at the Inacumba location (Tickell, Technical Report 20/2020), however it has not been defined as a regional aquifer due to varying reservoir quality (porosity and permeability), mapped extent and lack of historical usage. The Gum Ridge Formation is recognised as a regional aquifer and is considered to be the deepest aquifer present at the proposed Tanumbirini well locations.

The Gum Ridge Formation is unconformably overlain by undifferentiated Cretaceous to Quaternary sediments of the Carpentaria Basin.

A map illustrating the structural outline of the Beetaloo Sub-basin is shown in Figure 4-2 and an illustrative section through the Beetaloo Sub-basin is presented in Figure 3-6. The stratigraphy described in this section is referenced from NTGS Special Publication 5 (Ahmad and Munson).

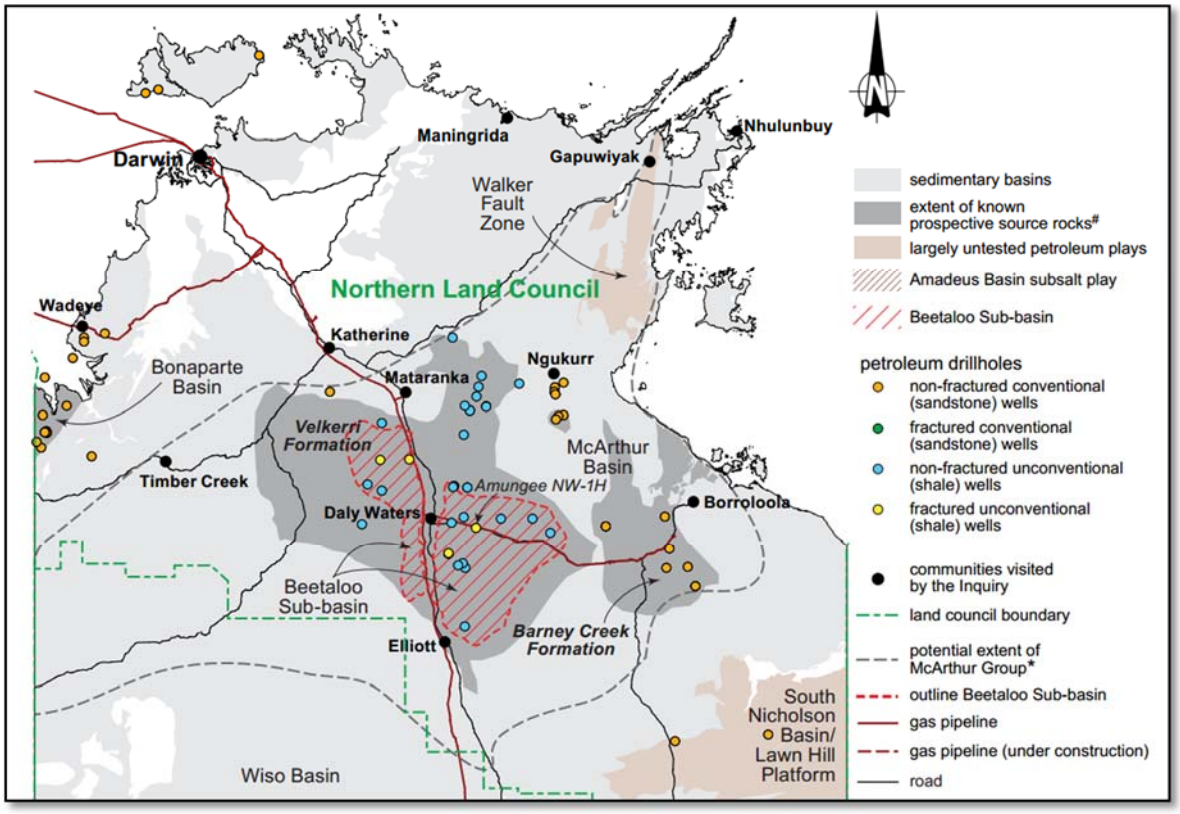


Figure 4-1 Geological setting of the Beetaloo Sub-basin / McArthur Basin (source: DIPR, ref: Final Report of the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory)

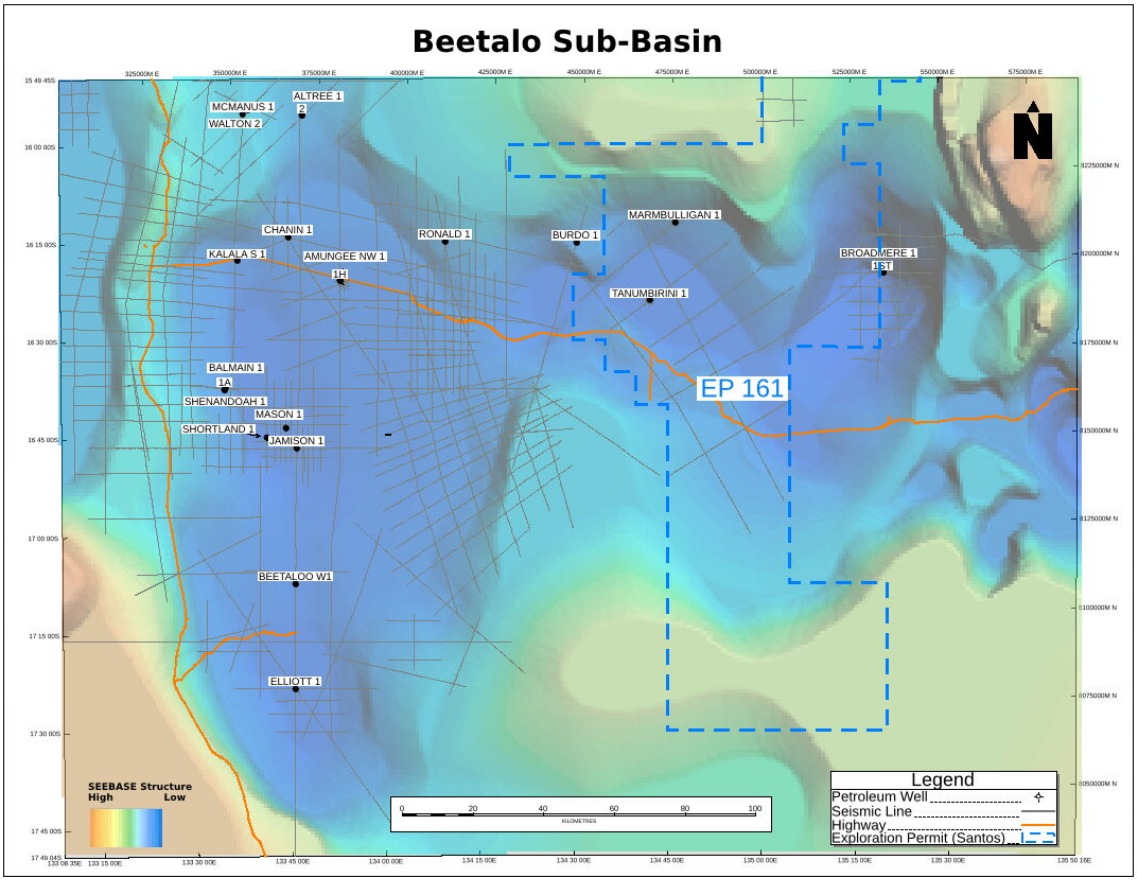


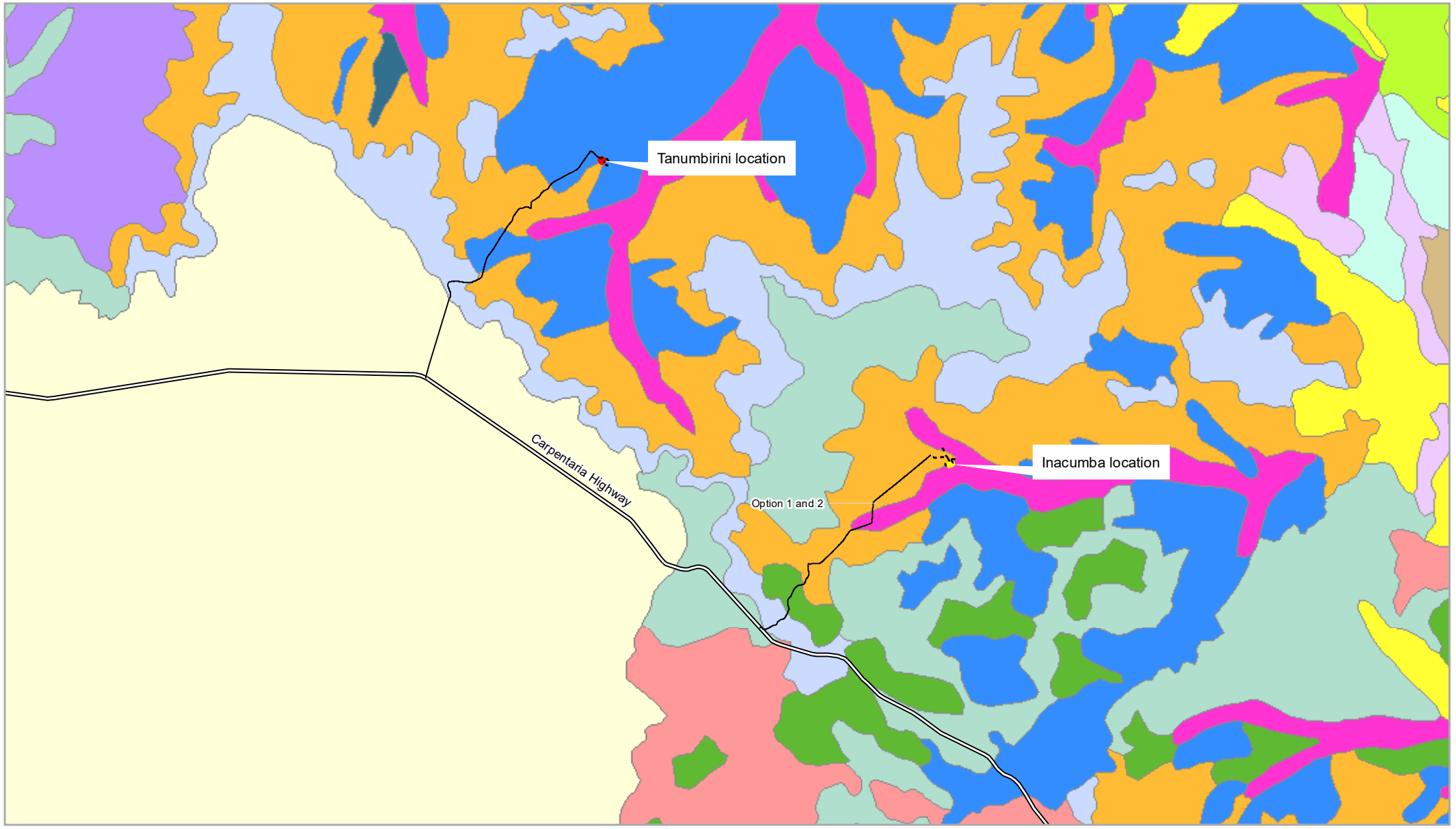
Figure 4-2 SEEBASE structural outline of the Beetaloo Sub-basin

4.1.4 Soils

An NT NRM Report was generated on 4 December 2018 from a search of the NRM Infonet tool (NTG, 2018). The Project Area soils are dominated by kandosols and rudosols (Appendix C). Rudosols are very shallow soils or those with minimal soil development and include very shallow rocky and gravely soils across rugged terrain. Kandosols are massive and gravelly soils (formerly red, yellow and brown earths) that are widespread across the Sturt Plateau bioregion.

4.1.5 Land Systems

Land systems are defined because of their distinct differences from the surrounding areas and by the recurring pattern of geology, topography, soils and vegetation. Land system information for the permit areas is described in Table 4-2 and shown in Figure 4-3.



Legend

- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases
- Beetaloo
- Bukalara
- Coolibah
- Cresswell
- Dalglese
- Inacumba
- Jumpup
- Lancewood 2
- Lancewood 3
- Lansen
- McArthur
- Miller
- Seigal
- Tanumbirini
- Wearyan

1:220,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

N

GHD

Santos
McArthur Basin
Environmental Management Plan

Land Systems

Project No. **12538768**
Revision No. **A**
Date **5/11/2020**

FIGURE 4-3

S:\Geospatial\43\12538768\GIS\Maps\12538768_007_LandSystems.mxd
Print date: 05 Nov 2020 - 16:14

Data source:NTG - Land systems South 1M, Land systems North NT (2017). GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

Table 4-2 Percentage of Land Systems and Total Area within EP 161

Land System	Landscape Class	Class Description	Landform	Soil descriptions	Vegetation description	% of Total area
Beetaloo	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Information not available	Information not available	Information not available	<1%
Coolibah	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Level to gently undulating plains on unconsolidated transported materials, rarely sedentary	Grey and brown clays, minor black earths	Mid-high open woodland of *E. microtheca, Excoecaria parvifolia* over *Chrysopogon fallax, Sorghum plumosum, Aristida spp*	1%
Inacumba	Lateritic plains and rises	Plains and rises associated with deeply weathered profiles (laterite) including sand sheets and other depositional products; sandy and earth soils	Gently undulating rises and undulating plains to low hills on ferruginised Lower Cretaceous sediments (laterite) and weathered sandstones	Lithosols	Mid-high open woodland of *C. dichromophloia, E. miniata, E. tetrodonta, C. ferruginea, E. leucophloia* with isolated stands of A. *shirleyi* on steeper slopes over *Eriachne spp, Chrysopogon fallax, Plectrachne pungens*	35%
Lancewood 2	Lateritic plateaux	Plateaux, scarps and some rises on deeply weathered sediments; shallow soils with rock outcrop	Plateau margins, escarpments and rugged low hills and plateaux	Lateritic lithosols	Mid-high open forest of *Acacia shirleyi* over *Schizachyrium* fragile, *Chrysopogon fallax, Triodia bitextura*	<1%
Lancewood 3	Sandstone plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Gently undulating plains and drainage floors on claystone	Grey and Brown clays	Tall open grassland of *Chrysopogon fallax, Eulalia aurea, Iseilema vaginiflorum*	25%

Land System	Landscape Class	Class Description	Landform	Soil descriptions	Vegetation description	% of Total area
McArthur	Alluvial floodplains	Alluvial floodplains, swamps, drainage depressions and alluvial fans; sandy, silty and clay soils on Quaternary alluvium	Broad or narrow fluvial corridors conducting regional drainage across various land systems towards the coast	Grey and brown clays, red and yellow earths and siliceous sands	Mid-high open woodland of *C. terminalis, E. microtheca, Excoecaria parvifolia, Lysiphyllum cunninghami, C. papuana* over *Chrysopogon spp, Eulalia fulva, Iseilema vaginiflorum*	2%
Tanumbirini	Lateritic plains and rises	Plains, rises and plateaux on mostly on sandstone, siltstone, claystone, shale and some limestone; commonly shallow soils with surface stone and rock outcrop	Gently sloping pediplains below, but isolated from lateritic escarpments	Lateritic yellow earths and brown clays	Mid-high open woodland of *E. chlorophylla, Erythrophleum chlorostachys, C. polycarpa, E. tetrodonta, Terminalia grandifolia* over *Chrysopogon fallax, Eulalia fulva, Plectrachne pungens*	36%

4.1.6 Groundwater

Table 4-3 summarises the regional hydrostratigraphy of the Beetaloo Basin.

Table 4-3 Regional hydrostratigraphy of the Beetaloo Basin (modified from Fuller and Knapton, 2015)

PROVINCE	PERIOD / AGE	FORMATION		AQUIFER STATUS	THICKNESS (m)	YIELD (l/s)	AVE. EC (µs/cm)
CARPENTARIA BASIN	CRETACEOUS 145 – 66 Ma	Undifferentiated		*Local Aquifer*	0 - 130	0.3 - 4	1800
GEORGINA BASIN	CAMBRIAN 497-541 Ma	Cambrian Limestone Aquifer (CLA)	Anthony Lagoon Beds	REGIONAL AQUIFER	0 – 200	1 - 10	1600
			Gum Ridge Formation	REGIONAL AQUIFER	0 – 300	0.3 - >20	1400
		Antrim Plateau Volcanics		REGIONAL AQUITARD *Local Aquifer*	0 – 440	0.3 - 5	900
		Inacumba aquifer		*Local Aquifer*	0 – 75	0.3 - 5	1000
BEETALOO BASIN (ROPER GROUP)	NEO-PROTEROZOIC 541-1000 Ma	Cox Formation		REGIONAL AQUITARD *Local Aquifer*	0 – 450	-	32000
		Bukalara Sandstone		*Local Aquifer*	0 – 150	-	138000
	MESO-PROTEROZOIC 1430-1500 Ma	Kyalla Formation		REGIONAL AQUITARD	0 – 800	-	-
		Moroak Sandstone		*Local Aquifer*	0 – 500	0.5 - 5	131000
		Velkerri Formation		REGIONAL AQUITARD	700 – 900	-	-
		Bessie Ck Sandstone		*Local Aquifer*	450	0.5 - 5	-

The major hydrogeological units of the Roper River catchment are the Cambrian limestones of the Daly, Wiso and Georgina Basins. These major groundwater systems provide dry season inputs to the Roper River (Knapton, 2009).The Cambrian Limestone Aquifer (CLA) forms the major water resource in the region and where it is absent, local scale, Proterozoic fractured rock aquifers are utilised with varied success. The Inacumba Unit is considered to be a local aquifer in the vicinity of the Inacumba location but not across the Project Area. The CLA is a regional scale aquifer that provides groundwater resources for pastoral enterprises, domestic bores at homesteads and town water supplies at a number of small communities across the region. The CLA is subdivided into the Anthony Lagoon Beds (ALB) and the Gum Ridge Formation (GRF).

Figure 4-5 shows the elevation of the base of the GRF relative to the proposed well locations. This shows that the GRF is expected to be present at the proposed well locations.

The Anthony Lagoon Beds also overly the GRF across parts of the basin. Figure 4-6 shows the elevation of the top of the Gum Ridge Formation, and the lateral extent of the ALB. This map shows that the ALB are not expected to be present at the location of the proposed well sites.

Where fractured and cavernous the GRF can support bore yields of up to 100 l/s although yields from pastoral bores are typically less than 5 L/s but often reflect the stock water demand rather than the potential aquifer yield (Fulton 2018).

Depth to groundwater in the CLA ranges from 32 to 123 mBGS (metres below ground surface) with groundwater levels generally deeper further away from the basin margin in the south-west of EP 161 (Fulton 2018).

The regional groundwater flow direction in the GRF is north-west toward Mataranka, where the aquifer discharges into the Roper River approximately 100 km north-west of the Beetaloo Basin where it supports significant groundwater dependent ecosystems (Fulton 2018).

The groundwater flow direction in the GRF broadly follows the north-west regional flow pattern however, gradients are very flat (0.0001) with little change in groundwater elevations observed over large distances. This is shown in Figure 4-8. Large decadal changes in discharge rates to the Roper River suggest that most recharge of the Roper River occurs close to the discharge zone, i.e. beyond the Beetaloo Sub-basin region (Fulton 2018).

Groundwater recharge mechanisms to the CLA are poorly characterised but are likely to be dominated by infiltration through sinkholes and soil cavities. Recharge is likely to be lower in areas where the overlying Cretaceous deposits, which contain clay and mudstone sequences, are thick and continuous (Fulton 2018). The Project Area straddles the north-east margin of the Georgina Basin. The Top Springs Limestone (main constituent of the CLA in the area) is present across the centre and south-west of the Project Area but pinches out in the north-east where Roper Group formations outcrop (Fulton 2018).

Drilling and geophysical logs confirm a local stratigraphy as per Table 4-4. This was confirmed by geophysical logging of the Tanumbirini 1 exploration well at the location of the proposed well sites.

Table 4-4 Stratigraphy logged at the location of Tanumbirini 1

Formation	Depth to formation top (m)	Thickness (m)
Undifferentiated Cretaceous	Surface	43.9
Gum Ridge Formation	52	150
Inacumba Unit	202	380
Cox Formation	582	570
Bukalara Sandstone	1152	145
Kyalla Sandstone	1297	772
Moroak Sandstone	2069	368
Velkerri Formation	2437	1482.5
Bessie Ck Sandstone	3920	>30.5

A baseline survey of water bores in the vicinity of the proposed well sites was undertaken in 2018. The bore locations are shown in Figure 4-9. This shows that the Gum Ridge Formation is expected to be absent (north and east of the proposed well locations) there are more bores completed in undifferentiated Proterozoic fractured rock aquifers are targeted by water bores. These fractured rock aquifers are not present at the location of the proposed well sites.

Groundwater Electrical Conductivity (EC) in the CLA ranges from 1170 - 2260 µS/cm (average of 1580 µS/cm) and the pH is typically neutral (6.3 - 7.3) (Fulton 2018). Figure 4-7 maps the distribution of total dissolved solids (mg/L) detected in all groundwater relative to the proposed well sites. Santos has established groundwater monitoring bores at the Tanumbirini and Inacumba locations. The groundwater from these bores is fresh, ranging between 800-1000 mg/L TDS. Table 4-5 provides a more detailed breakdown of the groundwater chemistry in the Gum Ridge Formation (compliant with the sampling and testing requirements outlined in the Preliminary Guideline: Groundwater Monitoring Bores for Exploration Wells in the Beetaloo Sub-basin (DENR, 2018)).

Santos has continued to collect groundwater monitoring bore results throughout 2019 and 2020, these results are made publicly available on the DENR website (website yet to be updated to DEPWS) as per the code. Results as recent as March 2020 concluded that water quality at the Tanumbirini site (Impact monitoring bore) has remained consistent with that of the control monitoring bore following hydraulic fracture activities. This indicates that groundwater quality has not been impacted by project attributable activities.

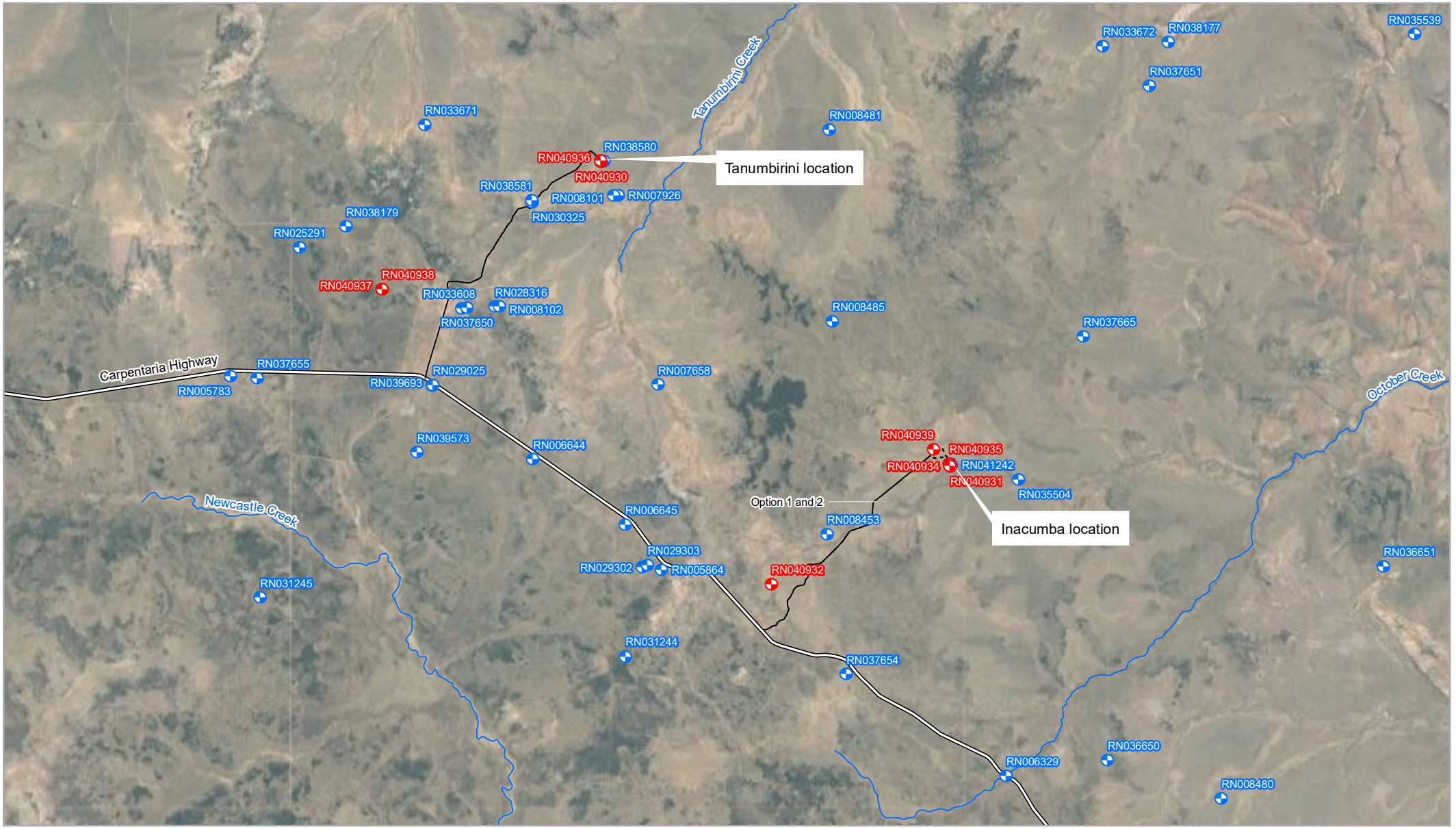
The existing bores are shown in Figure 4-4. In addition, CSIRO led baseline studies are underway with extensive effort being put into the understanding of recharge, this information will form part of the Strategic Regional Environmental Baseline Assessment (SREBA) managed by the NT government.

