Environment Management Plan: McArthur Basin Civil and Seismic Program

NT Exploration Permit (EP) 161

Date	Rev	Reason for Issue	Author	Checked	Approved
11/02/2019	0	For Review	MB	PW	DC
08/04/2019	1	For Review	MB	PW	DC
14/05/2019	2	For Approval	MB	PW	DC
21/05/2019	3	Updated with AAPA AC Ref Number	MB	PW	DC
12/06/2019	4	Updated to include ESCP	MB	PW	DC

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, the drilling of two exploration wells Tanumbirini-1 and Marmbulligan-1 and most recently the development of a water bore drilling and monitoring program in 2018.

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 EMP to seek approval for activity Santos proposes to undertake in 2019, including a two-dimensional (2D) Seismic Program and civil works, as shown in Figure ES-2. The civil works program will be undertaken to expand the Tanumbirini-1/2H and construct the Inacumba-1/1H well leasepads, associated tank pads, storage pads and access tracks. The 2D seismic program involves a 10 km seismic line that runs through the Tanumbirini-1/2H well leasepad.

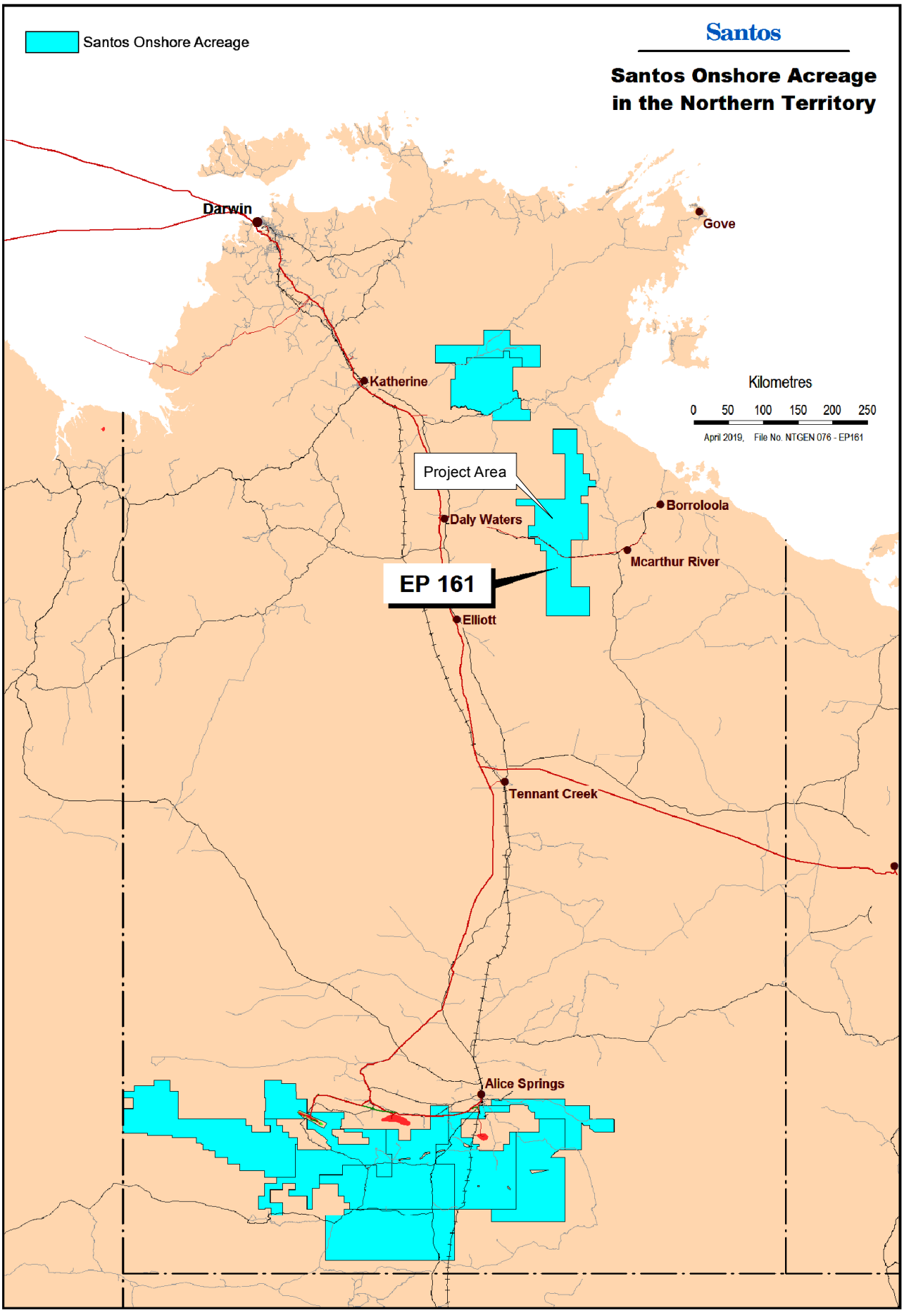
Description of the Activity

Civil works will be required to prepare the seismic line prior to data acquisition and for the expansion of one well leasepad at the Tanumbirini-1/2H location and the construction of a new well leasepad at the Inacumba-1/1H location. Civil works will also include the upgrade of existing access tracks and the creation of some new access tracks; and for the Inacumba-1 well, two options are being considered. Infrastructure at the leasepads consist of laydown areas, water tank pads, camp pads and dams. Borrow pits are required to source material for the civil works, which are adjacent to access roads or leasepad infrastructure. Ongoing maintenance will be required to maintain the civil works such as grading, watering (sourced from bores) and minor patching.

The 2D seismic survey requires the deployment of nodal geophones from a light 4WD every 2.5 m or 5 m along the seismic line. Recording will commence once the entire 10 km line has been laid out on the ground. The acoustic energy source is an array of three truck mounted vibrator units, electronically synchronised to vibrate in phase with each other. They line up along the seismic line, a few metres apart, centred on midway between two specified receiver points. Simultaneously each unit, on command from the instrument truck, inputs one or more frequency sweeps into the ground at each source point. Each sweep lasts for only a few seconds. Generally, four seconds of reflected data is recorded. On completion of one source point, the set of vibrators are moved to the next source point.

The Activity Location

The proposed activity will be undertaken in EP161, 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 project area refers to the physical footprint of the proposed infrastructure and activities, which is shown in Figure ES-2.



Not to scale

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GHD

Santos
McArthur Basin Drilling
Environmental Management Plan

Project No. 43-22812
Revision No. A
Date 05/02/2019

Santos's acreage in the NT

FIGURE ES-1

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Print date: 02 May 2019 - 13:46

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

Legend

- Water Bores
- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Major Waterways
- Principal Road
- Borrow Pit
- Inacumba Lease
- Tanumbirini Lease

1:300,000 @ 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

Santos
McArthur Basin Drilling
Environmental Management Plan

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

Proposed Infrastructure

FIGURE ES-2

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Print date: 28 Mar 2019 - 15:35

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, Borrow Pit, Seimic Line (2019)
Created by: xlee

Existing Environment

The proposed civil and seismic activities are located the middle of two bioregions, the Sturt Plateau and Gulf Fall and Upland Bioregions. Plateaus, sandstone outcrops and undulating plains outline the landscape. The vegetation is comprised of 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 are comprised of kandosols and rudosols, and the major water system in the vicinity is the Roper River Catchment. The main ground water resource s 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 project area, which includes a range of birds, mammals and reptiles. Eleven migratory species, and two weeds and nine invasive fauna species have been identified as potentially occurring within the project area. No protected areas or places with historical or cultural significance were found to be within a 10 km radius of the project area.

The environmental values and/or sensitivities with the potential to occur in the vicinity of the project area are provided in Table ES-1.

Table ES-1: Summary of Environmental Values and Sensitivities

Environmental Factors	Environmental Values and Sensitivities	Summary
Terrestrial Flora and Fauna	Sensitive or significant vegetation	Ecoz (2019) recorded riparian vegetation (a sensitive vegetation type) along the drainage lines to the south of the Inacumba 1/1H location.
	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.
	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.

Environmental Factors	Environmental Values and Sensitivities	Summary
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
Social, economic and cultural surroundings	Cultural heritage, sacred sites	An application for an AAPA Authority Certificate or Authority Certificate Variation 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 2019 Drilling Program have been appropriately surveyed and subsequently conditioned. A cultural heritage (archaeological) survey and assessment of Aboriginal and non-Indigenous heritage was completed by an independent consultant to support this EMP (report attached in Appendix D).
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-2 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-2.

Table ES-2 Summary of risk assessment

Environmental Value	Risk Sources
Terrestrial Flora and Fauna	• Planned clearing and loss of habitat impacts on flora and fauna due to physical disturbance • Clearing and vehicle and plant movements creating dust • Vehicle movements and seismic equipment generating noise and vibration • Lighting from the camp • Vehicle movements and seismic equipment causing fauna strike at night and fauna entrapment in open pits and dams • Plant and vehicles carrying weeds from outside the project area. • Spread of weeds in project area through clearing and vehicle movements • Ignition sources from plant and machinery • Inappropriate disposal of cigarettes • Waste stored inappropriately attracting native fauna
Terrestrial Environmental Quality	• Physical disturbance including clearing and vehicle and plant movements • Chemical spills and leaks
Inland water environmental quality	• Inappropriate storage or handling of hazardous substances • Poor refuelling or fuel transfer practices
Hydrological processes	• Alteration of drainage contours through clearing processes • Use of groundwater for project activities
Air quality and greenhouse gases	• Emissions from vehicles and plant
Social, economic and cultural surroundings	• Removal of vegetation exposing cultural sensitive site • Reduction in groundwater available for other users • Clearing and vehicle and plant movements creating dust • Vehicle movements and seismic equipment generating noise and vibration

Environmental Value	Risk Sources
	• Vehicle movements and seismic equipment generating light at night. • Lighting from camp. • Vehicle movements and seismic equipment causing fauna strike at night • Plant and vehicles carrying weeds from outside the project area. • Spread of weeds in project area through clearing and vehicle movements. • Ignition sources from plant and machinery. • Inappropriate disposal of cigarettes • Vehicle and plant movements throughout the project area • Use of groundwater for project activities
Human health	• Clearing and vehicle and plant movements creating 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).

Control measures have been identified using the Santos hierarchy of controls; a process that moves from risk elimination through to protection, in descending order of effectiveness, until a control measure can be identified.

Stakeholder Engagement

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.

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 operations and have any objections or claims considered and addressed. The key stakeholders identified and engaged include:

- Station Managers for Tanumbirini, Beetaloo / O.T Downs and Broadmere
- Northern Land Council (NLC)
- Northern Territory Government
- Aboriginal Affairs Protection Authority (AAPA)

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 H-2 Stakeholder Engagement Records.

Approvals Process

A comprehensive review of the approval requirements and relevant legislation is included in Chapter 2; and Table 2-1 summarises the requirements of this EMP to be approved and where they are addressed in this EMP. For clarity and ease of review the key documents or processes relevant to this EMP are summarised Table ES-3.

Table ES-3 Summary of Key Approval Processes

Process or activity	Approval process summary	Civils and Seismic Program EMP status
Northern Land Council (NLC) and Traditional Owner Consultation	• Santos and the NLC (on behalf of Traditional Owners over the permit areas) are parties to a "Co-operation and Exploration Agreement". This agreement details the steps, and related terms and conditions, necessary for exploration activities to be undertaken. • The key steps facilitated by the NLC include community consultations to ensure free, prior and informed consent of proposed work program activities and sacred site avoidance surveys (i.e. field surveying activity by appropriately identified Traditional Owners) • The NLC complete an Anthropological Report, which summarises the outcomes of the consultation and surveying processes and is provided as an input to the Aboriginal Area Protection Authority certification process	• Multiple consultations and/or sacred site avoidance surveys completed in 2013, 2014, 2018 and 2019 • Consultation specific to the proposed 2019 program has been ongoing with NLC since Q4 2018 and included sacred site avoidance surveys in October 2018 and an On Country consultation with Traditional Owners in March 2019
Aboriginal Area Protection Authority (AAPA)	• AAPA are the only authority upon which a proponent can be indemnified for works in relation to sacred sites. AAPA are able to issue Authority Certificates that provide this indemnity. Proponents can apply for written advice specifying the constraints (if any) to a particular activity imposed by the existence of sacred sites. • A formal application for an Authority Certificate is made to AAPA • Applications made by exploration proponents are typically activity and location specific • If AAPA are satisfied with the Anthropological Report provided by the NLC and any other independent consultation or register searches that they consider necessary, then they can issue an Authority Certificate to a proponent	• Application for an Authority Certificate or Authority Certificate Variation to cover all of the locations and activities in the 2019 proposed program submitted in January 2019; Authority Certificate C2019/043, as a variation to C2014/053, was awarded on 13 May 2019 • A valid Authority Certificate or Authority Certificate Variation has been provided to support this EMP
Archaeological surveying	• Surveying of proposed work locations completed to ensure any Aboriginal and/or non-Indigenous sites or artefacts of archaeological significance are appropriately identified	• Archaeological surveying completed by independent consultant in March 2019

Process or activity	Approval process summary	Civils and Seismic Program EMP status
Land Access and Compensation Agreement (LACA)	• A LACA, or equivalent, is required for approval to undertake exploration activities in the NT • The LACA includes terms and conditions regarding the scope and location of activity and what compensation is appropriate based on the scope, location and interaction with the pastoral lessee's operations, business and/or other amenity • We engage with impacted pastoral lessees to ensure minimal impacts to their operations, business and/or other amenity	• Existing LACAs in place for ongoing work at Tanumbirini-1 location and water monitoring bore construction and sampling • Detailed, collaborative engagement continuing regarding 2019 program
Groundwater monitoring	• Under the Code of Practice a compliant groundwater monitoring plan must be developed • The Code of Practice sets out mandatory requirements; which include compliance with the guideline for *Groundwater Monitoring Bores for Exploration Petroleum Wells in the Beetaloo Sub-basin* • This guideline sets out explicitly the timing, scope and location of groundwater monitoring required to establish baseline data	• Water monitoring bores installed at both proposed 2019 drilling locations in November/December 2018 • A groundwater monitoring plan has been developed in accordance with the Guideline which includes the timing and scope of monitoring
Weeds surveying	• Under the Code of Practice a project specific weed management plan must be developed which meets the requirements of the *NT Weed Management Planning Guide: Onshore Petroleum Projects*	• A weed management plan has been in place since Q4 2018 for the project area and baseline surveying was completed prior to the installation of water monitoring bores in 2018. This includes all areas subject to this EMP • In accordance with the weed management plan, monitoring surveys will follow the 2018-19 wet season
Well Operations Management Plan (WOMP)	• Under the Code of Practice a Well Operations Management Plan (WOMP) must be approved by the regulator for regulated well activities (such as drilling)	• No Drilling Program activity will commence until a relevant WOMP has been approved • The WOMP will set out all key information required to ensure safe operation and well integrity is maintained throughout the well life-cycle, for example it will detail: well design considerations for all phases of the well life-cycle, risk management, control measures, measurement criteria, and any other relevant information
Water Extraction Licence	• Under the Water Legislation Amendment Act 2018 gas companies are required to obtain a water extraction licence to extract groundwater to support exploration activities	• Application for a water extraction licence accepted in February 2019

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Appendices

Abbreviations and Units

Acronym	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
CPESC	Certified Professional in Erosion and Sediment Control
DENR	Department of Environment and Natural Resources
DoEE	Department of Environment and Energy
DPIR	Department of Primary Industry and Resources
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
HDPE	High-density polyethylene
kL	Kilolitre
km	Kilometre
LACA	Land Access Compensation Agreement
NLC	Northern Land Council
m	Metres
MNES	Matters of National Environmental Significance
MoC	Management of Change
NRM	Natural Resource Management
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
NVIS	National Vegetation Information System
PL	Petroleum Lease
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

Acronym	Description
TPWC Act	Territory Parks and Wildlife Conservation Act 2014
WHS	Work Health and Safety
WoNS	Weed of National Significance
WWPC Act	Waste Management and Pollution Control Act

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, the drilling of two exploration wells Tanumbirini-1 and Marmbulligan-1 and most recently the development of a water bore drilling and monitoring program in 2018.

Santos proposes to undertake additional exploration activities throughout 2019, 2020 and beyond. 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. To meet this purpose, exploration activities in 2019 include:

- Civil engineering activity – upgrading and creation of new access tracks, leasepads, water bore installation and water extraction as required
- 2D seismic acquisition
- Exploration drilling – both vertical and horizontal drilling
- Well evaluation – including wireline logging, formation testing, core acquisition, fluid sampling, open-hole formation integrity testing (i.e. DFITs) and other standard evaluation techniques as appropriate
- Hydraulic fracture stimulation
- Flow-back and production testing
- Environmental monitoring
- Well suspension and/or well decommissioning
- Ongoing site and well maintenance and monitoring, work-over and re-entry, and evaluation as required

These exploration activities will be subject to a number of EMPs and the Scope of this EMP is limited to the civil and seismic scopes as detailed further in Section 1.2 below.

1.2 Scope of this EMP

Under the Petroleum (Environment) Regulations (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.

Santos proposes to undertake a two-dimensional (2D) Seismic Program and civil works in 2019.

The civil works program will be undertaken to expand the Tanumbirini-1/2H and construct the Inacumba-1/1H well leasepads, associated tank pads, storage pads and access tracks. The 2D seismic program involves a 10 km seismic line that runs through the Tanumbirini-1/2H well leasepad. This EMP covers these new proposed works.

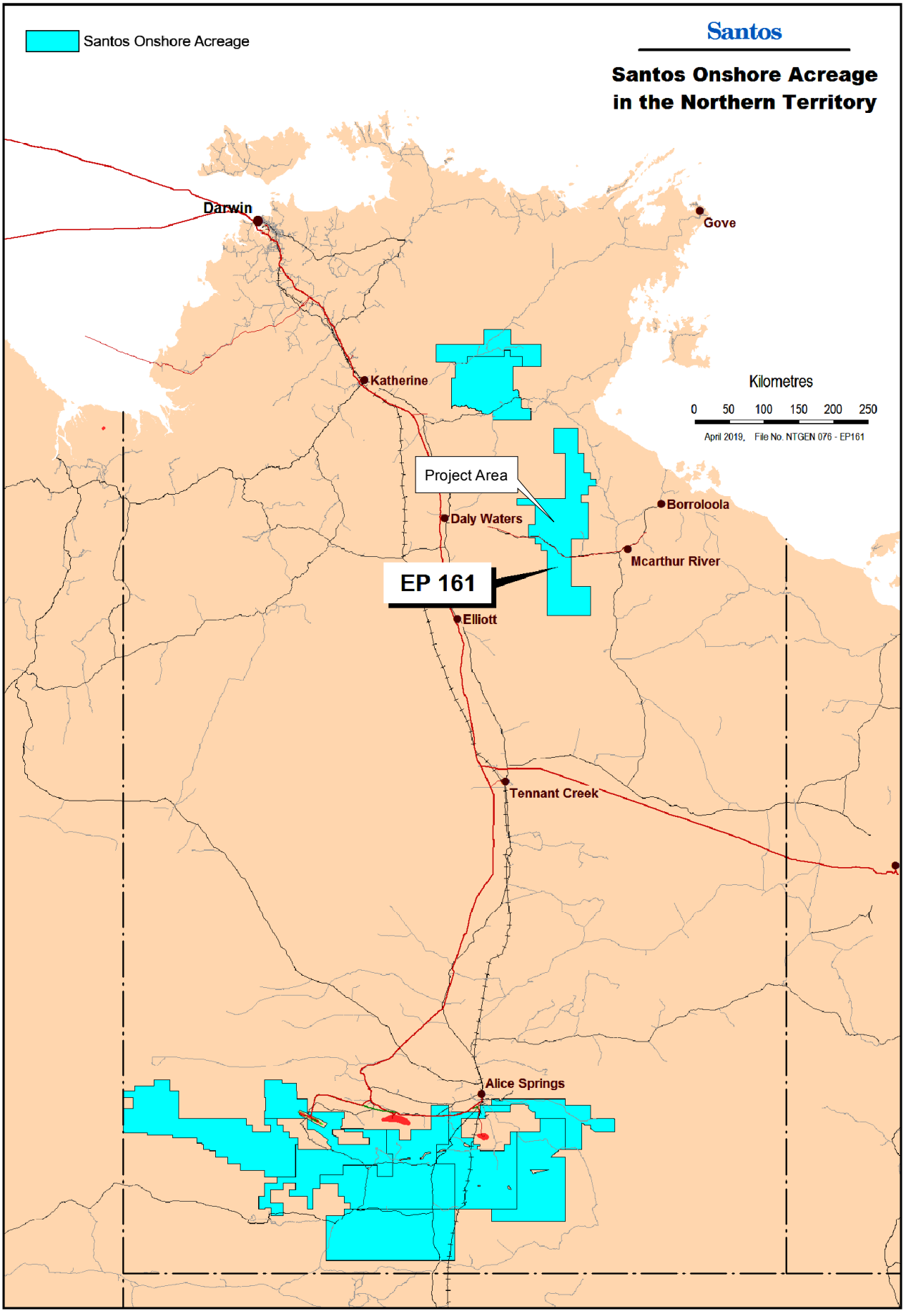
1.3 Titleholders Details

Table 1-1 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 Primary Industry and Resources (DPIR) and the Department of Environment and Natural Resources (DENR).

Table 1-1 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: David Close Position: Exploration Manager – Onshore NT, Qld and NSW Company: Santos Ltd Address: 60 Flinders Street, Adelaide, SA 5000 Phone : 08 8116 7952 Email: david.close@santos.com



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GHD

Santos
McArthur Basin Drilling
Environmental Management Plan

Project No. 43-22812
Revision No. A
Date 05/02/2019

Santos's acreage in the NT

FIGURE 1-1

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Print date: 02 May 2019 - 13:47

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

2.0 Environmental Legislation and Other Requirements

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.