Table 4-5 Groundwater chemistry from the Tanumbirini and Inacumba Control Monitoring Bores

CHEMICAL NAME	RESULT UNIT	LIMIT OF DETECTION	Tanumbirini RN040930 - Control Bore				Inacumba RN040931 - Control Bore			
			No. results	Min	Median	Max	No. results	Min	Median	Max
Total Alkalinity as CaCO3	mg/L	1	25	251	410	467	20	251	436.5	470
Electrical Conductivity @ 25°C	µS/cm	1	25	886	1310	1410	20	1230	1780	1940
Total Dissolved Solids @180°C	mg/L	10	25	639	837	928	20	708	1165	1330
Suspended Solids	mg/L	5	25	<5	8.5	40	20	<5	20.5	36
Mercury	mg/L	0.0001	21	<0.0001	-	<0.0001	19	<0.0001	-	<0.0001
Calcium	mg/L	1	25	109	139	152	20	22	136	163
Magnesium	mg/L	1	25	37	57	63	20	82	103	122
Potassium	mg/L	1	25	8	12	13	20	22	27	33
Chloride	mg/L	1	25	65	110	114	20	142	154.5	160
Fluoride	mg/L	0.1	25	0.5	0.7	0.8	20	1.5	2.55	3
pH - Lab	pH Unit	0.01	25	7.27	7.76	8.16	20	7.36	7.88	8.47
Nitrite as N	mg/L	0.01	25	<0.01	-	<0.01	20	<0.01	-	<0.01
Nitrate as N	mg/L	0.01	25	<0.01	0.025	0.04	20	<0.01	0.09	2.12
Sulphate as SO4 2-	mg/L	1	22	132	171.5	206	20	192	372.5	451
Gross alpha	Bq/L	0.05	22	0.35	0.76	0.91	19	0.05	0.265	0.4
Gross beta activity - 40K	Bq/L	0.1	22	0.21	0.36	0.47	19	0.1	0.22	0.33
Arsenic	mg/L	0.001	21	0.001	0.0055	0.014	20	<0.001	0.002	0.01
Barium	mg/L	0.001	21	0.032	0.0475	0.053	19	0.026	0.036	0.048
Boron	mg/L	0.05	25	0.08	0.18	0.22	20	0.06	0.26	0.3
Cadmium	mg/L	0.0001	25	<0.0001	0.0002	0.0002	20	<0.0001	-	<0.0001
Chromium	mg/L	0.001	25	<0.001	0.002	0.003	20	<0.001	-	<0.001
Copper	mg/L	0.001	25	<0.05	0.007	0.015	20	<0.001	0.001	0.002
Iron	mg/L	0.05	25	0.09	0.53	3.54	20	1.45	7.805	19.1
Lead	mg/L	0.001	25	<0.001	0.005	0.028	20	<0.001	-	<0.001
Lithium	mg/L	0.001	21	0.031	0.069	0.08	19	0.199	0.45	0.606

CHEMICAL NAME	RESULT UNIT	LIMIT OF DETECTION	Tanumbirini RN040930 - Control Bore				Inacumba RN040931 - Control Bore			
			No. results	Min	Median	Max	No. results	Min	Median	Max
Manganese	mg/L	0.001	21	0.008	0.018	0.058	19	0.072	0.2	0.269
Selenium	mg/L	0.01	25	<0.01	0.05	0.05	20	<0.01	-	<0.01
Silver	mg/L	0.001	24	<0.001	-	<0.001	20	<0.001	-	<0.001
Strontium	mg/L	0.001	20	0.546	0.834	0.911	19	0.082	0.958	1.16
Zinc	mg/L	0.005	21	0.01	0.042	0.103	19	0.028	0.05	0.473
Ethane	µg/L	1	24	<1	-	<1	19	<1	-	<1
Methane	µg/L	1	24	<1	-	<1	19	<1	-	<1
Propane	µg/L	1	24	<1	-	<1	19	<1	-	<1
>C10 - C16 Fraction	µg/L	100	25	<100	-	<100	20	<100	-	100
>C10 - C16 Fraction (-) Naphthalene (F2)	µg/L	100	25	<100	-	<100	20	<100	-	100
>C10 - C40 Fraction (sum)	µg/L	100	25	<100	-	<100	20	<100	240	380
>C16 - C34 Fraction	µg/L	100	25	<100	-	<100	20	<100	190	280
>C34 - C40 Fraction	µg/L	100	25	<100	-	<100	20	<100	-	<100
C6 - C36 Fraction (Sum)	µg/L	20	20	<20	-	<20	16	<20	-	60
C6 - C10 Fraction	µg/L	20	25	<20	-	<20	20	<20	-	<20
C6 - C10 Fraction minus BTEX (F1)	µg/L	20	25	<20	-	<20	20	<20	-	<20
C6 - C9 Fraction	µg/L	20	25	<20	-	<20	20	<20	-	<20
Benzene	µg/L	1	25	<1	-	<1	20	<1	-	<1
Ethylbenzene	µg/L	2	25	<2	-	<2	20	<2	-	<2
meta- & para-Xylene	µg/L	2	25	<2	-	<2	20	<2	-	<2
Naphthalene	µg/L	5	25	<5	-	<5	20	<5	-	<5
ortho-Xylene	µg/L	2	25	<2	-	<2	20	<2	-	<2
Sum of BTEX	µg/L	1	25	<1	-	<1	20	<1	-	2
Toluene	µg/L	2	25	<2	-	<2	20	<2	-	2
Total Xylenes	µg/L	2	25	<2	-	<2	20	<2	-	<2
3-Methylcholanthrene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
7.12-Dimethylbenz(a)anthracene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1

CHEMICAL NAME	RESULT UNIT	LIMIT OF DETECTION	Tanumbirini RN040930 - Control Bore				Inacumba RN040931 - Control Bore			
			No. results	Min	Median	Max	No. results	Min	Median	Max
Acenaphthene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Acenaphthylene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Anthracene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Benz(a)anthracene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Benzo(a)pyrene	µg/L	0.05	21	<0.05	-	<0.05	18	<0.05	-	<0.05
Benzo(a)pyrene TEQ (zero)	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Benzo(b+j)fluoranthene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Benzo(g.h.i)perylene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Benzo(k)fluoranthene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Chrysene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Dibenz(a.h)anthracene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Fluoranthene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Fluorene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Indeno(1.2.3.cd)pyrene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Naphthalene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Phenanthrene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Pyrene	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1
Sum of polycyclic aromatic hydrocarbons (PAHs)	µg/L	0.1	21	<0.1	-	<0.1	18	<0.1	-	<0.1



Legend

- Santos bore
- Groundwater bore
- Proposed Access Road
- Major Waterways
- Principal Road
- Inacumba Lease
- Tanumbirini Leases

1:220,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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Date **20/01/2021**

Groundwater Bores

FIGURE 4-4

S:\Geospatial\43\12538768\GIS\Maps\12538768_014_Groundwater.mxd
Print date: 20 Jan 2021 - 14:42

Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

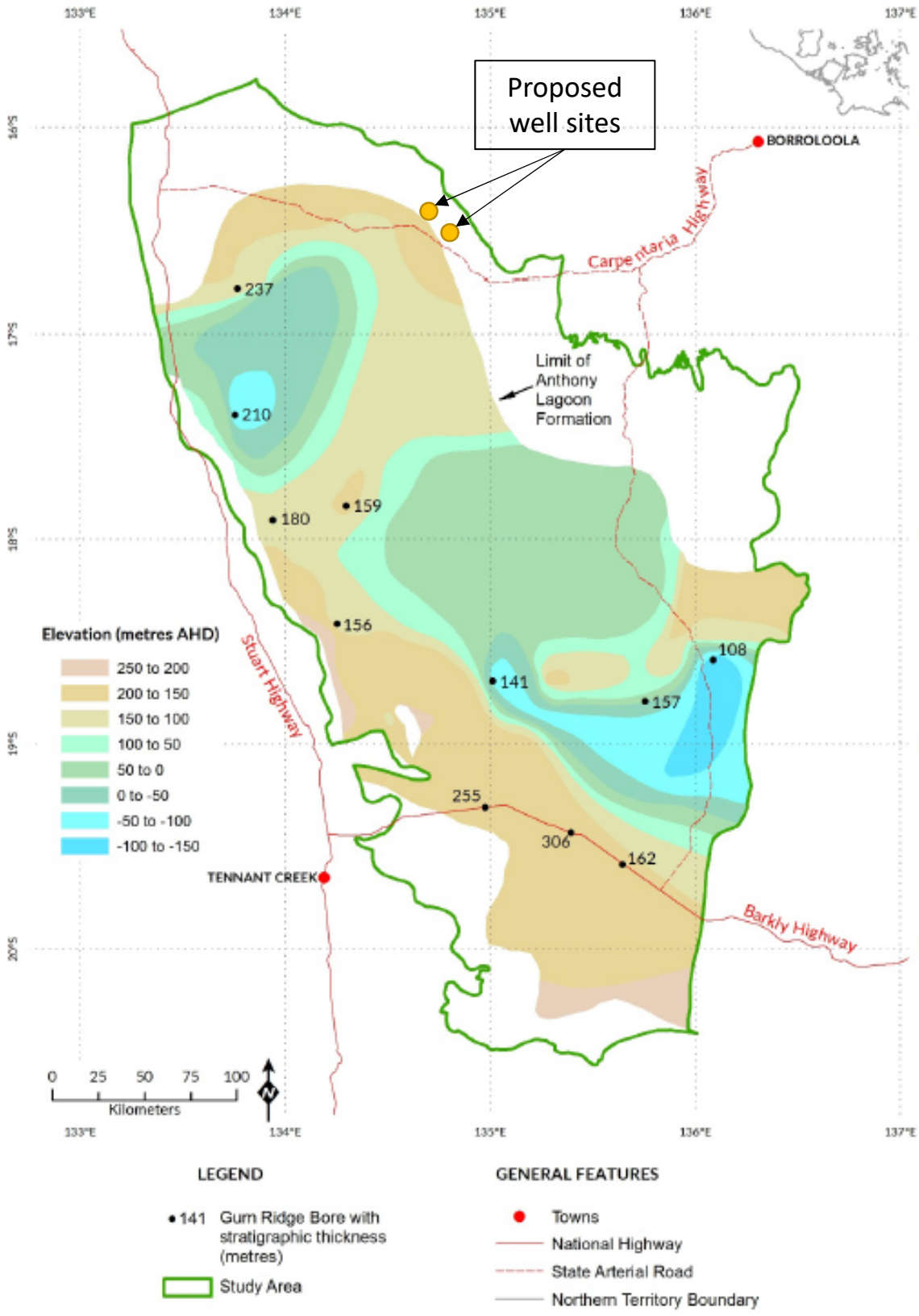


Figure 4-5 Elevation (mAHD) of the top of the Gum Ridge Formation relative to the proposed well sites (adapted from Tickell and Bruwer (2017) *Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek*)

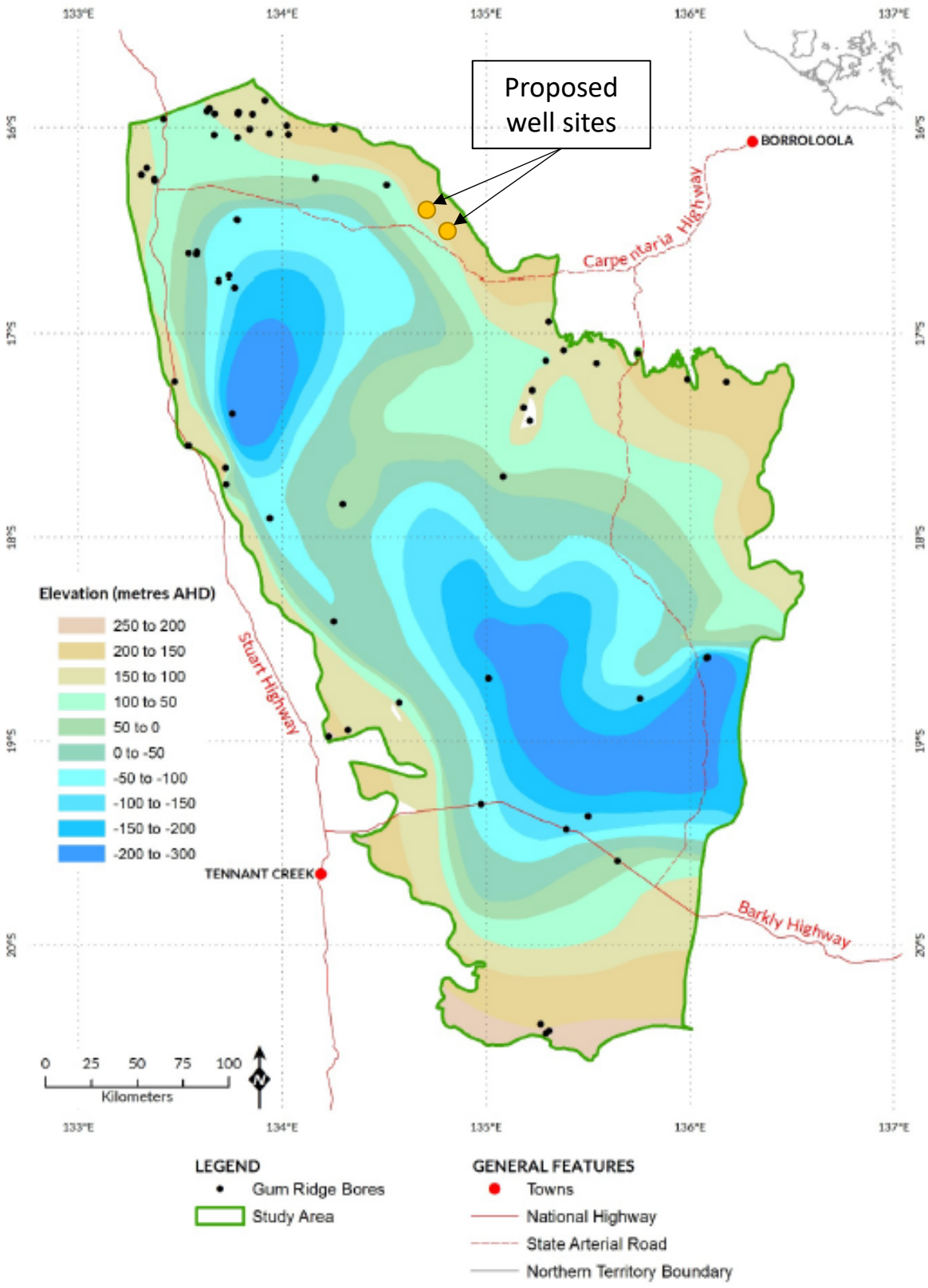


Figure 4-6 Elevation (m AHD) of the base of the Gum Ridge Formation relative to the proposed well sites (adapted from Tickell and Bruwer (2017) *Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek*)

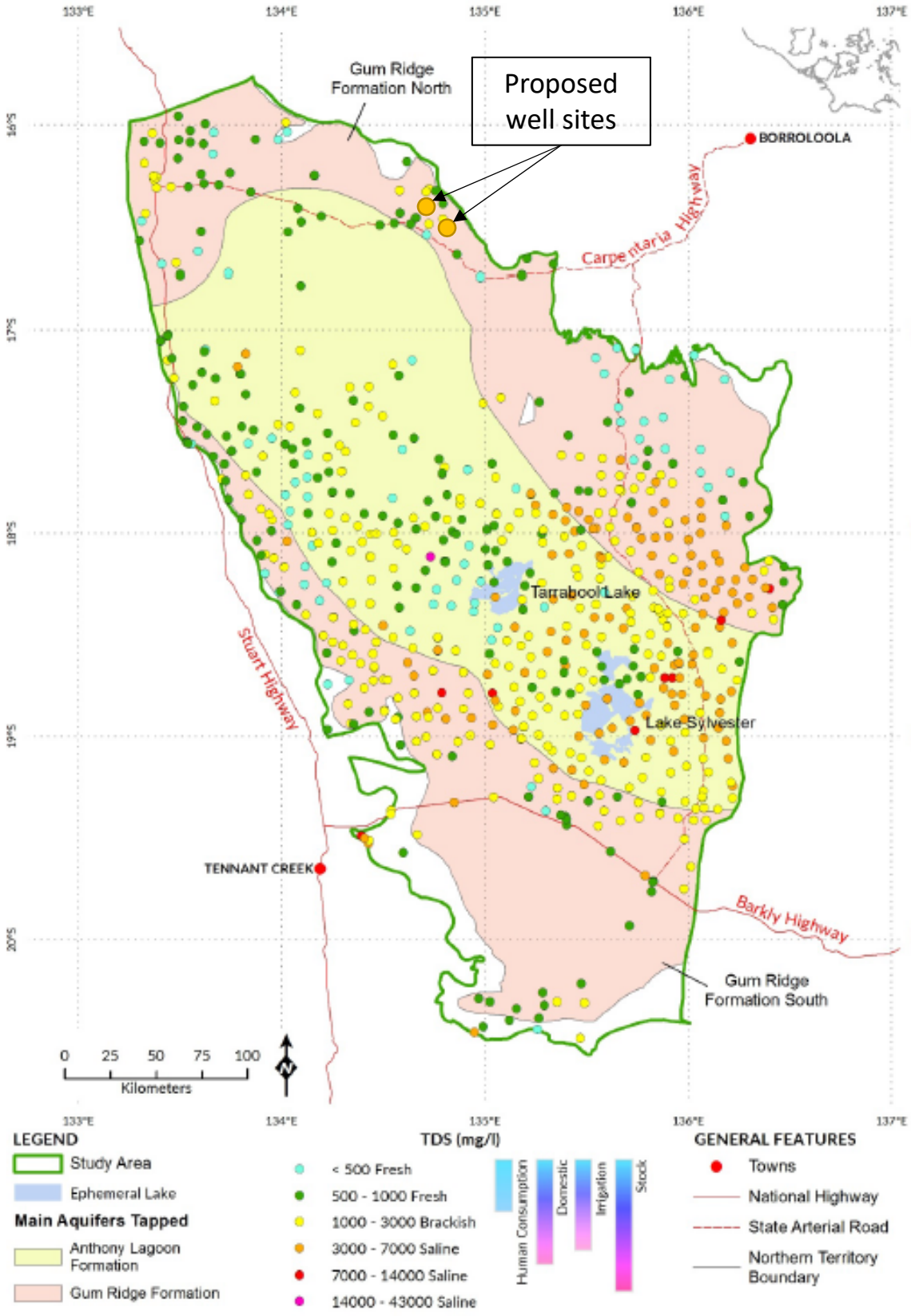


Figure 4-7 Groundwater total dissolved solids (mg/L) relative to the proposed well sites (adapted from Tickell and Bruwer (2017) *Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek*)

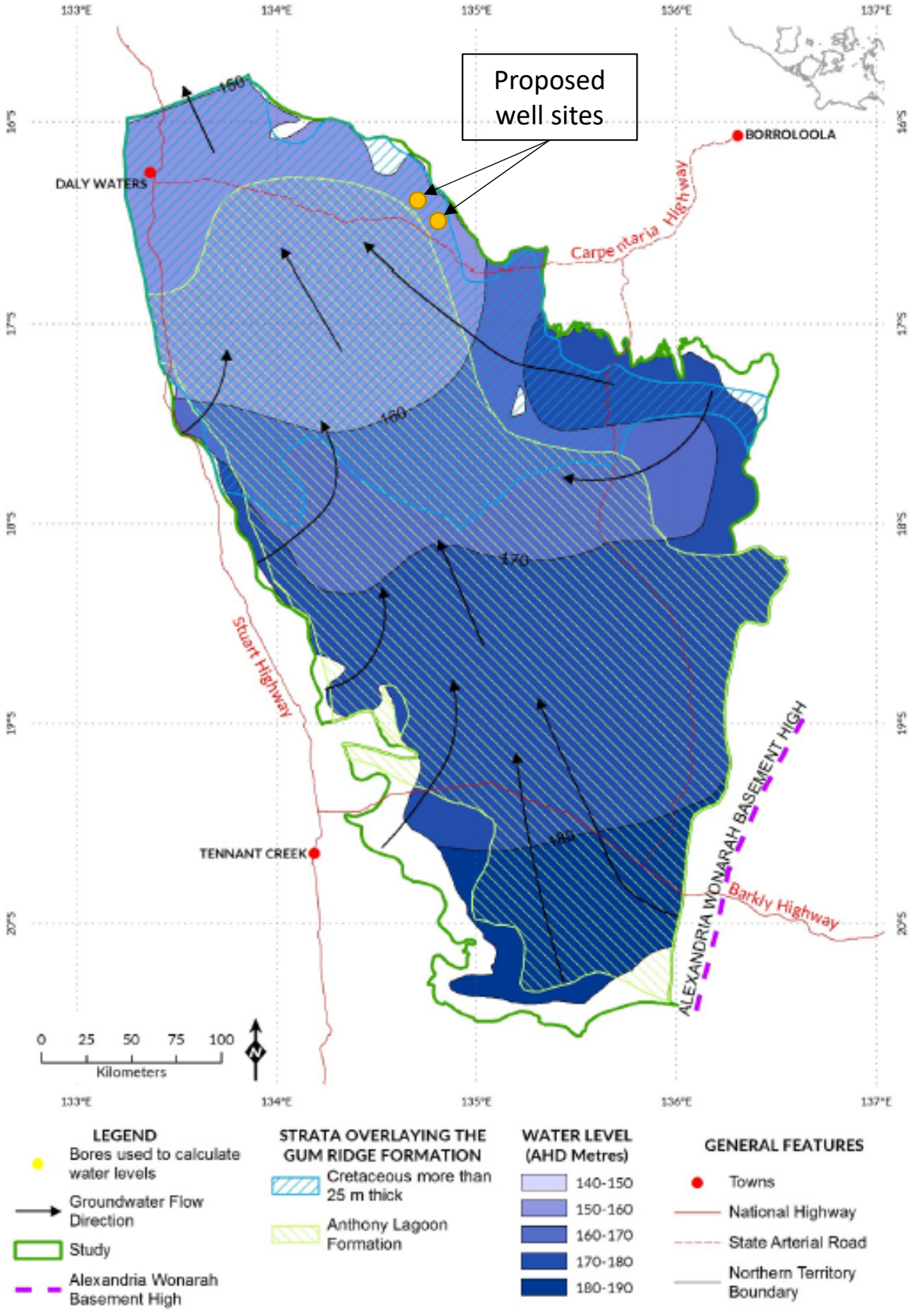


Figure 4-8 Regional groundwater level contours in the Gum Ridge Formation relative to the proposed well sites (adapted from Tickell and Bruwer (2017) *Georgina Basin Groundwater Assessment: Daly Waters to Tennant Creek*)

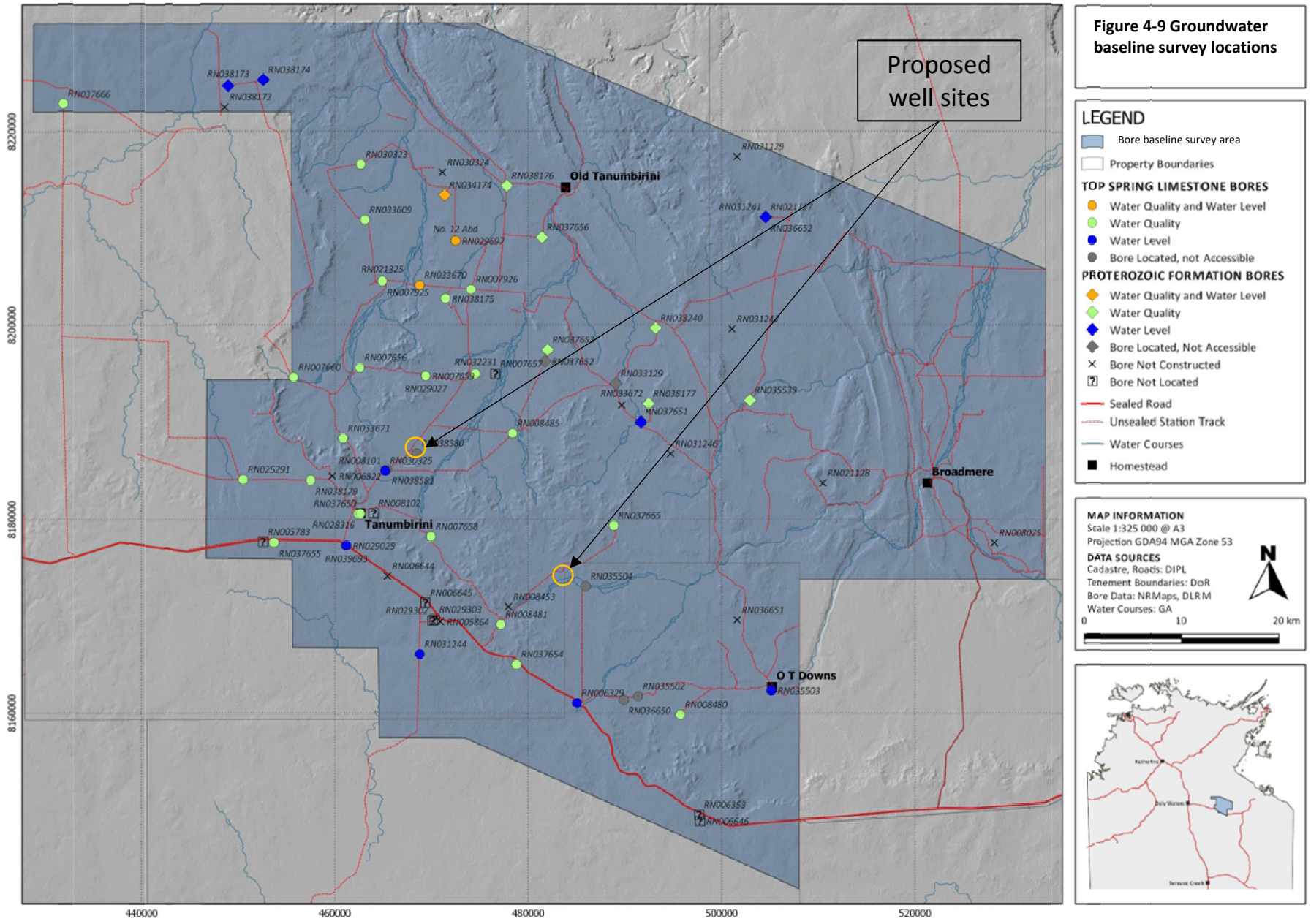


Figure 4-9 Groundwater baseline survey locations

LEGEND

- Bore baseline survey area
- Property Boundaries

TOP SPRING LIMESTONE BORES

- Water Quality and Water Level
- Water Quality
- Water Level
- Bore Located, not Accessible

PROTEROZOIC FORMATION BORES

- Water Quality and Water Level
- Water Quality
- Water Level
- Bore Located, Not Accessible
- Bore Not Constructed
- Bore Not Located
- Sealed Road
- Unsealed Station Track
- Water Courses
- Homestead

MAP INFORMATION
Scale 1:325 000 @ A3
Projection GDA94 MGA Zone 53

DATA SOURCES
Cadastre, Roads: DIPL
Tenement Boundaries: DoR
Bore Data: NRMaps, DLRM
Water Courses: GA

N

0 10 20 km

4.1.7 Surface water

The Project Area is located in the headwaters of the Limmen Bight River catchment, which drains north easterly towards the Gulf of Carpentaria as shown in Figure 4-10. Rivers include the Limmen Bight River and its tributary, the Cox River (NR Maps, 2018).

The highest flows for these rivers occur during the wet season, predominantly due to cyclones and monsoonal rainfall. In contrast to these larger rivers, smaller braided streams and drainage lines such as the Tanumbirini Creek and October Creek to the north, and Newcastle Creek to the south are largely ephemeral. Ephemeral rivers and streams are subject to short flow duration and high turbidity.

There is also a range of small wetlands associated with springs, sinkholes and minor depressions in the generally flat landscape. Riparian zones of these rivers and wetlands are generally in fair to good condition, affected mostly by livestock and feral animals and weeds.

Any major creek crossings and floodways intersected by the access tracks will be constructed to include rocking to avoid and minimise erosion. To minimise erosion along access tracks, Mitre drains and flow control banks (whoa boys) will be installed where required. An Erosion and Sediment Control Plan (ESCP) will be developed by a Certified Professional in Erosion and Sediment Control (CPESC) and approved by DEPWS prior to commencement of the project.

4.1.7.1 Preliminary Flood Modelling

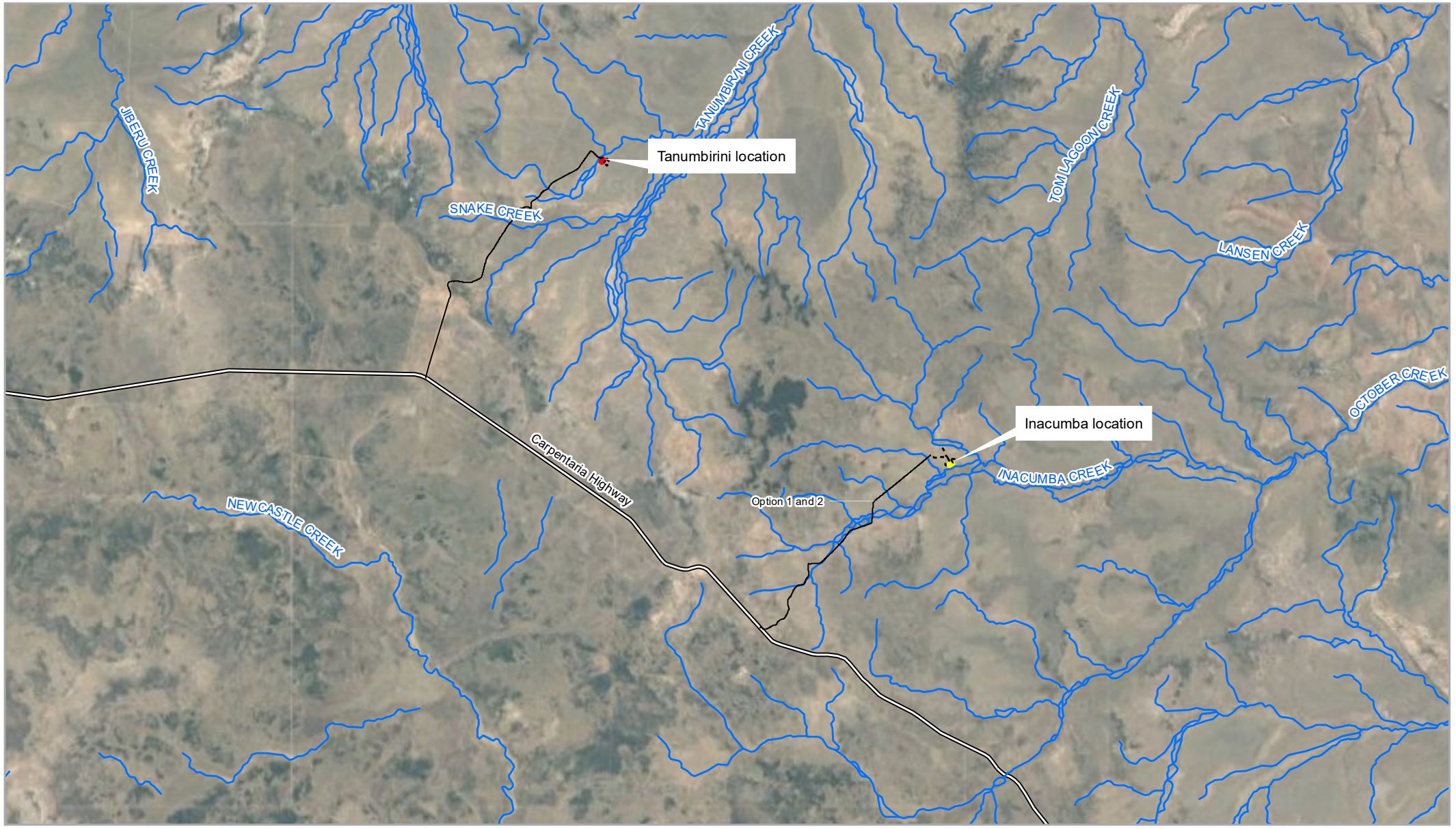
Preliminary flood modelling was completed for the Annual Exceedance Probability (AEP) - the probability that a given rainfall total accumulated over a given duration will be exceeded in any one year, of 1 in 10, 1 in 20, 1 in 50 and 1 in 100.

The flood modelling was based on a hydrologically enforced SRTM digital elevation model (vertical accuracy +/- 9.8m), with design discharge rates based on estimates from the regional flood frequency estimation (RFFE) model, rational method and regression equations outlined in Weeks, 2006 (Northern Territory Hydrology - The Alice Springs to Darwin Railway). A TUFLOW model was then developed based on the SRTM data, running a steady-state simulation based on peak flow rates from the RFFE model.

The results indicate the lease pad at the Tanumbirini location will be subject to minor flooding during a 1 in 10 AEP flood event. That flooding extends to an average depth of 1 to 1.5m during a 1 in 100 AEP flood event. However the supporting infrastructure areas, including the camp, tank pads and laydown areas in the south east remain unaffected by a 1 in 100 AEP flood event. The Inacumba location including the lease pad and the supporting infrastructure areas remains mostly unaffected in a 1 in 100 AEP flood event. Note, the model for the Tanumbirini location was adjusted to consider the elevation of the existing lease pad design (i.e. 2 m above the level of the adjacent creek bed).

Detailed evacuation plan will be developed prior to commencement of the drilling program to ensure safe evacuation in the event of flooding. Details regarding the site evacuation plan will be included in the site induction package.

The 1 in 100 AEP flood extent at the Tanumbirini and the Inacumba locations is shown in Figure 4-11 and Figure 4-12 below.



Legend

- Major Waterways
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases

1:220,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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Surface Water

Project No. **12538768**
Revision No. **A**
Date **5/11/2020**

FIGURE 4-10

S:\Geospatial\43\12538768\GIS\Maps\12538768_009_SurfaceWater.mxd
Print date: 05 Nov 2020 - 16:12

Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

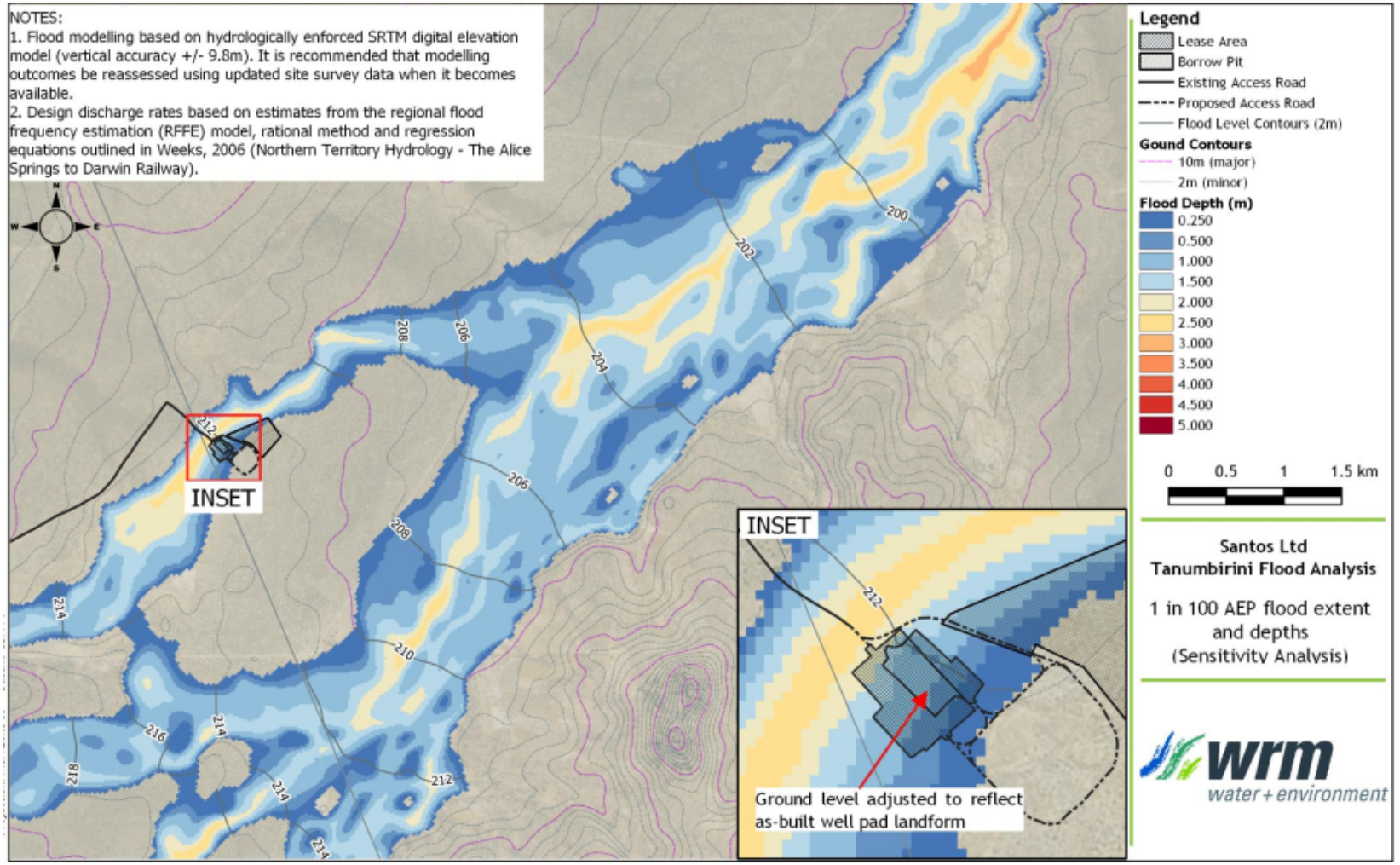


Figure 4-11 The 1 in 100 AEP flood extent at the Tanumbirini location

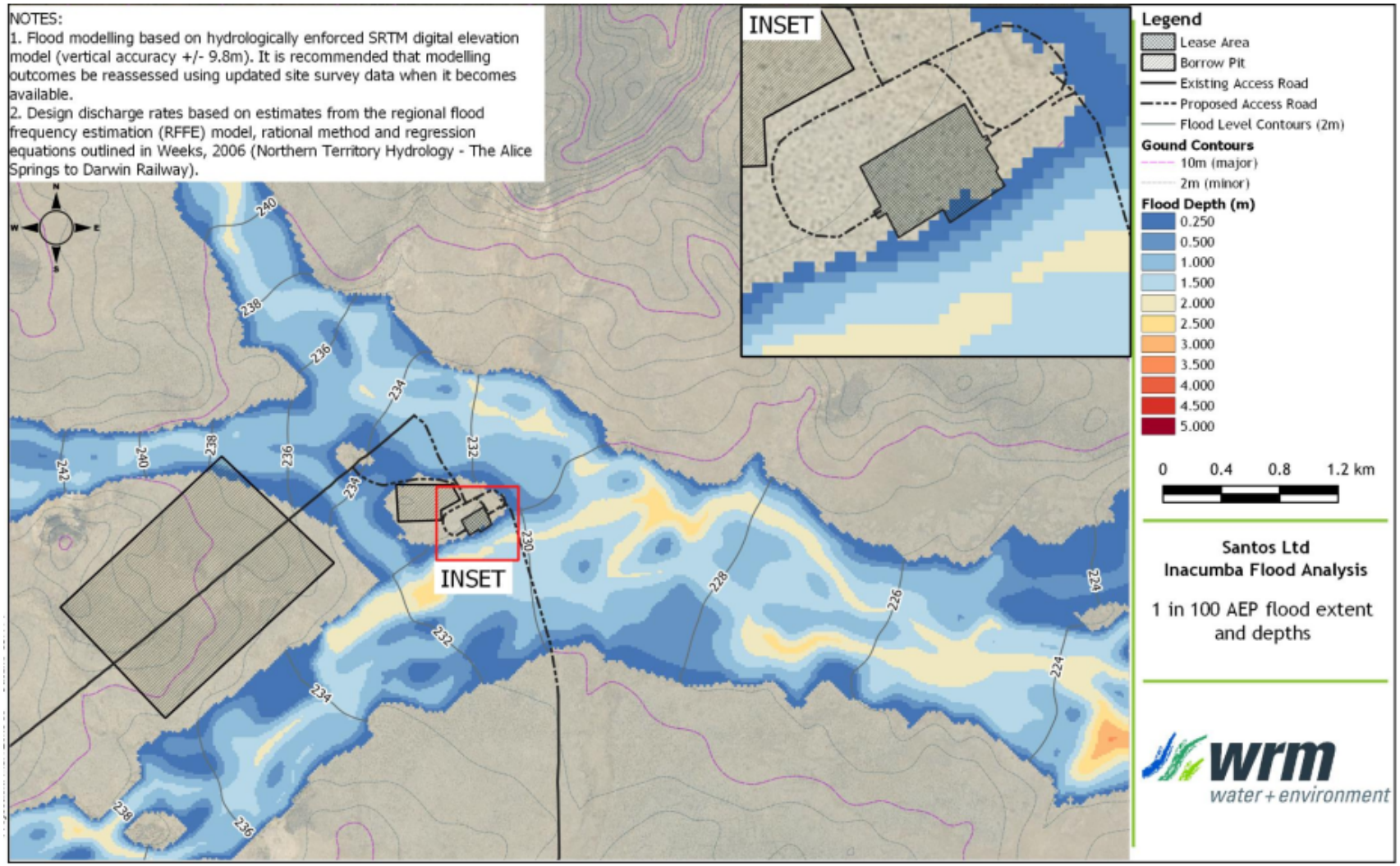


Figure 4-12 The 1 in 100 AEP flood extent at the Inacumba location

4.1.8 Air Quality

Baseline methane monitoring has been conducted to monitor and measure background methane levels and rate of change in methane levels using mobile survey technology. The methane monitoring program was conducted by CSIRO using the methodology established by the Gas Industry Social and Environmental Research Alliance (GISERA). Data collected during this monitoring is available online here: https://gisera.csiro.au/project/baseline-measurement-and-monitoring-of-methane-emissions-in-the-beetaloo-sub-basin/.

The pre-exploration final report (CSIRO 2019), found that the average methane concentration across the survey area were found to be close to the normal background concentrations expected in rural or natural areas. Isolated pockets of slightly elevated methane concentrations were observed in some areas; the sources of these were identified as grazing cattle, townships, a section of above-ground gas pipeline, fires, termites and wetland.

4.2 Natural Environment

A description of the natural environment in the areas surrounding the project are detailed below. In addition, an ecological assessment report of the ecological survey work conducted on Tanumbirini Station between 2017 and 2019 is provided in Appendix D.

4.2.1 Bioregions

The Interim Biogeographic Regionalisation of Australia (IBRA) is a nationally recognised ecosystem classification system. Bioregions are large, geographically distinct ecosystems that are distinguished by broad physical and biological characteristics. These regions are used as the basis for regional comparisons and conservation of flora and floristic communities.

Tanumbirini Station is located at the junction of two biogeographic regions as well as the headwaters of a number of catchments. As a result, the landscapes reflect to some degree those of the southern Sturt Plateau and Gulf Fall and Upland (upper Roper River) Bioregions, see Figure 4-13.

4.2.1.1 Gulf Fall and Upland Bioregion

The Gulf Fall and Upland Bioregion covers an area of 118,480 km^2 and includes gorges, water holes and dissected sandstone plateaus comprising Proterozoic sandstone outcrops. Vegetation is predominantly eucalypt woodlands over spinifex grasslands. Cattle grazing and mining are the main land uses. Other land uses include Aboriginal land and conservation reserves. Major population centres are Borroloola and Ngukurr (DoEE 2008).

Feral animals, weeds and a broad fire regime are eroding the bioregion however, it is generally in good condition. The bioregion also provides refuge for threatened species including the endangered Carpentaria rock-rat and Gouldian finch (Department of Lands Resource Management 2015).

The riparian zones of water courses are in reasonably good condition however, experience degradation from uncontrolled livestock and feral animals. Other issues localised watercourses face are weed infestations, altered fire regimes and pollution related to mining.

The bioregion is generally in good condition, but is being eroded by continuing increases in the number of feral animals (especially pigs, buffalo, donkeys and cattle) and weeds, and broad-scale changes in fire regime.

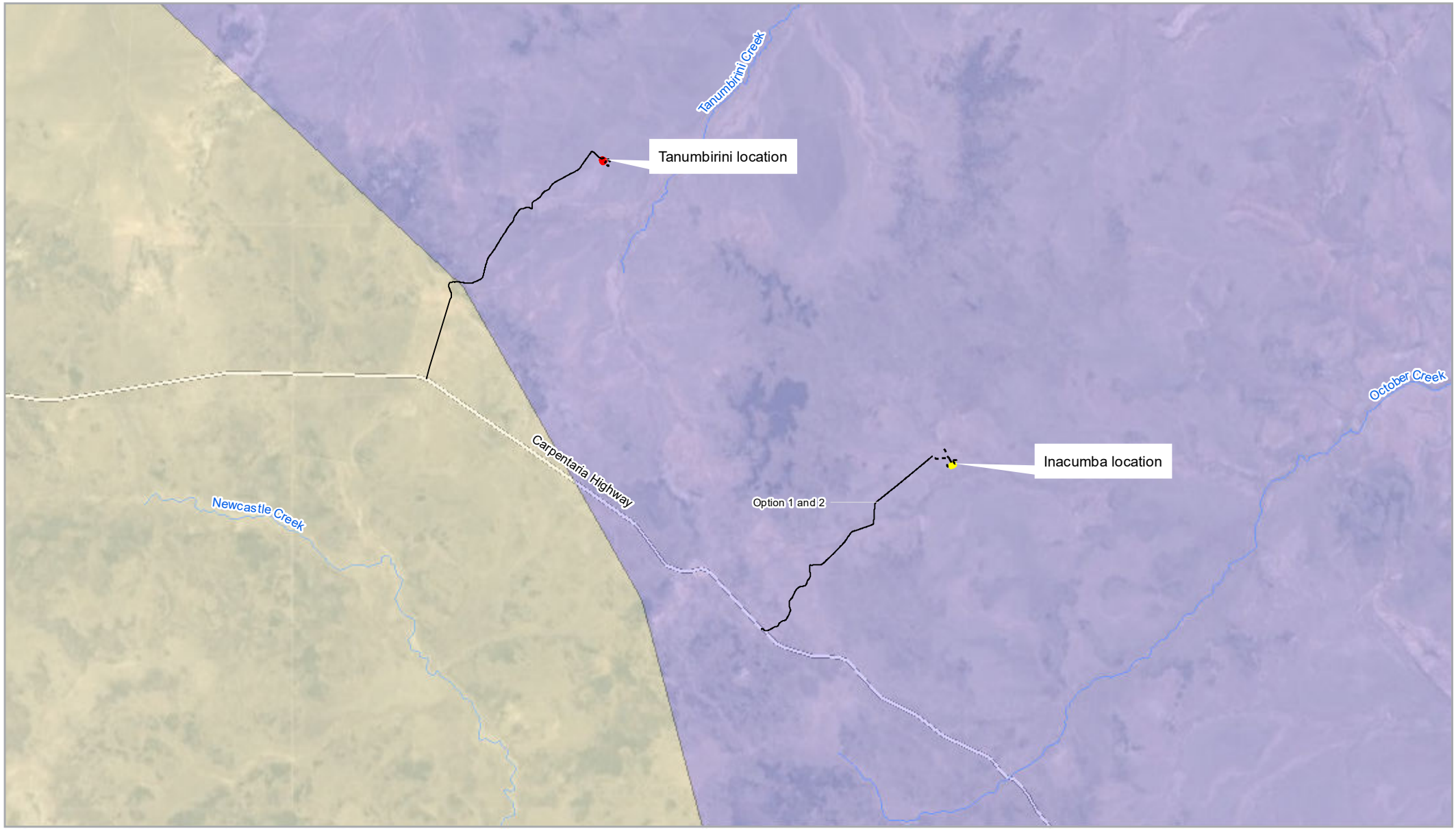
4.2.1.2 Sturt Plateau Bioregion

The Sturt Plateau Bioregion comprises a total area of approximately 98,575 km^2. The topography is characterised by low-lying flat to gently undulating plains. The vegetation is mostly eucalypt open forests and woodlands dominated by bloodwoods. Open areas are dominated by perennial grasses and annual grasses. The main industry use in this region is cattle grazing. The major population centres include Larrimah and Daly Waters (Bastin and Acris, 2008).

The climate in this bioregion is dry but influenced by monsoonal activity. Historically water supply issues have affected this region, but the increase in groundwater information has led to improved success rates for drilling bores and subsequently better land development.

It has been estimated that 77% of the Sturt Plateau bioregion is grazed by stock. There are a number of weeds that are known to occur in this bioregion such as hyptis, prickly acacia, sicklepod and mission grass. The Alice Springs to Darwin railway corridor has provided an avenue for new weeds to invade and spread in the region. Known invasive animals include pigs, dogs, camels, cats and horses (Bastin and Acris, 2008).

The strategic placement of water access points has increased the development of infrastructure, reduced the number and intensity of wildfires and increased the area available for grazing.



Legend

- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases

Bioregion Name

- Gulf Fall and Uplands
- Sturt Plateau

1:220,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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GHD

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Bioregions

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FIGURE 4-13

S:\Geospatial\43\12538768\GIS\Maps\12538768_010_BioRegions.mxd
Print date: 05 Nov 2020 - 16:15

Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: BioRegions, Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

4.2.2 Vegetation

The National Vegetation Information System (NVIS) 2007 Level 2 survey describes the vegetation contained within the EP and surrounding Tanumbirini Station as Tussock grassland, Acacia open forest, and Eucalyptus low woodland (DEPWS, 2000), as shown Figure 4-16.

The dominant vegetation type in the immediate area of the Tanumbirini Project Area is woodland. The dominant species within the woodland vegetation communities present is dominated by Kullingal *Eucalyptus pruinosa and* variable barked Bloodwood *Corymbia dichrompophloia* with *Melaleuca* spp. with tussock grass understorey.

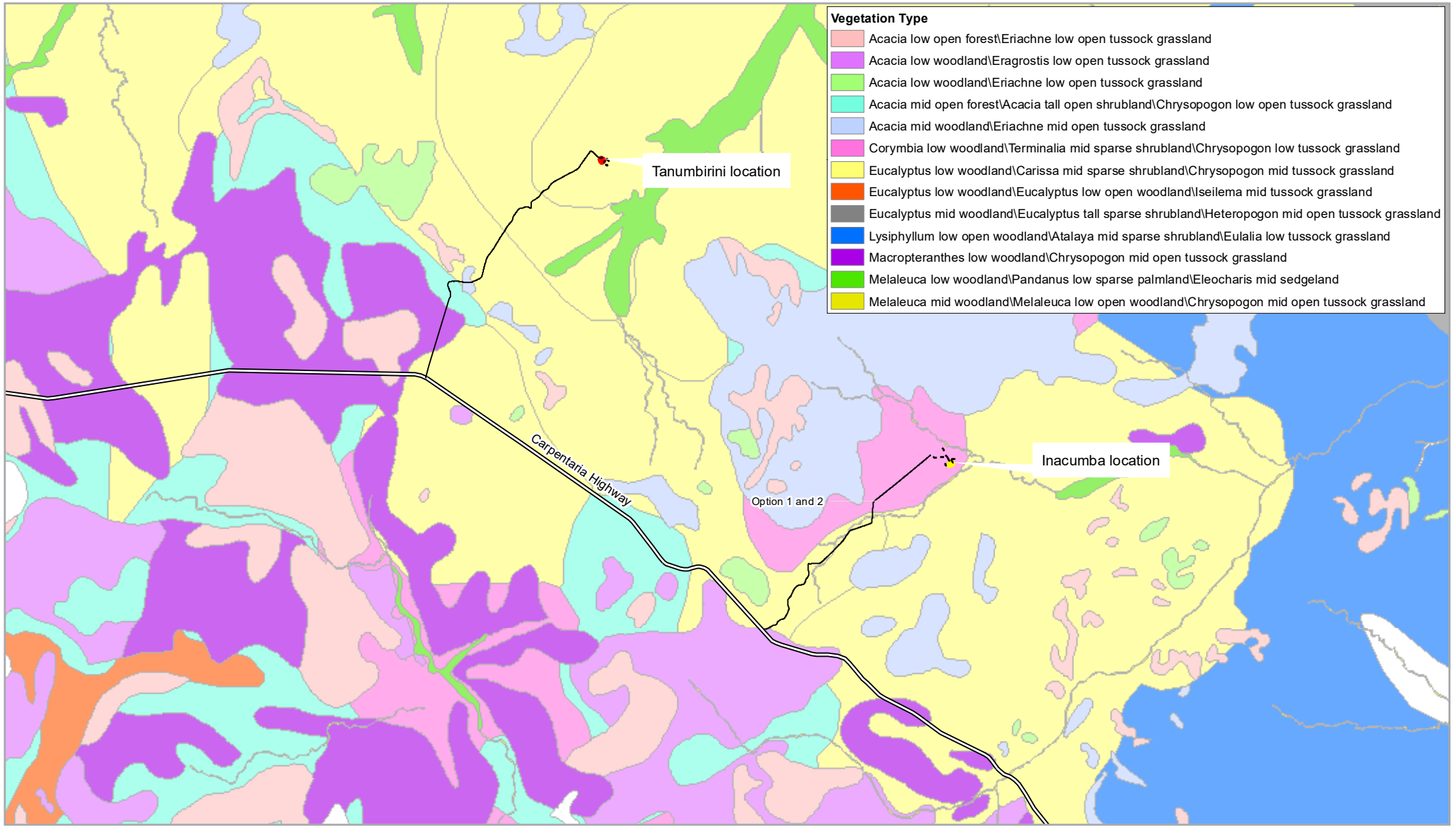
Ecoz undertook a survey of the vegetation in the vicinity of the proposed Tanumbirini well location and found vegetation communities within the Project Area are dominated by Eucalyptus and Corymbia species (in the plains and undulating hills), Acacia woodlands/forests, and Melaleuca communities (within drainages lowlands, and depressions), Lancewood (*Acacia shirleyi*) woodland/forests and Bullwaddy (*Macropteranthes kekwickii)* woodlands. Although not indicated on the national vegetation information system (NVIS) mapping, areas of tussock grasslands on lateritic plains or alluvial plains were recorded. These communities were surrounded by either Eucalyptus or Melaleuca woodlands (Aldrick and Wilson 1992, Ecoz 2019).

Vegetation exhibited impacts from cattle. Understorey grass species showed extensive impact from cattle grazing. Trampling and impacts to the soil surface were also evident.

Eucalyptus woodlands containing *Eucalyptus leucophloia* which occur on rises (particularly within the lateritic plateau land systems) may provide nesting habitat for Gouldian Finch (see Section 4.2). However, none of these habitat areas occur within the Tanumbirini or Inacumba locations.