The approval criteria for an environment management plan 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 subregulation (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
1.1	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
1.2	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
1.3	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. ○ Example for clause 3(2)(b) of other activities or events Activities or events associated with: ○ (a) other exploration for, or production of, petroleum; or ○ (b) the exploration for, or extraction of, minerals or extractive minerals.	Section 5.0
1.4	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
1.4A	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
2.5	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
2.6	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
2.7	Personnel	An implementation strategy must: (a) establish a clear chain of command, including during emergencies or potential emergencies; and	Section 8.2 Section 8.3

Part	Section	Requirement	Section in this Plan
		(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.	
2.8	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
3.9	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
3.10	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
3.11	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 8.11

Part	Section	Requirement	Section in this Plan
3.12	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

There are other legislation, agreements and codes of practice relevant to the project, which are detailed in Sections 2.1 to 2.3.

2.1 Key Legislation Overview

Table 2-2 Key Relevant Commonwealth and Northern Territory Legislation

Act	Summary
Commonwealth	
Aboriginal and Torres Straights Heritage Protection Act 1984	Protects areas and objects in Australia that are of particular significance to Aboriginals in accordance with Aboriginal tradition. The Act allows the Commonwealth Environment Minister, on the application of an Aboriginal person or group of persons, to make a declaration to protect an area, object or class of objects from a threat of injury or desecration.
Aboriginal Land Rights (Northern Territory) Act 1976	This Act is the key mechanism for the creation of Aboriginal-owned freehold land in the NT. It also includes provisions for the establishment of Land Trusts (over which the Land Councils have oversight).
Australian Heritage Council Act 2003	Establishes the Australian Heritage Council that is the principal adviser to the Australian Government on heritage matters. The Council's main role is to assess the heritage values of places nominated for the National Heritage List and the Commonwealth Heritage List, and to advise the Minister on promotion, research, education, policies, grants, conservation and other matters.
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity. It regulates a development or activity if it is likely to have a significant environmental impact on matters of national environmental significance (MNES). This Act is administered by the Commonwealth Department of the Environment and Energy (DoEE). It is considered that the proposed activities will not adversely impact MNES therefore; the project has not been referred for assessment nor approval under the EPBC Act.
National Environment Protection Council Act 1994	Provides national standards for ambient air quality, movement of controlled wastes and contaminated sites. This Act is administered by DoEE.
National Greenhouse and Energy Reporting Act 2007	Titleholders are required to report emissions and energy use annually in accordance with this Act.
Native Title Act 1993	This Act provides statutory recognition and protection for the concept of native title, including provisions for reaching Indigenous land use agreements.
Northern Territory	

Act	Summary
Biological Control Act 1984	Makes provision for the biological control of pests in the NT, and related purposes.
Bushfires Management Act 2016	Provides for the protection of life, property and the environment through the mitigation, management and suppression of bushfires, and for related purposes.
Control of Roads Act 1953	Provides for the administration and control of public or gazetted roads, including the maintenance of roads and opening and closing of roads.
Dangerous Goods (Road and Rail Transport) Act 2012	Makes provision for safety in the transport of dangerous goods by road as part of the system of nationally consistent road transport laws and makes provision for safety in the transport of dangerous goods by rail. Establishes common guidelines so that dangerous goods can be transported between states and territories.
Energy Pipelines Act 1981	Makes provision for the construction, operation, maintenance and cessation of use or abandonment of pipelines for the conveyance of energy-producing hydrocarbons.
Environmental Assessment Act 1982	Establishes the framework for the assessment of potential or anticipated environmental impacts of developments, and provides for protection of the environment. The NT Environment Protection Authority (NT EPA) is responsible for administering the Act. The NT EPA also determines the appropriate level of assessment for new developments or material changes to existing operations, based on the sensitivity of the local environment, the scale of the proposal and its potential impact upon the environment.
Environmental Offences and Penalties Act 1996	Establishes a penalty structure for environmental offences based around four offence levels. Penalties are defined in a variety of environmental statutes such as the Waste Management and Pollution Control Act and the Water Act.
Heritage Act 2011	Establishes the Heritage Council and the NT Heritage Register. It sets the process by which places become heritage places, allows for interim protection of places and sets out the process for getting permission to do work to heritage places and allows for fines and imprisonment for offences against the Act.
Northern Territory Aboriginal Sacred Sites Act 1989	Establishes the Aboriginal Areas Protection Authority (AAPA) as the body responsible for overseeing the protection of sacred sites in the NT. The AAPA provides a process for avoidance of sacred sites and/or entry onto sacred sites and the issue of Authority Certificates, which indemnify the holder against prosecution under the Act for damage to sacred sites in the certificate area, provided works or use has occurred in accordance with the conditions of the Authority Certificate.
Pastoral Land Act 1992	The Pastoral The Pastoral Land Act 1992 (NT) is an 'Act to make provision for the conversion and granting of title to pastoral land and the administration, management and conservation of pastoral land, and for related purposes. In particular, the Act provides for (i) the monitoring of pastoral land so as to detect and assess any change in its condition; (ii) the prevention or minimisation of degradation of or other damage to the land and its indigenous plant and animal life; and (iii) the rehabilitation of the land in cases of degradation or other damage.
Petroleum Act 1984	The Petroleum Act is the principal legislation dealing with petroleum tenure, exploration and production activities onshore and in inland waters of the NT. The Act provides a legal framework to undertake exploration for petroleum and to develop petroleum production so that the optimum value of the resource is returned to the NT.

Act	Summary
	The Act is supported by the Petroleum (Environment) Regulations (Regulations) and the Schedule of Onshore Petroleum Exploration and Production Requirements 2012 (Schedule). The rules governing access by an interest holder to Pastoral Leases (granted under the Pastoral Land Act 1992) are set out in the Petroleum Act Stakeholder Engagement Guidelines Land Access (Land Access Guidelines). The Act and Requirements are administered by the Northern Territory Petroleum Registry (Registry) which forms part of the DPIR. The Minister for Primary Industry and Resources (Minister) is the applicable Minister for the purposes of the Act. The Petroleum (Environment) Regulations aim to ensure that: a) onshore oil and gas activities are carried out in a manner consistent with the principles of ESD; and b) environmental impacts and risks associated with onshore oil and gas activities are reduced to a level that is 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. The Regulations also provide that the EMP will also form the basis of a Notice of Intent under the *Environmental Assessment Act*. The Minister for Environment has responsibility for the administration of the Regulations.
Public and Environmental Health Act 2011	Makes provision to protect and promote the health of individuals and communities in the Territory, and to monitor, assess and control environmental conditions, factors and factors and agents, facilities and equipment and activities, services and products that impact on, or may impact on, public and environmental health. Other relevant regulations under the Act include Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations. Wastewater treatment systems are be 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.
Soil Conservation and Land Utilisation Act 1969	Makes provisions for the prevention of soil erosion and soil conservation and reclamation. It makes provisions for restricting construction activities that may damage or further damage land that is not environmentally stable, such as areas suffering soil erosion or areas that have the potential to erode.
Territory Parks and Wildlife Conservation Act 1976 (TPWC Act)	Makes provision for the establishment of Territory Parks and other Parks and Reserves and the study, protection, conservation and sustainable utilisation of wildlife. It sets aside areas of the NT as parks and conservation areas that may not be developed. Flora and fauna can also be declared as threatened species under the Act.
Waste Management and Pollution Control Act 1998 (WMPC Act)	Aims to protect, and where practicable, restore and enhance the quality of the NT environment; encourage ecologically sustainable development; and facilitate the implementation of National Environmental Performance Measures established by the National Environment Protection Council. It is designed to prevent contamination of the surrounding environment, including soil, air, and water, and imposes a general duty on conducting an activity or action that causes or is likely to cause pollution resulting in environmental harm, or that generates or is likely to generate waste. The disposal of listed waste and discharge of water to the environmental requires a licence under the Act. The WMPC Act does not apply within the petroleum permit area however applies to project activities undertaken outside the petroleum permit area.
Water Act 1992	Provides for the investigation, allocation, control, protection, management and administration of water resources in the NT. The Act prohibits waste to come in contact with water or water to be polluted unless under authorisation.

Act	Summary
	The Water Act requires gas companies to obtain a water extraction licence prior to the extraction of any groundwater.
Weeds Management Act 2001	Aims to prevent the spread of weeds throughout the NT, ensuring the management of weeds is an integral component of land management. It is designed to ensure there is community consultation in the creation of weed management plans and that the landholder or interest holder takes responsibility in implementing weed management plans. If a weed is declared, all landholders, land managers and land users must comply with the declaration classification. The following are the three classes of declared weeds in the NT: • Class A - to be eradicated • Class B - growth and spread to be controlled • Class C - not to be introduced into the NT. All Class A and Class B weeds are also Class C weeds.
Work Health and Safety (National Uniform Legislation) Act 2011	The WHS Act is part of the nationally harmonised work health and safety laws, which aim to provide all workers in Australia with the same standard of health and safety protection regardless of the work they do or where they work.
International Agreements	
• Migratory species: • Japan-Australia Migratory Bird Agreement • China-Australia Migratory Bird Agreement • Republic of Korea-Australia Migratory Bird Agreement • Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention)	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.
Ramsar Convention on Wetlands	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.

2.1.1 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 2-3.

Table 2-3 Summary of Legislative Requirements

Legislative Requirement	Relevant Legislation	Administrator	Proposed Action
Commonwealth			
Exploration Permit	*Petroleum Act 2016* and Petroleum (Environment) Regulations	DPIR	Activities operated under Exploration Permit 161.
Approved Environmental Management Plan	Petroleum (Environment) Regulations	DNER	Santos will ensure this document is approved prior regulated activities occurring.
Minister's Approval	*Environment Protection and Biodiversity Conservation Act*	DOEE	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.
Notice of Intent and Formal Environmental Assessment	*Environmental Assessment Act 2013* and Administrative Procedures	NT EPA	This EMP does not constitute any material change of use. Santos therefore considers it unnecessary to refer the activity for assessment. Refer to Section 6.2.2.
Must not enter, damage or interfere with a Sacred Site (even if not registered)	*Northern Territory Aboriginal Sacred Sites Act 2013*	CLC	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.
AAPA Authority Certificate	*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.
Work approval (for removal or damage of archaeological sites)	*Heritage Act 2011*	DENR	A survey has been completed and no archaeological sites were identified. As a result, Santos does not anticipate a work approval will be required.
Groundwater Extraction Licence	*Water Legislation Amendment Act 2018*	DENR	Application for a groundwater extraction licence associated with NT Portion 701 accepted in February 2019.
Reporting under National Greenhouse and Energy Reporting Scheme (NGERS)	*National Greenhouse and Energy Reporting Act*	Australian Government – Clean Energy Regulatory	Santos is obligated and registered to report under the scheme.

Legislative Requirement	Relevant Legislation	Administrator	Proposed Action
Dangerous Goods Business Licence	*Dangerous Goods Act*	NT Worksafe	Santos will ensure licence is held by Santos or contractor if applicable.
Dangerous Goods Vehicle Licence	*Transport of Dangerous Goods by Road* and *Rail (National Uniform Legislation) Act*	NT Worksafe	Santos will ensure licence is held by Santos or contractor if applicable.
Land Access and Compensation Agreement (LACA)	*Petroleum Act 2016 and* Petroleum Act Stakeholder Engagement Guidelines Land Access (Land Access Guidelines)	DPIR	Existing LACAs 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.

2.2 Relevant Agreements and Operating Consents

Land access guidelines under the Petroleum Act require Santos to reach agreement with the Pastoralist prior to the commencement of exploration activities.

The Regulations sets out a process for stakeholder engagement when a company proposes to undertake a regulated activity. Stakeholder engagement undertaken for the project is discussed in Section 8.

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'.

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.

2.3 Codes of Practice and Relevant Guidelines

The Code of Practice for Petroleum Activities in the Northern Territory (Northern Territory Government, 2019) 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.

Measures to ensure the proposed 2019 Civil and Seismic Program are compliant with the Code have already commenced. In November and December 2018 two separate EMPs were approved for the construction of leasepads and installation of groundwater monitoring bores at the Tanumbirini 1/2H and Inacumba 1/1H locations. These control monitoring bores have been installed and baseline monitoring in compliance with the Guideline and the Code has commenced. A well lease layouts showing the location of the monitoring bores is provided in Figure 3-3 and Figure 3-6.

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)

2.4 Referrals under NT and Commonwealth legislation

2.4.1 Referral under the Environment Protection and Biodiversity Conservation Act

The *Environment 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 Environment and Energy is required if the proposed action will have, or is likely to have a significant impact, which is discussed in section 6.2.1.

2.4.2 Referral under the Environmental Assessment 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, pursuant to Section 7 of the *Environmental Assessment Act* (EA Act). . The Petroleum (Environment) Regulations also provide that this EMP will also form the basis of a Notice of Intent under the EA Act. Using the guideline “Referring a proposal to the NT EPA: A guide for proponents and referral agencies” (NT EPA 2018), a detailed review of and assessment the potential risks of the proposed civil and seismic activities against the relevant Environmental Factor and corresponding Environmental Objectives, which is discussed in section 6.2.2.

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 5000 km^2 cattle grazing property within NT Portion 701 of Arnold.

Santos has undertaken exploration activities in EP 161 since 2013, including acquiring 2D seismic data, drilling of one exploration well (Tanumbirini-1), one core hole (Marmbulligan-1), and the installation of four water bores.

Santos proposes to undertake a two-dimensional (2D) Seismic Program comprising a single, 10 linear km 2D seismic line, in a northwest to southeast orientation across the Tanumbirini-1/2H well. Santos also proposes to complete civil works to support both this program and the future proposed Drilling Program at Tanumbirini and Inacumba wells. ('Proposed Drilling Program' are subject to a separate EMP). This EMP seeks approval for the seismic and civil activities only.

The project area refers to the physical footprint of the proposed infrastructure and activities. The project area for the seismic and civil activities is 99.4 hectares, which includes the existing roads and the seismic line (Figure 3-1). Of the project area, 59.5% is considered new disturbance and the remaining 40.5% is located in areas of existing disturbance. Table 3-1 describes the project area separated in to areas to be cleared and existing cleared areas.

Table 3-1 Estimated New and Existing Cleared Areas

Location	Infrastructure	New Areas to be cleared	Existing Cleared areas	Total area (ha)
Inacumba	Access road one	0.7	9.2	9.9
	Access road two	0.5	9.6	10.1
	Laydown Area	1.0	0.0	1.0
	Campsite	0.7	0.0	0.7
	Cuttings pit	0.3	0.0	0.3
	Tankpad 1	0.8	0.0	0.8
	Tankpad 2	1.1	0.0	1.1
	Dam	0.1	0.0	0.1
	Leasepad loop road	0.4	0.0	0.4
	Leasepad	1.8	0.0	1.8
	Borrow pit	8.2	0.0	8.2
	Fire protection area	19.7	0.0	19.7
	TOTAL	**35.3**	**18.8**	**54.1**
Tanumbirini	Access road	0.0	13.2	13.2
	Lease loop road	0.3	0.2	0.5
	Laydown area	0.8	0.1	0.9
	Campsite	0.6	0.0	0.6
	Existing topsoil area	0.0	0.1	0.1

Location	Infrastructure	New Areas to be cleared	Existing Cleared areas	Total area (ha)
	Dam	0.0	0.1	0.1
	Water Tank Pad 1	0.4	0.7	1.1
	Water Tank Pad 2	0.7	0.1	0.8
	Cuttings Pit	0.0	0.3	0.3
	Waterline	0.1	0.0	0.1
	Borrow pit*	5.5	0.0	5.5
	Fire Protection Area	10.4	5.1	15.5
	Leasepad	0.6	1.6	2.2
	Seismic line	4.5	0.0	4.5
	TOTAL	**23.9**	**21.4**	**45.3**

Other key details of the proposed project is given in Table 3-2 and is described in further detail in the sections to follow.

Table 3-2 Summary of Project details

Component	Details
Operating hours and workforce numbers	24hrs (12-hour day shifts where possible)
Civil activities – grading, excavation, compaction, stockpiling etc.	Grading, excavation, compaction, stockpiling.
Equipment and machinery	Grader, Bulldozer, Tipper, Water Cart, Mobile Camps, Scraper, Hand & Power Tools
Access Route options and key issues for each option	Option One and Option Two use the existing landholder access road. Option One takes a deviation to avoid existing landholder infrastructure, whereas Option Two continues further north past the landholder infrastructure. Both options meet the proposed leasepad loop road.
Volumes diesel required for power supply, equipment, vehicles	Approximately 175,000 L
Water source/s, demand (estimate with breakdown for dust suppression, construction and amenities), volumes of onsite water storages, discharges.	Approximately 45.5 ML
Rehabilitation methods proposed	On completion of the 2D seismic activities, any removed vegetation will be respread on the seismic lines to promote regeneration. Photo points are established at regular intervals along the seismic lines to monitor rehabilitation. Unless the landholder requests infrastructure to remain in place all surface infrastructure will be removed and rehabilitated.

Legend

- Water Bores
- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Major Waterways
- Principal Road
- Borrow Pit
- Inacumba Lease
- Tanumbirini Lease

1:300,000 @ 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 Drilling
Environmental Management Plan

Proposed Infrastructure

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 3-1

\\ghdnet\ghd\AU\Brisbane\General\Services\GIS\Projects\43228121\GIS\Maps\43228120_022_ProposedInfrastructure_RevB.mxd
Print date: 28 Mar 2019 - 15:35

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, Borrow Pit, Seimic Line (2019)
Created by: xlee

3.1 Timing and Personnel

The Civil and Seismic program is expected to take up to 20 weeks and will be undertaken in the 2019 dry season. An indicative project schedule is provided in Table 3-3. The project will be carried out in 12-hour day shifts where possible.

Table 3-3 Indicative project schedule

Activity	Estimated duration	Estimated commencement
Civil works	4 – 12 weeks	May 2019
Seismic data acquisition	1 – 2 weeks	May – June 2019
Rehabilitation of seismic lines	1 week	May – June 2019

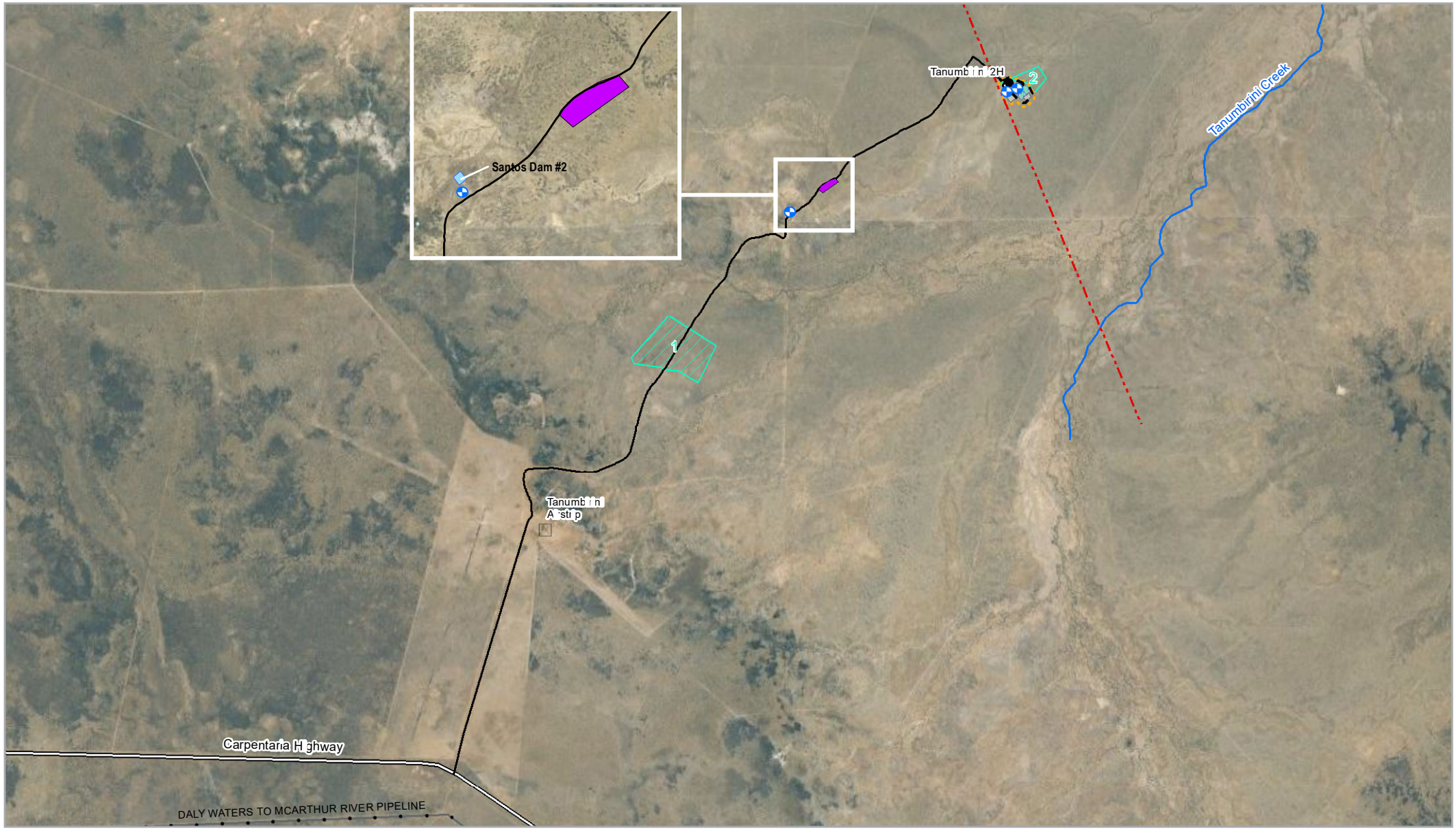
3.2 Civil works

Civil works will be required to prepare the seismic lines prior to data acquisition and for the creation of two well leasepads and associated access tracks and infrastructure. Ongoing maintenance will be required to maintain the roads, campsite, laydown areas and wellsite. This consists of grading, watering (sourced from bores) and minor patching.