Figure 4-14 The Inacumba location and the surrounding vegetation

Figure 4-15 Looking west towards the watercourse at the Tanumbirini location



Legend

- Existing Access Road
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases

1:220,000 @ A4

0 2.5 5 7.5 10

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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Vegetation Types

FIGURE 4-16

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Print date: 05 Nov 2020 - 16:21

Data source: NTG - NVIS (2007) . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

4.2.3 Listed Threatened Species

A search of the NT Flora and Fauna Atlas (NR Maps, 2018) was completed on 5 December 2018 to determine threatened species records within 10 km of the Project Area, which found records of one reptile (Mertens` Water Monitor) and one mammal (Carpentarian Antechinus).

A search of the PMST database (DoEE 2018) was undertaken on 4 December 2018 to identify MNES likely to occur within 10 km of the Project Area (Appendix B). The PMST Report identified six birds, five mammals and one reptile that are listed threatened species that may occur within 10 km of the Project Area. No listed insects were reported. The results of the PMST Report and NT Fauna Atlas are outlined in

Table 4-6 below and a likelihood assessment has been undertaken, utilising information from desktop and field studies undertaken on EP 161 (Appendix D).

The likelihood assessment was based on habitat requirements, distribution, and the number and dates of proximate records (Ecoz 2017). On-ground habitat assessment was also used to assist the assessment. In this assessment, the likelihood of a species occurring is ranked as none, low, medium, and high. In the context of this report, this means:

- **None** – There is no likelihood of this species occurring within the survey area
- **Low** – The survey area occurs outside of the core distribution for the species and there is no or only marginally suitable habitat. Some vagrant records may exist
- **Medium** – There is suitable habitat within the survey area but records are either old, infrequent or some distance from the project footprint
- **High** – There is suitable habitat within the survey area and records are proximate and recent.

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Table 4-6 Likelihood assessment for potential threatened species

Common Name	Scientific Name	EPBC Status	TPWC Status	Likelihood of occurrence	Distribution and Habitat
Birds					
Australian Painted Snipe	*Rostratula australis*	Endangered	Vulnerable	Low	This species is found in the fringes of permanent and temporary wetlands, swamps and inundated grasslands (Taylor et al. 2013) and is nomadic and scattered across Australia with no predictable occurrence (Rogers 2001). The closest known occurrence is approximately 50 km north-east of the Project Area but the Project Area would provide occasional habitat for this species during periods of inundation.
Crested Shrike-tit	*Falcunculus frontatus whitei*	Vulnerable	-	Medium	Species occurs sparsely across the NT. Populations persist in areas burnt every year and highly grazed, particularly in the Sturt Plateau Bioregion. This is the bioregion containing the Project Area. The Crested shrike-tit inhabits a wide range of forests and woodlands, and are thought to have large home ranges (Woinarski 2004). The Project Area provides potentially suitable habitat for this species.
Curlew Sandpiper	*Calidris ferruginea*	Critically Endangered	Vulnerable	Low	The habitat of this species is coastal and estuarine with tidal mudflats and is rarely found inland (Ecoz 2017). This species has a low likelihood of occurring with the Project Area.
Gouldian Finch	*Erythrura gouldiae*	Endangered	Vulnerable	Medium	Gouldian finches have specific habitat needs including the presence of established hollows for nesting. The preferred tree species for nesting are Snappy Gums *(Eucalyptus Leucophloia)*, which have been identified as occurring within the Project Area. Gouldian Finches feed on the seeds of perennial grasses and require a water source within 2-4 km of their home range (O'Malley 2006). Due to the presence of potential nesting habitat within the study area, it is possible that the Gouldian Finch may occur.
Masked Owl	*Tyto novaehollandiae kimberli*	Vulnerable	Vulnerable	Low	This species is found mainly in Eucalyptus tall open forests (especially those dominated by *Eucalyptus miniata* and *E. tetrodonta*), but also roosts in monsoon rainforests and forages in more open vegetation types, including grasslands (Woinarski and Ward 2012).There is no suitable tall open

Common Name	Scientific Name	EPBC Status	TPWC Status	Likelihood of occurrence	Distribution and Habitat
					Eucalyptus forest for roosting in the Project Area, although the open woodland habitat may provide suitable foraging habitat (Ecoz 2017).
Red Goshawk	*Erythrotriorchis radiatus*	Vulnerable	Vulnerable	Low	The Red Goshawk prefers tall, open Eucalyptus forest and riparian areas and nests in large trees, which occur within 1 km of permanent water (Ecoz, 2017). No nesting habitat of this type was observed within the Project Area (Ecoz, 2017).
Grey Falcon*	*Falco hypoleucos*	-	Vulnerable	Medium	Occurs in areas of lightly-timbered lowland plains, typically on inland drainage systems, where the average annual rainfall is less than 500 mm and the majority of records are from the southern half of the NT. (Ward 2012). The Project Area has a higher rainfall than 500 mm however it was observed 100 km north-west of the Project Area in 2000 (Ecoz 2017). This species may occasionally occur within the study area.
Painted Honeyeater*	*Grantiella picta*	Vulnerable	Vulnerable	Low	The Painted Honeyeater is distributed predominantly in Eastern/South-eastern Australia. There are no known breeding colonies in the NT, and it has been speculated that sightings have been of an occasional bird that has moved west. It is believed that degradation of breeding habitat in Eastern Australia has led to their population to decline nationally, including in the NT (DEPWS, 2012). It is unlikely that this species occurs within the study area with any regularity.
Mammals					
Bare-rumped Sheath-tailed Ba	*Saccolaimus nudicluniatus*	Vulnerable		Low	The species is predominantly found throughout the monsoonal tropics and the dry open woodlands and grasslands in the Project Area are unlikely to be suitable habitat (Ecoz 2017.)
Carpentarian Antechinus	*Pseudantechinus mimulus*	Vulnerable	-	Low	The species habitat in the NT is sloping sandstone hills with boulders, pavement, outcrops and rocky surface, with open woodland of *Eucalyptus tetrodonta* and E. *aspera*, and a dense understorey and ground cover of *Plectrachne pungens* (DoE 2017a). There is only a small area of rocky outcropping in the Project Area and the Project Area is towards the edge of the species' distribution (Ecoz 2017). Not recorded in the area since 1987.

Common Name	Scientific Name	EPBC Status	TPWC Status	Likelihood of occurrence	Distribution and Habitat
Ghost Bat	*Macroderma gagis*	Vulnerable	-	Low	The species is found from the arid Pilbara (WA) to tropical savannah woodlands and north Qld rainforests and. distribution likely influenced by the availability of suitable caves and mines for roost sites (TSSC 2016). There is no suitable permanent roost sites in the Project Area and no occurrences near the Project Area (Ecoz 2017)
Greater Bilby	*Macrotis lagotis*	Vulnerable	Vulnerable	None	In the NT, the species is found in hummock grasslands on sandy soils with a preference for paleo-drainage lines (Southgate 1990). There is no suitable habitat in the Project Area and the Project Area is outside the historic distributional extent for this species.
Northern Quoll	*Dasyurus hallucatus*	Endangered	Critically Endangered	None	The species is found in rocky sandstone escarpments or coastal Eucalyptus tall open forest, which are not found within the Project Area (Ecoz 2017). The Project Area is outside the distribution of the species.
Pale Field-rat*	*Rattus tunneyi*	-	Vulnerable	Low	The species was found historically in a wide range of habitats, but now occurs primarily in dense vegetation along creeks (Aplin *et al.* 2008). There is no suitable habitat in the Project Area. This species was not found in the PMST database or NT Fauna Atlas but has been identified by DEPWS as potentially occurring in the Project Area in comments received in the previous EMP submission for EP 161.
Reptiles					
Gulf Snapping Turtle	*Elseya lavarackorum*	Endangered	-	None	This species is found in large rivers and their associated overflow lagoons and deeper permanent pools, which are not present within the Project Area (Ecoz 2017).
Mertens' Water Monitor	*Varanus mertensi*	-	Vulnerable	Medium	This species is found in and around freshwater waterways and associated riparian vegetation (Ward et al 2006). This monitor species has a broad geographic range in the NT. There is a record of this species being recorded within the study area in 1993, therefore there is the potential for this species to continue to persist.

Common Name	Scientific Name	EPBC Status	TPWC Status	Likelihood of occurrence	Distribution and Habitat
Mitchell's Water Monitor*	*Varanus mitchelli*	-	Vulnerable	Low	The species is found in semi-aquatic and arboreal habitats, inhabiting the margins or watercourse, swamps and lagoons (Ward 2012). The ephemeral watercourses and limited wetlands in the Project Area are unlikely to provide suitable habitat (Ecoz 2017). This species was not found in the PMST database or NT Fauna Atlas but has been identified by DEPWS as potentially occurring in the Project Area in comments received in the previous EMP submission for EP161.

4.2.4 Listed Migratory Species

A search of the PMST database (DoEE 2018) was undertaken on 4 December 2018 to identify MNES likely to occur within 10 km of the Project Area (Appendix B). The PMST Report identified 12 birds and one reptile that are listed migratory species which may occur within 10 km of the Project Area. These results are outlined below in

Table 4-6, and a likelihood assessment has been undertaken, utilising information from desktop and field studies undertaken on EP 161 (Appendix D).

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Table 4-7 Likelihood assessment for listed migratory species

Species Name	Scientific Name	Likelihood of occurrence	Comments
Birds			
Fork-tailed Swift	*Apus pacificus*	Medium	The species is almost exclusively aerial and mostly occurs over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh (Ecoz 2017). Given the broad distribution and wide ranging nature of the species it is likely to be present within or over the Project Area (Ecoz 2017) depending on climatic conditions.
Red-rumped Swallow	*Cecropis daurica*	Low	The species is vagrant to Australia and the woodland vegetation of the Project Area is unlikely to provide suitable foraging habitat for the species, which forages over wetlands (Ecoz 2017).
Oriental Cuckoo	*Cuculus optatus*	Low	Although the Project Area is within the distribution of this species, the open woodland vegetation and creek line vegetation within the Project Area does not provide suitable habitat for this species (Ecoz 2017).
Barn Swallow	*Hirundo rustica*	Low	The Barn Swallow is found foraging above open vegetated areas including farmland, sports grounds, native grasslands and airstrips as well as over open water such as billabongs, lagoons, creeks and sewage treatment plants (Ecoz 2017). The species is vagrant to the region and has not been found within 200 km of the Project Area (Ecoz 2017) and is therefore unlikely to occur.
Grey Wagtail	*Motacilla cinerea*	Low	The species is a vagrant visitor to Australia and there is only one record from the Roper River, over 150 km from the Project Area. Although the Project Area is south of the known distribution of the species in Australia, the creek areas within the Project Area may provide limited suitable habitat for the species (Ecoz 2017) although given this species is a vagrant visitor, it is unlikely to occur.
Yellow Wagtail	*Motacilla flava*	Low	The vegetation of the Project Area is provides limited suitable open areas for foraging of this species and the Project Area is also south of the known distribution of the species in Australia (Ecoz 2017), indicating the unlikely presence of this species within the Project Area.
Common Sandpiper	*Actitis hypoleucos*	Low	Widespread across coastal regions of the Top End of the Northern Territory, and widespread but scattered inland, mostly north of Tennant Creek (DoE 2017b). If occasionally present, in low numbers only.

Species Name	Scientific Name	Likelihood of occurrence	Comments
Sharp-tailed Sandpiper	*Calidris acuminate*	Low	The species prefers muddy edges of shallow wetlands, with inundated low vegetation (DoE 2017c), therefore the Project Area does not provide suitable habitat
Curlew Sandpiper	*Calidris ferruginea*	Low	The habitat of this species is coastal and estuarine with tidal mudflats and is rarely found inland (Ecoz 2017), therefore unlikely to occur within the Project Area.
Pectoral Sandpiper	*Calidris melanotos*	Low	The species is found in shallow fresh waters, often with low grass or other herbage, flooded pastures, sewage ponds, occasionally tidal areas, saltmarshes. (Ecoz 2017). Given the preference for wetland areas, there is little suitable habitat within the Project Area for this species (Ecoz 2017).
Oriental Pratincole	*Glareola maldivarum*	Low	Oriental Plover is a non-breeding visitor to Australia, where the species occurs in both coastal and inland areas, mostly in northern Australia. It is found on black soil plains in the Northern Territory and Queensland (DoE, 2017d). The Project Area is within the species range and the grasslands (and black soil plains) within the Project Area represent suitable habitat (Ecoz 2017).
Osprey	*Pandion haliaetus*	Low	The Osprey is found primarily along coastal areas of mainland Australia, and inland along major waterways. Due to the lack of a permanent supply of water, the Project Area represents unsuitable habitat for this species. (DEPWS, 2018)
Painted Snipe	*Rostratula australis*	Low	This species is found in the fringes of permanent and temporary wetlands, swamps and inundated grasslands (Taylor et al. 2013) and is nomadic and scattered across Australia with no predictable occurrence (Rogers 2001). The closest known occurrence is approximately 50 km north-east of the Project Area and the inundated grassland may provide seasonally suitable habitat (Ecoz 2018a).
Reptiles			
Freshwater crocodile	*Crocodylus johnstoni*	Low	The Freshwater Crocodile preferred habitat is in wetland environments upstream from the coast. (DEPWS, 2018). Ecoz (2017) recorded a number of freshwater crocodiles at Rocky Hole, which is a permanent water hole used for pastoral operations however, it is unlikely that permanent waters exist in the Project Area based on aerial imagery and field survey (Ecoz 2017).

4.2.5 Pest Species and Weeds

Weeds and animal pest species can cause varying degrees of damage to the environment and land management on pastoral lands. The Weeds of National Significance (WoNS) list is compiled by the federal government and provides a national standard for ranking the impact of individual pest weed species. The *Weeds Management Act 2013* (Weeds Act) is the relevant law in the NT which describes the procedures involved with weed control. Under the Weeds Act, weeds can be declared as:

- Class A – To be eradicated
- Class B – Growth and spread to be controlled
- Class C – Not to be introduced into the NT (All declared weeds are automatically a class C weed)

The PMST Report (2018) (Appendix B) identified two species potentially occurring within 10 km of the Project Area:

- Prickly Acacia (*Acacia nilotica* subsp.) which is declared Class A in the NT and a WoNS
- Buffel-grass (*Cenchrus ciliaris*) which is not a declared weed in the NT or a WONS

EcOz undertook a baseline survey for weeds within the Project Area in August and November 2018 during preparation of the Weed Management Plan (EcOz 2019) (Appendix E). No Weeds of National Significance were found within the area. Declared weeds observed in and around the Project Area are listed below in Table 4-8.

Table 4-8 Declared Weeds

Species	NT Declared Class	Weed of National Significance (WoNS)
Hyptis (*Hyptis suaveolens*)	B/C	No
Rubber Bush *(Calotropis procera)**	B/C	No
Spinyhead sida (*Sida acuta)*	B/C	No
Sicklepod (*Senna obtusifolia*)	B/C	No

Other species of concern that have the potential to become established in the Project Area are outlined below in Table 4-9.

Table 4-9: Weeds with a potential to become established

	Common name	Scientific name	NT Class	WoNS
Katherine region priority weeds	Mesquite	*Prosopis* spp.	A/C	Y
	Prickly acacia	*Vachellia nilotica*	A/C	Y
	Parkinsonia	*Parkinsonia aculeate*	B/C	Y
	Chinee Apple	*Ziziphus Mauritania*	A/C	
	Mimosa	*Mimosa pigra*	A/C	Y
	Bellyache bush	*Jatropha gossypiifolia*	A/C	Y
	Gamba grass	*Andropogon gyanus*	A/C	Y

	Common name	Scientific name	NT Class	WoNS
	Neem	*Azadirachta indica*	B/C	
	Grader grass	*Themeda quadrivalvis*	B/C	Y
	Snake weed	*Stachytarpheta spp.*	B/C	
	Devils claw	*Martynia annua*	A/C	
Other declared weeds	Parthenium	*Parthenium hysterophorus*	A/C	Y
	Starburr	*Acanthospermum hispidum*	B/C	
	Mossman River grass	*Cenchrus achinatus*	B/C	
	Spiny-head sida	*Sida acuta*	B/C	
	Flannel weed	*Sida cordifolia*	B/C	
	Paddy's Lucerne	*Sida rhombifolia*	B/C	
	Caltrop	*Tribulus terrestris*	B/C	
	Noogoora Burr	*Xanthium strumarium*	B/C	
	Khaki weed	*Alternanthera pungens*	B/C	

Weed distribution is often related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds are most prevalent on land under pastoral lease, with infestations generally concentrated around infrastructure such as water points, fence lines and tracks, and along the banks of watercourses where cattle and feral animals tend to congregate. This EMP and the Weed Management Plan (Appendix E) are consistent with the threat abatement plan to reduce the impacts on northern Australia's biodiversity by the five listed grasses.

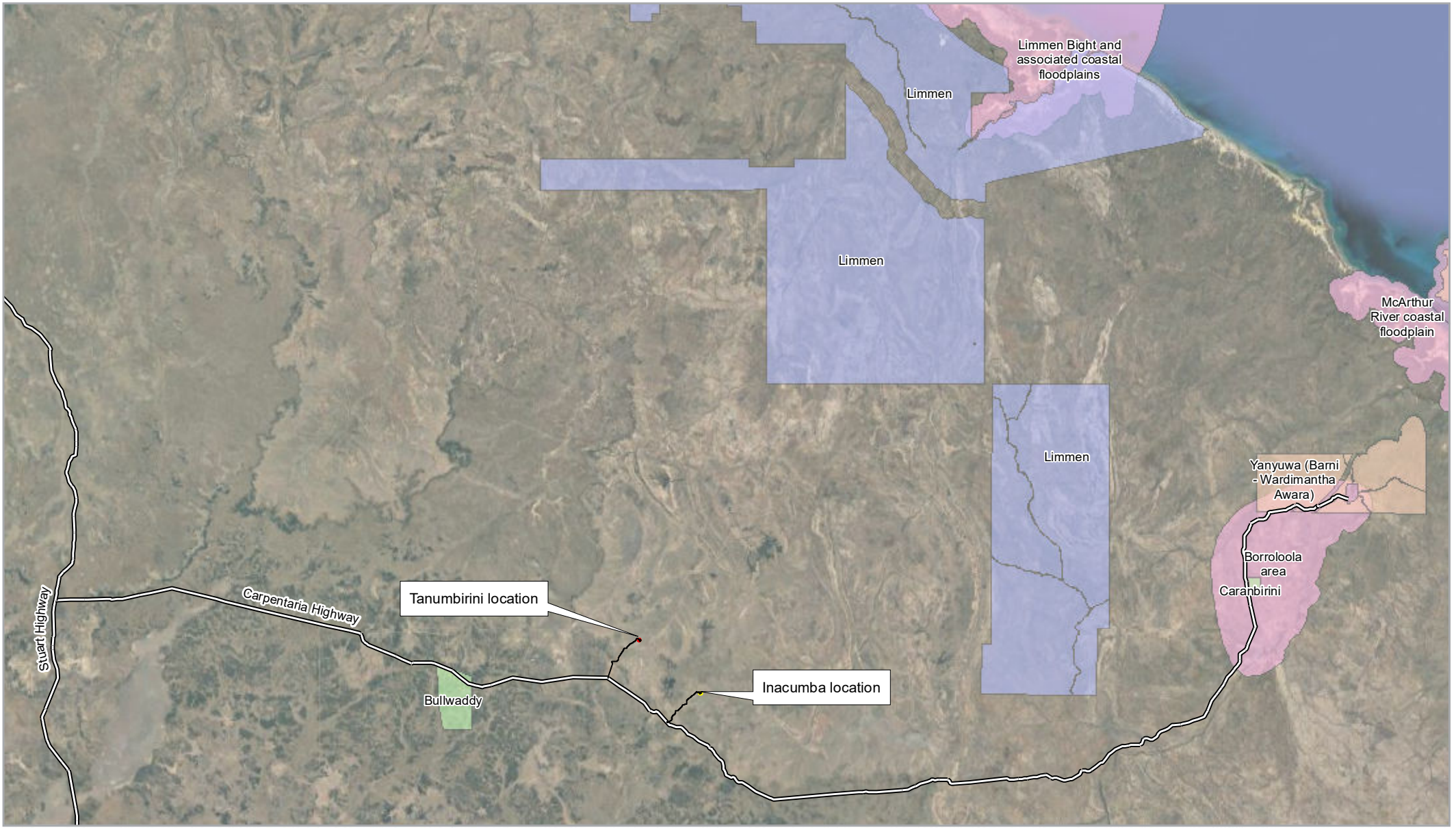
Nine prohibited fauna species were also identified in the PMST report (DoEE 2018) as likely occurring within 10 km of the Project Area (refer Appendix B, C and D). Pest animals identified in the Project Area include cane toads, cattle, sparrows, buffaloes, dogs, donkeys, cats, horses and pigs.

4.2.6 Protected Areas

There are no National Parks or conservation areas or Sites of Conservation significant near the Project Area. (Figure 4-17).

The Bullwaddy Conservation Reserve is approximately 40 km southwest of Tanumbirini Station (NTG 2009), and in a different catchment. The reserve is a declared conservation area within the Sturt Plateau bioregion, conserving Acacia woodlands and the unique *Acacia shirleyi* (Lancewood) / *Macropteranthes kekwickii* (bullwaddy) vegetation type.

The Limmen National Park is located approximately 80 km downstream of the Project Area. It is adjacent to the Limmen Bight and associated coastal floodplains, which is a Site of Conservation Significance. The site is dominated by huge coastal mudflats, which are some of the most extensive in the NT, and mangrove forests associated with the mouth of the Roper River and the large coastal delta system at the mouth of the Limmen River (DNRETAS, 2009))



Legend

- Existing Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases
- Sites of Conservation Siginificance
- Conservation Reserve
- Indigenous Protected Area
- National Park

1:1,125,000 @ A4

0 10 20 30 40

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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Date **5/11/2020**

Protected and Conservation Areas

FIGURE 4-17

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Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

4.2.7 Significant vegetation

Significant or sensitive vegetation communities are described in the NT Land Clearing Guidelines (NRETAS 2010). They are vegetation communities that are distinct and limited in extent or support important ecological values and include vine thicket, closed forest or riparian vegetation, mangroves, monsoon vines forest, sand-sheet heath and vegetation containing large trees with hollows suitable for fauna.

Riparian vegetation occurs along freshwater waterways (ephemeral or permanent). It covers a relatively small land area and provides unique habitat features and dry season refuge for a range of native fauna species (DEPWS 2018). In these areas, maintaining bank stability to reduce erosion is important. An ecological assessment report of the ecological survey work conducted on Tanumbirini Station between 2017 and 2019, including the mapping of significant riparian vegetation is provided in Appendix D.

Riparian vegetation has been observed along the drainage lines within the Project Area. Ecoz (Appendix D) found that riparian vegetation forms a distinct community along the edge of the drainage lines in the vicinity of the proposed Inacumba wells. Ecoz (Appendix D) also surveyed around the Tanumbirini pad locations and found that although the vegetation along the watercourse comprised primarily a narrow strip of sparse *Eucalyptus camaldulensis*, the vegetation is located away from the Tanumbirini well locations.

Importantly no riparian vegetation will be disturbed as a result of this Drilling Program.

4.2.8 Groundwater Dependent Ecosystems

A search of the National Groundwater Dependent ecosystems (GDE) Atlas (BoM 2018b) was conducted on 11 January 2021. 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.

There are no terrestrial or aquatic GDEs identified at either location (BoM 2021). The riparian vegetation communities present along the watercourse, particularly those dominated by *Eucalyptus camaldulensis* may rely on rainfall stored in alluvial sediments and therefore may be groundwater dependant. However, project activities are unlikely to include impacts on these communities.

4.2.9 Fire

Aboriginal people have traditionally used fire as a tool during hunting and gathering. Patch burning shortly after the end of the rainy season has shaped vegetation and faunal patterns across central Australia. The advent of pastoralism brought new approaches regarding fire use resulting in fewer but larger fires initiated later in the dry season.

Fire management or controlled burns within the region are a common occurrence. Controlled burns are undertaken early in the dry season to reduce the possibility of uncontrolled fires and to assist in land management.

The peak fire danger season for the region is during the late dry season. At this time, high fuel loads and dry windy conditions fuel potentially very large bushfires. Periods of increased temperature and reduced rainfall and humidity due to climatic cycles such as El Niño can exacerbate these conditions.

Bullwaddy vegetation communities are very sensitive to frequent and intensive fires (PWCNT 2005). Late season fires also impact pastoralism because the heat of these large wildfires kills the understorey grass species that stock rely on during the lean times before the wet season rains. The NT NRM Report (Appendix C) indicates fire frequency in the immediate vicinity of the Project Area is

very low at three or less between 2000 and 2017. Historically, fire around the Tanumbirini Station has not occurred, however increases in frequency have been observed to the east, south and west (NTG 2018a). Fire management is discussed in the Fire Management Plan provided in Section 7.2.

4.3 Cultural environment

4.3.1 Historic and Natural Heritage

A search of the PMST database (DoEE 2018) showed no World Heritage Properties or National Heritage Places are registered within 10 km of the Project Area.

In addition, a search of the NT Heritage Register (Department of Tourism and Culture 2018) for NT Portion 701 was conducted and no recorded NT heritage items or places are present in the Project Area.

To ensure there are no archaeological artefacts or sites of significance that will be impacted by the Drilling Program, an independent archaeologist was contracted by Santos to survey the Project Area. The key finding of the consultant report (attached in Appendix F) is that there are no sites of archaeological or heritage significance that will be impacted by the Drilling Program. If sites were found, they would be reported to the NT Heritage Branch, as is required under Section 114 of the NT *Heritage Act* 2011.

4.3.2 Sacred Sites

Areas of significance for sacred sites as defined by the *Northern Territory Aboriginal Sacred Sites Act 1989* (NT) is considered through the process of securing an Authority Certificate from Aboriginal Areas Protection Authority (AAPA). This process aims to prevent damage to, and interference with sacred sites, by identifying and setting out the conditions for entering and working on the land.

All activity approvals requested under this EMP are required to be supported by an AAPA Authority Certificate. Application was made in January 2019 and Authority Certificate C2019/043 was issued on 13 May 2019. The terms of conditions of the AAPA Authority Certificates are incorporated into project planning and this Authority Certificate covers all activities included in this EMP.

4.3.3 Northern Land Council

Santos has an executed Exploration Agreement in place with the Northern Land Council (NLC) which has defined processes for community consultation, sacred site surveying, and reporting to AAPA. Community consultations and sacred site avoidance surveys of EP 161 work program areas were completed by NLC and Traditional Owners in 2013, 2014, and 2016 for different proposed work programs (respectively 2D seismic surveying, exploration drilling, and water bore drilling). Any sacred sites or restricted work areas have been identified by these processes; relevant information and conditions are then communicated to Santos as conditions on any granted Authority Certificate from AAPA. The NLC consulted Traditional Owners in relation to the proposed Drilling Program in early March 2019 (in addition to other relevant work program activity covered under other EMPs), and also facilitated consultation directly with Santos.

4.4 Socioeconomic Environment

There is a range of current land uses within the area including conservation, tourism, oil and gas exploration and pastoral activities.

The EP-161 lease overlays two Local Government Areas; Barkly Regional Council to the south, and Roper Gulf Regional Council to the north. The Barkly Regional Council covers an area of 323,514 km^2

and has a population of approximately 7,531. The Barkly Regional Council includes the Barkly Tablelands, numerous Aboriginal land trusts and pastoral properties.