Borrow pits will be utilised for civil works at both the Inacumba and Tanumbirini well pads and will be constructed with a maximum horizontal: vertical slope of 3:1 and an estimated maximum depth of 3 m. When the clearing is undertaken, the vegetation and topsoil will be stockpiled separately.

3.2.1 Civil works required for the Tanumbirini-2H well

The infrastructure required for the Tanumbirini-2H well is shown in Figure 3-2 and Figure 3-3.



Legend

- Water Bore
- Existing Well
- Proposed Well
- Tanumbirini Air Strip
- Existing Access Road
- Proposed Access Road
- 2D Seismic Line
- Pipeline
- Major Waterways
- Principal Road
- Laydown Area
- Borrow Pit
- Dam

1:70,000 @ A4

0 0.5 1 1.5 2

Kilometres

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

N

Santos
McArthur Basin Civil & Seismic
Environmental Management Plan

Proposed Infrastructure for the Tanumbirini-1/2H location

Project No. **43-22812**
Revision No. **A**
Date **28/03/2019**

FIGURE 3-2

\\ghdnet\ghd\AU\Brisbane\General\Services\GIS\Projects\4322812\GIS\Maps\432281200_019_TanumbiriniAccessRoad_RevA.mxd
Print date: 28 Mar 2019 - 15:37

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) Created by: xlee

Legend

- Water Bore
- Existing Well
- Proposed Well
- 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

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

Santos
McArthur Basin Civil & Seismic
Environmental Management Plan

Project No. **43-22812**
Revision No. **B**
Date **30/04/2019**

Tanumbirini Lease Pad

FIGURE 3-3

\\ghdnet\ghd\AU\Brisbane\General\Services\GIS\Projects\43228 12\GIS\Maps\432281200_005_TanumbiriniLeasePad_RevB.mxd
Print date: 30 Apr 2019 - 14:31

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: ACJackson

3.2.1.1 Access roads

The existing 13.2 km landowner access road from the Carpentaria Highway to the Tanumbirini-1 T-Junction may require minor upgrades, which will not increase the width of the road, but will require access to fill.

It is estimated that approximately 2,500 m^3 of additional capping may be required to reinstate the existing road and provide effective drainage to maintain vehicular access on the existing landowner access track.

A new section of road approximately 1300 m length x 8 m width is required to allow for placement of the new infrastructure. It is estimated that approximately 1,780 m^3 of rock/clay rubble will be required to cap this new section of access road.

3.2.1.2 Leasepad activities

The proposed infrastructure at the Tanumbirini-1/2H location consists of the well pad, the campsite, storage pad, two water tank pads and a water bore pad, which has a total area of approximately 6.5 ha and is surrounded by the wider Fire Control Area. This area will be cleared, with vegetation mulched or stockpiled separately with topsoil for rehabilitation, before cut to fill is carried out to establish a suitable level work area. The vegetation and topsoil will be stored within the Fire Control Area.

Capping with compacted clay or rubble at the wellsite, campsite and storage pad may be required to improve the resilience of the work surface.

There is an existing disturbance 3.2 km southwest of the wellsite adjacent to the landowners' access, which has previously been used as a civil works campsite and parking area. This area has been partially rehabilitated however, 3,600 m^2 remains cleared which will be utilised for temporary storage or equipment parking. This is shown as a laydown area on Figure 3-2.

Approximate disturbance area summary and capping volumes below are provided in Table 3-4 below.

Table 3-4 Estimated disturbance area and cut/fill and capping volumes

Activity/Area	Area (m^2)	Capping required (m^3)	Cut to fill required (m^3)
Well Leasepad	22,000	1,120 – 3,950	11,700
Campsite	10,000	1,580	1,326
Laydown area	10,100	1,620	3,695
Water Tank Pads	18,400	0 (uncapped)	5,498

All of this infrastructure is contained within a Fire Control Area, which requires an additional area to be selectively cleared and rolled or subject to a controlled burn to remove vegetation.

There is an existing water supply bore and a combined water supply / water monitoring bore at the Tanumbirini-1/2H location. Water will be distributed from the bores through a 300 m pipe network to various tanks and above ground ponds at the Water Tank Pad area and an existing dam for storage prior to use. Crossings will be constructed as required to protect existing pipelines from vehicles and machinery by placing the pipeline in to a steel or HDPE conduit on the ground and constructing a 500 mm high earth ramp crossing.

The cuttings pits and water storage tank areas located at the Water Tank Pad area require specific civils to prepare for the water management measures that will be implemented during drilling activities.

The Water Tank Pads will have low point drains to allow the collection of rainwater and in the event of a leak from the tank, the fluid will be collected and either pumped back in to the tank or disposed to a licenced facility. Water storage tank areas will have bunded walls constructed to prevent mixing of streams, divert rain water runoff and contain fluids within the defined areas.

The cuttings pit will impermeable and will be lined with HDPE or bentonite in accordance with the Code.

Fencing will be erected to prevent accidental entry into pits by personnel, livestock and native fauna. Fauna escape ramps and gateways will be installed in the existing dam on the leasepad and the proposed dam shown in Figure 3-3.

3.2.1.3 Borrow pits

The proposed infrastructure construction for the proposed Tanumbirini-2H leasepad will require approximately 11,430 m^3 of clay/gravel select fill. It is proposed that the select fill will be sourced from two areas (Pit 1 and Pit 2) shown in Figure 3-3.

Pit one is an existing borrow pit located approximately 6 km from Tanumbirini-2H leasepad. It is estimated that project activities will involve the extraction of approximately 4,500 m^3 of fill from the pit. A larger extent has been shown on Figure 3-3 however only an area of 200 m x 100 m x 3 m deep is required to obtain these volumes. A 300 m access road will be constructed at each of the borrow pit to link to the main access track.

Pit two is a proposed new pit located adjacent to the Tanumbirini-2H leasepad. It is estimated that project activities will involve the extraction of approximately 6,930 m^3 of fill from the pit. A larger extent has been shown on Figure 3-3 however an area of 200 m x 100 m x 3 m deep is required to obtain these volumes. There is existing access tracks into this borrow pit.

3.2.2 Civil works required for the Inacumba-1/1H well

3.2.2.1 Access Roads

There are two options for access to the Inacumba-1/1H well:

- Option 1 – Total Distance 13.5 km uses 11.5 km of existing landowner access route then requires a 900 m minor deviation around landholder infrastructure to intersect 1.1 km of wellsite loop/access roads.
- Option 2 – Total distance 13.9 km, uses existing 12.1 km of landowner access. This option goes past the deviation required for Option 1, before turning south east 700 m along a seismic line to intersect 1.1 km of wellsite loop roads.

A detailed description of the two options is provided in the following sections.

The two access options will be constructed to Santos Class C specification. The Class C specifications as shown in Figure 3-4. New road sections and floodways will require clearing, grubbing and stripping of full depth (min 100 mm) of topsoil within the road right of way. This material will be used to repair erosion, construct pipeline crossings, diversion banks.

Side batter slopes shall be four horizontal to one vertical in cut and fill. Formation shall be elevated to provide stable running surface with no provision for drainage. The maximum level of disturbance associated with road corridors is 12 m, however as shown in Figure 3.4, the road corridor is generally 10 m wide.

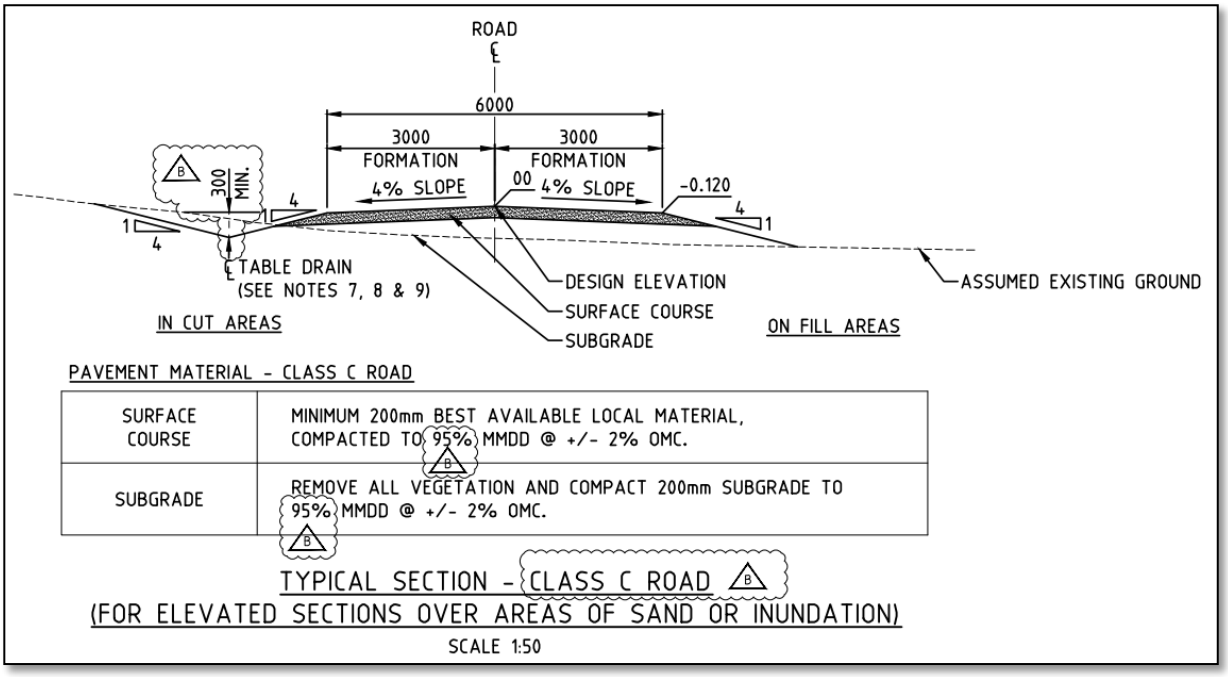


Figure 3-4 Typical road cross-section (Class C)

3.2.2.1.1. Option One

Option 1 has a total distance 13.5 km and uses 11.5 km of the existing landowner access used for the Inacumba North water bore access route that was approved in the EP 161 Water Bore Monitoring Program EMP (Santos 2018). The existing access track will require the straightening of creek access points, clearing of overhanging trees, and realigning the access back to the original parallel path however no additional clearing is required to undertake these civil works.

After 11.5 km, the proposed access deviates to the east to avoid the existing landholder stock water trough and water tank. Approximately 900 m of new access track is required. This track then intersects the 1.1 km of wellsite loop roads required for drill rig. This option requires four waterline crossings to be installed. Option 1 is shown in Figure 3-5.

Works for Option 1 include:

- capping of some low lying areas and rocking of up to 11 floodways and six creek crossings on the existing landowner access road
- Installation of mitre drains as required to prevent erosion
- Installation of a cattle grid adjacent the Carpentaria Highway
- Construct four crossings (including new “T” junction) to protect landowner waterline. The crossings will require landowner pipe to be sheathed 400 mm below natural surface within heavy wall HDPE pipe >150 mm diameter and the backfilled and compacted and covered with 200 mm of fill. The existing landholder waterline will be identified with steel marker posts with “Water Line” name plates to be installed within 3 m of each side of the road where the waterline crosses.

3.2.2.1.2. Option Two

Option Two has a total distance 13.9 km and uses existing 12.1 km of landowner access used for the Inacumba North water bore access route that was approved in the EP 161 Water Bore Monitoring Program EMP (Santos 2018). The existing access track will require the straightening of creek access

points, clearing of overhanging trees, and realigning the access back to the original parallel path however no additional clearing is required to undertake these civil works

Option two continues north past the deviation required for Option 1, between landowner infrastructure, before turning south east 700 m along an existing seismic line to intersect the 1.1 km of wellsite loop roads. Option 2 is shown in Figure 3-5.

Works for Option two include:

- capping of some low lying areas and rocking of up to 11 drainage line crossings on the landowner access road
- Installation of mitre drains as required to prevent further erosion
- Installation of a cattle grid adjacent the Carpentaria Highway
- Construct three crossings (including new T-junction) to protect landowner waterline, crossing will require landowner pipe to be sheathed 400 mm below natural surface within heavy wall HDPE pipe >150 mm diameter, before it is backfilled and compacted and covered with 200 mm of fill. The existing landholder waterline will be identified by steel marker posts with “Water Line” name plates to be installed within 3 m of each side of the road where the waterline crosses.

Legend

- Water Bores
- Proposed Well
- Drainage Line Crossings
- Waterline
- Existing Access Road Option 1
- Existing Access Road Option 2
- Inacumba Proposed Access Road Option 1
- Inacumba Proposed Access Road Option 2
- Pipeline
- Major Waterways
- Principal Road
- Borrow Pit

1:90,000 @ A4

0 0.5 1 1.5 2

Kilometers

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

N

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Inacumba Option 1 and 2 Access Routes

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 3-5

\\ghdnet\ghd\AU\Brisbane\General\Services\GIS\Projects\4322812\GIS\Maps\432281200_010_InacumbaOption1and2_RevB.mxd
Print date: 28 Mar 2019 - 15:47

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: Drainage Line Crossings (2019). GA: Waterways, Pipelines, Roads (2007). Created by: xlee

3.2.2.2 Leasepad activities

The proposed infrastructure at the Inacumba well consists of the well leasepad, the campsite, laydown pad, dam, two water tank pads and a water bore pad, which has a total area of approximately 5.7 ha and is shown in Figure 3-6. This area will be cleared, with some fill and capping with clay required. This infrastructure is contained within a fire protection action zone, which requires an additional nine ha to be selectively cleared and rolled or subject to a controlled burn to remove vegetation.

Capping with compacted clay or rubble to the wellsite, campsite and storage pad may be required to improve the resilience of the work surface. Approximate disturbance area summary and capping volumes below are provided in Table 3-5 below.

Table 3-5 Estimated disturbance area and cut/fill and capping volumes

Activity/Area	Area (m^2)	Capping required (m^3)	Cut to Fill required (m^3)
Well Leasepad	18,000	1,120 – 3,950	3,804
Campsite	10,000	1,580	0
Laydown pad	10,100	1,620	681
Water Tank Pads	18,128	0 (uncapped)	2977
Dam	1,000	680	194

There is an existing water bore at the Inacumba wellsite and water will be transported through a 300 m pipe to a dam for storage prior to use. The dam will be constructed as part of the civil works and will be approximately 40 m x 40 m.

The water bore, approved in 2018, at Inacumba south may be utilised for the project, and water would be piped up to the dam prior to use. Crossings will be constructed as required to protect existing pipelines from vehicles and machinery by placing the pipeline in to a steel or HDPE conduit on the ground and constructing a 500 mm high earth ramp crossing.

The suggested design for the stormwater and secondary containment for the Water Tank Pads will have low point drains to gather rainwater and in the event of a leak from the tank, the fluid will be collected and either pumped back in to the tank or disposed to a licenced facility. Water storage tank areas will have bunded walls constructed to prevent mixing of streams, divert rain water runoff and contain fluids within the defined areas.

The cuttings pit will impermeable and will be lined with HDPE or bentonite in accordance with the Code.

Fencing will be erected to prevent accidental entry into pits by personnel, livestock and native fauna. Fauna escape ramps and gateways will be installed on the dam shown in Figure 3-6.

3.2.2.3 Borrow pits

The proposed infrastructure construction for the proposed Inacumba 1/1H leasepad and access roads will require approximately 28,000m^3 of clay/ gravel select fill. Currently there are no established gravel sources within 10 km of this location. Five areas of investigation have been selected for possible gravel sources. The five areas are located within the two borrow pit areas shown in Figure 3-5.

Investigations involve excavations within the proposed borrow pit regions to a depth of 3 m to identify the best material available without disturbing the entire area. Final volumes extracted from each pit

may vary and will depend on the resource quality and quantity, however approximate areas of each borrow pit will be 200 m x 100 m x 3 m deep.

Prior to taking borrow material, vegetation and topsoil will be stockpiled separately and a contour bank will be created to divert rainwater around the borrow pits, as required.

Access Option One and Option Two will use the same two borrow pit locations (Pit one and Pit two) for the access track and all wellsite, ancillary pads and access construction or upgrades. Pit one and two are shown in Figure 3-5.

Legend

- Water Bores
- Proposed Well
- Proposed Topsoil Area
- Waterline
- New Access Road Option 1
- New Access Road Option 2
- Fire Control Area
- Proposed Facilities
- Dam
- Water Tank Pad
- Inacumba Lease
- Borrow Pit
- Cuttings Pit
- Proposed Irrigation Area

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

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Proposed Infrastructure for the Inacumba-1/1H Location

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 3-6

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Print date: 28 Mar 2019 - 11:43

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: Irrigation Area, Proposed Topsoil Area (2019). Created by: xlee

3.3 Seismic Program

The aim of the seismic survey is to produce detailed images of the various rock types and their location beneath the earth's surface. This information is used to determine the location and size of oil and gas reservoirs.

The seismic method uses vibrator trucks to produce sound waves, which are reflected off underground rock formations. The waves that reflect to the surface are captured by recording sensors called geophones. Analysing the time the waves take to return provides valuable information about rock types and possible gases or fluids in rock formations. The returning reflections are recorded in a digital format and sent to a seismic data processing centre to produce a 'cross-section' of the layers of the earth's crust.

3.3.1 Seismic Line Preparation

Line preparation is undertaken prior to acquisition to provide safe access and a defined line for the acquisition crew to follow. Due to varying terrain, the line preparation is usually undertaken by a dozer/grader and a light 4WD vehicle. The dozer will 'walk' with the blade up in easily traversable terrain, with the marks of the dozer tracks being sufficient for the surveyors and recording crew to follow. The dozers will not be utilised in areas where riparian vegetation is present.

The line position are pre-programmed into GPS units housed in the dozer and grader. These GPS units are kinematic dual frequency units that allow the dozer operators to get real time position fixes. These are plotted on a pilot display that also indicates the weaving tolerances for the dozer operators.

3.3.2 Line Surveying

Surveying commences shortly after line preparation. The field surveyors use real time kinematic GPS receivers to position receiver points for 2D surveys. Surveyors mark the ground with biodegradable paint, with selected points marked by wooden stakes. Line detours may also be marked with temporary biodegradable flagging.

Each survey team consists of one surveyor in a light 4WD vehicle, and generally makes only one pass over any given section of line. Back tracking may occur in areas where vehicle access routes have deviated from the true line position and markers must be inserted by personnel on foot. This may occur in areas of riparian vegetation if there is adequate access either side of the watercourse.

3.3.3 Recording

Recording normally commences two to three weeks after the start of line preparation. This operation is the largest part of the seismic operation in terms of personnel and vehicles. A recording crew would normally consist of up to 34 personnel and 16 vehicles. The size of the crew will vary depending on the recording technique used, terrain and season and recording is generally restricted to daylight hours.

3.3.4 2D Seismic Operations

Work commences with the deployment of nodal geophones from light 4WD vehicles. The nodal geophones are autonomous units, containing the actual geophone as well as battery and data storage in one unit of approximately 10 cm by 10 cm square and 10 cm in length with a spike on the bottom so that they can be easily pushed into the ground. These nodes are deployed at regular intervals along the line, in this case every 2.5 m or 5 m. As each node weighs approximately 1 kg each, these may be able to be carried through areas of riparian vegetation to avoid any damage to vegetation where access permits.

Recording will commence once the entire 10 km line has been laid out on the ground. This layout is termed 'the spread' and picks up the acoustic energy reflected from subsurface layers, converts it to electrical energy and stores the data on the nodal unit, until it is retrieved from the field and the data downloaded to the recording system.

The acoustic energy source is an array of three truck mounted vibrator units, electronically synchronised to vibrate in phase with each other. They line up along the seismic line, a few metres apart, centred on midway between two specified receiver points. Simultaneously each unit, on command from the instrument truck, inputs one or more frequency sweeps into the ground at each source point. Each sweep lasts for only a few seconds. Generally, four seconds of reflected data is recorded. On completion of one source point, the set of vibrators are moved to the next source point.

The 'live' section of the spread is the only part of the spread where signal is recorded for any given source position. Given the short line length, the entire line will be left 'live' during acquisition of the survey.

Along any single line, the following vehicle passes can be expected to occur during normal operations:

- Vibrators – less than 5 passes for each truck
- Vibrator service truck – equivalent to vibrator passes
- Instrument truck - will be situated on well pad
- Light vehicles - 15-20 passes in total

Line surveying and spread layout is expected to take two days, the acquisition is expected to take two to three days, and the retrieval of equipment is expected to take a further two days. Providing that no repeat acquisitions are required for areas with bad quality data, this will conclude the seismic acquisition operations

3.4 Operations Support Facilities for the Program

3.4.1 Accommodation Campsite

3.4.1.1 Civils Crew

A temporary campsite will be constructed at both the Inacumba 1/1H and Tanumbirini 1/2H well pads. The campsite includes:

- 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.

3.4.1.2 Seismic Crew

The seismic crew will be accommodated offsite at a third party location (i.e. nearby hotel, motel).