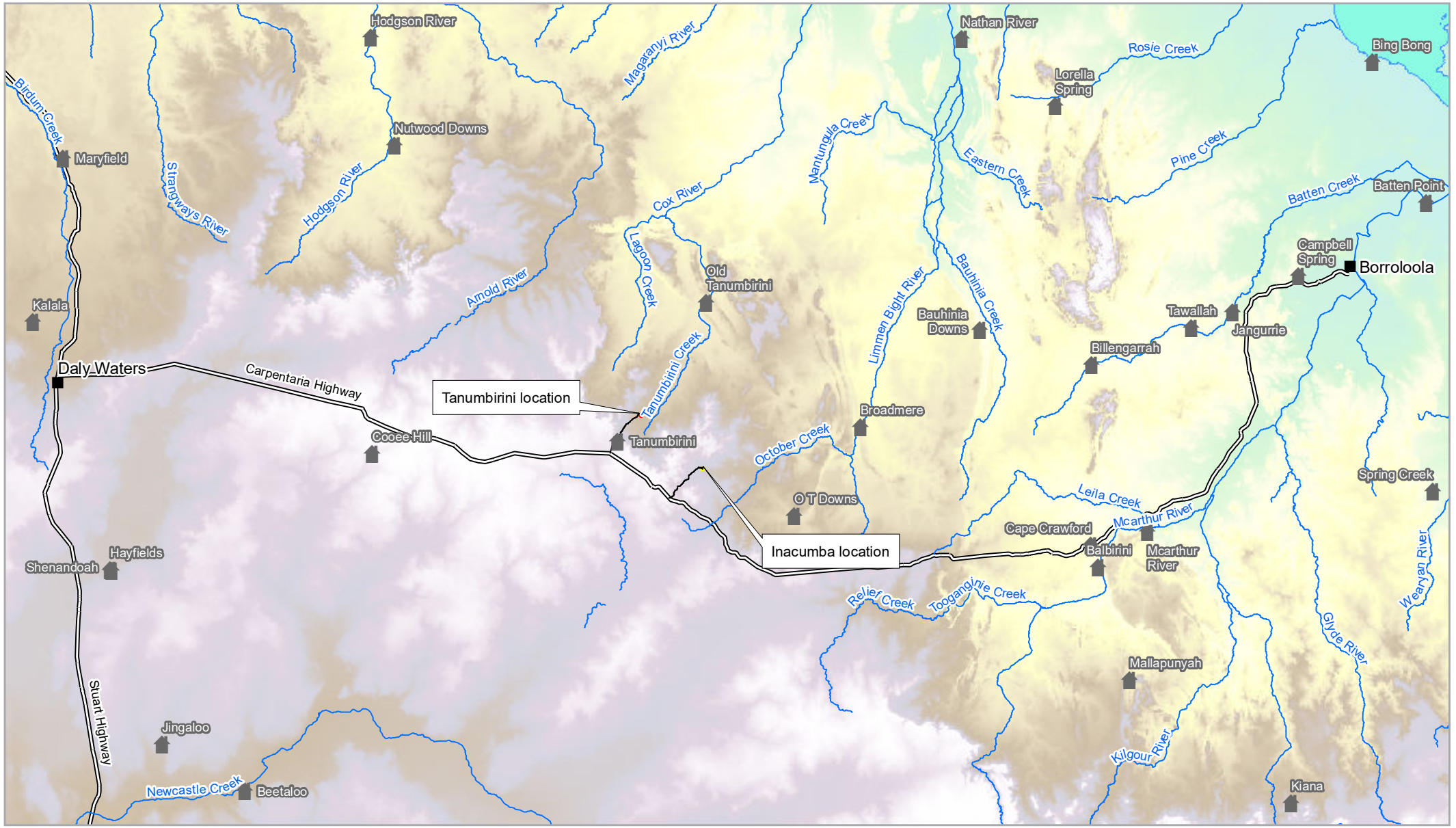
The Roper Gulf Regional Council covers an area of 186,000 km^2 and has a population of approximately 6,121. The Roper Gulf Regional Council includes 16 towns and communities of varying sizes, major roadhouses, 22 outstations and 50 pastoral properties.

The local area remains generally undeveloped in terms of infrastructure and roads. Major infrastructure within EP-161 includes the Carpentaria Highway and the Daly Waters to McArthur River gas pipeline, which run approximately parallel with one another east-west through the southern half of the tenement. The McArthur River Mine is located approximately 100 km east of the Project Area.

The Carpentaria Highway is frequented as a tourist route in the dry season, both as a route to destinations around the Gulf of Carpentaria, and as a link between the NT and Queensland.

4.4.1 Settlements

The closest towns to the Project Area are Daly Waters (approximately 130 km to the west) and Borroloola (approximately 180 km to the east). The closest significant population centre is Katherine located approximately 350 km to the north-west. Pastoral properties and towns in the vicinity of the Project Area are shown in Figure 4-18.



Legend

- Homesteads
- Towns
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Leases

1:1,250,000 @ A4

0 10 20 30 40

Kilometres

Map Projection: Universal Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 53

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GHD

Santos
McArthur Basin
Environmental Management Plan

Stations and Communities

Project No. **12538768**
Revision No. **A**
Date **5/11/2020**

FIGURE 4-18

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Data source: Google Earth: imagery (Jun 2016, captured Mar 2017 . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: cmacgregor

4.5 Environmental Values as defined under the Environmental Protection Act

The existing environment and the associated environmental values are discussed in detail from sections 4.1 through to 4.4. There can be particular environmental values and sensitivities that should be considered - in particular, the potential for a significant impact on an Environmental Value is the key consideration on whether a proposed activity will require further assessment under the Environmental Protection Act. The Environmental Factors (NT EPA 2020) and corresponding Environmental Values for this proposed project are described Table 4-10.

Table 4-10 Environmental Values and/or Sensitivities that may be affected by the project

Environmental Factors	Environmental Values and Sensitivities	Summary
Terrestrial Ecosystems	Sensitive or significant vegetation	Ecoz (2018b and 2018c) recorded riparian vegetation (a sensitive vegetation type) along the watercourses and drainage lines within the Project Area.
	Groundwater dependent ecosystems	There is a low potential for terrestrial GDEs and aquatic GDEs in the Project Area (BoM 2018b).
	Threatened fauna species and their habitat	The PMST and NT database searches identified 12 listed, threatened species have the potential to occur in the Project Area. Of these, the Gouldian Finch, Grey Falcon and Crested Shrike-tit have a medium likelihood of occurrence.
	Listed Migratory Species	The PMST search identified 13 EPBC listed migratory species that were potentially occurring in the Project Area. Of these, the Fork-tailed Swift had a medium likelihood of occurrence.
	Listed threatened flora species and ecological communities	There are no Threatened Ecological Communities (TECs) or threatened flora listed under the EPBC Act and/or TPWC Act known to occur within 10 km of the Project Area.
Terrestrial Environmental Quality	Soils	The Project Area has intact soils within ephemeral creeks and drainage lines maintain the stability of water course and reduce sedimentation when rainfall events occur.
Inland water environmental quality	Groundwater	The Cambrian Limestone Aquifer is a regional scale aquifer that provides groundwater resources for pastoral enterprises, domestic bores at homesteads and town water supplies at a number of small communities across the region.
	Surface water	There are ephemeral creeks and drainage lines present in the Project Area. In significant rainfall events, these drain into larger rivers eventually in to the Gulf of Carpentaria. 80 km downstream of the Project Area the rivers traverse the Limmen Bight National Park.
Hydrological processes	Supply and quantity of water	Ephemeral creeks adjacent to the Project Areas are located in the headwaters of the Limmen Bight river catchment and feed into the Limmen Bight River during significant rainfall events
Culture and heritage, communities and economy	Cultural heritage, sacred sites	An application for an AAPA Authority Certificate was submitted to AAPA in January 2019 (awarded on 13 May 2019 as Authority Certificate C2019/043, as a variation to C2014/053) to ensure that the locations and activities covered under this EMP for the proposed Drilling Program have been appropriately surveyed and subsequently conditioned.

Environmental Factors	Environmental Values and Sensitivities	Summary
		Archaeological surveying for artefacts or sites of archaeological significance was completed by an independent consultant to support this EMP (report attached in Appendix F)
Human health	People and communities	There are a number of pastoral properties with livestock and infrastructure in the vicinity of the Project Area. The nearest property is Tanumbirini Homestead, located approximately 8.5 km southwest of Tanumbirini-1 location.

5.0 Overview of the Environmental Risk Assessment Process

The Regulations operate around the concepts of environmental risks and environmental impacts. Environmental risk is defined as "*the chance of something happening that will have an environmental impact, measured in terms of the environmental consequences and the likelihood of those consequences occurring*". Environmental impact is defined as "*any adverse change, or potential adverse change, to the environment resulting wholly or partly from a regulated activity*".

It is acknowledged that environmental risks are inherent in some onshore oil and gas activities, and without control, environmental impacts may arise. As such, the Regulations require detailed assessment, reduction and control of these environmental risks and impacts through the development and implementation of the EMP for the project. This section provides an overview of the environmental risk assessment process.

5.1 Process Overview

The planned and potential interactions between the described activity, the aspects triggered and the described environment represent a source of risk (or impact) which has potential to result in a change to the environment.

An Environmental Risk Assessment (ERA) involves assessment of the likelihood and consequence of these impacts. An EMP must demonstrate that the environmental impacts and environmental risks will be reduced to a level that is ALARP and acceptable.

ALARP essentially involves making a judgement about whether all reasonably practicable measures are in place to control a potential risk or impact considering the level of consequence and cost, time and resources involved to mitigate it.

To determine whether potential environmental risks and inputs are 'acceptable' is a matter of judgement that depends on issues such as the nature and scale of impacts and the social or economic benefits. In determining acceptability, the Regulations require consideration of the principles of ESD. In particular, demonstration that the principles of inter-generational equity and the maintenance of biological diversity and ecological processes is required.

To meet the requirements for ERA under the regulations, the principles of the risk management process of AS/NZS ISO 31000:2009 Risk management – principles and guidelines, in addition to HB 203:2006 Environmental risk management - Principles and process have been followed. The summary of this approach is:

1. Identification of environmental aspects
2. Description of the environment that may be affected
3. Identification of the particular values and sensitivities
4. Identification and evaluation of potential environmental impacts
5. Determination of the pre-treatment risk ranking
6. Control measure identification and ALARP decision
7. Determine severity of consequence
8. Determine likelihood
9. Determine residual risk ranking
10. Determination of acceptability

Section 6 Environmental Risk Assessment, details the outcomes of this process.

5.2 Identification of risk events

Santos considered the activities that would be undertaken and identified the potential risk event and associated impact and defined the source of the impact.

5.3 Identification of the Environment that may be affected

Following the identification of potential risk events, the likely extent of each impact is considered and the environment which may be affected determined. The environment which may be affected is categorised by the EPA Factors (NT 2018) described within section 4.5.

5.4 Identification of Particular Values and Sensitivities

Based on Santos' and publicly available information, a review of the existing environment (section 4.0) was undertaken to identify the environmental values and / or sensitivities with the potential to occur within the Project Area. Table 4-10 provides a summary of these values and sensitivities, which were used to inform the risk assessment as they provide the potential worst-case consequence.

5.5 Identification and Evaluation of Potential Environmental Impacts

The known and potential impacts of environmental aspects to the identified environmental receptors were identified. These were evaluated and specifically considered:

- Receptor sensitivity to identified aspect
- Extent and duration of the potential impact.

5.6 Pre-treatment Risk Ranking

Risk is expressed in terms of a combination of the consequence of an impact and the likelihood of the impact occurring (see sections 5.8 and 5.9).

A pre-treatment risk ranking is identified to assist with the determination of the level of controls required to reduce the risk or impact.

5.7 Control Measure Identification and ALARP Decision Framework

Based on the identified impacts, and the ranking of their pre-treatment risk, control measures were identified in accordance with the defined environmental performance outcomes, to eliminate, prevent, reduce or mitigate consequences associated with each of the identified environmental impacts. Control measures were identified through previous surveys, in workshops and through review of best practice techniques across the industry. When determining whether the risk or impact has been reduced to ALARP, it must be asked whether environmental risks can be lowered further without a grossly disproportionate increase in impost.

Santos' approach to this decision is based on the Oil and Gas UK's 'Guidance on Risk Related Decision Making' (Table 5-1). This framework considers impact severity and several guiding factors to achieve ALARP risk demonstration:

- Activity type
- Risk and uncertainty
- Stakeholder influence.

This framework provides appropriate tools, commensurate to the level of uncertainty or novelty associated with the impact or risk (referred to as the Decision Type A, B or C). Decision types and methodologies to establish ALARP are outlined in Figure 5-1.

Table 5-1 ALARP Decision Making based upon Level of Uncertainty

Decision Type	Description	Decision Making Tools
A	Risks classified as a Decision Type A are well-understood and established practice	Good Practice Control Measures are considered to be: Legislation, codes and standards: Identifies the requirements of legislation, codes and standards that are to be complied with for the activity. Good Industry Practice: Identifies further engineering control standards and guidelines that may be applied over and above that required to meet the legislation, codes and standards. Professional Judgement: Uses relevant personnel with the knowledge and experience to identify alternative controls. When formulating control measures for each environmental impact or risk, the 'Hierarchy of Controls' philosophy, which is a system used in the industry to identify effective controls to minimise or eliminate exposure to impacts or risks, is applied.
B	Risks classified as a Decision Type B are typically in areas of increased environmental sensitivity with some stakeholder concerns.	Risk-based tools, such as cost based analysis or modelling: this assesses the results of probabilistic analyses such as modelling, quantitative risk assessment and/or cost benefit analysis to support the selection of control measures identified during the risk assessment process.
C	Risks classified as a Decision Type C will typically involve sufficient complexity, high potential impact, uncertainty or stakeholder interest	Precautionary Approach: OGUK (2014) state that if the assessment, taking account of all available engineering and scientific evidence, is insufficient, inconclusive or uncertain, then a precautionary approach to hazard management is needed. A precautionary approach will mean that uncertain analysis is replaced by conservative assumptions that will result in control measures being more likely to be implemented.

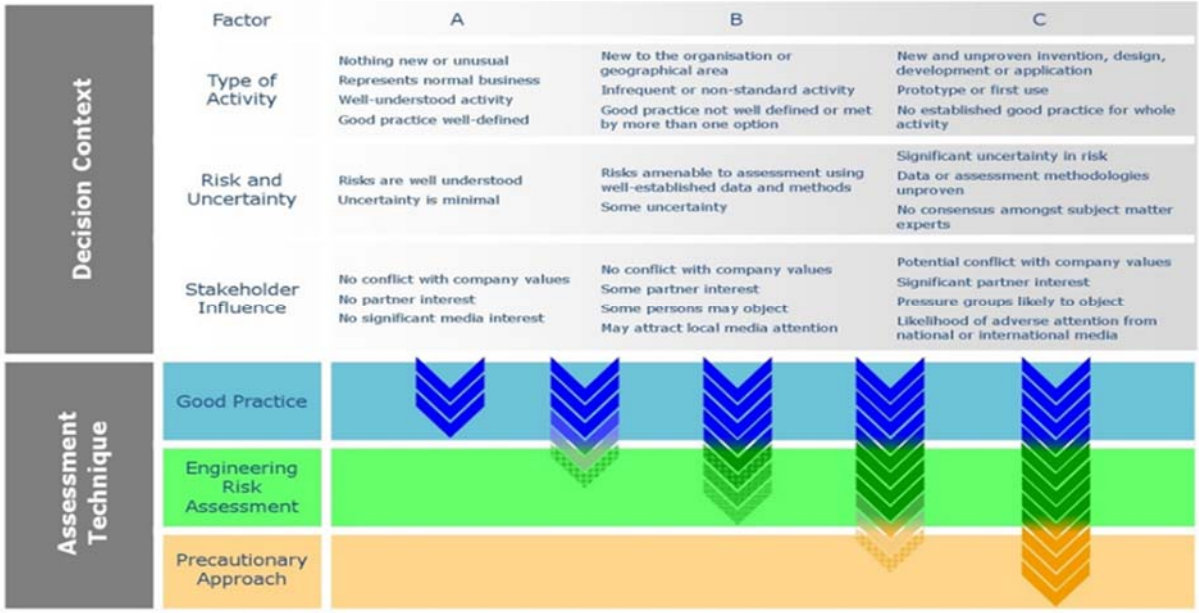

Figure 5-1 Impact and Risk 'Uncertainty" Decision-Making Framework

5.8 Determination of Severity of Consequence

The potential level of impact (consequence) was assessed and assigned in line with potential hazards and receptors, using the 'Santos Environmental Consequence Classification' (Table 5-2) from the Santos Operational Risk Matrix. The consequence level for each hazard is documented in the risk assessment tables in Section 6.0.

Table 5-2 Santos Environmental Consequence Classification

Level	Environment
VI	Regional and long-term impact on an area of significant environmental value. Destruction of an important population of plants and animals with recognised conservation value. Complete remediation impossible.
V	Destruction of an important population of plants or animals or of an area of significant environmental value. Complete remediation not practical or possible.
IV	Extensive and medium term or localised and long-term impact to an area, plants or animals of recognised environmental value. Remediation possible but may be difficult or expensive.
III	Localised and medium term or extensive and short-term impact to areas, plants or animals of significant environmental value. Remediation may be difficult or expensive.
II	Localised and short-term impact to an area, plants or animals of environmental value. Readily treated.
I	Localised and short term environmental or community impact – readily dealt with.

Definitions	
Duration of potential impact	Extent of impact
Short term: Days or weeks	**Localised**: Within the Project Area
Medium Term: Less than 12 months	**Extensive**: Within the permit area
Long Term: Greater than 12 months	**Regional**: Outside of the permit area

5.9 Determination of Likelihood

Likelihood relates to the potential for a consequence to occur. This includes the likelihood of an event occurring and the subsequent potential consequence. This is defined using the Santos Likelihood Descriptors (Table 5-3) from the Santos Operational Risk Matrix.

Table 5-3 Santos Likelihood Descriptors

Level		Criteria
Almost Certain	f	Occurs in almost all circumstances or could occur within days to weeks
Likely	e	Occurs in most circumstances or could occur within weeks to months
Occasional	d	Has occurred before in Santos or could occur within months to years
Possible	c	Has occurred before in the industry or could occur within the next few years
Unlikely	b	Has occurred elsewhere or could occur within decades
Remote	a	Requires exceptional circumstances and is unlikely even in the long term or only occurs as a '100 year event'

5.10 Residual Risk Ranking

Risk is expressed in terms of a combination of the consequence of an impact and the likelihood of the impact occurring. Santos uses a Corporate Risk Matrix (Table 5-4) to plot the consequence and likelihood to determine the level of risk.

Once the level of risk is determined Santos uses a Risk Significance Rating (Table 5-5) to determine the magnitude of the risk and if further action is required to reduce the level of risk using the process described in section 5.10.

Table 5-4 Santos Risk Matrix

	I	II	III	IV	V	VI
f	2	3	4	5	5	5
e	2	3	4	4	5	5
d	2	2	3	4	4	5
c	1	2	2	3	4	5
b	1	1	2	2	3	4
a	1	1	1	2	3	3

Table 5-5 Santos Risk Significance Rating

Risk Level	Mitigation/Investigation Focus
5	Intolerable risk level Following verification of the residual risk at level 5, activity must stop Activity cannot recommence until controls implemented to reduce the residual risk to level 4 or lower Detailed multi-disciplinary incident investigation team Management involvement in the investigation
4	Assess risk to determine ALARP If ALARP, activities related to maintenance of controls/barriers prioritised and managed If not ALARP, improve existing controls and/or implement new controls Detailed multi-disciplinary incident investigation team
3	Assess risk to determine ALARP If ALARP, activities related to maintenance of controls/barriers prioritised and managed If not ALARP, improve existing controls and/or implement new controls Full incident investigations
2	Assess risk to determine ALARP If ALARP, activities related to maintenance of controls/barriers prioritised and managed If not ALARP, improve existing controls and/or implement new controls Incident investigations using simple tools
1	Managed as stipulated by the related work processes No incident investigation required

5.11 Determination of Impact and Risk Acceptability

The model Santos used for determining acceptance of residual risk is detailed in the Santos Residual Risk Acceptance Model in Figure 5-2. In summary:

- A Level 5 residual risk is intolerable and must not be accepted or approved by Management
- A Level 2 – 4 residual risk is acceptable provided that ALARP has been achieved and demonstrated
- A level 1 residual risk is acceptable and it is assumed that ALARP has been achieved

In addition to the requirements detailed above, for the purposes of petroleum activities, impacts and risk to the environment are considered broadly acceptable if:

- The residual risk is determined to be 1 (and ALARP Decision Type A selected and good practice control measures applied), or
- The residual risk is determined between 2 and 4 and ALARP can be demonstrated; and

- The following have been met:
  - Principles of ecologically sustainable development
  - Legal and other requirements
  - Santos policies and standards
  - Stakeholder expectations

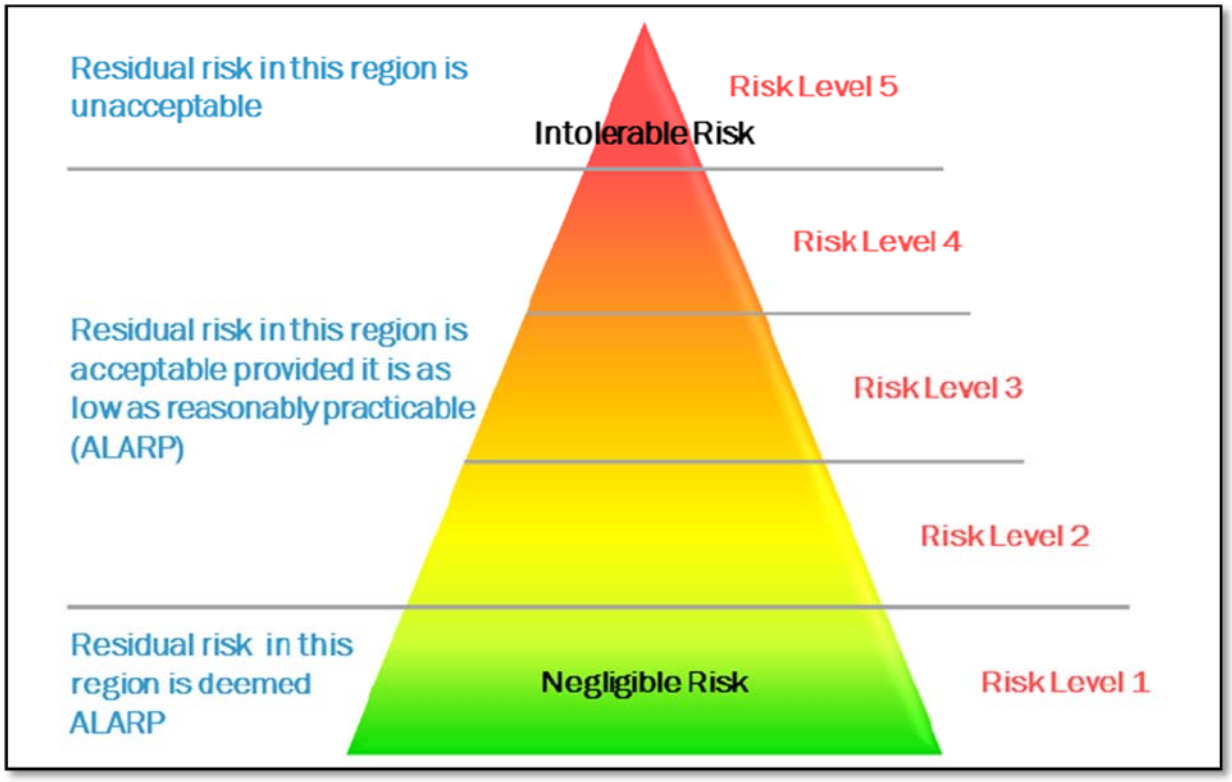

Figure 5-2 Santos Residual Risk Acceptance Model

5.11.1 Risk Determination and the Code

The purpose of the Code is to ensure that petroleum activities are managed according to minimum acceptable standards to ensure that risks are managed to a level that is ALARP and acceptable. The Code of practice is mandatory and will be implemented during all stages of this activity.

The Code identifies industry standards, good and acceptable industry practice and mandatory requirements for the conduct of petroleum activities and will ensure on compliance with their obligations under Northern Territory's petroleum legislation.

6.0 Environmental Risk Assessment

An environmental risk assessment was undertaken for the proposed activities using the methodology outlined in section 5.0 and the results are reported in Table 6-1.

Table 6-1 Risk Assessment for proposed activities

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Physical disturbance including vehicle and plant movements	Disturbance to soil	Terrestrial environmental quality	vehicles leave the previously constructed roads or work areas	F	I	2	Driving is only permitted on designated access	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	C	I	1	Yes	Type A Risk – Risks are well-understood with established management practices (e.g. Land Clearing Guidelines and the ESCP)
Physical disturbance including vehicle and plant movements	Disturbance to Aboriginal archaeological sites	Culture and Heritage	vehicles leave the previously constructed roads or work areas	B	II	1	Archaeological surveys completed by independent consultant(s) prior to activity commencement. Results indicate that no Aboriginal archaeological or historical sites/relics will be encountered or impacted by proposed activities in this portion of EP161 Driving is only permitted on designated access	A.3.1 Site Selection and Planning	A	I	1	Yes	Type A Risk – Risks are well-understood heritage survey complete with avoidance measures in place
Groundwater extraction	Reduction in groundwater quantity	Hydrological processes	Use of groundwater for project activities	B	II	1	Valid water extraction licence Compliance with water extraction licence limits and conditions Ensure groundwater extraction is limited to the volumes required by the drilling program (See water use estimates in Section 3.0). Bore numbers and estimated extraction volumes will be provided to DITT and DEPWS.	A.3.1 Site Selection and Planning B.4.17 Groundwater monitoring	A	II	1	Yes	Type A Risk – Risks are well-understood. The regional understanding of the CLA is sufficient to understand the risks. Groundwater Monitoring has been undertaken and will continue.
Groundwater extraction	Reduction in groundwater available for other users	Communities and economy	Use of groundwater for project activities	B	IV	2	Valid water extraction licence Compliance with water extraction licence limits and conditions Ensure groundwater extraction is limited to the volumes required by the drilling program (See water use estimates in Section 3.0). Bore numbers and estimated extraction volumes will be provided to DITT and DEPWS.	B.4.17 Groundwater monitoring	A	III	1	Yes	Type A Risk – Risks are well-understood. The regional understanding of the CLA is sufficient to understand the risks. Groundwater Monitoring has been undertaken and will continue.
Creation of dust	Smothering of flora	Terrestrial ecosystems	Vehicle and plant movements	F	II	3	Driving is only permitted on designated access roads. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Water trucks will be used, to manage dust emissions from vehicle movement and drilling activities as appropriate.	A.3.1 Site Selection and Planning A.3.5 Biodiversity protection	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices.
Creation of dust	Loss of amenity	Communities and economy	Vehicle and plant movements	F	I	2	Driving is only permitted on designated access roads. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Water trucks will be used, to manage dust emissions from vehicle movement and drilling activities as appropriate.	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	A	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices.
Creation of dust	Public ingesting dust	Human health	Vehicle and plant movements	D	II	2	Driving is only permitted on designated access. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Water trucks will be used, to manage dust emissions from vehicle movement and drilling activities as appropriate.	A.3.1 Site Selection and Planning A.3.4 Erosion and sediment control	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices.
Creation of atmospheric emissions	Reduction in air quality	Air quality atmospheric processes	Vehicle and plant movements	C	II	2	Vehicles and fixed plant maintained as per maintenance schedule.	A.3.1 Site Selection and Planning	B	I	1	Yes	Type A Risk - Risks associated with diesel combustion are well known, both within Australia and Internationally. Methods for estimating emissions are available via the National Pollutant Inventory and NGERS.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Creation of atmospheric emissions	Reduction in air quality	Air quality atmospheric processes	Fugitive emissions	C	II	2	Real time monitoring of conditions during drilling including drilling monitoring and gas detection monitoring Wells to be constructed with cement isolation All cement slurries to be laboratory tested for ensure slurry is fit for purpose. Cement placement modelling conducted prior to the job including but not limited to casing standoff, drilling fluid displacement, anticipated job pressures and equivalent circulating densities A geohazard assessment was used to select the well locations to mitigating shallow gas hazards	A.3.1 Site selection and planning D.5.1 Baseline Methane assessment D.5.9.4 Other fugitive emissions	B	I	1	Yes	Type A Risk - Risks and impacts associated with Fugitive emissions are well known. Emissions during petroleum activities are estimated using the NGERS estimation tools.
Noise and vibration from project activities	Disturbance to native fauna	Terrestrial ecosystems	Vehicle movements and drilling activities	D	II	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices.	A.3.1 Site selection and planning A.3.3 Noise	C	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices.
Noise and vibration from project activities	Disturbance to landholders	Communities and economy	Vehicle movements and drilling activities	D	II	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices. Wells are located >8km from the Tanumbirini homestead.	A.3.1 Site selection and planning A.3.3 Noise	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Land access agreements are in place and stakeholder engagement is ongoing.
Light from project activities	Disturbance to native fauna	Terrestrial ecosystems	Vehicle movements and drilling activities at night Lighting from camp.	F	I	2	Task focussed lighting will be used and all boundary lighting for the camp will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Santos has extensive experience in managing disturbance to native fauna.
Light from project activities	Disturbance to landholders	Communities and economy	Vehicle movements and drilling activities at night, Lighting from camp.	F	I	2	Task focussed lighting will be used and all boundary lighting will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill. Wells are located >8km from the Tanumbirini homestead.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Land access agreements are in place.
Fauna interaction	Disturbance, injury or death to terrestrial fauna	Terrestrial ecosystems	Vehicle movements, drilling activities, and entrapment in open pits	E	I	2	Fauna ladders will be installed at all open pits. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited, with to a maximum of 60 km/hr. Pits and dams will be fenced Daily checks of pits and dams throughout the drilling program	A.3.5 Biodiversity protection A.3.8 Containment of contaminants	C	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices (e.g. site roads are speed limited). Santos has extensive experience in managing fauna interactions and entrapment.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Fauna interaction	Disturbance, injury or death to livestock	Communities and economy	Vehicle movements, drilling activities, and entrapment in open pits.	E	I	2	Relevant landowners and occupiers are notified prior to the commencement of the activity. All gates are left in the condition in which they were found (i.e. open / closed). When necessary, all fences are restored to satisfaction of landowner / managers. Speeds on unsealed roads will be limited to a maximum of 60 km/hr. Pits and dams will be fenced. Daily checks of pits and dams throughout the drilling program	A.3.5 Biodiversity protection A.3.8 Containment of contaminants	C	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices (e.g. site roads are speed limited).
Introduction of pest species	Loss of native vegetation through competition for resources	Terrestrial ecosystems	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through vehicle movements.	D	III	3	A Weed Management Plan has been developed for the project (Appendix E). Mitigation measures described in the Weed Management Plan for the project will be implemented.	A.3.6 Weed management A.5.3 Biodiversity protection	B	III	2	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Baseline weed survey complete and DEPWS approved weed management plans in place.
Introduction of pest species	Loss of pasture species through competition for resources	Communities and economy	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through vehicle movements.	D	II	2	A Weed Management Plan has been developed for the project (Appendix E). Mitigation measures described in the Weed Management Plan for the project will be implemented.	A.3.6 Weed management	B	II	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Baseline weed survey complete and DEPWS approved weed management plans in place.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Fire	Disturbance or death to terrestrial fauna, loss of terrestrial flora	Terrestrial ecosystems	Ignition sources from plant and machinery Inappropriate disposal of cigarettes.	C	III	2	Fire-fighting equipment and competent fire-fighting personnel will be available. All vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts to land. All personnel will receive information prior to the commencement of the activity relating to: • Provisions of the Emergency Response Plan including procedures during a fire emergency • The operation of firefighting equipment and communications • Restricted smoking requirements Toolbox meetings will be conducted to: • Alert the workforce of the fire risk level for the day • Discuss any fire risk management breaches and remedial actions	A.3.7 Fire management	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.
Fire	Injury or death to livestock, loss of pasture, dwellings and infrastructure	Communities and economy	Ignition sources from plant and machinery and well control events (flaring) Inappropriate disposal of cigarettes.	C	III	2	Fire-fighting equipment and competent fire-fighting personnel will be available. All vehicles will be equipped with portable fire extinguishers. Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material. Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters. All vehicles will be equipped with operational VHF and / or UHF radio transceivers. Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts. All personnel will receive information prior to the commencement of the activity relating to: • Provisions of the Emergency Response Plan including procedures during a fire emergency • The operation of firefighting equipment and communications • Restricted smoking requirements Toolbox meetings will be conducted to: • Alert the workforce of the fire risk level for the day • Discuss any fire risk management breaches and remedial actions.	A.3.7 Fire management	B	II	1	Yes	Type A Risk - Risks associated with bushfire are well known, with numerous literature and NT Government mapping and management plans in place.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Disturbance to landholder/public	Disturbance to landholders activities	Communities and economy	Vehicle and plant movements throughout the project area	D	II	2	Relevant landowners and occupiers are notified prior to activity of preparation of camp sites, preparation of survey lines and undertaking of operations. Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues. System is in place for logging public/landholder complaints to ensure that issues are addressed. Damage to station tracks and fences is reported and restored to satisfaction of landowner / managers. All gates are left in the condition in which they were found (i.e. open / closed). Speeds on unsealed roads will be limited to a maximum of 60 km/hr.	A.3.1 Site selection and planning 4.3.2 Well pad site selection requirements	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Land access agreements are in place and stakeholder engagement is ongoing.
Chemical spills and leaks associated with chemical and fuel storage and handling	Localised contamination of soil	Terrestrial Environmental Quality	Inappropriate storage or handling of hazardous substances, including drilling muds. Poor refuelling or fuel transfer practices	D	III	3	Bunded containment for storage of hydraulic fluid Spill containment for storage of liquid drilling chemicals Spill management kits located onsite for response to any small scale spills Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed in accordance with SDS and meet NT WorkSafe requirements with industry standards. Riser and diverter will be used to prevent mud spills Pre-spud checks / Pre-job checks when transferring mud Secondary containment in use for storage of chemicals will comply with clause A.3.8(g) of the code, including the requirement that Secondary containment will have sufficient capacity to hold 110% of the volume of the largest container. Drilling fluid system mixed, contained and monitored in engineered fluid storage tanks. Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved.	B.4.16 Site material and fluid management C.7.2 Spill management plan	B	III	2	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia and this experience includes managing storage and handling of hazardous substances.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Chemical spills and leaks associated with chemical and fuel storage and handling	Reduction in surface and groundwater water quality	Inland Water Environmental Quality	Inappropriate storage or handling of hazardous substances Poor refuelling or fuel transfer practices	D	III	3	Installation of blow-out prevention equipment systems. Bunded containment for storage of hydraulic fluid. Spill containment for storage of liquid drilling chemicals. Spill management kits located onsite for response to any small scale spills. Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed in accordance with SDS and meet NT WorkSafe requirements with industry standards. Riser and diverter will be used to prevent mud spills. Pre-spud checks / Pre-job checks when transferring mud. Secondary containment in use for storage of chemicals will comply with clause A.3.8(g) of the code, including the requirement that Secondary containment will have sufficient capacity to hold 110% of the volume of the largest container. Primary Drilling fluid system mixed, contained and monitored in engineered fluid storage tanks. Cuttings transferred from a cuttings skip to a lined cutting pit/sump Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved.	B.4.16 Site material and fluid management C.7.2 Spill management plan C.3 Well site water management	B	II	2	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia and this experience includes managing storage and handling of hazardous substances including fuels.
Spill of water based drill fluid during fluid recycling process	Localised contamination of soil	Terrestrial environmental quality	Inappropriate storage or handling of potentially hazardous substances	D	I	2	Water based drilling mud system planned. Spill containment for storage of liquid drilling chemicals. Spill management kits located onsite for response to any small scale spills. Any spills contained and remediated. Pre-spud checks / Pre-job checks when transferring mud. Primary Drilling fluid system mixed, contained and monitored in engineered fluid storage tanks. Drill Rig active fluid storage system tanks are monitored and alarmed (Gain/Loss) during drilling operations. Cuttings transferred from a cuttings skip to a lined cutting pit/sump Excess drilling cuttings fluid transferred from cuttings pit/sump to drilling fluid storage tanks to be treated/recycled back into the active system to minimise wastage and reduce total disposal volume. Cuttings pit / sump freeboard planned to maintain a 1.5m to mitigate against a 1 in 1000year rain event	B.4.16 Site material and fluid management C.7.2 Spill management plan C.3 Well site water management	C	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia and this experience includes managing storage and handling of drilling fluids.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Transport of chemicals and wastewater on unsealed roads during the wet season	Localised contamination of soil	Terrestrial environmental quality	Transport vehicle accident due to weather Transport vehicle stuck truck being stuck due to mechanical or weather events	C	II	2	Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads. Transport of wastewater will only occur in enclosed tanks. Detailed weather monitoring and forecasting to be used. In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe. Licenced waste transporters to be used to transport listed wastes.	A.3.8 Containment of contaminants	A	II	1	Yes	Type A Risk – Risks are well-understood with established management practices. Rainfall data and the use of enclosed tanks for transport.
Transport of chemicals and wastewater on unsealed roads during the wet season	Reduction in surface and groundwater water quality	Inland Water Environmental Quality	Transport vehicle accident due to weather Transport vehicle stuck truck being stuck due to mechanical or weather events	C	II	2	Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads. Transport of wastewater will only occur in enclosed tanks. Detailed weather monitoring and forecasting to be used. In the event of a truck being stuck due to mechanical or weather reason, transfer or recovery will only occur once safe. Licenced waste transporters to be used to transport listed wastes.	A.3.8 Containment of contaminants	A	II	1	Yes	Type A Risk – Risks are well-understood with established management practices. Rainfall data and the use of enclosed tanks for transport.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Chemical spills and leaks and aquifer / reservoir cross-flow	Reduction in groundwater quality	Inland Water Environmental Quality	Cross-flow during well drilling, construction, operation and decommissioning of wells at a Multi-well pad operation Well blow out Faults or major structures enables cross-flow	C	IV	3	Installation of blow-out prevention equipment systems. A geohazard assessment has been performed and the results of this assessment indicate that subsurface hazards such abnormal pressure zones, shallow gas, lost circulation and potential zones of instability are unlikely to be encountered. To avoid interconnection of exploration wells, the proposed horizontal wells have been planned to be approximately 10m apart at surface i.e., wellhead to wellhead, and the lateral sections planned to be 500m apart (Figure 3-8 and Figure 3-10). The horizontals will target separate shale intervals and be vertically separated with a minimum spacing of approximately 50mTVD. After being completed with casing/tubing, the wells will also be monitored with pressure gauges to detect communication during operations. Drilling of wells off-structures using seismic data for control. Wells are located away from major faults and structures based on seismic data control; further seismic data acquisition planned where “dip” and “strike” line control is not available. Ground water monitoring bores installed on location prior to drilling operations. Baseline monitoring conducted six months prior to and post drilling operations. Shallow aquifers isolated behind cemented concentric casing strings. Water based drilling fluids proposed. Cemented casing, following the Code of Practice requirements, will prevent aquifer cross-flow once well is constructed and passes well acceptance criteria. Specifically the casing is designed to: • Maintain hole stability and withstand all planned life cycle well loading conditions without loss of well integrity • Ensure the establishment of the well barriers required at various stages of the well life. • Ensure equivalent circulating density in the next hole section does not exceed the fracture propagation pressure while maintaining the required static overbalance. • Ensure the formation strength at the previous casing shoe or at a deeper zone will not be exceeded whilst circulating out a gas influx taken from the bottom of the open hole with the anticipated fluid weight and 0.5 ppg (60 g/l) kick intensity over prognoses formation pressure. Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved.	B.4.1 Well Integrity management B.4.2 Aquifer protection B.4.3 Well design and well barriers B.4.6 Casing and tubing B.4.7 Primary cementing B.4.9 Well control C.7.2 Spill management plan	B	II	2	Yes	Type A Risk – Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. In addition the CSIRO regional baseline monitoring program is underway and the knowledge of the regional aquifers is well established. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia. Control and monitoring bores as per Preliminary Guidelines: Groundwater Monitoring bores for Exploration Petroleum Wells in the Beetaloo Sub-Basin
Waste	Fauna attracted to waste	Terrestrial ecosystems	Waste stored inappropriately attracting native fauna	F	II	2	Waste will be segregated and stored on site and all putrescible waste material will be held in fauna proof containers. Only waste from approved wastewater systems and grey water will be disposed of to land. Licenced waste contractor will be used for any offsite transfer or disposal.	C.7.1 Wastewater management plan	B	I	1	Yes	Type A Risk – Risks are well-understood with established and proven management practices. Santos has extensive experience in managing wastes to avoid attracting native fauna.

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial Risk Ranking*			Mitigation and Management Measures		Residual Risk Ranking*			Effective Controls	Uncertainty Ranking
				L	C	R	EMP Commitments	Relevant Code of Practice	L	C	R		
Waste	Reduction in surface water and groundwater quality	Inland Water Environmental Quality	Overflow of pits Leaching from pit increases cutting volumes as a result of additional horizontal wells	D	III	3	Storage tanks and pits are designed and operated to prevent overtopping due to rainfall and designed with enough freeboard to accommodate total rainfall anticipated. Daily monitoring of weather and for predicted significant rainfall events will be undertaken. Cuttings pits and fluid storage levels will be monitored during and after high rainfall at all times while drilling. Cuttings pit will be appropriately designed and constructed with an impermeable containment barrier. Cuttings pit will be inspected daily to check integrity. Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. Implementation of an approved Spill Management Plan and Wastewater Management Plan, as defined by the code. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved.	A.3.8 Containment of contaminants B.4.16 Site material and fluids management C.7.2 Spill management plan C.7.1 Wastewater management plan	B	II	2	Yes	Type A Risk – Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. Preliminary water balance modelling completed. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia including the management of fluids and cuttings.
Waste	Impact to soil quality	Terrestrial Environmental Quality	Overflow of pits Leaching from pits Additional horizontal wells increases cutting volumes	D	II	2	Storage tanks and pits are designed and operated to prevent overtopping due to rainfall and designed with enough freeboard to accommodate total rainfall anticipated. Cuttings and flare pit levels will be monitored for overflow during and after high rainfall at all times while drilling. An assessment of environmental hazards posed by the drill cuttings and residual drilling fluid will be carried out including a baseline sample to drilling, sampling cuttings pit fluid post drill and sampling cuttings when dried out. The hazard of NORMs in cuttings will be assessed using continuous, real-time, quantitative monitoring of NORMs concentrations from X-ray fluorescence data against the *Radiation Protection Act 2004 (NT).* Cuttings blending and burial or isolation and removal will be subject to sampling results and on the advice of an independent environmental consultant. Cuttings pit will be appropriately designed and constructed with an impermeable containment barrier. Cuttings pit will be inspected daily to check integrity. At the completion of the project a decision on the in-situ disposal of the drilling cutting will be made on the advice of an independent environmental consultant. Code of Practice: Onshore Petroleum Activities (the code) will be implemented. The code includes requirements for well operations and wastewater management. Implementation of an approved Spill Management Plan and Wastewater Management Plan, as defined by the code. A WOMP will be developed to cover well activities. The Project will not commence until a WOMP has been approved.	A.3.8 Containment of contaminants B.4.16 Site material and fluids management C.7.2 Spill management plan C.7.1 Wastewater management plan	C	II	2	Yes	Type A Risk – Risks are well known and have been extensively assessed through the Scientific Inquiry into Hydraulic Fracturing in the Northern Territory (2018) Final Report. Preliminary water balance modelling completed. Santos has extensive experience in drilling conventional and unconventional petroleum wells in the NT and across Australia including the management of fluids and cuttings.

**L=Likelihood, C = Consequence and R = Risk Ranking Combined*

6.1 Discussion on ALARP, acceptability and ESD

As discussed in section 5.7, Santos uses a model to determine acceptance of residual risk is detailed in the Santos Residual Risk Acceptance Model. In summary:

- A Level 5 residual risk is intolerable and must not be accepted or approved by Management.
- A Level 2 – 4 residual risk is acceptable provided that ALARP has been achieved and demonstrated.
- A level 1 residual risk is acceptable and it is assumed that ALARP has been achieved.

In addition to the requirements detailed above, for the purposes of petroleum activities, impacts and risk to the environment are considered broadly acceptable if:

- The residual risk is determined to be 1 (and ALARP Decision Type A selected and good practice control measures applied), or
- The residual risk is determined between 2 and 4 and ALARP can be demonstrated; and
- The following have been met:
    - Principles of ESD
    - Legal and other requirements
    - Santos policies and standards
    - Stakeholder expectations.

All the residual risks in the risk assessment in Table 6-1 are between 1 and 2, which means that they are acceptable, ALARP and have considered ESD.

In the risk assessment, all risks have been considered a decision 'Type A', meaning that they are well understood and that are established practices in place to manage these risks.

Activities conducted under this EMP will be done in compliance with the Code of Practice: Petroleum Activities in the Northern Territory. This ensures that that petroleum activities are managed to ensure that risks are managed to a level that is as low as reasonably practical (ALARP) and acceptable.

6.2 Referrals to DAWE and NT EPA

6.2.1 Significant Impact test for EPBC listed species

Referral of the project to the Department of Agriculture, Water and Environment is required if the proposed action will have, or is likely to have a significant impact on MNES. Gouldian Finch, Grey Falcon and Crested Shrike-tit were identified as having a medium chance of occurring within the Project Area. However, the proposed drilling program will not directly impact habitat for these species and significant impact to these species or their habitat as a result of project activities is considered remote. The project will not be referred to the Department of Agriculture, Water and the Environment. The proposed action will not have a significant impact on any MNES

6.2.2 Significant impact test for Environmental Protection Act

Petroleum activities that could reasonably be considered to be capable of having a significant effect on the environment are referred to the NT EPA. Using the guideline 'Referring a proposed action to the NT EPA: Environmental impact assessment guidance for proponents" (Draft for consultation NT EPA 2020), a detailed review of and assessment against each prescribed Environmental Objectives for

each Environmental Factor was conducted in relation to the proposed Drilling Program and is included in Table 6-2. The results of the assessment in in Table 6-2 clearly demonstrate that the proposed petroleum activities that could not reasonably be considered to be capable of having a significant effect on the environment.

Table 6-2 Assessment against the Environmental Protection Act's Environmental Objectives and Environmental Factor

Theme	Environmental Factor	Environmental Objective	Relevance to the application
Land	Terrestrial Ecosystems	Protect terrestrial habitats to maintain environmental values including biodiversity, ecological integrity and ecological functioning.	The proposed activities occur within previously cleared areas devoid of fauna habitat features. The proposed activities are unlikely to result in impacts to vegetation or native fauna. The mitigation measures outlined in Table 6-1 will be implemented to manage these risk to a level that is ALARP and acceptable. Accordingly, biological diversity and ecological integrity will be maintained and there would be no potential for a significant effect to terrestrial flora and fauna because of the proposed activities.
Land	Terrestrial Environmental Quality	Protect the quality and integrity of land and soils so that environmental values are supported and maintained.	Should a release occur, the proposed activities are likely to result in only minor localised impacts to the land. The mitigation measures outlined in Table 6-1 will be implemented to manage these risk to a level that is ALARP and acceptable. Accordingly, biological diversity and ecological integrity will be maintained and there would be no potential for a significant effect to land and soils because of the proposed activities.
Land	Landforms	Conserve the variety and integrity of distinctive physical landforms.	The landforms within EP 161 include gorges, water holes and dissected sandstone plateaus (within the Gulf Falls and Uplands Bioregion) and flat to gently undulating plains with little local relief (within the Sturt Plateau Bioregion), as outlined in Section 4.3.1.The Project Area is located in areas of previous disturbance that are devoid of outstanding landforms. Given the implementation of the mitigation measures outlined in Table 6-1, it is unlikely that distinct physical landforms will be impacted. Accordingly, there would be no potential for a significant effect on landforms.
Water	Aquatic Ecosystems	Protect the quality of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	It is unlikely aquatic ecosystems will be impacted by the purposed activities, given that no sensitive vegetation will be disturbed and there is a lack of permanent surface waters and aquatic GDEs in the Project Area. Furthermore, the mitigation measures outlined Table 6-1, will be employed to ensure that potential risks and impacts are managed and further mitigated. Accordingly, there would be no potential for a significant effect on aquatic ecosystems.
Water	Inland water environmental quality	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.	The proposed activities have the unlikely potential to result in localised and short-term disturbance to inland water quality through unplanned erosion and spills. Given the lack of permanent surface waters and the turbid nature of surface waters during times of flood, in conjunction with the mitigation measures outlined in Table 6-1 it is unlikely the inland water quality will be impacted. Accordingly, there would be no potential for a significant effect on the quality of groundwater and surface water.

Theme	Environmental Factor	Environmental Objective	Relevance to the application
Water	Hydrological Processes	Protect the hydrological regimes of groundwater and surface water so that environmental values including ecological health, land uses and the welfare and amenity of people are maintained.	It is unlikely hydrological regimes of groundwater or surface waters will be altered by the proposed activities. The area of planned disturbance is small, minimal volumes of groundwater are required and groundwater extraction associated with the project is regulated and reported on. Furthermore, the control measures outlined in Table 6-1 will be implemented to ensure that these potential risks and impacts are managed and further mitigated. Accordingly, there would be no potential for a significant effect on hydrological regimes of groundwater and surface water.
Air	Air Quality	Maintain air quality and minimise emissions and their impact so that environmental values are protected.	The proposed activities have the potential to result in localised, short-term minor impacts to air quality through planned atmospheric emissions. The mitigation measures outlined in Table 6-1 will be implemented to manage these risks. Given this, and the relatively small nature of operations, there would be no potential for significant effect to air quality and greenhouse gases.
Air	Atmospheric processes	Minimise greenhouse gas emissions so as to contribute to the NT Government's aspirational target of achieving net zero greenhouse gas emissions by 2050.	The proposed activities have the potential to result in localised, short-term minor impacts to air quality through planned atmospheric emissions. The mitigation measures outlined in Table 6-1 will be implemented to manage these risks. Given this, and the relatively small nature of operations, there would be no potential for significant effect to air quality and greenhouse gases.
People	Communities and economy	Enhance communities and the economy and foster resilience to a changing climate, for the welfare, amenity and benefit of current and future generations of Territorians.	The proposed activities have the unlikely potential to result in disturbance to culturally sensitive sites and/landholders through weeds, fire, planned physical disturbance, and unplanned stakeholder interactions. The control mitigation measures outlined in Table 6-1 will be implemented to manage these risks. Given this, and the relatively short duration of this activity, the proposed activities will maintain the social and economic values of the region.
People	Culture and heritage	Protect sacred sites, culture and heritage.	The proposed activities have the unlikely potential to result in disturbance to culturally sensitive sites and/landholders through lighting, weeds, fire, planned physical disturbance, and unplanned stakeholder interactions. The control mitigation measures outlined in Table 6-1 will be implemented to manage these risks, such as the areas proposed to be disturbed have been surveyed for sacred sites and cultural heritage significance and an AAPA certificate is in place (on 13 May 2019 Authority Certificate C2019/043, as a variation to C2014/053, was granted in relation to activity covered under this EMP). Given this, and the relatively small nature of operations and proposed actual ground disturbance, the proposed activities will maintain the cultural and heritage values of the Northern Territory.

Theme	Environmental Factor	Environmental Objective	Relevance to the application
People	Human Health	Protect the health of the Northern Territory population.	The proposed activities have the unlikely potential to result in human health impacts due to inhalation of dust. The mitigation measures outlined in Table 6-1 will be implemented to manage this risk. Accordingly, there would be no potential for significant effect to human health.

7.0 Management Plans

7.1 Weed Management Plan

A project specific weed management plan must be developed as part of the EMP which meets the requirements of the *NT Weed Management Planning Guide: Onshore Petroleum Projects* (DEPWS 2019). The Weed Management Plan for the Drilling Program is provided in Appendix E.

7.2 Fire Management Plan

7.2.1 Baseline Fire Information

Baseline fire information has been provided by Infonet and the Fire History Report available from http://www.ntinfonet.org.au/infonet2/.

7.2.1.1 Fire Frequency

The Fire History Report indicates fire frequency in the immediate vicinity of the Project Area and within Tanumbirini Station is very low at three or less between 2000 and 2018. Fire frequency increases to the east, south and west and less so to the north (NTG 2019). The number of years burnt between 2000 and 2018 at the Tanumbirini well location and the Inacumba well location is shown in Figure 7-1.