3.4.2 Airstrip Maintenance

The landowner airstrip adjacent the Tanumbirini Homestead may be used for crew changes and emergency response evacuations. The 1,400 m length airstrip is a dry weather strip and contains no lighting and is regularly used to deliver landowner mail and other irregular private aircraft. The location of the airstrip is shown on Figure 3-2.

The airstrip surface is unsealed and requires annual maintenance to control ant mound growth, repair erosion and remove vegetation which has emerged following the wet season. Proposed works at the airstrip include maintenance grading and rolling of the entire runway, parking areas and signal areas to restore the surface and repair any minor erosion following the wet season. In addition, regular maintenance watering may be required on the airstrip access and runway to maintain the surface and control dust. All proposed maintenance works will be limited to the cleared airstrip footprint and no new clearing will be required.

3.4.3 Waste Management

Seismic crews will be staying at existing off-site accommodation sewage and grey water will be managed at the offsite accommodation facilities.

For the civils crew, wastewater from laundry, showers and kitchen is piped to an irrigation area, as shown Figure 3-3 and Figure 3-6. Sewage management practices at the campsite will consist of the use of port-a-loos and grey water capture and disposal to a ground pit with the aim to minimise any risks to human health or the environment. Alternatively the civils contractor my supply a mobile camp complete with an approved Effluent Treatment Plant.

Wastepaper, cardboard and food scraps are disposed of into sealed bins set up adjacent to the campsite. The sealed bins will be transported regularly for disposal of waste to a licensed landfill. Recyclable materials will be segregated on site and regularly transported to an approved waste depot facility (likely in Katherine or Darwin).

Appropriate chemical and fuel storage will be in place at the campsite. Fuel drums are stored within portable bunding and bulk fuel is stored within tankers equipped with safety features such as double-skins (or temporary bunding), safety cut-off valves, top accessing etc. Spill leak and drip trays will be used to address minor drips and spills resulting from re-fuelling operations.

A summary of the disposal methods for waste are presented in Table 3-6.

Table 3-6 Waste Disposal Method

Domestic Waste	Disposal Methods
Putrescible and municipal waste	Collected at campsite for disposal to approved landfill
Recyclables (glass and cans)	Collected at campsite for disposal to approved landfill and recycling

For wastewater management measures please refer to the Wastewater Management Plan.

3.4.4 Water Use

The civils crew will source water from approved potable water suppliers or utilise existing water bores in close proximity to the leasepads, as described in section 3.2.1.2 and 3.2.2.2. The seismic crew will source water at the third party accommodation.

Water for dust suppression is required and will be sourced from the existing bores (See Figure 4-5). Volumes of water used for dust suppression will depend on the weather conditions and dust

production. The personnel water use will be approximately 200 L/day per person. Estimated water use for the project is provided in Table 3-7.

Table 3-7 Estimated Water Use Volumes (ML)

Use	Scope	May	June	July	Aug	Total Use
Pastoral lease road maintenance, upgrade and construction	Minor upgrade of 24km of pastoral lessee access and a water cart on dust control for 12 hours each day	10	6	6	2	**24**
Construction activities	Construction activities Construct 2 x: Wellsite, campsite, storage pad, 2 x tank pads and new well lease access roads, includes temp. camp use	11	4	2	0.5	**17.5**
Road and site maintenance	Assume 1 ML per month	1	1	1	1	**4**
Totals		**22**	**11**	**9**	**3.5**	

3.4.5 Greenhouse Gas Emissions

Greenhouse gas emissions for the civils and seismic 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 vegetation clearing were quantified using the Department of Environment's Full Carbon Accounting Model (FullCAM). FullCAM is the model used to construct Australia's national greenhouse gas emissions account for the land sector.

The greenhouse gas emissions estimates for the civils and seismic program is provided in Table 3-8.

Table 3-8 Greenhouse Gas Emissions for the civils and seismic EMP

Source of GHG Emissions	Key Inputs	Assumptions	tCO_2e
Transport fuel combustion	125.35 kL Diesel oil (post-2004 vehicles)	Diesel volumes taken from Table 3-2. Estimate based on the Emissions and Energy Threshold Calculator – 2018	341
Non-transport fuel combustion	49.65 kL Diesel oil	Diesel volumes taken from Table 3-2. Estimate based on the Emissions and Energy Threshold Calculator – 2018	135
Vegetation Clearance	59.2ha of eucalypt woodland	Area of clearance taken from Table 3-1.	11,238.44
Total			**11,714.44**

3.5 Closure and Post Survey Monitoring

On completion of the 2D seismic activities, all pegs and pins will be removed from the source lines. Any removed vegetation will be respread on the seismic lines to promote regeneration. Photo points are established at regular intervals along the seismic lines. By establishing numerous photo points, it provides a balanced representation of the various landform and vegetation types encountered and enables rehabilitation success to be effectively monitored.

Photo points are GPS coordinated prior to the start of line preparation and photographs are taken at each location along the proposed line direction to give a view of the terrain prior to line-preparation. All photographs are digital for consistent comparison. The process is repeated after line preparation and again after recording. These photo points are then revisited at year one, year two and year four although the return period is determined by weather/road conditions and current activity in the region.

3.6 Long-term Rehabilitation

Rehabilitation is discussed in the Rehabilitation Management Plan (Section 7.0)

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 including spatial information from NR Maps, the Australian Government Protected Matters Search Tool (PMST) (Appendix A) and NT NRM Report (Appendix B).

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 short, hot 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 & 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 most rain during the year falls in 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 & 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 1/2H and Inacumba 1/1H locations can be seen on Figure 4-1 and Figure 4-2.

Figure 4-1 Elevation change across Tanumbirini 1/H

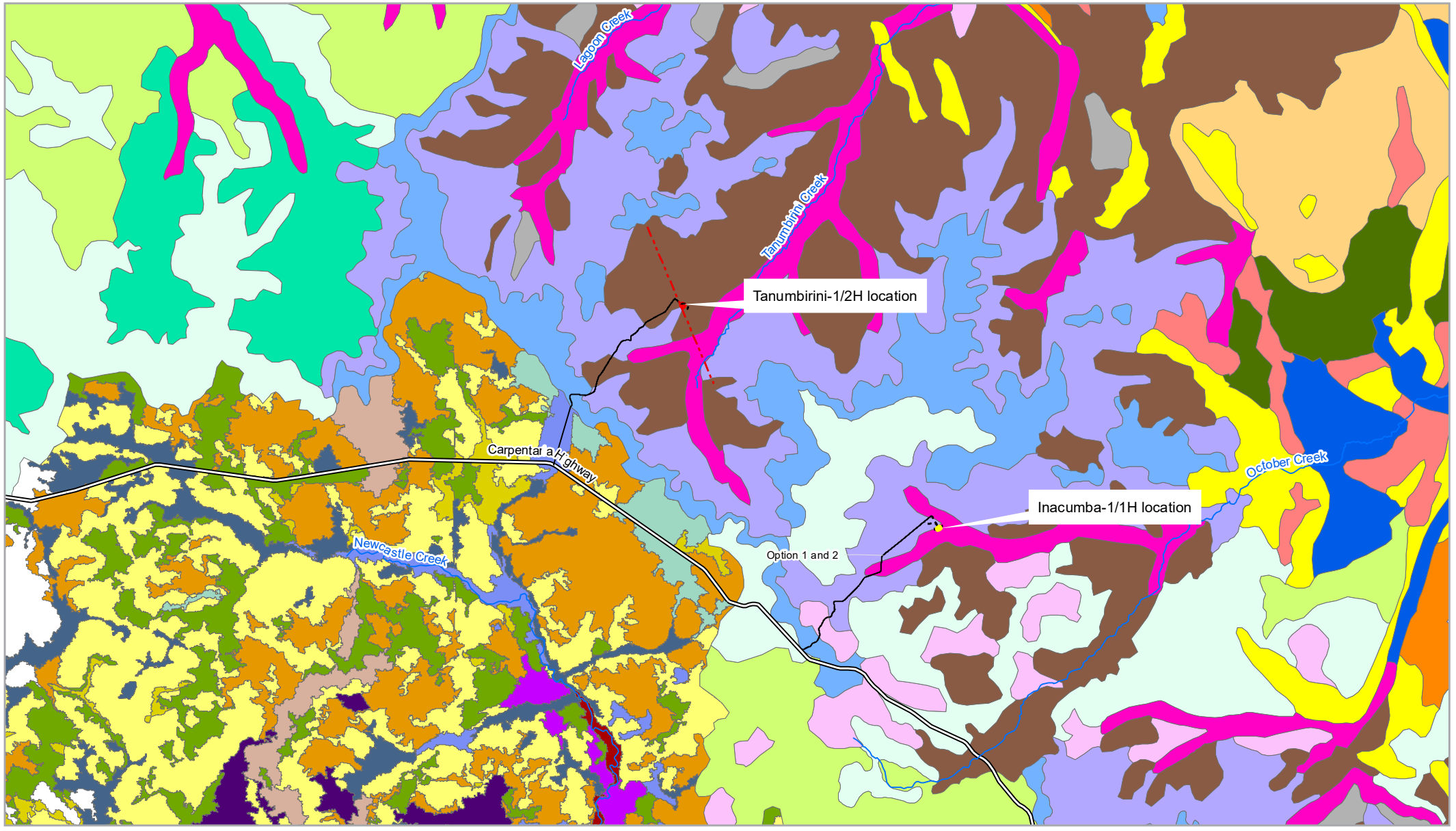
Figure 4-2 Elevation change across Inacumba 1/1H

4.1.3 Geology

Gas exploration on Tanumbirini Station is targeting shale sequences within the Beetaloo Basin. The Beetaloo 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 and with the exception of the north and eastern margins occurs at an average depth of about 500 m. The Beetaloo basin overlies the McArthur Basin that comprises a thick sequence of relatively undeformed sedimentary rocks that are sub divided into the Tallawah, McArthur, and Nathan Groups.

The northern Georgina Basin unconformably overlies the Roper Group and comprises the clastic Kiana Group, basalts of the Kalkarindji Province and the marine sedimentary succession of the Barkly Group. The Georgina basin is unconformably overlaid by Cretaceous mudstones and sandstones of the Carpentaria Basin that are discontinuously capped with a thin veneer of laterised Tertiary and Quaternary sediments. The total sedimentary sequence encompassing the McArthur, Beetaloo, Georgina and Carpentaria basins has an estimated thickness of over 10,000 m (Fulton & Knapton 2015).

The geology in the project area is shown in Figure 4-3.



Legend

- 2D Seismic Line
- Proposed Access Road
- Existing Access Road
- Major Waterways
- Principal Road
- Inacumba Lease
- Tanumbirini Lease
- All
- Alo
- Als
- Asb
- Lwc
- Lwi
- Lwl2
- Lwl3
- Tac
- Tam
- Tcd
- Tcj
- Tcm
- Tct
- Tcw
- alv
- bt2
- bt2a
- bul5
- cr2s
- j1s
- p1a
- p2
- p4
- shd
- tan1

1:300,000 @ 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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FIGURE 4-3

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Print date: 28 Mar 2019 - 11:36

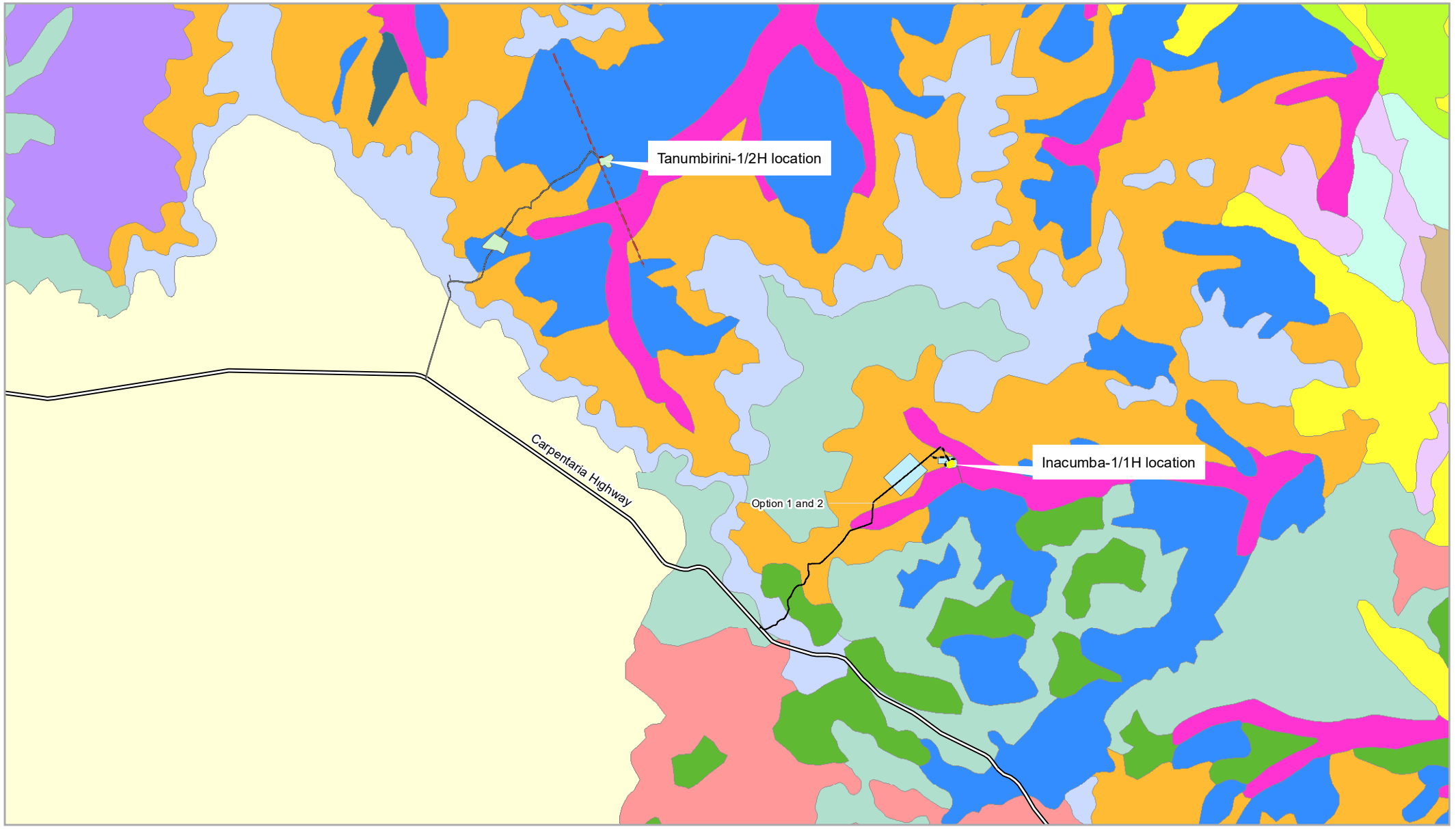
Data source:NTG - Land resources Gulf 250, Land resources Southern NT (2017), . GA: Roads, Waterways (2015) Santos: Proposed Access Roads, Existing Access Roads, Inacumba and Tanumbirini Lease Pads, (2019) Created by: xlee

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 B). 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 4-4.



Legend

- 2D Seismic Line
- Existing Access Roads
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Lease

- Beetaloo
- Bukalara
- Coolibah
- Cresswell
- Dalglese
- Inacumba
- Jumpup
- Lancewood 2
- Lancewood 3
- Lansen
- McArthur
- Miller
- Seigal
- Tanumbirini
- Wearyan

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0 2.5 5 7.5 10

Kilometres

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

N

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Environmental Management Plan

Land Systems

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 4-4

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Print date: 28 Mar 2019 - 15:49

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: xlee

Table 4-2 Percentage of Land Systems and Total Area within the Project Area

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 (taken 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 497-630 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
		Bukalara Sandstone		*Local Aquifer*	0 – 75	0.3 - 5	1000
BEETALOO BASIN (ROPER GROUP)	NOT KNOWN	Hayfield Mudstone		REGIONAL AQUITARD *Local Aquifer*	0 – 450	-	32000
		Jamison 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 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). The CLA is the only aquifer at the location of the proposed activities, as confirmed by hydrogeologists DENR. There are no other formations present which are considered aquifers.

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. 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

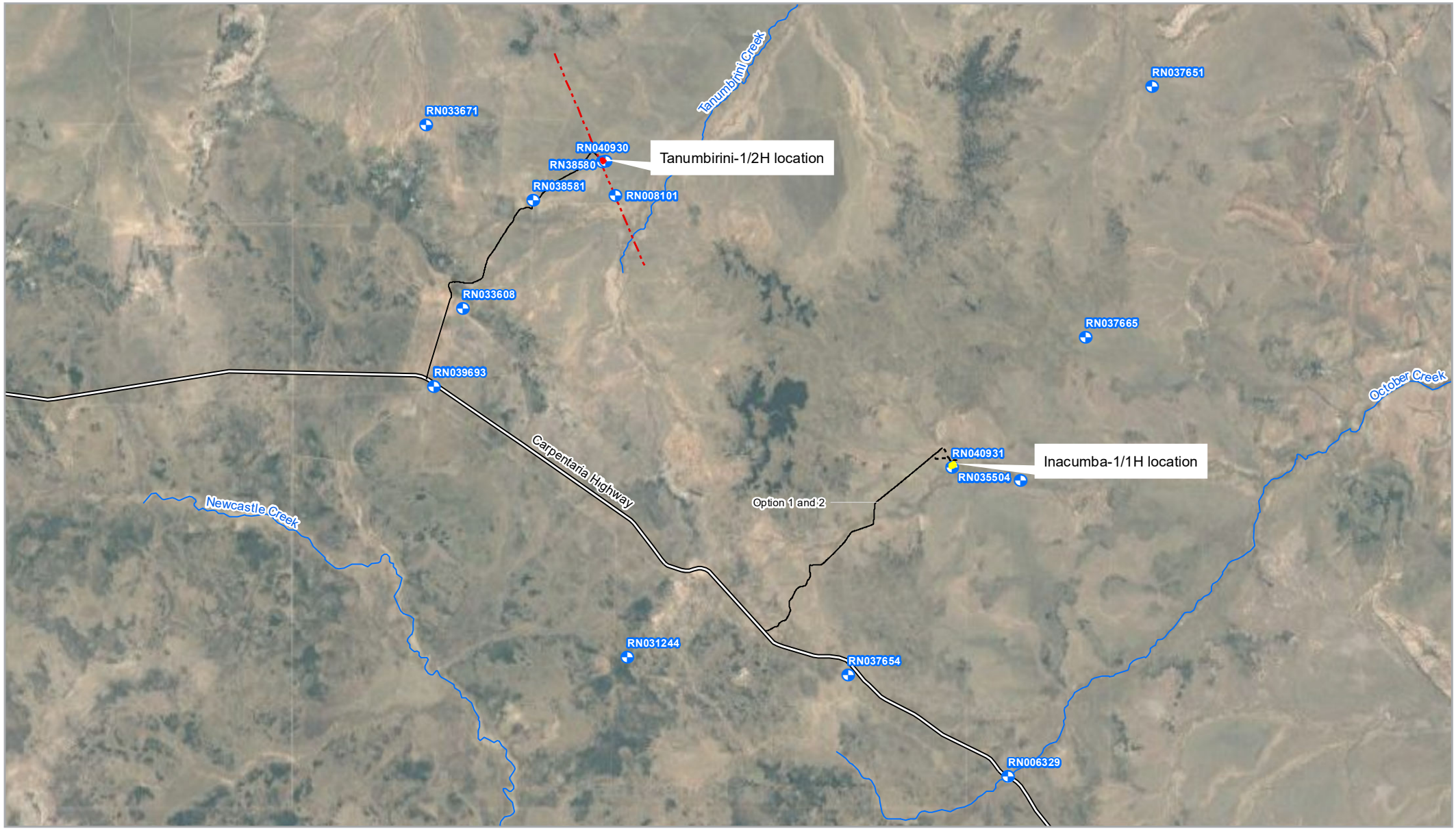
Formation	Depth to formation top (m)	Thickness (m)
Undifferentiated Cretaceous	Surface	43.9
Gum Ridge Formation	52	150
Bukalara Sandstone	202	380
Chambers River Formation	582	570
Bukalorkmi Sandstone	1152	145
Kyalla Sandstone	1297	772
Moroak Sandstone	2069	368
Velkerri Formation	2437	1482.5
Bessie Ck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

A baseline survey of water bores in the vicinity of the proposed well sites was undertaken in 2018. 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). Santos has established groundwater monitoring bores at the Tanumbirini-1/2H location and Inacumba-1/1H location. 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)).

The existing bores that Santos will monitor as part of their groundwater monitoring program are shown in Figure 4-5. In addition, CSIRO led baseline studies underway with extensive effort being put into understanding of recharge.