The location immediately surrounding the Tanumbirini well location appears to have been burnt zero or one time between 2000 and 2018. The Inacumba well location appears to have been burnt three or four times between 2000 and 2018

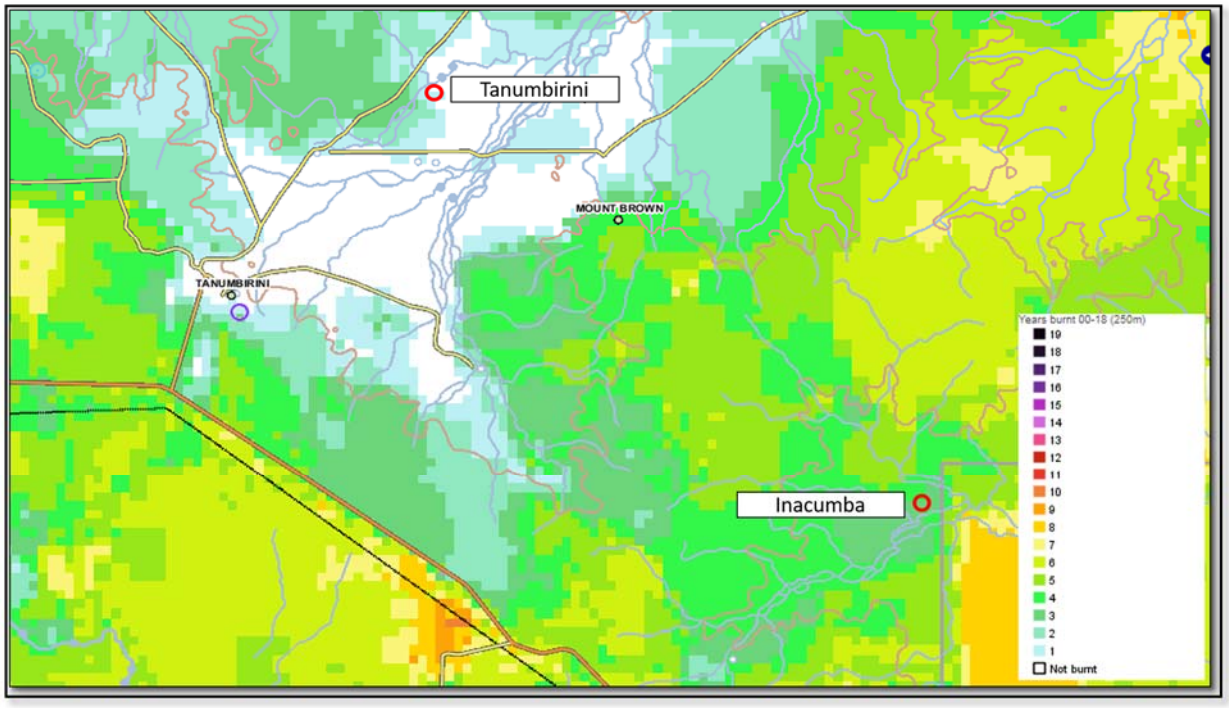

Figure 7-1 Fire frequency between 2000 and 2018 at Tanumbirini and Inacumba locations

7.2.1.2 Last Burn

Generally, the most recent fires have occurred west and east of the Tanumbirini and Inacumba locations respectively. In 2012 much of the area in the vicinity of the project was subject to fire (NTG 2018). The number of years burnt between 2000 and 2018 at the Tanumbirini and the Inacumba locations is shown in Figure 7-2.

The Tanumbirini location was last burnt in 2006. The Inacumba location, and much of the area that surrounds this location, was last burnt in 2012.

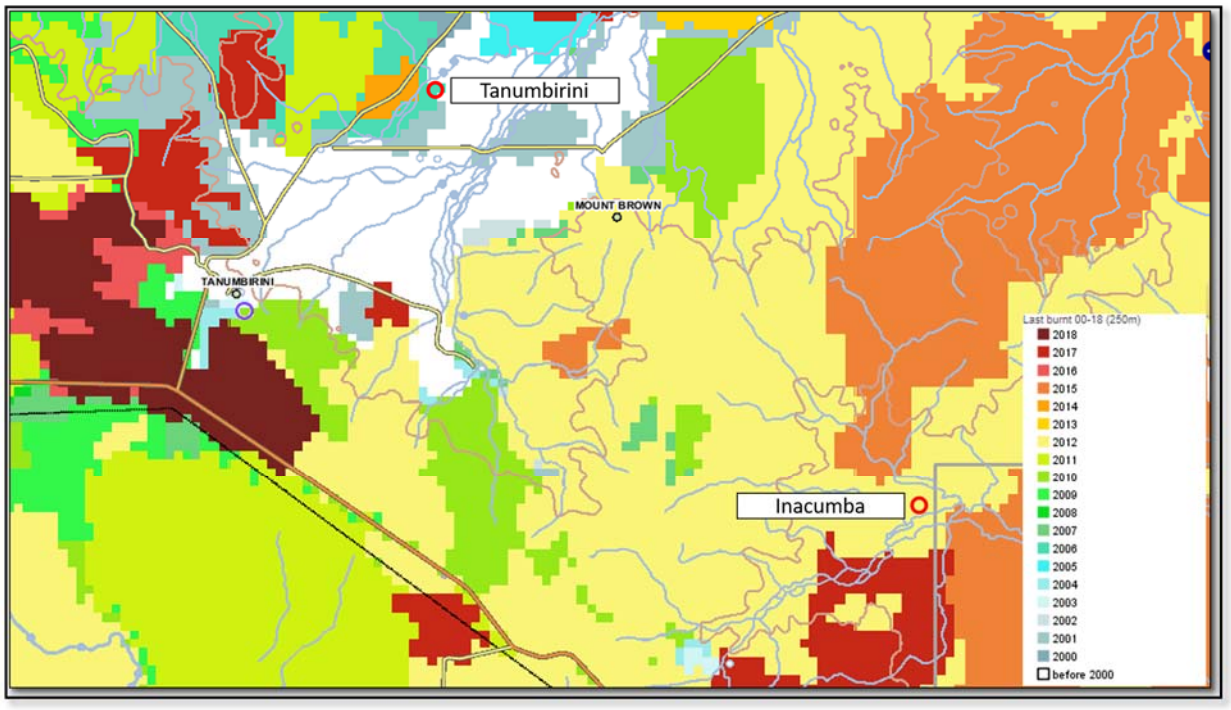

Figure 7-2: The year of last burn between 2000 and 2018 at Tanumbirini and the Inacumba locations

7.2.2 Fire management

7.2.2.1 Impacts of the proposed activities on the existing fire management

The proposed activities will be located on existing cleared infrastructure. The small size of the development footprint will ensure that there will be no impacts on existing fire management.

7.2.2.2 Coordination with the landholder and other land users

The proposed development will require a Land Access and Compensation Agreement with the landholder/s. Through this process Santos will ensure that the project does not affect the landholder's fire management obligations and strategies.

The project lies within the Savanna Fire Management Zone in the Northern Territory. The Savanna Regional Bushfires Management Plan 2018 has been developed to support community wide fire management within the Savanna Fire Management Zone in line with the *Bushfires Management Act 2016*.

The proposed activities do not include the use of fire and fire exclusion from the lease pads is proposed. Outside of the lease pads there will be no impact on fire management. This is consistent with the Savanna Regional Bushfires Management Plan 2018 and the Fire management objectives for petroleum exploration.

7.2.2.3 Fire Mitigation Measures

The Central Piece of fire mitigation for the project is the implementation of a Fire control zone surrounding the Inacumba location and the Tanumbirini location (See EMP Figure 3.2 and Figure 3.3). This fire control zone has been established. The objectives of the fire control zones are:

- Assets - Protecting assets (resources, materials and equipment) by removing fuel in their vicinity may be done using other means
- Safety - Manage fire to maintain safety of employees and visitors to site in regards to removing vegetation and managing bushfire hazards involved in machinery used.
- Neighbours - Unplanned Fires during exploration have the ability to quickly impact on neighbouring properties where grass is a major asset to their livelihoods.
- Firebreaks - Installation of firebreaks to allow for management to ensure fire does not enter lease or possible exit lease impacting on neighbours.

Prior to the commencement of drilling activities and throughout operations the fire control zones will be cleared of vegetation and maintained to ensure no fire encroachment during drilling activities. During well suspension, vegetation removal requirements will be assessed during the post wet weed survey when vegetation growth will be greatest. If required, slashing / grading will occur to remove well site vegetation.

The access to the Inacumba and the Tanumbirini locations are also the fire access trails. These will be upgraded in places and maintained to ensure ongoing access to land to allow for exploration work to be undertaken and to allow landholder to access to the areas.

Communication of fire alerts will include:

- All personnel will receive information prior to the commencement of the activity relating to:
    - Provisions of the Emergency Response Plan including procedures during a fire emergency
    - The operation of firefighting equipment and communications
    - Restricted smoking requirements
- Toolbox meetings will be conducted to:
    - Alert the workforce of the fire risk level for the day ‘
    - Discuss any fire risk management breaches and remedial actions.

All project infrastructure will be designed and constructed to mitigate risks of ignition. Project specific requirement to mitigate risks of ignition include:

- Fire-fighting equipment and competent fire-fighting personnel will be available.
- All vehicles will be equipped with portable fire extinguishers.
- Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material.
- Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters.
- All vehicles will be equipped with operational VHF and / or UHF radio transceivers.
- Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts.

7.2.3 Monitoring

7.2.3.1 Annual Fire Mapping

If during the proposed exploration works a fire has occurred in and around the project footprint, Santos in consultation with the landholder and with the landholders approval endeavour to map the extent of the fire and provide that information to DEPWS. Santos will review the North Australia and Rangelands Fire Information site's (https://www.firenorth.org.au/nafi3/) annual fire mapping to monitor changes to fire frequency in the relevant area.

7.2.3.2 Operational Fire Monitoring

The Santos Onsite Company Representative is responsible for monitoring for bushfire alerts (primarily via the https://securent.nt.gov.au/alerts and https://www.bushfires.nt.gov.au/incidentmap/ websites and notifying all site personnel of the risks of fire. Communication of these alerts will via the daily toolbox meetings. Where bushfire alert information becomes known after the toolbox meeting, the Onsite Company Representative will communicate to all site personnel.

7.3 Rehabilitation Management Plan

Santos may request approval to undertake additional exploration activities following the completion of the activities covered under this EMP (which would require further EMP and other regulatory approvals and are not covered by this EMP). The wells proposed as part of this EMP are part of an exploration program with uncertainty on reservoir outcome. The timing of rehabilitation activities for activities included in this EMP will depend on exploration outcomes and the potential for reservoir development and production.

7.3.1 Scope

Rehabilitation of access tracks and lease pads will are not included in the scope of this EMP. The reprofiling of access tracks and lease pads utilised under this EMP will be done as part of the Civils and Seismic EMP and in accordance with the Code of Practice.

7.3.2 Progressive rehabilitation

Progressive rehabilitation of significantly disturbed land which is not required for the ongoing conduct of the petroleum activities or future activities, will commence as soon as practicable, but not longer than 12 months following the cessation of the activity.

As discussed above the wells proposed as part of this EMP are part of an exploration program with uncertainty on reservoir outcome. The timing of progressive rehabilitation a will depend on exploration outcomes and the potential for reservoir development and production.

7.3.3 Final land use

All surface infrastructure will be removed and the disturbances rehabilitated. The following activities will be undertaken:

- Removal of fencing.
- Back filling of pits. Pits to be levelled off, mixed with dry stockpiled fill material and capped with at least 750 mm of dry stockpiled fill material.
- Removal of drilling infrastructure such as steel cellar box and backfilling of the drill cellar.
- Water bore holding ponds to be drained of liquids.
- Lightly scarifying or rolling all disturbed areas to break up consolidated surfaces.

- Spreading of stockpiled topsoil material and trees, shrubs and grasses across the lease pad and areas not needed for future monitoring and maintenance.
- Ripping and spreading of stockpiled vegetation to promote revegetation.
- Removal of fencing and well site infrastructure.
- Any reusable materials and pumps to be delivered to the landholder.
- Repair or reinstate any landholder infrastructure damaged due to drilling activities.

7.3.4 Rehabilitation goals

Given the rehabilitation efforts associated with this EMP involve drilling activities only rehabilitation goals are limited to:

- Removal of all rubbish and waste
- Removal of above ground infrastructure so that in the event the civils works rehabilitation such as the reprofiling of access tracks and lease pads can occur unimpeded.
- Provide that the drilling sites are reshaped (if required) to a stable landform to ensure the lease pad is safe and stable.

Following completion of the rehabilitation works final photo point revisit and any required additional rehabilitation, Santos will submit the final Environmental Reports to DITT and DEPWS along with the application to release the long-term Rehabilitation Security. In accordance with the Environmental Closeout Procedures for Petroleum Activities (DPIR 2016), the final rehabilitation assessment and endorsement will be conducted by an appropriately qualified third party.

7.3.5 Monitoring and maintenance program

Photo points will be established at the wellsite. Each photo point is geo-referenced and is captured digitally to ensure consistency. By establishing photo points, it provides a balanced representation of the ground condition and various landform and vegetation types encountered and enables rehabilitation success to be effectively monitored.

The process is repeated after the drilling program is completed (i.e. post well completion). The revisit intervals are generally immediately after rehabilitation works have been completed post decommissioning, following the first wet season, one year after rehabilitation works, and three years after rehabilitation; although the return period is determined by weather/road conditions and current activity in the region. Revisits may also be targeted, with emphasis on sensitive areas and areas potentially subject to erosion such that environmental impact of re-accessing remote locations is minimised in consultation with, and on the advice of, an independent environmental consultant.

If during any monitoring events (weed monitoring, rehabilitation monitoring, groundwater monitoring etc.) contamination is detected, an incident will be logged and remediation will commence immediately.

7.4 Wastewater Management Plan

An EMP for a petroleum activity must include a wastewater management plan (WWMP). The WWMP for the Drilling Program is provided in Appendix G

7.5 Spill Management Plan

An EMP for a petroleum activity must include a Spill Management Plan (SMP). The SMP for the Drilling Program is provided in Appendix H.

8.0 Implementation Strategy

The Implementation Strategy described in this section is a summary of the Santos systems, practices and procedures in place to manage the environmental risks of the Drilling Program. The strategy aims to ensure that the control measures, environmental performance outcomes and standards, detailed in Section 7, are implemented and monitored to ensure environmental impacts and risks are continually identified and reduced to a level that is ALARP and acceptable.

8.1 Environmental Outcomes, Performance Standards and Measurement Criteria

Santos is committed to ensuring that its activities are undertaken in a manner that is environmentally responsible through setting Environmental Outcomes (EO) and Environmental Performance Standards.

Under the Regulations, an EMP must include EO's that address the risks identified in section 6.0. The EO's must address the legislative and other controls that manage the environmental aspects of the activity.

For each EO, there must be at least one related EPS, that either reduces the likelihood of the risk or impact occurring, or reducing the impact or consequence of the risk. The EPS intend to validate the controls that have been implemented to manage the environmental risks. An EPS will relate to the quality of the control in place, including people, systems, equipment and procedures.

For each EO and its relevant EPS, specifically related measurable criteria should be included to measure the performance against the EO and EPS. These Measurement Criteria (MC) must enable a determination to be made on whether the EOs and EPS are being consistently met. The EO, EPS and MC for the Drilling Program are described in Table 8-1

Table 8-1 Environmental Outcomes, Environmental Performance Standards and Measurement Criteria

Risk Sources	Environmental Outcome	Environmental Performance Standard	Measurement Criteria
Environmental Value: Terrestrial Ecosystems			
Vehicle and plant movements generating dust and depositing on flora Vehicle and plant movements generating noise and vibration and disturbing wildlife Vehicle movement, drilling activities and camps generating light and disturbing wildlife turbance, injury or death to terrestrial fauna due to vehicle strike, drilling activities and / or entrapment in open excavations	No significant impact to threatened flora or fauna species, their habitat or sites of conservation significance resulting from conduct of the regulated activity.	Injury and disturbance to threatened fauna during the conduct of the activity will be minimised	Site induction records show all personnel have completed site inductions, which includes requirements for managing impacts to terrestrial fauna
			IVMS records show 60km/hr speed limit adhered to and any non-compliance recorded.
			IVMS records show no off-road driving.
			Equipment maintenance logs demonstrate engines and machinery have been maintained in accordance with required maintenance schedule and have been fitted with noise suppression devices.
			Audit records of lighting at the camp show inward-facing lights that are adequate for safe operations.
			Daily checklist shows inspection of fences, excavations, pits, storages for entrapped fauna and fauna escapes intact.
			Daily checklist shows all domestic waste receptacles have lids secured.
			Audit records show only waste from approved wastewater systems and grey water disposed of to land.
Vehicle and plant movements generating dust and depositing on flora		Dust generation on the well pad in the dry season will be minimised through tracking of wind forecasts, use of dust suppression when undertaking operations, and strict adherence to speed limits on unsealed roads.	Records show when and where water trucks have been used for dust control including weather condition observations.
			IVMS records show no off-road driving.
			IVMS records show 60km/hr speed limit adhered to and any non-compliance recorded.
Plant and vehicles distributing weeds		No introduction of new species of weeds or plant pathogens, or increase	Site induction records show all personnel have completed site inductions, which include information on weeds in the region and method of spread.

Risk Sources	Environmental Outcome	Environmental Performance Standard	Measurement Criteria
from outside or within the project area		in abundance of existing weed species, as a result of project activities.	Audit records show weed management plan implemented in accordance with stated schedule.
			Hygiene declaration available for all vehicles coming into EP161 on each occasion.
			Weed monitoring shows no new weed species introduced to work area.
Ignition sources from plant and machinery causing fire.		No fire in EP161 as a result of conduct of the regulated activity.	Site induction records show all personnel have completed site inductions, which include information on fire risk and impact to landholder for unplanned fire.
			Weekly checklist shows SDS available and appropriate and in-test fire-fighting equipment next to flammable material stores.
			Weekly checklist shows all vehicles have portable fire extinguishers and operational VHF or UHF radio transceivers.
			No use of petrol motor vehicles and audits show all petrol-powered pumps have spark arresters fitted.
			Training records shows staff trained in use of fire-fighting equipment.
			Training records verify that operations personnel participate in at least annual fire and emergency drills.
			Records show toolbox meeting discussions of fire risk levels and fire risk management and remedial actions.
			Records show daily assessment of fire weather during dry season.
			No smoking allowed on site and any instance of smoking recorded as a non-conformance.
Environmental Value: Terrestrial Environmental Quality			
Vehicles leave the previously constructed roads or work areas	No significant impact to the quality and integrity of land and soils resulting from conduct of the regulated activity	No unauthorised physical disturbance to soil.	Site induction records shows all personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan.
			Records show the erosion and sediment control plan implemented prior to the commencement of the activity

Risk Sources	Environmental Outcome	Environmental Performance Standard	Measurement Criteria
			IVMS records show no off-road driving.
			IVMS records show 60km/hr speed limit adhered to and any non-compliance recorded.
Inappropriate storage or handling of potentially hazardous substances Transport vehicle accident due to weather erflow of Pits		No releases of contaminants (wastes, wastewater, chemicals, hydrocarbons or drilling fluids) resulting in long-term contamination of the soil	Weekly inspection checklists confirm all hazardous materials and stored and managed in accordance with the EMP, the Code of practice and the WOMP.
			Records of spills and completed remediation in the Santos Incident Management System.
			A record of the assessment of environmental hazards posed by the drill cuttings to determine disposal methods.
			Daily inspection records confirm the freeboard is sufficient to accommodate the relevant wet season and dry season freeboard requirements, and that the pit integrity is appropriate
			Audit records show Bureau of Meteorology provided timely notification significant rainfall event and site evacuation plan put into pace following notification.
Environmental Value: Inland Environmental Water Quality			
Cross-flow during well drilling, construction, operation and decommissioning, well blow out, faults or major structures enables cross-flow Inappropriate storage or handling of hazardous substances	No significant impact on Inland environmental water quality resulting from conduct of the regulated activity	No releases of contaminants (wastes, wastewater, chemicals, hydrocarbons or drilling fluids) resulting in long-term contamination of the waters.	Well control monitoring demonstrates adequate well control.
			Well acceptance criteria met.
			Weekly inspection checklist confirms compliance with the EMP, the Code and the WOMP.
			Records of spills and completed remediation in the Incident Management System
			Road conditions for heavy vehicle transport will be assessed prior to mobilisation on unsealed roads.
			Daily inspection records confirm the freeboard is sufficient to accommodate the relevant wet season and dry season freeboard requirements, and that the pit integrity is appropriate

Risk Sources	Environmental Outcome	Environmental Performance Standard	Measurement Criteria
Transport vehicle accident due to weather Overflow of pits			Audit records show Bureau of Meteorology provided timely notification significant rainfall event and site evacuation plan put into pace following notification.
Project groundwater extraction results in the reduction in groundwater quantity		No reduction to groundwater resource availability in the area as a result of project activities.	Groundwater extraction volumes at the end of the project provided to DITT and DEPWS.
			Groundwater monitoring results show groundwater quality, extraction volumes and static water level are relatively unchanged and water availability is unchanged.
Environmental Value: Air Quality and Atmospheric Processes			
Vehicle and plant movements	No significant impact on air quality and minimise emissions (including greenhouse gas emissions) and their impact so that environmental values are maintained	No reduction in air quality as a result of project activities.	Audit records demonstrate vehicles compliant with Northern Territory Motor Vehicle registry regulation and work health and safety regulations.
			Real time monitoring and gas detection monitoring data confirms no reduction in air quality / fugitive emissions.
Vehicle and plant movements Fugitive emissions		Minimise greenhouse gas emissions resultant from project activities.	Audit records demonstrate that actual emissions were reported in compliance NGERS
Environmental Value: Human Health			
Vehicle and plant movements generating Dust and impacting on health or amenity	No impact on the health of the Northern Territory population	Dust generation on the well pad in the dry season will be minimised through tracking of wind forecasts, use of dust suppression when undertaking operations, and strict adherence to speed limits on unsealed roads.	Site induction records show all personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan.
			IVMS records show speed limits adhered to.
			Any off-road has been reported to the supervisor and investigated.
			Stakeholder engagement records demonstrate all reasonable dust complaints received were resolved; or if unable to be resolved, dust monitoring demonstrates dust emissions comply with the relevant legislation
Environmental Factor: Communities and Economy			

Risk Sources	Environmental Outcome	Environmental Performance Standard	Measurement Criteria
Noise from vehicle movements and drilling activities results in noise disturbance to landholders	Minimise negative impact to communities and enhance the economy	Noise complaints from vehicle movements and drilling activities associate with the project are minimised. Amicable resolution of complaints	Stakeholder engagement records show active consultation with surrounding stakeholders on any potential noise increase and results of these consultations.
Vehicle movements, drilling activities, and entrapment in open pits results in disturbance, injury or death to livestock		Disturbance, injury or death to livestock from vehicle movements and drilling activities minimised through active stakeholder engagement	Daily inspection records show fences are intact, gates are left in the condition in which they were found and no livestock entrapment.
			Site induction records show all personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan.
			Stakeholder engagement records demonstrate active stakeholder engagement (i.e. notification prior to the commencement of activities).
Vehicle and plant movements throughout the project area results in disturbance to landholders		Disturbance to landholders from vehicle movements and drilling activities minimised. Amicable resolution of complaints.	Site induction records show all personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan.
			Stakeholder engagement records demonstrate all reasonable disturbance complaints received were resolved; or if unable to be resolved, dust monitoring demonstrates dust emissions comply with the relevant legislation.
Environmental Factor: Culture and heritage			
Vehicle and plant movements throughout the project area results in disturbance to sacred sites.	Protect sacred sites, culture and heritage	No impact to sacred sites, culture and heritage	Audit records show that all activities including horizontal drilling occur within the areas shown in AAPA Authority Certificate C2019/043.
			Records show that sacred site data provided for it in the GIS is accurate, maintained and updated

8.2 Santos Management System

Santos manages the environmental impacts and risks of its activities through the implementation of the Santos Management System (SMS). The SMS provides a formal and consistent framework for all activities of Santos employees and contractors. The Santos SMS Framework is provided in Table 8-2.

The framework for the SMS includes:

- Constitution, Board Charters, Delegation of Authority - define the purpose and authorities of the Santos Limited Board, Board Committees and senior staff.
- Code of Conduct and Policies – outline the key requirements and behaviours expected of anyone who works for Santos. The Policies are set and approved by the Board.
- Management Standards - prescribe the minimum performance requirements and expectations in relation to the way we work at Santos (the 'What').
- Processes, procedures and tools - support implementation of the Management Standards and Policy requirements by providing detail of 'How' to achieve performance requirements.

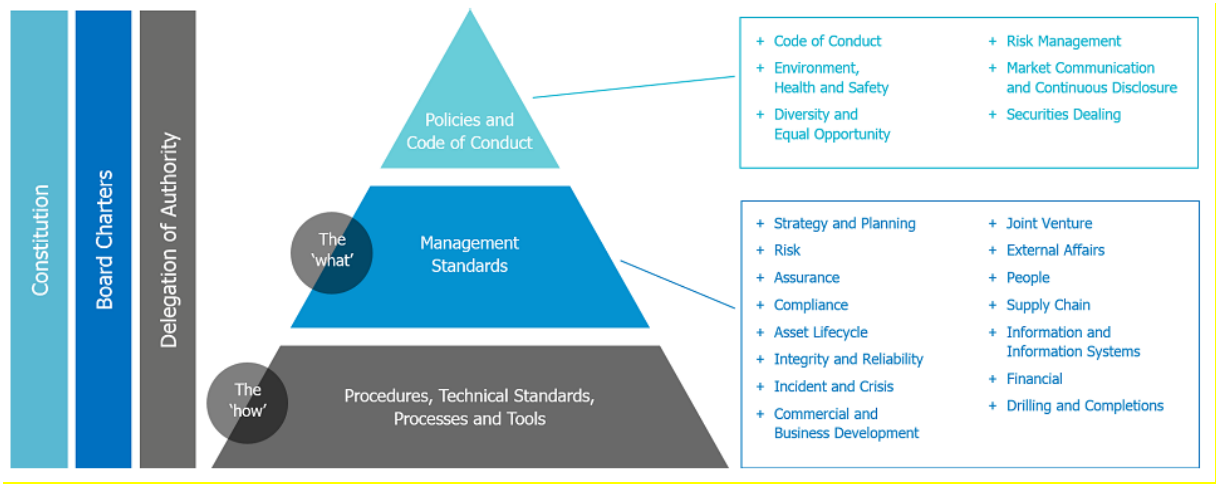

Table 8-2 Santos Management System Framework

8.3 Roles and Responsibilities

Key roles and environmental responsibilities for the activity are detailed in Table 8-3 and will be communicated to these positions prior to the activity commencing and when any changes are made to these positions.

Table 8-3 Key Personnel Roles and Responsibilities

Role	Responsibilities
Santos Field Drilling Supervisor	To supervise drilling and/ or completions engineering, planning, designing, contracting and supporting operations within Santos, ensuring compliance with SMS. To develop an environment that promotes innovation, collaboration and engineering excellence and manages engineering risk. Ensure adequate resources are in place to meet the requirements within the EMP. Undertake daily checklist as described in Table 6-1 Ensure incidents and non-conformances are managed as per Section 8.8 and 8.9.4 respectively. Report environmental incidents to the Exploration Manager and ensure reporting (Incident Reporting Requirements (Table 8-4) and investigations undertaken. Ensure records and documents are managed so they are available and retrievable (Section 8.9.1). Ensure non-conformances identified are communicated, raised in EHS Toolbox and corrective actions completed (Section 8.9.4).
NT Exploration Manager	Notify DITT of a change in titleholder, a change in the titleholder's nominated liaison person or a change in the contact details for either (Section 8.6). Ensure overall compliance with the EMP. Ensure compliance with SMS including the EHS Policy. Ensure relevant environmental legislative requirements, performance outcomes, performance standards, measurement criteria and requirements in the implementation strategy in this EMP are: Communicated to the activity key personnel Audited to inform the EMP Performance Report. Ensure the EMP Performance Report is prepared and submitted to DITT (Section 8.10).
Santos Land Access Adviser	Undertake consultation with relevant persons throughout project planning and implementation. Document consultation with relevant persons. Ensure any commitments to relevant persons are undertaken.
Santos Environment Lead	Identify and communicate relevant environmental legislative requirements, Performance Outcomes, Environmental Performance Standards, Measurement Criteria and requirements in the implementation strategy in this EMP to the NT Exploration Manager and Santos Drilling Field Supervisor. Develop the environmental component of the activity induction (Section 8.4). Assess any environmentally relevant changes (Section 8.6). Review any non-conformances relevant to Environment Performance to ensure corrective actions are appropriate to prevent recurrence (Section 8.9.4). Prepare and submit the Environmental Performance Report quarterly (unless otherwise determined by the Minister) to DITT within 15 days of the quarter finishing (Section 8.10).