Table 4-5 Groundwater chemistry from installed Control Monitoring Bores

		Bore ID	RN040930	RN040931
		Description	TANUMBIRINI 2 CONTROL MONITORING BORE	INACUMBA 1 CONTROL MONITORING BORE
		Sample Date	9/12/2018	17/12/2018
Analyte	**Unit**	**Limit of detection**	**Result**	**Result**
Bicarbonate Alkalinity as CaCO3	mg/L	1	417	363
Carbonate Alkalinity as CaCO3	mg/L	1	< 1	< 1
Hydroxide Alkalinity as CaCO3	mg/L	1	< 1	< 1
Total Alkalinity as CaCO3	mg/L	1	417	363
Electrical Conductivity @ 25°C	µS/cm	1	1330	1560
Total Dissolved Solids @180°C	mg/L	10	824	976
Suspended Solids	mg/L	5	< 5	35
Calcium (dissolved)	mg/L	1	137	134
Magnesium (dissolved)	mg/L	1	57	88
Potassium (dissolved)	mg/L	1	12	22
Sodium (dissolved)	mg/L	1	78	103
Total Hardness as CaCO3	mg/L	1	577	697
Chloride	mg/L	1	106	148
Fluoride	mg/L	0.1	1.0	1.8
pH - Lab	pH Unit	0.01	7.97	8.06
Sulfate as SO4 2- (dissolved)	mg/L	1	208	328
Aluminium (total)	mg/L	0.01	< 0.01	< 0.01
Aluminium (dissolved)	mg/L	0.01	< 0.01	0.30
Barium (total)	mg/L	0.001	0.039	0.028
Barium (dissolved)	mg/L	0.001	0.040	0.036
Boron (total)	mg/L	0.05	0.18	0.31
Boron (dissolved)	mg/L	0.05	0.16	0.27
Chromium (total)	mg/L	0.001	< 0.001	< 0.001
Chromium (dissolved)	mg/L	0.001	< 0.001	< 0.001
Copper (total)	mg/L	0.001	< 0.001	< 0.001
Copper (dissolved)	mg/L	0.001	< 0.001	0.002
Iron (total)	mg/L	0.05	< 0.05	< 0.05
Iron (dissolved)	mg/L	0.05	0.23	7.33
Manganese (total)	mg/L	0.001	0.026	0.142
Manganese (dissolved)	mg/L	0.001	0.029	0.163
Molybdenum (total)	mg/L	0.001	0.003	0.046
Molybdenum (dissolved)	mg/L	0.001	0.003	0.050



Legend

- Groundwater Bores
- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Major Waterways
- Principal Road
- Inacumba Lease
- Tanumbirini Lease

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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Groundwater Bores

Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 4-5

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Print date: 28 Mar 2019 - 11:46

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: xlee

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 4-6. 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.

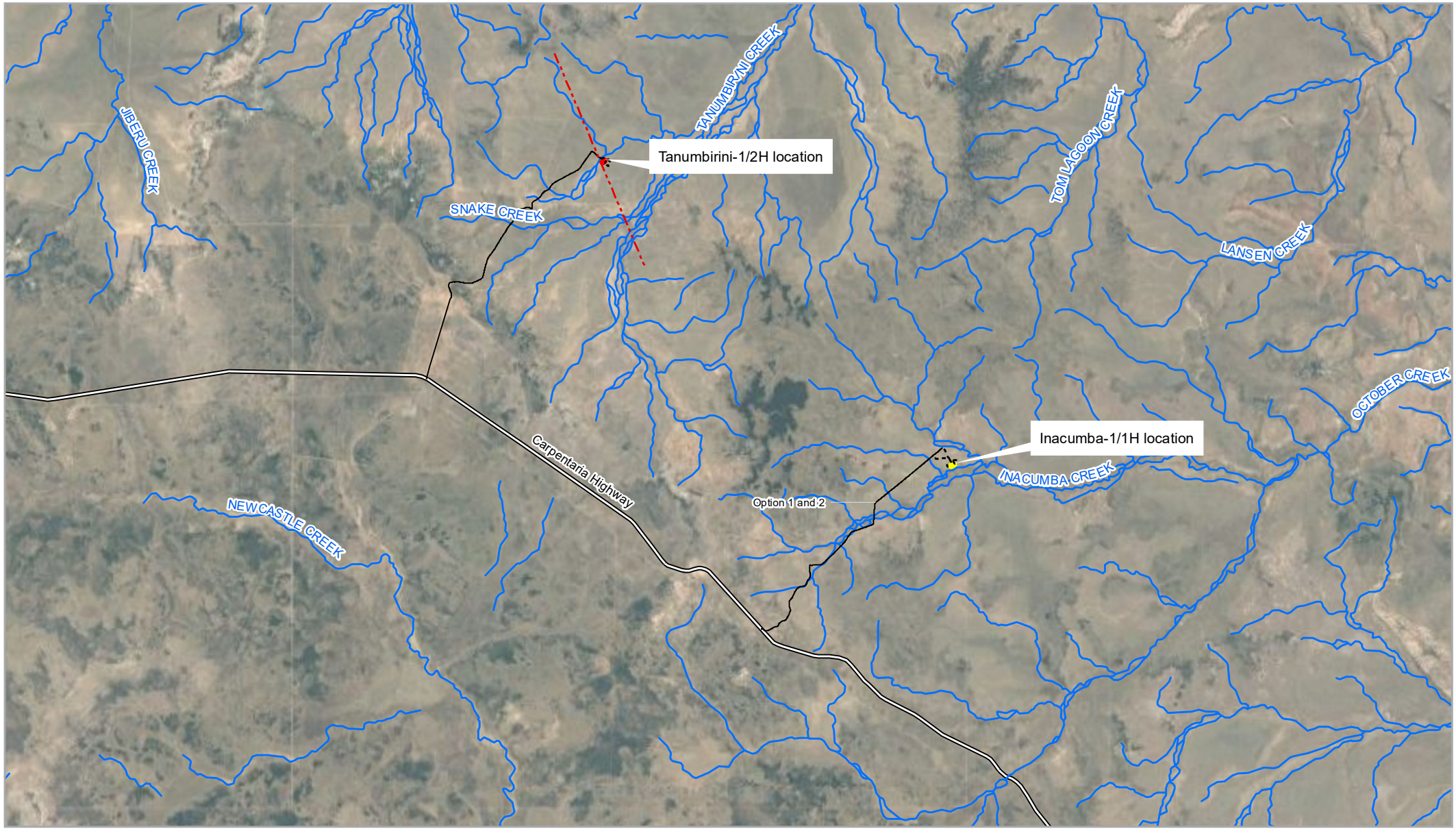
4.1.7.1 Preliminary Flood Modelling

Preliminary flood modelling of both leasepads 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 1/2H 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 1/1H 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 Tanumbirini 1/2H was adjusted to consider the elevation of the existing lease pad design (i.e. 2 m above the level of the adjacent creek bed).

The 1 in 100 AEP flood extent at the Tanumbirini 1/2H location and the Inacumba 1/1H location is shown in and Figure 4-7 and shown below.



Legend

- Major Waterways
- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Lease

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. **43-22812**
Revision No. **B**
Date **28/03/2019**

FIGURE 4-6

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Print date: 28 Mar 2019 - 11:49

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: xlee

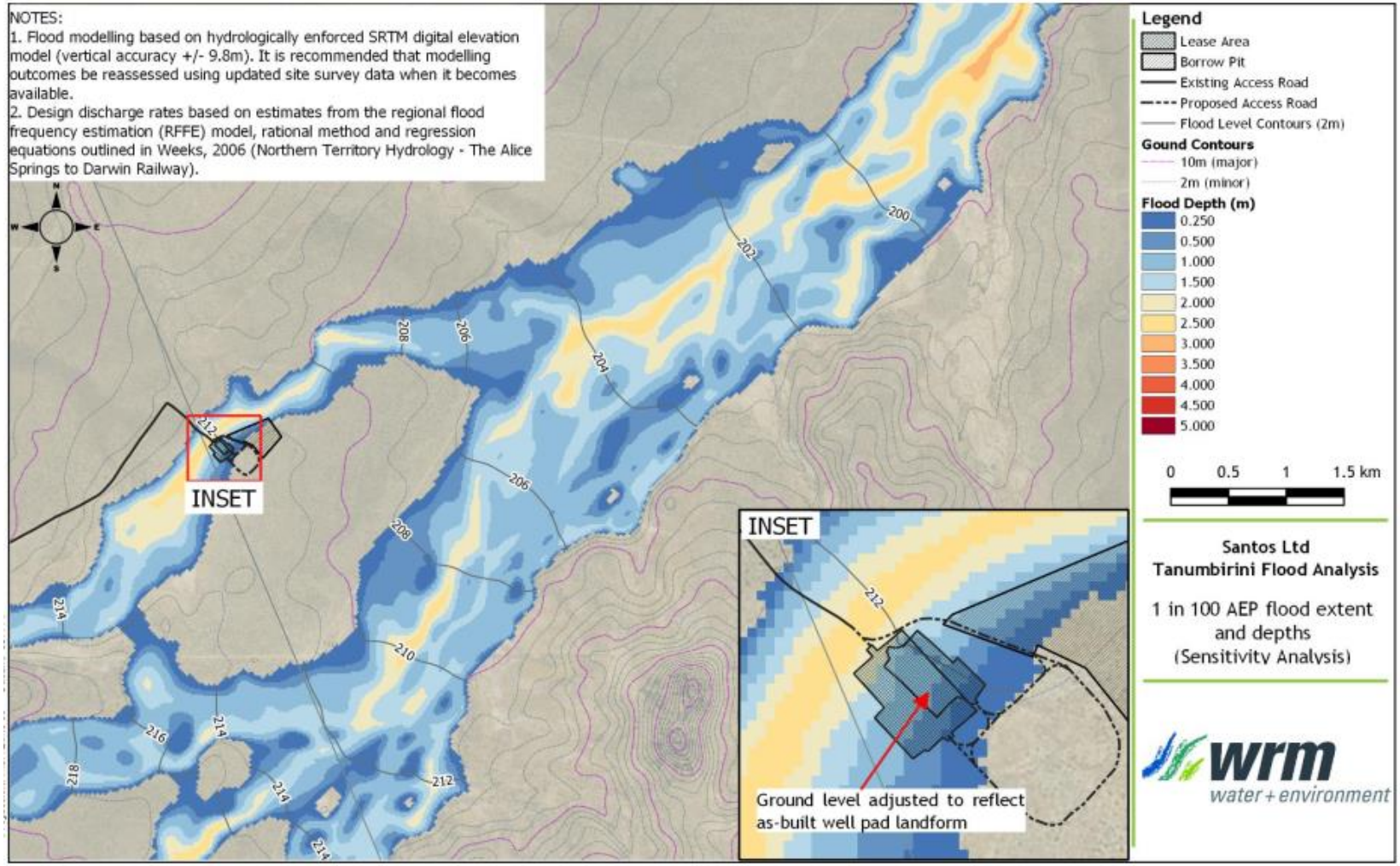


Figure 4-7 The 1 in 100 AEP flood extent at Tanumbirini 1/2H

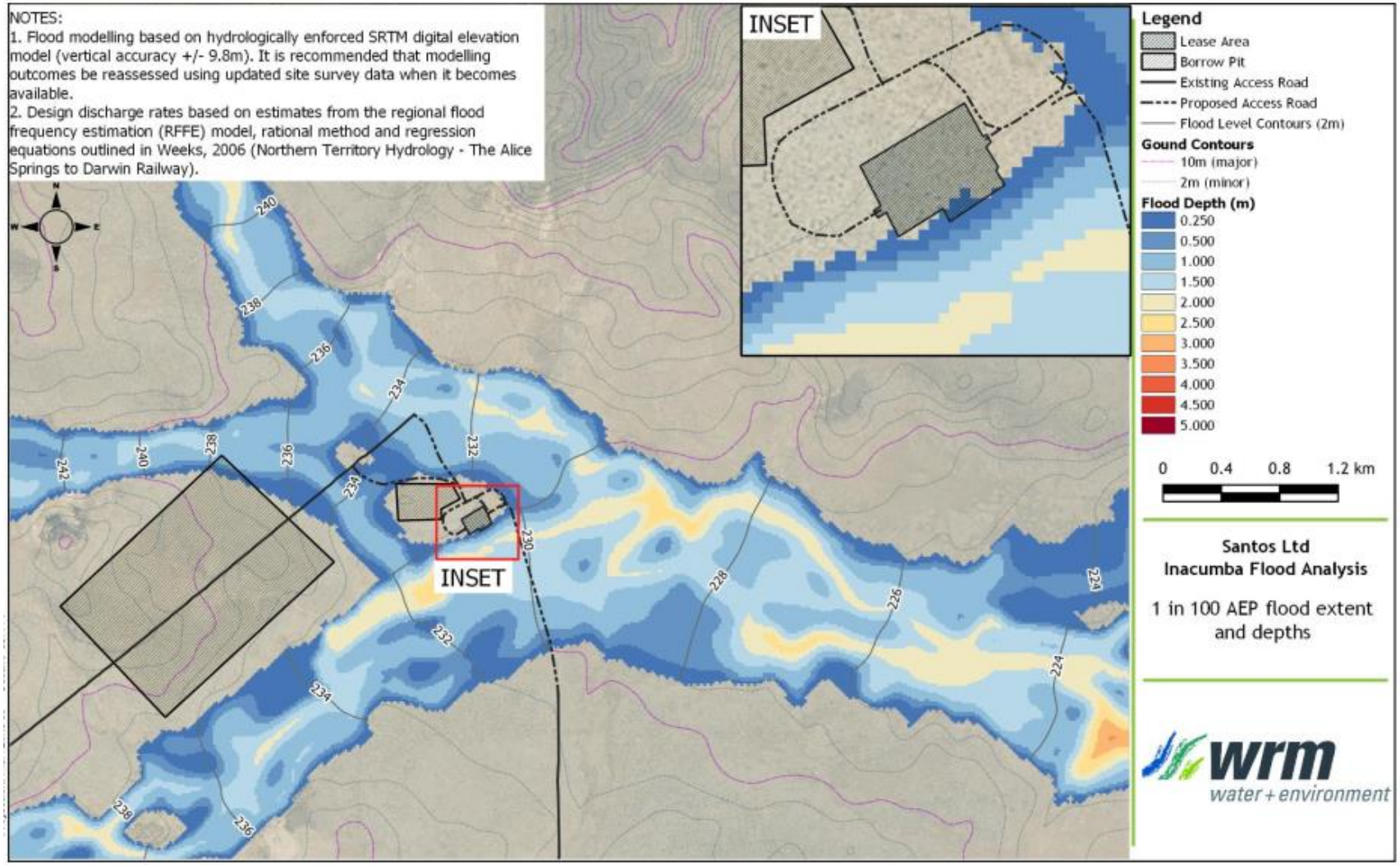


Figure 4-8 The 1 in 100 AEP flood extent at Inacumba 1/1H

4.2 Natural Environment

4.2.1 Bioregions

The Interim Biogeographic Regionalisation of Australia 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 4-9.

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.

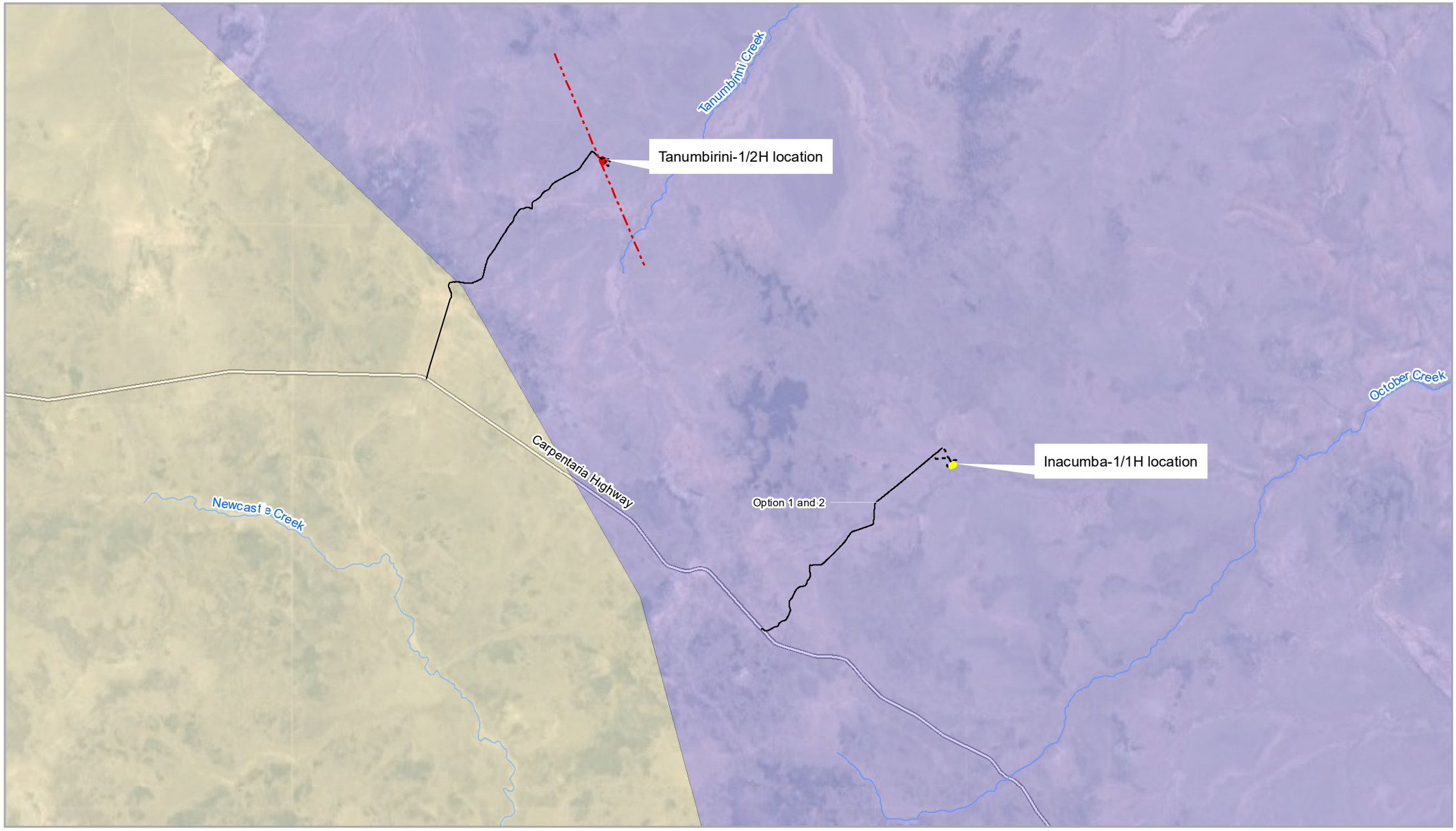
4.2.1.2 Sturt Plateau Bioregion

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 & 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 & 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

- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Lease

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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Project No. **43-22812**
Revision No. **B**
Date **28/03/2019**

Bioregions

FIGURE 4-9

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Print date: 28 Mar 2019 - 11:52

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: xlee

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 (DENR, 2000), as shown Figure 4-12.

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-1/2H 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 4.2.3). However, none of these habitat areas occur with the Tanumbirini 1/2H or Inacumba 1/1H locations.

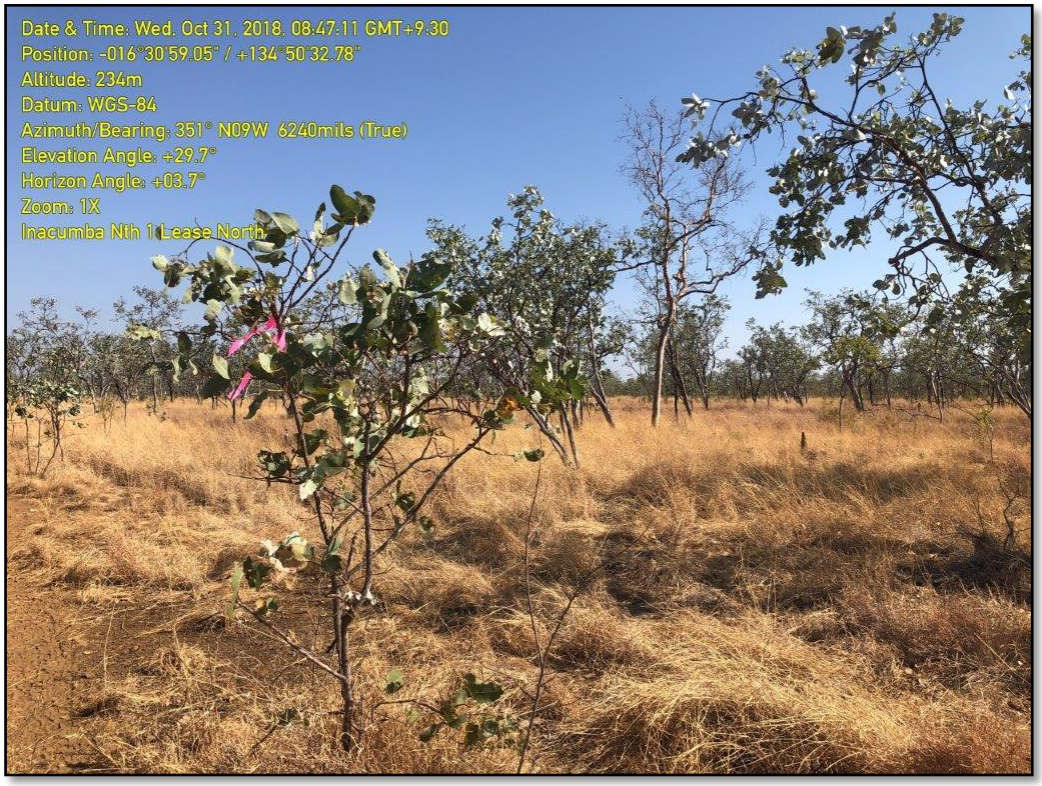
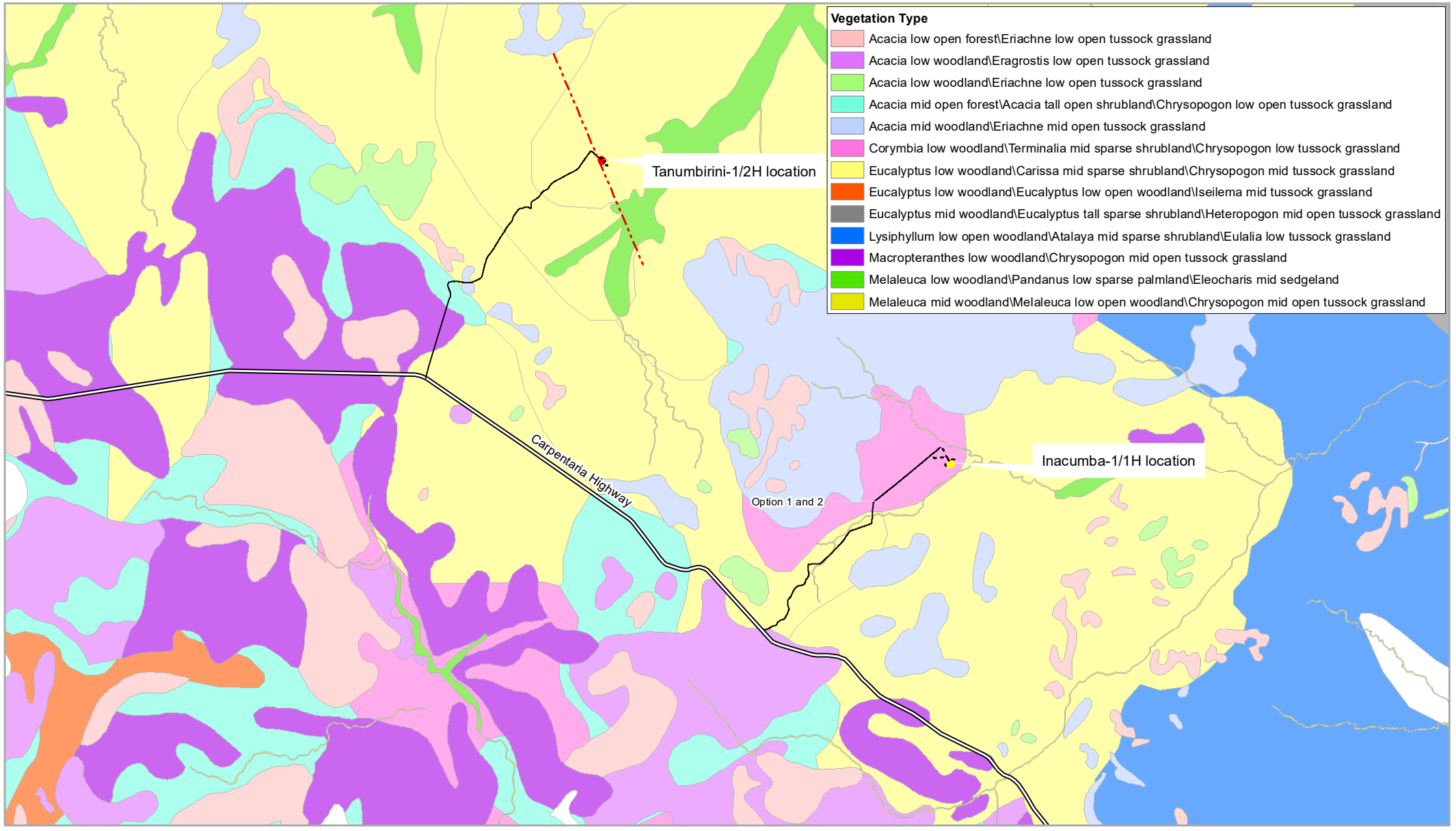


Figure 4-10 The Inacumba 1/1H location and the surrounding vegetation

Figure 4-11 Looking west towards the watercourse at the Tanumbirini 1/2H location



Legend

- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Lease

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 **28/03/2019**

Vegetation Types

FIGURE 4-12

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Print date: 28 Mar 2019 - 11:55

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

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 A). 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 Ecoz (2019) undertook a likelihood assessment as described in detail in Appendix C.

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 area
- **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 & 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 (DENR, 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 DENR as potentially occurring in the project area in comments received in the previous EMP submission for EP161.
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 DENR 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 A). 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

, and a likelihood assessment has been undertaken, utilising information from desktop and field studies undertaken on EP 161 (Ecoz 2017, 2018a, 2018b).

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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. (DENR, 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. (DENR, 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 A) 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. The weed surveys were focussed on the weed species that were already recorded on the property, shown Table 4-8. Potential weeds of concern within the Katherine Region, as shown in Table 4-9 are also considered in this survey.

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

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
	Neem	*Azadirachta indica*	B/C	
	Grader grass	*Themeda quadrivalvis*	B/C	Y
	Snake weed	*Stachytarpheta spp.*	B/C	

	Common name	Scientific name	NT Class	WoNS
	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	

The baseline weed survey (Ecoz 2019) recorded 48 occurrences of five declared weed species. The majority of weed species were found along the station access tracks, with no weed species being observed within the survey around the Inacumba well. The declared weed species that were found in the 5 km buffer of the Tanumbirini-2 well are shown in Table 4-10.

Table 4-10 Declared Weeds

Species	NT Declared Class	No. of records	Seeded
Hyptis (*Hyptis suaveolens*)	B/C	35	4 plants
Rubber Bush *(Calotropis procera*)	B/C	7	4 plants
Spinyhead sida (*Sida acuta)*	B/C	4	0
Sicklepod (*Senna obtusifolia*)	B/C	1	0

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 A and B). Pest animals identified in the project area include cane toads, cattle, sparrows, buffaloes, dogs, donkeys, cats, horses and pigs.

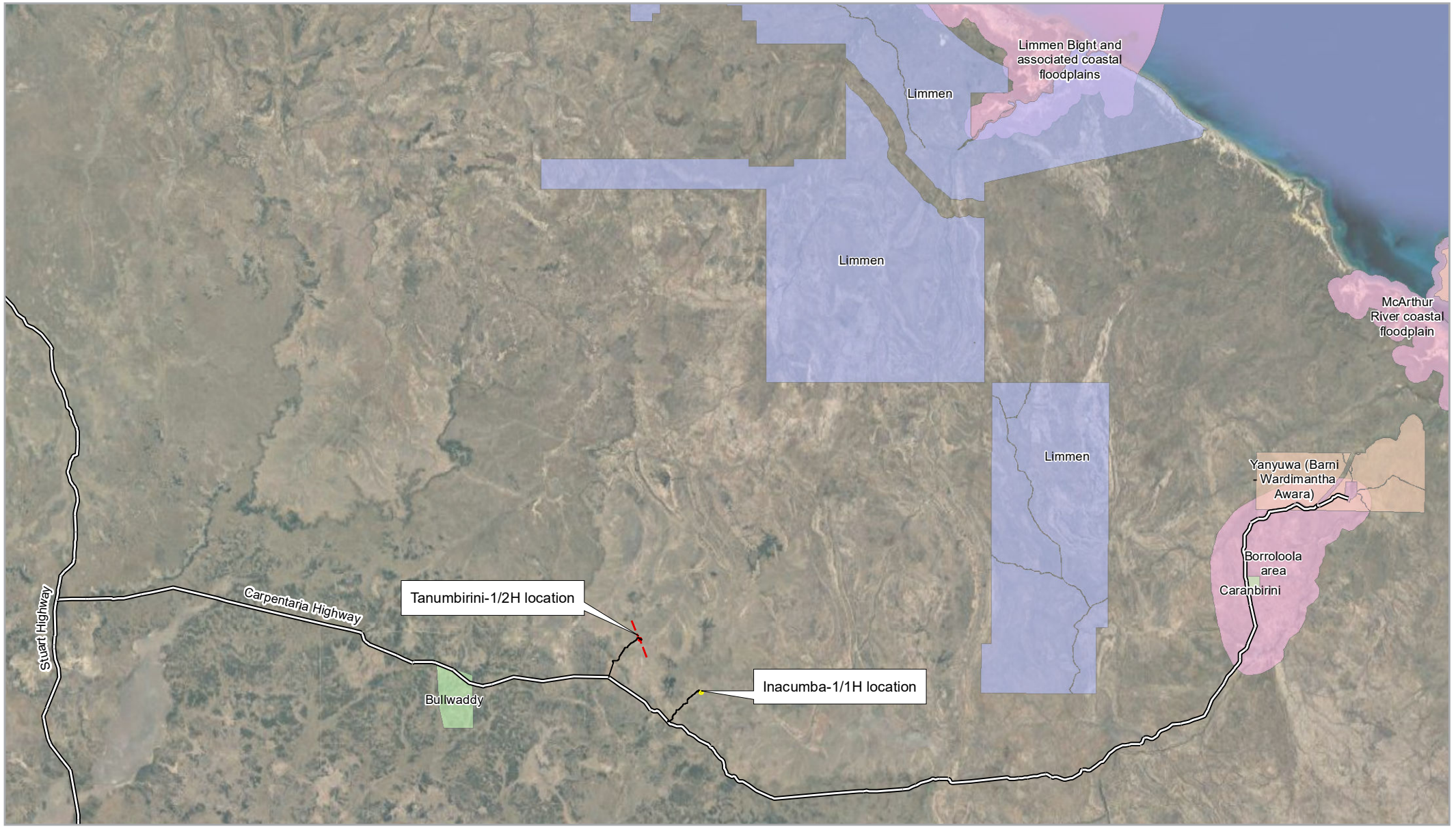
4.2.6 Protected Areas

There are no National Parks or conservation areas or Sites of Conservation significant near the project area. (Figure 4-13).

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

- 2D Seismic Line
- Existing Access Road
- Proposed Access Road
- Principal Road
- Inacumba Lease
- Tanumbirini Lease
- 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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Revision No. **B**
Date **28/03/2019**

Protected and Conservation Areas

FIGURE 4-13

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Print date: 28 Mar 2019 - 11:57

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: xlee

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.

Within the project area, riparian vegetation is the most likely sensitive vegetation to occur. Initial site visits by Ecoz in 2017, found that community was present in the vicinity of the project area associated with ephemeral watercourses. Ecoz (2019) found that not all the vegetation along these watercourses should be considered to be a sensitive vegetation community and vegetation along a watercourse can split in to two categories;

- Riparian vegetation (considered sensitive under the NT Clearing Guidelines)
- Drainage line vegetation (not considered sensitive vegetation under the NT Clearing Guidelines).

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 (DENR 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 C.

Riparian vegetation has been observed along the drainage lines within the Project Area. Ecoz (Appendix C) found that riparian vegetation forms a distinct community along the edge of the drainage lines in the vicinity of the proposed Inacumba-1/1H wells. Ecoz (Appendix C) also surveyed around the Tanumbirini-1/2H wells and found that although the vegetation along the watercourse comprised primarily a narrow strip of sparse *Eucalyptus camaldulensis.* This vegetation is located away from the Tanumbirini-1/2H wells.

4.2.8 Groundwater Dependent Ecosystems

A search of the National Groundwater Dependent ecosystems (GDE) Atlas (BoM 2018b) was conducted on 25 January 2018. 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 within the Project Area (BoM 2018b). 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 B) 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 to the east, south and west (NTG 2018a). Fire management is discussed in the Fire Management Plan provided in Section 7.3.

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.

An independent archaeologist was contracted by Santos to undertake a survey of the Project Area to determine the presence of archaeological artefacts or sites of significance within the Project Area. The key finding of the consultant report (attached in Appendix D) is that there are no sites of archaeological or heritage significance that will be impacted by the civil and seismic 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 *Sacred Sites Act* (NT) is considered through the process of an Authority Certificate from 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.

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 Program in early March 2019 (in addition to other relevant work program activity covered under other EMPs), and also facilitated consultation directly with Santos

4.3.4 AAPA

An AAPA Authority Certificate (Certificate C2018/105 – Variation to C2018/102, Reference: RA2018/108) was granted in 2018 to facilitate the development of the access track needed to construct the Inacumba North and Tanumbirini North water monitoring bores located within the project area of this EMP. Proposed works subject to AAPA Authority Certificate (Certificate C2018/105 – Variation to C2018/102, Reference: RA2018/108) includes upgrading and maintenance of approximately 33 km of vehicle) access tracks (within a 50 m wide corridor) providing vehicular access from the Carpentaria Highway. This AAPA certificate will be utilised for access options 1 and 2.

AAPA Authority Certificate C2014/053, Reference: 2013/2250 was granted in 2014 for the construction of up to 3 wells along with associated facilities and Vertical Source Profiling (VSP) seismic activities within EP 161. The areas covered by AAPA Authority Certificate C2014/053 include the Tanumbirini-1/2H and Inacumba-1/1H locations. However, although the existing Authority Certificate does allow for further exploration drilling and associated activities, all activity approvals requested under this EMP are proposed to be supported by an AAPA Authority Certificate application made in January 2019

(awarded on 13 May 2019 as Authority Certificate C2019/043, as a variation to C2014/053). AAPA has determined a variation to Authority Certificate C2014/053 is most appropriate to support the proposed 2019 work program.

The terms of conditions of the AAPA Authority certificates are incorporated into project planning.

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.

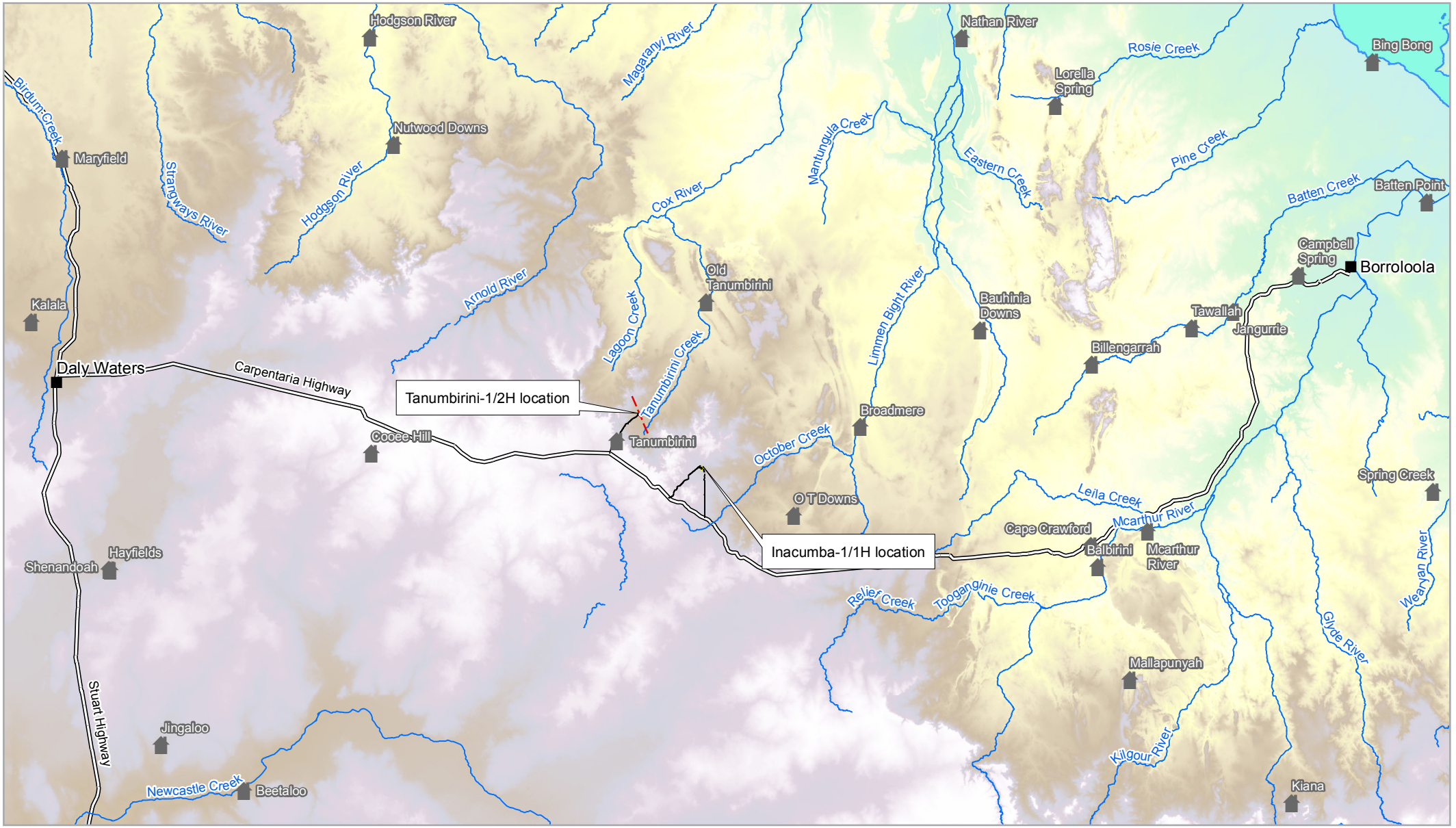
The Roper Gulf Regional Council covers an area of 186,000 km^2 and has a population of approximately 6,121. The Roper Gulf Regional Council includes 16 towns and communities of varying sizes, major roadhouses, 22 outstations and 50 pastoral properties.

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 4-14.



Legend

- Homestead
- Town
- 2D Seismic Line
- 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

N

GHD

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Project No. **43-22812**
Revision No. **A**
Date **8/02/2019**

Stations and Communities

FIGURE 4-14

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Print date: 08 Feb 2019 - 15:54

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 Assessment Act

Although the existing environment and the sensitive environmental values are discussed in detail above, sections 4.1 to 4.4 discusses the Environmental Values as defined under the *Environmental Assessment Act* and whether they may be affected by the proposed project.

In the existing environment, 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 Assessment Act*. The Environmental Factors (as described in (NT EPA 2018)) and corresponding Environmental Values for this proposed project are described in Table 4-11.

Table 4-11 Environmental Values and/or Sensitivities that may be affected by the project

Environmental Factors	Environmental Values and Sensitivities	Summary
Terrestrial Flora and Fauna	Sensitive or significant vegetation	Ecoz (2019) recorded riparian vegetation (a sensitive vegetation type) along the one of the drainage lines to the south of the Inacumba 1-1H location.
	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

Environmental Factors	Environmental Values and Sensitivities	Summary
Social, economic and cultural surroundings	Cultural heritage, sacred sites	An application for an AAPA Authority Certificate or Authority Certificate Variation 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 2019 Drilling Program have been appropriately surveyed and subsequently conditioned. The terms of conditions of the AAPA authority certificates are incorporated into project planning. No registered or recorded sacred sites are known to occur within the project area. Archaeological surveying for artefacts or sites of archaeological significance was completed by an independent consultant to support this EMP (report attached in Appendix D)
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-2 Well.

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 4-11 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 'Guidance on Risk Related Decision Making' (OGUK, 2014) (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.

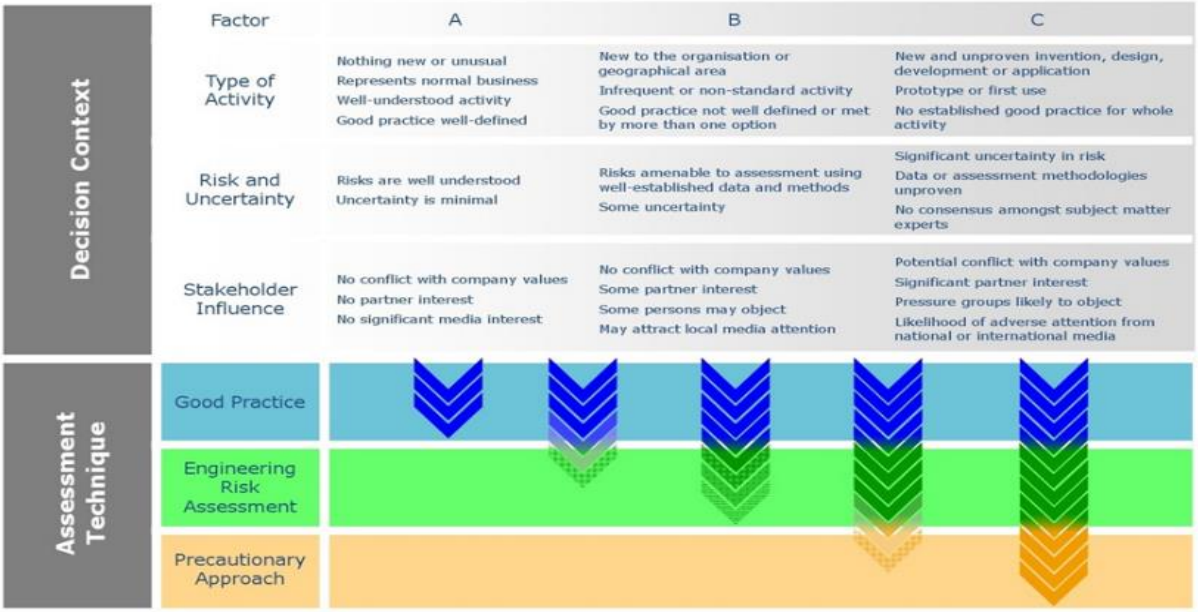

Figure 5-1 Impact and Risk 'Uncertainty" Decision-Making Framework

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 Risk Matrix

Level		Criteria
Almost Certain	f	Occurs in almost all circumstances or could occur within days to weeks

Level		Criteria
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 (Add additional Business Unit specific requirements where required)
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