8.4 Training and Competencies

Santos staff and contractors undertaking work in the field are required to undertake a two-stage induction process. The general Onshore EHS Induction focuses on hazard identification and sets Santos' expectations for Environment, Health and Safety management for workers at Santos' onshore operational sites.

The general Onshore EHS Induction is supported by an activity specific induction. All field personnel will be required to complete the activity specific induction that will cover the requirements in this EMP. At a minimum, the induction will cover:

- Activity description
- Environmental
- Environmental impacts and risks, and associated controls to be implemented including cultural heritage
- Management of change process
- Roles and responsibilities
- Incident and non-conformance reporting and management

Key roles for the activity, as detailed in Table 8-3, will be specifically briefed on their roles and responsibilities for this project in addition to the inductions.

Competency of contractors is assessed as part of the contracting qualification and via the prestart audit.

Competencies assessed during the contracting process includes;

- Maturity of EHS systems
- EHS Performance
- Internal training and auditing processes
- Existing procedures and training
    - Weed identification and management
    - Refuelling procedures
    - Procedures for clearing
    - Hazardous material and waste management procedures
    - Incident notification and management processes.

8.5 Santos Drilling and Completions

The objective of Santos Drilling and Completions (D&C) is to be a leader in D&C operations, delivering injury free operations that are fit for purpose, upholding health and safety standards for our personnel and the community and minimising environmental impacts. The Santos Policies and Management Standards provide clear direction for the way of working in Santos D&C. The D&C Management Process Description, the D&C Management Process Workflow and the D&C Technical Standards are the governing documents used to meet the performance requirements of the D&C Management Standard.

Santos D&C Managers are responsible for ensuring D&C team members are selected, trained, developed and evaluated periodically to ensure they attain and maintain the level of competency required for the position they hold.

The D&C workflow provides a structured planning process that is divided into five phases. Key aspects of the workflow are governance and assurance which are provided by the assurance review system. This is a complimentary process to the overarching asset lifecycle framework, where projects contain a D&C component, some of the D&C materials and review outcomes may be used as inputs to the asset lifecycle framework.

Santos is responsible for the well design and planning, including preparing and obtaining approval from the authorities for operations programs. In addition, Santos provides well construction materials and a number of third party and support services which have a direct impact on the day-to-day management of EHS on the rig and on the management of incident response. Assurance is provided by the appointment of Competent Personnel and the development of a number procedures and plans

aimed at delivering a high standard of environmental and safety performance. These include the Emergency Response Plan and the Well Operations Management Plan (WOMP) will be developed prior to the commencement of drilling activities.

8.5.1 Emergency Response Plan

The Emergency Response Plan is attached to this EMP (Appendix J). If the Emergency Response Plan is updated, a revised version will be provided to DEPWS.

The emergency response arrangements within the Emergency Response Plan will form part of the induction delivered to all personnel involved in the drilling campaign to ensure that personnel are familiar with the plan and the type of emergencies to which it applies and that there will be a rapid and effective response in the event of a real emergency occurring. Following the exercise, lessons will be captured and the plan updated if required.

Other triggers for revising or updating the Emergency Response Plan may include:

- New information becomes available following an incident, near miss or hazard
- Learnings from an exercise or drill
- Change in contractor undertaking the work
- Organisational changes
- Changes to government agency contact details or portfolios

8.5.2 Well Operations Management Plan

Well Operations Management Plan (WOMP) will be submitted to the regulator for approval prior to spud of the first well activity to which the plan would apply. The WOMP will provide details on:

- Description of the well and well activities
- Well integrity risk management process
- Design, construction, operations and management of wells
- Performance outcomes
- Well lifecycle control measures
- Performance standards for control measures
- Performance objectives measurement criteria
- Monitoring, audit and well integrity assurance
- Well decommissioning and suspension considerations
- Responsibilities and competencies of contractors service providers
- Source control and blowout contingency measures

A copy of the approved WOMP will be provided to DEPWS post approval by the regulator.

8.6 Notice of Commencement

Santos will notify the Minister and the Tanumbirini Station owner of the proposed date of commencement of construction, drilling or seismic surveys through the submission of a letter.

8.7 Management of Change

The SMS establishes the processes required to ensure that when changes are made to a project, control systems, an organisational structure or to personnel, the EHS risks and other impacts of such changes are identified and appropriately managed.

The SMS requires that all environmentally relevant changes must obtain environmental approval (internal i.e. within Santos and/or external i.e. regulatory) prior to undertaking any activity.

Environmentally relevant changes include:

a) New activities, assets, equipment, processes or procedures proposed to be undertaken or implemented that have potential to impact on the environment and have not been:

- Assessed for environmental impact previously, in accordance with the requirements of the standard; and
- Authorised in the existing management plans, procedures, work instructions, or maintenance plans.

b) Proposed changes to activities, assets, equipment, processes or procedures that have potential to impact the environment or interface with an environmental receptor.

c) Changes to requirements of an existing external approval (e.g. changes to conditions of environmental licence).

d) New information or changes of information from research, stakeholders, legal and other requirements, and any other sources used to inform the EMP.

Where an environmentally relevant change is identified, the Management of Change (MoC) is assessed by an Environmental Adviser and if required appropriate technical and/or legal advice is sought. The MoC assessment is made against the approved EMP to ensure that impacts and risks from the change can be managed to ALARP and acceptable levels.

An EMP requires revision and re-approval if there is new or increase in an environmental impact or risk not provided for in the EMP. If the impact or risk is provided for in the EMP, then a modification notice may be required to be submitted. If a change to the existing environment, then a change notice might be required. DEPWS will be consulted prior to determining the change required to determine if a notice is applicable.

Table 1-2 details the permit titleholder, activity nominated liaison person and contact details for both. A change in any of these details are required to be notified to DEPWS and DITT.

8.8 Incident Reporting

Incidents that impact on the environment or have the potential to impact on the environment (i.e. near-misses) are to be reported and entered into the Santos EHS Toolbox Incident Management System (IMS).

In accordance with legislative requirements, environmental incidents within EP 161 that relate to the McArthur Basin Drilling Program may also be reportable to external stakeholders (i.e. government, CLC, non-governmental organisations, etc.).

All required incident reports shall be made formally in writing to external stakeholders with copies sent to applicable Santos managers, with incident details registered into the Santos EHS Toolbox IMS.

Table 8-4 details the external incident notification, reporting requirements and timeframes for environmental incidents associated with the activity.

Table 8-4 Incident and Reporting Requirements

Requirements	How and by when
Petroleum (Environment) Regulations	
Revision of an EMP	
A revision of an EMP is required if there has been a new environmental impact or an increase in an in an existing environmental impact or environmental risk, not provided for in the current plan for the activity the interest holder must submit to the Minister, for approval.	A proposed revision of the current plan must be provided no later than 30 days after the new environmental impact or environmental risk has occurred.
An interest holder for a current plan must submit to the Minister, for approval, at the end of each period of 5 years.	The proposed revision of the current must be submitted at least 90 days before the end of each period of 5 years.
Modification of an EMP	
If an interest holder for a current plan proposes to modify the regulated activity to which the plan relates in a manner that will not require a revision of the plan, must give the Minister a notice that specifies details of the proposed modification.	Before the interest holder modifies the regulated activity, the holder must give the Minister a notice that specifies details of the proposed modification.
If there is a change in the existing environment that is described in a current plan and the change will not require a revision of the plan, the interest holder for the current plan must give the Minister a notice that specifies details of the change	the interest holder for the current plan must give the Minister a notice within 30 days after the change occurs,
Recordable Incident Reporting	
A recordable incident is a breach of an Environmental Objective or Environmental Performance Standard in the Environment Management Plan that applies to the activity; and is not a reportable incident.	Unless otherwise advised by the minster an Environmental Performance Report will be provided quarterly.

Requirements	How and by when
The recordable incident report must contain: (i) a record of all recordable incidents that occurred during the reporting period; and (ii) all material facts and circumstances concerning the recordable incidents that the operator knows or is able, by reasonable search or enquiry, to find out; and (iii) any action taken to avoid or mitigate any adverse environment impacts of the recordable incidents; and (iv) the corrective action that has been taken, or is proposed to be taken, to prevent similar recordable incidents	
Reportable Incident Reporting	
A reportable incident is an incident relating to the activity that has caused, or has the potential to cause material or serious environmental harm as defined under the Petroleum Act. Based on the Santos Risk Matrix this is an incident that has an actual or potential consequence ≥ III.	
The **initial verbal report** will include as much preliminary information as is available about the incident (e.g. interest holder, location, type of incident, affected stakeholders, initial assessment of environmental harm and initial response).	The initial verbal report will be made as soon practicable but no later than 2 hours after the incident first occurred or when Santos became aware of the reportable incident to the DEPWS Petroleum Operations Team at: Onshoregas.DEPWS@nt.gov.au.
The initial written report will include: a) The results of any assessment or investigation of the conditions or circumstances that caused or contributed to the occurrence of the reportable incident, including an assessment of the effectiveness of the designs, equipment, procedures and management systems that were in place to prevent the occurrence of an incident of that nature; b) the nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause; c) any actions taken, or proposed to be taken, to clean up or rehabilitate an area affected by the incident; any actions taken, or proposed to be taken, to prevent a recurrence of an incident of a similar nature.	The initial written report will be provided as soon as practicable but not later than 3 days after the reportable incident first occurs.

Requirements	How and by when
Interim reports will include: a) The results of any assessment or investigation of the conditions or circumstances that caused or contributed to the occurrence of the reportable incident, including an assessment of the effectiveness of the designs, equipment, procedures and management systems that were in place to prevent the occurrence of an incident of that nature; b) the nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause; c) any actions taken, or proposed to be taken, to clean up or rehabilitate an area affected by the incident; any other matters relevant to the reportable incident.	Interim reports to be provided as agreed with the Minister or at intervals of 90 days, starting on the day the initial report was given.
The **final reportable incident report** must include a root cause analysis of the reportable incident.	The final report to be provided to the Minister as soon as practicable but no later than 30 days after the clean up or rehabilitation of the area affected by the reportable incident is completed.
Annual Environmental Performance Report	
An Annual Environmental Performance Report detailing the a) recording, monitoring and reporting information about the regulated activity to which the plan relates in a manner that will enable the Minister to determine whether the environmental outcomes and environmental performance standards in the plan are being met; and b) giving the Minister a report about the matters mentioned in paragraph (a), at approved intervals, but not less often than annually. The information mentioned above includes information required to be recorded, monitored or reported under these Regulations or any other law in force in the Territory applying to the regulated activity. The AEPR will, where relevant, also detail Wastewater tracking documentation regarding the disposal of wastewater.	Annually, due 3 months after the annual anniversary of the EMP approval date.
Flowback fluid reporting	

Requirements	How and by when
Santos will give the Minister a report about flowback fluid. The report must contain the following information: a) the identity of any chemical or NORM found in the flowback fluid; b) the concentration of any chemical or NORM found in the flowback fluid; c) details regarding how any chemical or NORM has been or will be managed; d) details regarding how any chemical or NORM has been or will be transported; Part 3A Reporting requirements for hydraulic fracturing Petroleum (Environment) Regulations 2016 28 e) details regarding how any chemical or NORM has been or will be treated; f) details regarding any action proposed to be taken to prevent any chemical or NORM spill; g) details of the emergency contingency plan included in the environment management plan to which the activity relates; the requirements in relation to the management of any chemical or NORM of the prescribed chemical legislation.	Within 6 months of the flowback occurring
Waste Management and Pollution Control Act	
Duty to notify of incidents causing or threatening to cause pollution. Where an incident occurs in the conduct of an activity and the incident causes, or is threatening or may threaten to cause, pollution resulting in material environmental harm or serious environmental harm. A notification is required to specify 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; and the identity of the person notifying.	The proponent must notify the NT EPA as soon as practicable after (and in any case within 24 hours) first becoming aware of the incident or the time they ought reasonable be expected to become aware of the incident.
Heritage Act	
When a proponent discovers a place or object that is known to be Aboriginal or Macassan archaeological place or object, they must provide • a description of the place or object; • its location; • the person's name and address; if known by the person –the name and address of the owner or occupier of the place or place where the object is located.	The proponent must provide the CEO of the NLC a written report as soon as practicable but within seven days of discovery.
Work Health and Safety (National Uniform Legislation) Act	

Requirements	How and by when
A person who conducts a business or undertaking must ensure that the regulator is notified immediately after becoming aware that a notifiable incident arising out of the conduct of the business or undertaking has occurred. notifiable incident means: (a) the death of a person; or (b) a serious injury or illness of a person; or (c) a dangerous incident	Any person who conducts a business or undertaking
Transport of Dangerous Goods by Road and Rail (National Uniform Legislation)	
If a driver of a road vehicle transporting dangerous goods and the vehicle is involved in an incident resulting in a dangerous situation they must notify the prime contractor for the goods, the Competent Authority, and the police or fire service, of the incident	As soon as practicable after the incident and

8.9 Environmental Performance Monitoring and Reporting

8.9.1 Monitoring

To ensure that the EMP requirements have been effectively implemented and that the Environmental Outcomes and Environmental Performance Standards have been met, a daily checklist will be completed on site by the Santos NT Projects Drilling Supervisor. The checklist will ensure compliance with mitigation and management measures detailed in Table 6-1.

Santos will undertake a suite of monitoring to implement this management plan and to deliver on the obligations described in Table 8-1. A summary of the key monitoring requirements is listed below in Table 8-5.

Table 8-5 Environmental Monitoring

Monitoring program	Description	Frequency
Induction Monitoring	Ensure induction records are kept to demonstrate what was covered in the induction and who was inducted	Following any site induction
Baseline soil monitoring	An assessment of physical properties of representative baseline soils at each well site will be conducted in accordance with the code.	Prior to establishing the well site
Daily Inspection Checklist	Daily inspection during operations includes: • Daily checks of pits and dams throughout the drilling program • Real time monitoring of conditions during drilling including drilling monitoring & gas detection monitoring has been undertaken • Pre-spud checks / Pre-job checks have been undertaken when transferring mud • Monitoring of the cuttings and flare pit levels during and after rainfall events • Inspection of fences, excavations, pits, storages for entrapped fauna and fauna and to ensure escapes are intact	Daily during operations

Monitoring program	Description	Frequency
	• Inspection of all domestic waste receptacles to ensure they have lids secured.	
Drill Fluid Monitoring	The fluid levels in tanks containing drilling fluids will be monitored to calculate the stored volume of drilling fluid in tanks	Daily during operations
	A representative sample of stored drill fluids will be taken. and tested for the suite shown in WWMP.	At least monthly during drilling operations.
Drill fluid, mud and cutting characterisation	The composition of residual drill cuttings will be analysed to determine whether it is consistent with the assumptions used for the assessment of environmental hazards and the design of proposed disposal methods	At the end of drilling operations
Weather monitoring	Monitoring of weather and for predicted significant rainfall events will be undertaken. The Bureau of Meteorology have been engaged to provide rapid and accurate notifications in of a significant rainfall event	Daily during operations
Weed Monitoring	A post wet-season weed survey will be conducted of both lease pads and access tracks. All weed monitoring and survey activities will be recorded in accordance with the *NT Weed Data Collection Guidelines*	Annual to coincide with the end of the wet season
Groundwater Monitoring	Detect changes in groundwater as a result of drilling and stimulation activities. Monitoring will be done in accordance with Government guidelines for groundwater monitoring for petroleum operations such as *Preliminary Guideline: Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin*. .	Ongoing For control monitoring bores - 6 months prior to drilling, and preferably to include both wet season and dry season samples
	Volume of water that is abstracted from the water bore will be measured using flowmeter. This will by recorded weekly during bore operations	Ongoing
	Fluid levels in storages containing abstracted groundwater will be monitored to provide a measure of the stored quantity of water.	Daily during operations
Rehabilitation Monitoring	Photo points established and revisited as part of the civils scope.	Photo points established and revisited.
Operational Fire Monitoring	Onsite Company Representative is responsible for monitoring for bushfire alerts (primarily via the https://securent.nt.gov.au/alerts and https://www.bushfires.nt.gov.au/incidentmap/ websites and notifying all site personnel of the risks of fire during toolbox meetings	Daily during operations
Fire Fuel Load Monitoring	Vegetation removal requirements will be assessed during the post wet weed survey when vegetation growth will be greatest. If required, slashing / grading will occur to remove well site vegetation.	Annual to coincide with the end of the wet season done in conjunction with the weed survey

8.9.2 Record Management

Key records for management relating to the activity include:

- Weed washdown records
- Induction records
- Weekly checklists
- Training records
- Photopoint records
- Records of monitoring program
- Records related to audits / inspections
- Records relating to investigation of incidents and non-compliances.

SMS Information and Information Systems detail the requirements to ensure that information is kept current and accurate, stored in a manner to facilitate retrieval, and is accessible to personnel who need it.

Document control and record keeping requirements including record retention periods are specified in the SMS. Where no record retention requirement is specified, the default for physical records is 10 years and 'life of plant' for electronic records.

8.9.2.1 Waste Water Tracking

The movement of water and wastewater will be tracked. The tracking of the wastewater will include al the requirements of section C.6.1of the Code as detailed in the Wastewater Management Plan. Wastewater tracking will be documented in an auditable chain of custody system and be in accordance with other legislative requirements such as those imposed under *the Waste Management and Pollution Control Act 1998* (NT*)* and the *Radiation Protection Act 2004* (NT). Wastewater tracking documentation will be reported to the Minister at least annually.

8.9.3 Audit

An operational audit assessing compliance with this EMP will be undertaken by a suitably qualified person in accordance with Santos' Assurance Procedure. Assurance at Santos refers to an assessment of the effectiveness and/or performance of controls in place to manage risks. Controls primarily reside within the SMS framework and include all physical, procedural, systemic or compliance-based mechanisms, activities, processes or requirements in place to manage risks. This process will audit against the performance standards and measurement criteria set in this EMP and review risk and mitigation measures employed to mitigate against this risks. Operational audits will be conducted during the drilling program and if the drilling program is extends beyond 12 months an additional audit will occur annually.

Audit / review findings including actions will be communicated to the Santos and Contractor Project Managers and Santos Field Representative. Actions are agreed with all parties and assigned an actioner and required completion date. The audit and actions are recorded in the Santos EHS Toolbox Audit & Compliance Manager which notifies the actioner and their manager when actions are due. If actions are not closed within the due date the system has a hierarchy notification system based on the number of days an action is overdue as to the level of manager who receive notification of the overdue action.

8.9.4 Management of Non-Conformances

For the activity, a non-conformance is classed as:

- A breach of an Environmental Outcome or Environmental Performance Standard (Section 7). This triggers the requirement to report as a "recordable incident" as per Section 8.7.
- Failure to implement a requirement in the implementation strategy.

Non-conformances are identified via:

- Audits and inspections
- Incident reporting and investigations

Where a non-conformance is identified, actions are implemented to correct the non-conformance and prevent reoccurrence.

To ensure that non-conformances lead to learning and improvements for the activity and on a company-wide basis, non-conformance are:

- Communicated to the NT Exploration Manager via Santos EHS Toolbox (see below), daily and weekly meetings and the appropriate reports (i.e. audit, performance, incident investigation) to ensure personnel are made aware of non-conformances and corrective actions to help prevent recurrence of similar incidents.
- Communicated to operational personnel at daily pre-start meetings via the Santos Drilling Field Supervisor to ensure personnel are made aware of non-conformances and corrective actions to help prevent recurrence of similar incidents.
- Communicated internally within Santos as per the Santos Internal Incident Notification Guide and where there are lessons learnt that are applicable to other areas of the business a Flash Notification is issued.
- Recorded in Santos EHS Toolbox and actions tracked to completion.
- Reviewed by the actioner's manager prior to being closed to ensure actions are completed and implemented.

8.10 Routine Reporting

As detailed in Table 8-4, Santos will submit a quarterly recordable incident report to DEPWS which provides information where there has been a breach of an Environmental Objective or Environmental Performance Standards detailed in this Environment Management Plan.

The Annual Environmental Performance Report (AEPR) will be submitted to DEPWS annually, due 3 months after the annual anniversary of the EMP approval date. The AEPR will be lodged in the DEPWS template and will enable the Minister to determine whether the environmental outcomes and environmental performance standards in the plan are being met and report on the compliance status of Santos against approval conditions, the code of practice and other commitments.

Santos is required to estimate and report all greenhouse gas emissions to the Australian Government's Clean Energy Regulator on an annual basis. This includes greenhouse gas emissions associated with activities conducted under this EMP.

9.0 Stakeholder Engagement

Santos is committed to upholding its long-held reputation as a trusted Australian energy company.

Santos seeks to establish and maintain enduring and mutually beneficial relationships with the communities of which it is a part; ensuring that Santos' activities generate positive economic and social benefits for and in partnership with these communities.

The Santos Management System (SMS) details the requirements for appropriate communication and consultation mechanisms to achieve the above objectives. The standard includes requirements to establish and maintain communication links with employees, contractors and external stakeholders, including local communities, government agencies and other organisations. Reporting and notification of EHS incidents to the appropriate government agency occurs as required. The SMS will be employed throughout this project.

9.1 Stakeholder Identification

Stakeholder identification was conducted prior to commencing drilling works at Tanumbirini-1 in 2014. The relevant stakeholder groups were identified and engaged such that they could be informed of the proposed activities and the associated risks, build an understanding as to why and how Santos operations and have any objections or claims considered and addressed. A key component of the engagement process was face-to-face briefing sessions with key stakeholders one-on-one and at local community events. Key relevant stakeholder groups include community, landholders, traditional owners and aboriginal peoples, and the Northern Territory Government departments. A list of the relevant stakeholders identified as well as contact details are provided in Appendix I.

9.2 Other Engagement Activities

Santos has continued to engage with these key stakeholders on an ongoing basis since initial identification, specifically with regard to this project and development in the Northern Territory generally. This includes providing information, presentations and mapping to key stakeholders. Government and industry stakeholders are updated through regularly scheduled industry and governmental joint meetings and one off conferences. Santos' industry and government engagement includes:

NT Resources Week South East Asia Australia Onshore Conference (SEAAOC) in September 2018. SEAAOC is Northern Australia's largest and longest established petroleum conference and brings together major players involved within Australasia's oil, gas and petroleum industries. During SEAAOC, Kevin Gallagher (Managing Director and CEO) gave a keynote speech. Other Santos delegates included:

- Bill Ovenden (Executive Vice President, Exploration and New Ventures)
- Tracey Winters (Head of Government and Public Affairs).

A meeting to discuss the work program and approvals including the scope of this EMP was completed on 31 January 2019. Meeting involved NT Government Departments and AAPA.

A meeting to discuss the program and approvals including the scope of this EMP was conducted on 5 December 2018 with the Board of the EPA.

Ongoing discussions and weed management planning has been conducted with Chris Parker – Regional Weed Officer (Onshore Shale Gas Development) – DEPWS. This consultation has included a site visit in August 2018, review, and approval of weed management plans and procedures.

In addition, Santos was actively engaged with the Hydraulic Fracturing Inquiry and its subsequent implementation process – providing detailed information to the Inquiry drawing from our existing knowledge of the Beetaloo region, the initial exploration activities that have occurred there and our extensive experience in gas exploration. Santos engages regularly with officials of the departments of Chief Minister, Primary Industries and Resources, and Environment and Natural Resources to advance the implementation of the 135 recommendations of the Pepper Inquiry.

Santos has agreed to support and contribute to the funding of the CSIRO led Gas Industry Social and Environmental Research Alliance (GISERA) to undertake research in the Beetaloo area. We have provided DEPWS with access to our existing groundwater monitoring data and data collected by CSIRO on our behalf over recent years, and have facilitated initial survey work by CSIRO for methane and in collaboration with DEPWS for weed monitoring. Santos is committed to the timely release of information from these research processes to ensure that all stakeholders are fully informed about the true state of the environment in the exploration area, and any impacts should they occur.

Engagement with the NLC, AAPA and Traditional Owners occurred throughout 2018 and are continuing and ongoing. Formal engagements included:

- Meeting with AAPA on the northern and southern scope of Beetaloo work program, including the scope of this EMP, was conducted on 31 January 2019. In attendance: Dr Sophie Creighton and Laura Roos, David Close, Che Cockatoo-Collins
- Presentation to Northern Land Council on the 2019 work program was conducted on 1 February 2019. Specifically this presentation identified proposed activities in EP 161, which include the scope of this EMP. Discussions focused on timeline, agreement commitments including clearance, consent and community consultation meetings. In attendance: Greg McDonald, Malcolm Hauser, Ian Harris, Walter Zukowski, David Close, Che Cockatoo-Collins
- Meeting with NLC to discuss future clearance requirements and resourcing on 2 April 2019
- Discussion with AAPA to discuss Authority Certificate applications and the proposed work program on 1 and 2 April 2019

Other stakeholder engagement has involved engagement with landholders/managers as documented in Appendix I. Appendix I details the information that has been provided to these key stakeholders, including the type of information and date of engagement. Landholders have been consulted on the proposed activities and have been directly involved in an on-ground inspection of proposed infrastructure locations. Land Access and Compensation Agreements (LACA) have been progressed and all LACAs will put be in place during the EMP assessment period and prior to Approval.

9.3 Ongoing Consultation

Prior to any land access a notice of entry is issued to the landholder. Santos will not access any person's land without prior consent in the form of a written agreement and in accordance with relevant policies and guidelines. Where stakeholders have requested or Santos believes it would be beneficial to engage with stakeholders on an ongoing basis during the activity, communications will continue until the activity has concluded.

Stakeholder engagement will be comprehensive. Santos commits to further engagement with:

- Local business (e.g. Hi-Way Inn, Daly Waters Pub, Borroloola Hotel Motel, Savannah Way Motel)
- Roper Gulf Regional Council and Barkly Regional Council
- Traditional Owners
- Annual Geosciences Exploration Seminar (AGES); Alice Springs in March
- Northern Territory Government Departments

9.4 Stakeholder Engagement Regarding this revision of the EMP

Stakeholder engagement regarding this revision of the EMP has been ongoing. Engagement with the landholder, station manager and Northern Land Council has occurred throughout 2020 and is detailed in Appendix I. Engagement included discussion of the additional wells at each location.

10.0 References

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