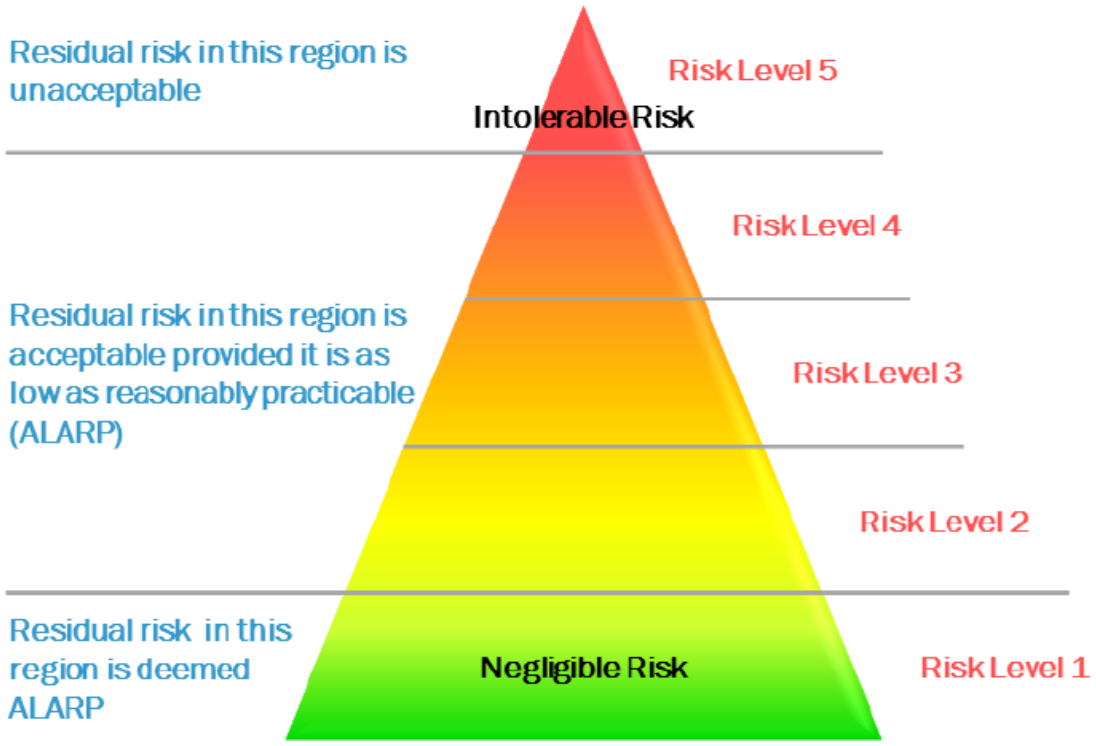

Figure 5-2 Santos Residual Risk Acceptance Model

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	Uncertainty ranking
Physical disturbance including clearing and vehicle and plant movements	Loss or disturbance to native vegetation	Terrestrial Flora and fauna	Planned clearing Loss of habitat impacts on flora and fauna	2	Majority of the project area preferentially located in previously disturbed areas. Where possible, existing tracks, roads or seismic lines will be used for access. Site selection surveys to be undertaken prior to on-ground disturbance. Mature trees selected for preservation are to be flagged to ensure their protection. Cleared vegetation will be either stockpiled and respread during rehabilitation or mulched and spread as a sediment control technique to reduce erosion. Along the seismic lines, if light grading is necessary, flora rootstock will be left intact to promote regeneration. Hollow timber/trees that may be nesting/roosting sites for fauna will not be cleared. Where possible branches will be pruned in preference to total tree removal.	2	A
Physical disturbance including clearing and vehicle and plant movements	Disruption of natural drainage lines	Hydrological processes	Alteration of drainage contours through clearing processes	2	All major creek crossings and floodways intersected by the access tracks will be subject to 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.	2	A
Physical disturbance including clearing and vehicle and plant movements	Disturbance to soil	Terrestrial Environmental Quality	Compaction of soils due to vehicle and equipment movement Erosion of soil due to loss of vegetative cover	2	The project area, including access tracks have been preferentially located in previously disturbed areas. Existing, landholder access tracks have been utilised where possible to minimise soil compaction. Grading will be minimised where feasible. Along the seismic lines, if light grading is necessary, flora rootstock will be left intact to promote regeneration. An Erosion and Sediment Control Plan (ESCP) has been developed by a Certified Professional in Erosion and Sediment Control (CPESC) in accordance with the guideline Best Practice Erosion and Sediment Control (IECA 2008).	2	A
Physical disturbance including clearing and vehicle and plant movements	Damage to culturally sensitive sites	Social, Economic and Cultural Surroundings	Removal of vegetation exposing cultural sensitive site	2	Disturbance restricted to subject land and avoids the restricted work areas as detailed in the AAPA Authority Certificate. Known sites of sacred or cultural significance are identified and avoided. Any new sites identified during the activity will be reported to the NT Heritage Branch. Maintain GIS database of project area and cultural heritage sites including details of any works conditions.	2	A
Groundwater extraction	Reduction in groundwater quantity	Hydrological Processes	Use of groundwater for project activities	1	A groundwater extraction licence will be sough prior to the project commencing	1	A
Groundwater extraction	Reduction in groundwater available for other users	Social, Economic and Cultural Surroundings	Use of groundwater for project activities	2	A groundwater extraction licence will be sough prior to the project commencing	1	A
Creation of dust	Smothering of flora	Terrestrial Flora and fauna	Clearing and vehicle and plant movements creating dust	3	For the seismic line blade work will not be undertaken on naturally smooth surfaces or flat easy terrain. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Water trucks will be used, to manage dust emissions from vehicle movement and civil operations on the site.	1	A

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial risk ranking	Mitigation and Management Measures	Residual Risk Ranking	Uncertainty ranking
Creation of dust	Loss of amenity	Social, Economic and Cultural Surroundings	Clearing and vehicle and plant movements creating dust	2	For the seismic line, blade work will not be undertaken on naturally smooth surfaces or flat easy terrain. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Duration of activities limited to approximately 20 weeks Water trucks will be used to manage dust emissions from vehicle movement and civil operations on the site.	1	A
Creation of dust	Public ingesting dust	Human health	Clearing and vehicle and plant movements creating dust	2	Blade work will not be undertaken on naturally smooth surfaces or flat easy terrain for the seismic lines. Minimal blade work is permitted elsewhere for access. Driving is only permitted on designated access and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Water trucks will be used, to manage dust emissions from vehicle movement and civil operations on the site.	1	A
Creation of atmospheric emissions	Reduction in air quality	Air Quality and Greenhouse Gas	Vehicle and plant movements creating air emissions	2	Vehicles and fixed plant maintained as per maintenance schedule. Vehicles compliant with Northern Territory Motor Vehicle registry regulation and work health and safety regulations.	1	A
Noise and vibration from project activities	Disturbance to native fauna	Terrestrial Flora and Fauna	Vehicle movements and seismic equipment generating noise and vibration	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices.	1	A
Noise and vibration from project activities	Disturbance to landholders	Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment generating noise and vibration	2	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices. Noise complaints from vehicle movements and drilling activities minimised through active stakeholder engagement and complaints management through CLC	1	A
Light from project activities	Disturbance to native fauna	Terrestrial Flora and Fauna	Vehicle movements and seismic equipment generating light at night. Lighting from camp.	2	All boundary lighting for the camp will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill."	1	A
Light from project activities	Disturbance to landholders	Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment generating light at night. Lighting from camp.	2	All boundary lighting will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill.	1	A
Fauna interaction	Disturbance, injury or death to terrestrial fauna	Terrestrial Flora and Fauna	Vehicle movements and seismic equipment at night and entrapment in open pits	2	Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Driving is only permitted on designated access roads and seismic lines. Pits and dams will be fenced Daily checks of pits and dams once constructed Borrow pit excavations will be backfilled with overburden once borrow removal has been completed. .	1	A
Fauna interaction with mobile plant and vehicles	Disturbance, injury or death to livestock	Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment at night.	2	Relevant landowners and occupiers are notified prior to activity of preparation of camp sites, preparation of survey lines and undertaking of operations. 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 – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines.	1	A

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial risk ranking	Mitigation and Management Measures	Residual Risk Ranking	Uncertainty ranking
Introduction of pest species	Loss of native vegetation through competition for resources	Terrestrial Flora and Fauna	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through clearing and vehicle movements.	4	Prior to approval and commencement a Weed Management Plan for the project will be approved by DENR	2	A
Introduction of pest species	Loss of pasture species through competition for resources	Social, Economic and Cultural Surroundings	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through clearing and vehicle movements.	2	Prior to approval and commencement a Weed Management Plan for the project will be approved by DENR.	1	A
Fire	Disturbance or death to terrestrial fauna, loss of terrestrial flora	Terrestrial Flora and Fauna	Ignition sources from plant and machinery. Inappropriate disposal of cigarettes.	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. Compliance with the Fire Management Plan	1	A
Fire	Injury or death to livestock, loss of pasture, dwellings and infrastructure	Social, Economic and Cultural Surroundings	Ignition sources from plant and machinery. Inappropriate disposal of cigarettes.	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. Prior to conducting a controlled burn during a Fire Danger Period, a permit to burn will be obtained from Bushfires NT. Compliance with the Fire Management Plan	1	A

Risk Event	Potential Impact	Relevant Environmental Factor	Risk Source	Initial risk ranking	Mitigation and Management Measures	Residual Risk Ranking	Uncertainty ranking
Disturbance to landholder/public	Disturbance to landholders activities	Social, Economic and Cultural Surroundings	Vehicle and plant movements throughout the project area	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 – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Seismic sources are not to operate within the distance defined by Santos standards, of any pipeline, utility, installation or building. No camps to be established less than 1 km from the Power Water Corporation (PWC) groundwater bores.	1	A
Chemical spills and leaks	Impact to soil quality	Terrestrial Environmental Quality	Inappropriate storage or handling of hazardous substances Poor refuelling or fuel transfer practices	2	Spill kits available to treat spills in-situ. Minimise fuel transfer where possible. Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940. Compliance with the Spill Management Plan	1	A
Chemical spills and leaks	Reduction in surface water and groundwater quality	Inland Water Environmental Quality	Inappropriate storage or handling of hazardous substances Poor refuelling or fuel transfer practices	2	Spill kits available to treat spills in-situ. Minimise fuel transfer where possible. Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940. Compliance with the Spill Management Plan	1	A
Waste	Fauna attracted to waste	Terrestrial flora and fauna	Waste stored inappropriately attracting native fauna	2	Waste will be segregated and stored on site and all putrescible waste material will be held in fauna proof containers. Other than waste from approved wastewater systems and grey water there will be no disposal of waste to the natural environment. Licenced waste contractor will be used for any offsite transfer or disposal. Compliance with the Wastewater Management Plan	1	A

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.

6.2 Referrals to DoEE and NT EPA

6.2.1 Significant Impact test for EPBC listed species

As discussed in section 2.4, referral of the project to the Department of Environment and Energy is required if the proposed action will have, or is likely to have a significant impact on MNES.

In section 4.2.3, three listed threatened species were identified as having a medium chance of occurring. The potential for significant impacts to occur to these species are discussed in Table 6-2.

Table 6-2 Significant Impact Test for Listed Species

Common Name	Scientific Name	Comments
Gouldian Finch	*Erythrura gouldiae*	The Gouldian Finch has specific habitat requirements, nesting in rocky hills that support the preferred nesting trees e.g. *Eucalytus leucophloaia* (Snappy gum) and being located between two and four km from permanent water. Ecoz (2018b and 2018c). Surveys were conducted in 2018. No threatened species were observed during surveys. Snappy Gum habitat trees were found at the proposed Inacumba- 1 well site and small patches were found along the proposed seismic line. The patches observed were typical open-woodland to woodland vegetation communities. However, the number of hollows present within the Snappy Gums at site are low and the observed patches do not present optimal

Common Name	Scientific Name	Comments
		habitat for the Gouldian Finch. It is considered unlikely that the species utilises this area for nesting. (Ecoz 2018c). It is unlikely that the proposed seismic and civil program would have a significant impact on this species or its habitat.
Grey Falcon	*Falco hypoleucos*	These species have broad ranges and utilise woodland habitat that is common to the region (Ecoz 2017). It is unlikely that the proposed seismic and civil program would have any significant impact on these species or their habitat.
Crested Shrike-tit	*Falcunculus frontatus whitei*	

The project will not be referred to the Department of Environment and Energy. The proposed action will not have a significant impact on any MNES.

6.2.2 Significant impact test for Environmental Assessments Act

As discussed in section 2.4.2, 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 proposal to the NT EPA: A guide for proponents and referral agencies' (NT EPA 2018), a detailed review of and assessment against each prescribed Environmental Objectives for each Environmental Factor was conducted in relation to the proposed civil and seismic program and is included in

Table 6-3. The results of the assessment in in Table 6-3 clearly demonstrate that the proposed petroleum activities that could not reasonably be considered to be capable of having a significant effect on the environment.

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Table 6-3 Assessment against the Environmental Assessments Act's Environmental Objectives and Environmental Factor

Theme	Environmental Factor	Environmental Objective	Relevance to the application
Land	Terrestrial Flora and Fauna	Protect NT's flora and fauna so that biological diversity and ecological integrity are maintained.	The proposed activities are likely to result in only minor localised impacts to non-sensitive vegetation, and have the potential to result in only localised impacts to native fauna through planned physical disturbance, noise; unplanned fauna interactions, weeds, light, fire, and waste. 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	Maintain the quality of the land and soils so that environmental values are protected.	The proposed activities are likely to result in only minor localised impacts to the land and soils, erosion, compaction and spills and leaks. 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 so that environmental values are protected.	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. However, the project area is not located with any areas of distinctive physical landforms. Given the nature (relatively small scale) and location (primarily in areas of existing disturbance) of the proposed activities, and the implementation of the mitigation measures outlined in Table 6-1, it is unlikely the distinct physical landforms within these two bioregions will be impacted. Accordingly, there would be no potential for a significant effect on landforms.
Water	Aquatic Ecosystems	Protect aquatic ecosystems to maintain the biological diversity of flora and fauna and the ecological functions they perform.	It is unlikely aquatic ecosystems will be impacted by the purposed activities, given that no sensitive vegetation will be disturbed, the area of disturbance is relatively small scale, 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.

Theme	Environmental Factor	Environmental Objective	Relevance to the application
Water	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 chemical leaks 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 inland water environmental quality.
Water	Hydrological Processes	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	It is unlikely hydrological regimes of groundwater or surface waters will be altered by the proposed activities, given that the area already has a low level of vegetation coverage (unlikely to change recharge water rates and volumes), the small area of planned disturbance and regulation and reporting on groundwater extraction associated with the project. 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 processes.
Sea	Marine Flora and Fauna	Protect marine flora and fauna so that biological diversity and ecological integrity are maintained.	The proposed activities are not located within, or in proximity to, a marine or coastal environment. Accordingly, there will be no potential for a significant effect on marine flora and fauna.
Sea	Benthic Communities and Habitats	Protect benthic communities and habitats so that biological and functional diversity and ecological integrity are maintained.	The proposed activities are not located within or in proximity to a marine or coastal environment. Accordingly, there will be no potential for a significant effect on benthic communities and habitats.
Sea	Marine Environmental Quality	Maintain the quality and productivity of water, sediment and biota so that environmental values are protected.	The proposed activities are not located within or in proximity to a marine or coastal environment. Accordingly, there will be no potential for a significant effect on marine environmental quality.

Theme	Environmental Factor	Environmental Objective	Relevance to the application
Sea	Coastal Processes	Maintain the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are protected.	The proposed activities are not located within or in proximity to a marine or coastal environment. Accordingly, there will be no potential for a significant effect on coastal processes.
Air	Air Quality and Greenhouse Gases	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.
People and Communities	Social, Economic and Cultural Surroundings	Protect the rich social, economic, cultural and heritage values of the Northern Territory.	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. Given this, and the relatively small nature of operations and proposed actual ground disturbance, the proposed activities will maintain the social, economic, cultural and heritage values of the Northern Territory.
People and Communities	Human Health	Ensure that the risks to human health are identified, understood and adequately avoided and/or mitigated.	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 Erosion and Sediment Control Plan

The Code requires an Erosion and Sediment Control Plan (ESCP) (being the Primary ESCP) for the activities to be developed by a suitably qualified person in accordance with relevant guidelines including specific environmental outcomes and environmental performance standards included in the Implementation Strategy in the EMP. Where the Primary ESCP requires it, a further ESCP (being the Secondary ESCP) must be developed by a suitably qualified person in relation to the relevant matters and implemented by the interest holder.

A primary ESCP has been developed by a Certified Professional in Erosion and Sediment Control (CPESC) in accordance with the guideline Best Practice Erosion and Sediment Control (IECA 2008) and in consultation with DENR. In addition, this ESCP includes consideration of the requirements of the Land Clearing Guidelines as published on the DENR website.

The project specific ESCP is provided in Appendix E.

7.2 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* (DENR 2019). The Weed Management Plan is provided in Appendix F.

7.3 Fire Management Plan

7.3.1 Baseline Fire Information

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

7.3.1.1 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 1/2H location and the Inacumba 1/1H location is shown Figure 7-1.

The location immediately surrounding the Tanumbirini 1/2H location and most of the access track appears to have been burnt zero or one time between 2000 and 2018. The Inacumba 1/1H location and most of the access track appears to have been burnt three or four times between 2000 and 2018.

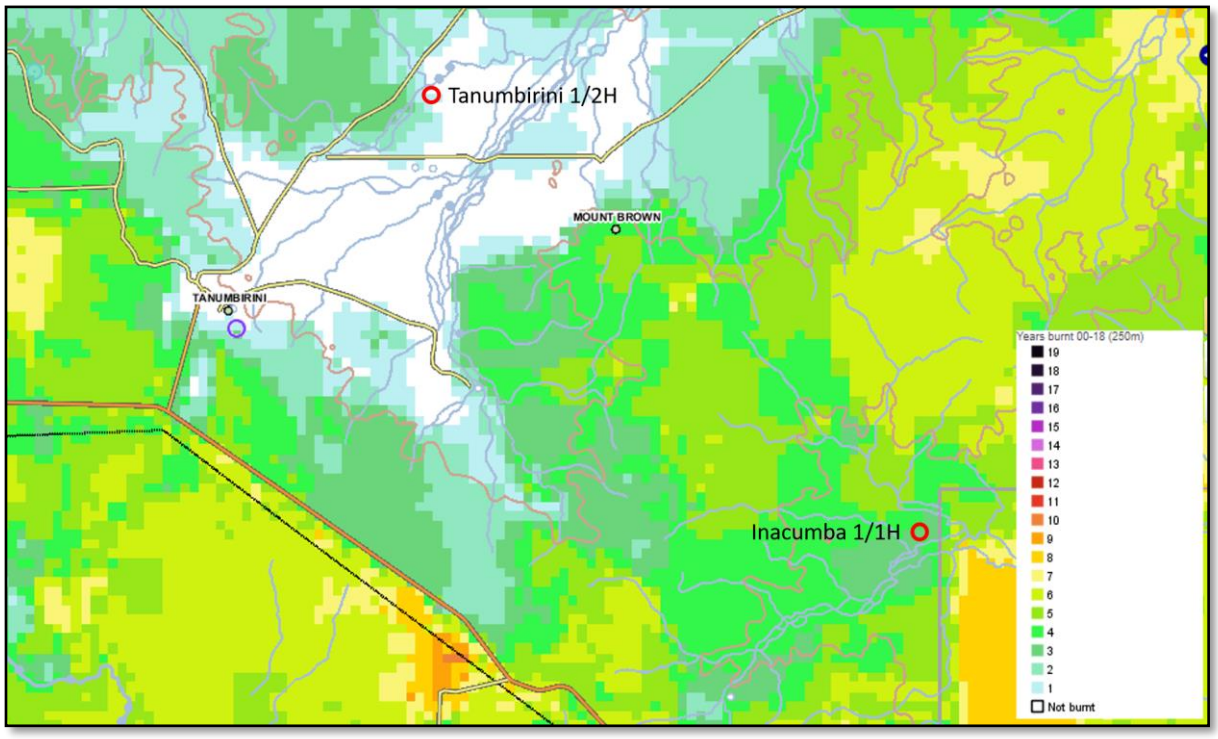

Figure 7-1 Fire frequency between 2000 and 2018 at Tanumbirini 1/2H and Inacumba 1/1H

7.3.1.2 Last Burn

Generally the most recent fires have occurred west and east of Tanumbirini 1/2H and Inacumba 1/1H 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 1/2H location and the Inacumba 1/1H location is shown in Figure 7-2.

The Tanumbirini 1/2H location was last burnt in 2006 and the vegetation adjacent to the access track has had been subject to fires in up to six different years. A large area in the central sections of the access track has had no burning since 2000. The Inacumba 1/1H location and most of the access track was last burnt in 2012.

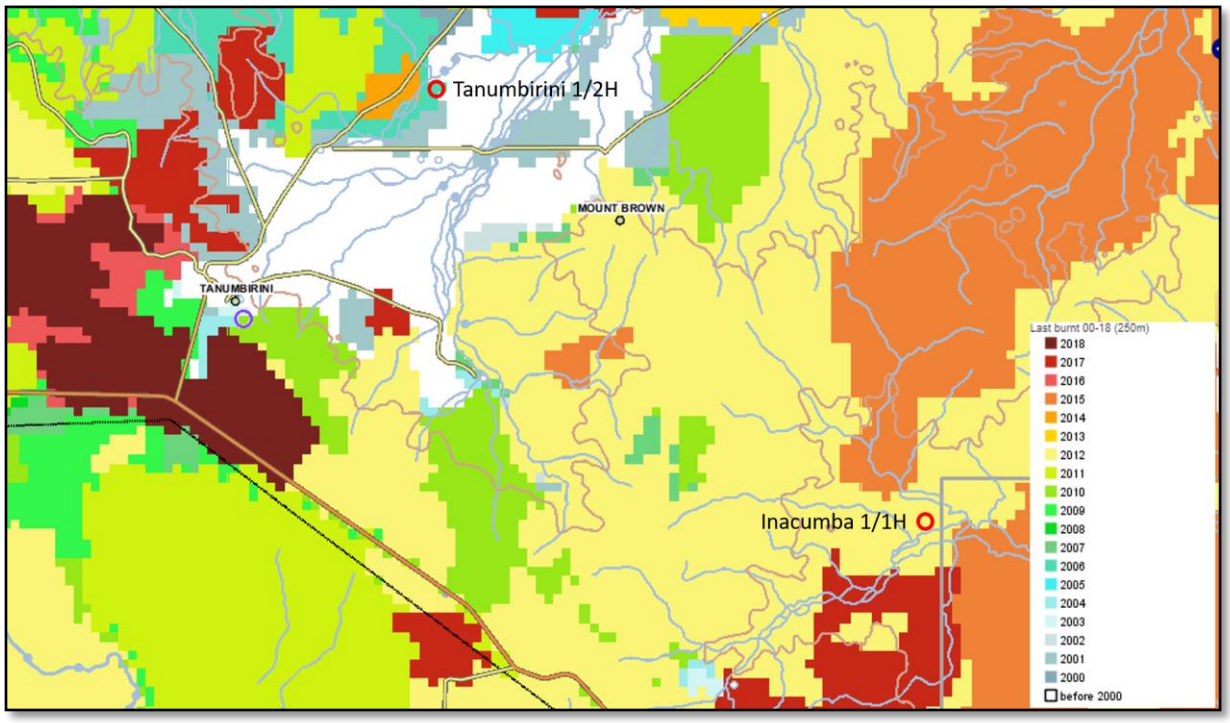

Figure 7-2 The year of last burn between 2000 and 2018 at Tanumbirini 1/2H and the Inacumba 1/1H

7.3.2 Fire management

7.3.2.1 Impacts of the proposed activities on the existing fire management

The small size of the development footprint will ensure there will be no impacts on existing fire management.

7.3.2.2 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 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.

7.3.2.3 Fire Mitigation Measures

The Central Piece of fire mitigation for the project is the implementation of a Fire Control Zone surrounding the Inacumba 1/1H location and the Tanumbirini 1/2H location (See EMP Figure 3.2 and Figure 3.3). 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.

The fire control zones will be cleared of vegetation and maintained to ensure no fire encroachment during project activities.

The access to the Inacumba 1/1H location and the Tanumbirini 1/2H 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.

7.3.3 Annual Fire Mapping

The proposed works are expected to commence and finalise in 2019. 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 DENR.

7.4 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 exploration works associated with the works described in 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.

7.4.1 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 works described in this EMP are part of an exploration program with uncertainty on reservoir outcome. The timing of progressive rehabilitation will depend on exploration outcomes and the potential for reservoir development and production.

7.4.2 Final land use and Rehabilitation goals

7.4.2.1 Seismic Activities

Whilst most of the areas will naturally regenerate following restoration works, there is the possibility that specific areas (sensitive areas or areas subject to erosion) may need additional rehabilitation following the first wet-season. Areas identified in post-survey photo point monitoring, or by subsequent landholder liaison, as requiring additional rehabilitation works will be re-visited and rehabilitated accordingly.

7.4.2.2 Civil Works

Unless the landholder requests infrastructure to remain in place all surface infrastructure will be removed and rehabilitated. Rehabilitation activities will only allow a landholder to acquire certain infrastructure types. If the landholder does request infrastructure to remain in place, the proposed infrastructure must be signed off with both the Pastoral Land Board and DPIR. Otherwise, the following activities will be undertaken:

- Removal of fencing
- Cuttings pits to be levelled off, mixed with dry stockpiled fill material and capped with at least 750 mm of dry stockpiled fill material;
- Water bore holding ponds to be drained of liquids and levelled out
- Lightly scarifying or rolling all disturbed areas to break up consolidated surfaces
- Re-shaping the landform to blend the pad areas with the surrounding area with deep ripping to ensure the heavily compacted pad is suitable for vegetation establishment
- Spreading of stockpiled topsoil material and trees, shrubs and grasses across the leasepad and areas not needed for future monitoring and maintenance.
- Ripping and spreading of stockpiled vegetation at the water bore site to promote revegetation
- Removal of fencing and water bore pumps from water bores. Any reusable materials and pumps to be delivered to the landholder
- Repair or reinstate any landholder infrastructure damaged due to civil activities.

Following completion of the rehabilitation works, final photo point revisit and any required additional rehabilitation, Santos will submit the final Environmental Reports to DPIR and DENR 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.

7.4.3 Monitoring and maintenance program

Photo points will be established. 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 program of works is completed. 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.

7.5 Wastewater Management Plan

An EMP for a petroleum activity must include a wastewater management plan (WWMP). This WWMP assesses all water and wastewater management activities which are proposed including:

1. “waste material” and material containing “contaminants” as defined in s 117AAB of the Petroleum Act 1984 (NT)
2. Wastewater meeting the definition of waste under the Waste Management and Pollution Control Act 1998 (NT)
3. Water that has been acquired or used in petroleum activities that is being disposed of

7.5.1 Wastewater management framework

This WWMP comprises a component of a wastewater management framework.

1. Estimate the quantities and quality of water and wastewater from the petroleum activity
2. Define the methods and approaches that will be used to store, treat, and reuse water and ultimately dispose of wastewater, including what activities will be undertaken at the site of the approved petroleum activity
3. Estimate the quantities and quality of wastewater, or wastewater derived solids, that will be removed from the petroleum site
4. Provide for the relevant activities and the environmental risks and environmental impacts they involve in a wastewater management plan (WWMP)

7.5.2 Waste management hierarchy

This WWMP has been developed in consideration of the waste management hierarchy outlined in the National Waste Policy, 2018. Where practical, waste and wastewater management activities are designed to sequentially and preferentially avoid, reduce, reuse, recycle and treat before disposing of waste and wastewater. This is described in Section 7.5.6.

7.5.3 Management

7.5.3.1 Activity description

This section contains a description of the activities that will generate waste and wastewater that is proposed to be handled, stored or transported away from the area in which the activity is approved to be carried out

Activities that will generate waste are summarised in Table 7-1 and described in the following sections.

Table 7-1 Waste generating activities

Activity waste source	Waste Type
Domestic activity (camp and offices)	Putrescible and municipal waste
	Recyclables (glass and cans)
	Grey water (laundry, showers, sink wastes, etc.)
	Treated sewage effluent
	Toilet waste (port-a-loos)
Activities ancillary to civils and seismic	Cardboard packaging materials
	Scrap metals
	Used fuel drums
	Timber pallets (skids)
	Vehicle tyres
	Oily rags, filters

7.5.3.2 Domestic activities

Sewage management practices at all camps will consist of the use of port-a-loos and a fully self-contained sewage treatment plant (STP). Sewage from port-a-loos will be transported offsite by a waste management contractor.

The STP will be furnished with an irrigation sprinkler system to manage sewage and grey water wastes. All waste water will be disposed of in accordance with the Public and Environmental Health Regulation 2018. Discharge from the camp will be treated to achieve the specifications provided in the Northern Territory's Code of Practice for On-site Wastewater Management. Treated effluent will be sprayed 50-100m away from the camp location to the surrounding environment, at a location will be well away from any place from which it is reasonably likely to enter any waters, and to minimise spray drift and ponding. Fencing will be installed around the irrigation area.

Wastepaper, cardboard and food scraps are disposed of into sealed bins set up adjacent to the camp area. The sealed bins will be transported for disposal of waste to a licensed landfill. Recyclable materials will be managed on site and transported to an approved local waste depot facility (likely in Katherine or Darwin).

7.5.3.3 Activities ancillary to civils and seismic

All waste streams from ancillary activities will be collected and stored on site. Waste will be transported for disposal or recycling as described in Section 7.5.4.

7.5.3.4 Waste characteristics

This section characterises the anticipated wastewater streams that will be generated, including chemical characteristics and volumes of each.

Table 7-2 provides a summary of the anticipated waste characteristics.

Table 7-2 Anticipated waste characteristics

Waste	Estimated volume	Chemical characteristic	Management method
Domestic waste – putrescible, municipal and recyclable	Less than 200m^3	Potentially hazardous to non-hazardous	Designated collection bins with transport off-site by licensed contractor
Domestic wastewater – grey water and treated sewage effluent	Less than 720m^3	Non-hazardous	Reticulated collection, on-site treatment and disposal via irrigation
Domestic wastewater – grey water	Less than 400m^3	Non-hazardous	Reticulated collection, on-site treatment and disposal via irrigation
Domestic wastewater – port-a-loo toilets	Less than 100m^3	Potentially hazardous	Collection and storage on-site, disposal off-site by licensed contractor
Ancillary activities to civils and seismic	Less than 100m^3	Hazardous to non-hazardous	Collection and storage on-site, and transport off-site by licensed contractor

7.5.4 Rainfall characteristics

This section contains estimates for the 1 in 1000 average recurrence interval (ARI) for rainfall for the duration of activities, along with the means used for their estimation.

Annual recurrence interval (ARI) is assumed to be equivalent to annual exceedance probability (AEP). The 1 in 1000 year annual recurrence interval (ARI) for rainfall over a 3-month period in the wet and the dry season at the location of the proposed petroleum activities is provided in Table 7-3 below. Operations will occur outside the wet season.

Table 7-3 The 1 in 1000 (0.1%) year AEP for rainfall (in mm) at the location of the proposed petroleum activities

0.1% AEP Rainfall	Wet season (mm)	Dry season (mm)
7-day	682	-
90-day	1,448	321

7.5.5 Waste management methods and locations

This section contains a proposed method and location of water and wastewater storage, transportation, treatment disposal and re-use as part of the proposed activity, with reference to any requirements mandated by the COP.

7.5.5.1 Proposed methods

A broad overview of the waste management methods are described in Section 7.5.3.1. Disposal options have taken into account the results of a risk assessment (see Section 7.5.7).

Control measures will be implemented to minimise interactions of all stored waste with wildlife, stock and human receptors. Controls measures will comprise fencing, signage and fauna-proof containment as necessary.

Table 7-4 Waste generating activities and management methods

Activity waste source	Waste type	Management and disposal method
Domestic activity (camp and offices)	Grey water (laundry, showers, sink wastes, etc.) and treated sewage effluent	Captured and piped to a treatment system that meet the NT Code of Practice for Small On-site Sewage, then piped to an irrigation area.
	Toilet waste (port-a-loos)	Toilet waste will be captured and transported offsite for recycling or disposal.
	Oily rags, filters	Collected in suitable containers for disposal at licenced landfill

Should the proposed and certified disposal method not be approved by DENR/DPIR, then it may be disposed of at a licenced facility (see Table 7-5).

7.5.5.2 Proposed locations

The EMP for the proposed activities provides a layout of the proposed infrastructure for each well site (refer to Figure 3-3 and Figure 3-6 of the EMP). These layouts show waste storage locations as follows:

- Campsite – which will be the area that the grey water is reticulated and all other camp wastes are stored
- Laydown area – which will be the area that waste from activities ancillary to civils and seismic words will be stored
- Water tank pads – these are engineered pads constructed to support above ground fluid storage tanks. However the construction and operation of these tanks is not included as part of the proposed petroleum activity related to this WWMP.

Proposed waste disposal locations are provided in Table 7-5.

Table 7-5 Waste Types and Waste Disposal Locations

Type of Waste	Disposal Location
General and food	Katherine or Darwin, NT
Empty IBCs	Katherine or Darwin, NT

Metal and plastic drums	Katherine or Darwin, NT
Waste material	Katherine or Darwin, NT
Batteries and tyres	Katherine or Darwin, NT
Listed Waste	Any waste prescribed wastes under the Waste Management and Pollution Control Act as specified as a listed waste by the NT EPA as found at https://ntepa.nt.gov.au/waste-pollution/approvals-licences/listed-waste, will be disposed of in accordance with the regulations and by a company licensed to handle and dispose of this waste.

7.5.6 Waste minimisation strategies

This section contains strategies to minimise or reduce the volume of wastewater that will be disposed of off-site, and the expected quality and quantity of water and wastewater that will be treated and re-used within the petroleum activity

Santos will ensure the generation of wastewater is minimised as far as possible. Waste water will be disposed. Water will not be re-used for any purpose due to public health restrictions. Personnel will be advised to minimise water usage when utilising showers, in the kitchen etc, to reduce volumes of greywater generated.

7.5.7 Risk assessment

This section contains a risk assessment in relation to the potential impact to the environment from water and wastewater management activities proposed as part of the petroleum activity

An assessment of environmental impacts and environmental risks posed by waste has been carried out. For completeness and consistency with the environmental risk assessment of all activities, this is presented in Section 6.0 of the EMP.

7.5.8 Monitoring plan

This section contains a monitoring plan that:

- *Outlines the sampling locations, frequency, proposed analytical methods and analytical detection limits, and any quality assurance and quality control measures that will be implemented*
- *Reflects all monitoring requirements mandated by the COP and the EMP, as well as any monitoring that is determined to be necessary as part of the risk assessment*
- *Requires all field measurements and sampling to be undertaken by suitably qualified personnel and to utilise equipment that is suitably maintained, laboratory checked and calibrated*
- *Requires all laboratory analyses to be conducted at a National Association of Testing Authorities (NATA) accredited lab, where possible.*

7.5.8.1 Baseline monitoring of soils

An assessment of physical properties of representative baseline soils at each well site will be conducted.

Three samples will be taken at equidistant depth intervals in a 0.6 metre deep soil core from three locations across the well site, adjacent to:

- the proposed well
- the proposed location for drill fluid storage tanks (i.e. on the well pad)
- cuttings pit location.

Soil tests for each sample will include:

- A permeability test, such as falling head permeability testing on a sample or triaxial constant head permeability testing.
- A sample tested for:
    - Particle size distribution
    - Total chlorides (mg/kg)
    - Exchangeable sodium (%)
    - Emmerson aggregate test

7.5.8.2 Monitoring of stored water

The quality and quantity of all water stored will be monitored as per the below.

Quantity

Volume of water that is abstracted from the water bore will be measured using flowmeter. This will by recorded weekly during bore operations.

Fluid levels in storages containing abstracted groundwater will be monitored daily during well site operations. This provides a measure of the stored quantity of water.

Quality

Water quality of abstracted groundwater stored in tanks will be sampled monthly. The suite will be tested as per Table 7-6. Testing will comprise grab samples from the tank, or a sample of water pumped from the storage tank.

7.5.8.3 Quality assurance and quality control measures

All field measurements and environmental sampling will be undertaken by suitably qualified personnel.

All monitoring equipment will be suitably maintained and calibrated prior to use, as per manufacturer's instructions.

All samples shall be collected using suitable sample containers, preservation methods and chains of custody prior to receipt by analytical laboratories. Holding times will be met, where practical.

All laboratory analyses will be conducted at a National Association of Testing Authorities (NATA) accredited lab, where possible.

Table 7-6 Suite of analysis for testing of stored groundwater

Analyte	ALS Method Code	Limit of reporting	Units
Electrical Conductivity (EC) (measured in field)	EA010-P	1	µS/cm
Total Dissolved Solids (TDS)	EA015H	10	mg/L

Analyte	ALS Method Code	Limit of reporting	Units
Total Suspended Solids (TSS)	EA025H	5	mg/L
pH (measured in field, and in lab)	EA05-P	0.01	pH Units
Sulfate (SO_4^{-2})	NT-2A	1	mg/L
Chloride (Cl^-)	NT-2A	1	mg/L
Carbonate (CO_3^{-2})	NT-2A	1	mg/L
Bicarbonate (HCO_3^-) (as CaCO3 equivalent)	NT-2A	1	mg/L
Bicarbonate Alkalinity (as CaCO3 equivalent)	NT-2A	1	mg/L
Hydroxide Alkalinity (as CaCO3 equivalent)	NT-2A	1	mg/L
Total Alkalinity (as CaCO3 equivalent)	NT-2A	1	mg/L
Nitrite (NO_2^-)	NT-8A	0.01	mg/L
Nitrate (NO_3^-)		0.01	mg/L
Fluoride (F^-)	NT-2A	0.1	mg/L
Sodium (Na^+)	NT-1B	1	mg/L
Magnesium (Mg^{2+})		1	mg/L
Potassium (K^+)		1	mg/L
Calcium (Ca^{2+})		1	mg/L
Arsenic	W-3, W-3T, EG020F, EG020T	0.001	mg/L
Barium		0.001	mg/L
Boron		0.001	mg/L
Cadmium		0.0001	mg/L
Chromium		0.001	mg/L
Lithium		0.001	mg/L
Copper		0.001	mg/L
Iron		0.05	mg/L
Lead		0.001	mg/L
Manganese		0.001	mg/L
Mercury		0.0001	mg/L
Selenium		0.001	mg/L
Silica		0.1	mg/L
Silver		0.001	mg/L
Strontium		0.001	mg/L
Zinc		0.001	mg/L

7.6 Spill Management Plan

Under the Petroleum (Environment) Regulations (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 Code of Practice for Petroleum Activities in the Northern Territory sets out the mandatory requirements for management plans for wastewater and spills. The Code states that an EMP for a petroleum activity must include a Spill Management Plan (SMP).

7.6.1 Potential Spill Materials

A list of chemicals, water and wastewater and the way that they will be stored, transported and transferred as part of activity is provided below

7.6.1.1 Grey Water and Sewage

Camp wastewater from laundry, showers and kitchen is proposed to be piped to an irrigation area. For treated sewage is sewage that has passed through a sewage treatment system, the liquid component of the sewage treatment is either disposed of using an irrigation system or transported with the solid waste to an approved disposal facility. Macerated sewage is not treated sewage.

7.6.1.2 Hydraulic Fluids and Fuel and Other Oils

Hydraulic fluid and fuel drums are stored within portable bunding and bulk fuel is stored within tankers equipped with safety features such as double-skins (or temporary bunding), safety cut-off valves, top accessing etc. Spill leak and drip trays will be used to address the risk of minor drips and spills associated with re-fuelling operations. Estimated Volumes and Storage of Fuels and Oils is provided in Table 7-7.

Table 7-7 Estimated Volumes and Storage of Fuels and Oils

Description	Stored on site (m^3)	Storage Location	Containment
Diesel Fuel	100	Rig Fuel storage Tanks (Double Skinned)	Secondary containment
Other Oils / lubricants	<1	Storage tanks & drums	Secondary containment (double skinned tank or bunded containment area or bunded pallet storage)

7.6.2 Spill Risk Assessment

7.6.2.1 Potential Spill Scenarios

A number of fluids and hydrocarbons will be handled, stored and transported. The potential impact of a spill or leak is dependent on the type and volume of material released and the release location. Due to the remote location of the project, fuels will be transported by road and stored on site prior to use.

Potential sources of spills during civil and seismic activities are shown in Table 7-8.

Table 7-8 Quality and quantity of spill scenarios

Potential spill scenario	Quantity of spill	Quality of spill	Design controls
Loss of containment of fuels from storage area.	Less than $1m^3$	Hazardous fluids	Secondary containment
Poor refuelling or fuel transfer practices	Less than $1m^3$	Hazardous fluids	Secondary containment

The mitigation measures to reduce the risks associated with these spill scenarios are discussed in Section 7.6.5

7.6.3 Potential Impact to the Environment

Potential impacts to the environment as a result of a spill event include reduction in quality of groundwater, surface water or soils. These are discussed in more detail below.

7.6.3.1 Groundwater

Chemicals and fuels used during the civils and seismic activities have the potential to leak to surface and infiltrate the ground, migrating to shallow groundwater. This may affect groundwater quality, however impacts to groundwater are extremely unlikely.

7.6.3.2 Surface Water

Spills to surface have the potential to migrate to surface waters such as ephemeral watercourses. This has the potential to effect surface water quality and ecological values of that habitat.

7.6.3.3 Soil

For smaller spills and leaks (<1m^3), migration is likely to be contained within the surface soils and would be readily removed or remediated. If a larger spill were to occur, such as that from a bulk tanker, there is the potential that product could infiltrate.

Shallow lithology obtained from exploration well Tanumbirini-1 reveals two main hydrogeological units; a relatively impermeable siltstone/claystone followed by limestone which has highly variable hydrogeological properties, but the potential for high permeability.

7.6.4 Risk Assessment Table

An assessment of environmental impacts and environmental risks posed by a spill event has been carried out. For completeness and consistency with the risk environmental risk assessment of all activities, this is presented in Section 6.0.

7.6.5 Procedures and Process

7.6.5.1 Minimising the Risk of a Spill

Santos SMS

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. This SMP and the Project EMPO have been developed in consideration of the Santos SMS, including:

- SMS-MS1 Risk – ST13 Environmental Hazard Controls Procedure
- SMS-MS11 Incident and Crisis Management Standard
- SMS-MS1 Incident and Crisis – ST1 – Emergency and Crisis Management Procedure.

In addition to this the Santos Emergency Response Plan (ERP) and the Contractors ERP provide additional processes and procedures to minimise the risks of a spill.

Emergency Response Plan

The Emergency Response Plan for the activity will be prepared by the site contractors and will be provided to DENR and DPIR and made available upon request. If the Emergency Response Plan is updated, a revised version will be provided to DENR and DPIR.

The emergency response arrangements within the Emergency Response Plan will be exercised early in the 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

7.6.6 Spill Detection

Spills monitoring measures used to detect spills throughout the civils and seismic program include:

- Fuel and chemical storages will be monitored throughout the program duration.
- Completion of the daily monitoring checklist.

7.6.7 Spill Response Strategy

7.6.7.1 Response

Small spills will be managed locally at the site using dedicated spill kits; which are readily available and appropriately stocked. For spills that are large and cannot be managed locally, the On-scene commander is to notify the Santos Incident Management Team Duty Manager as shown in the Detailed Emergency Response flowchart (refer Figure 7-3) to provide incident details and initiate an appropriate response (

All spills will be managed in accordance with:

- Santos Emergency Response Plan
- Contractors ERP
- SMS-MS1 Risk – ST13 Environmental Hazard Controls Procedure
- Incident & Crisis ST2 - Incident Reporting, Investigation and Learning Procedure
- The EMP

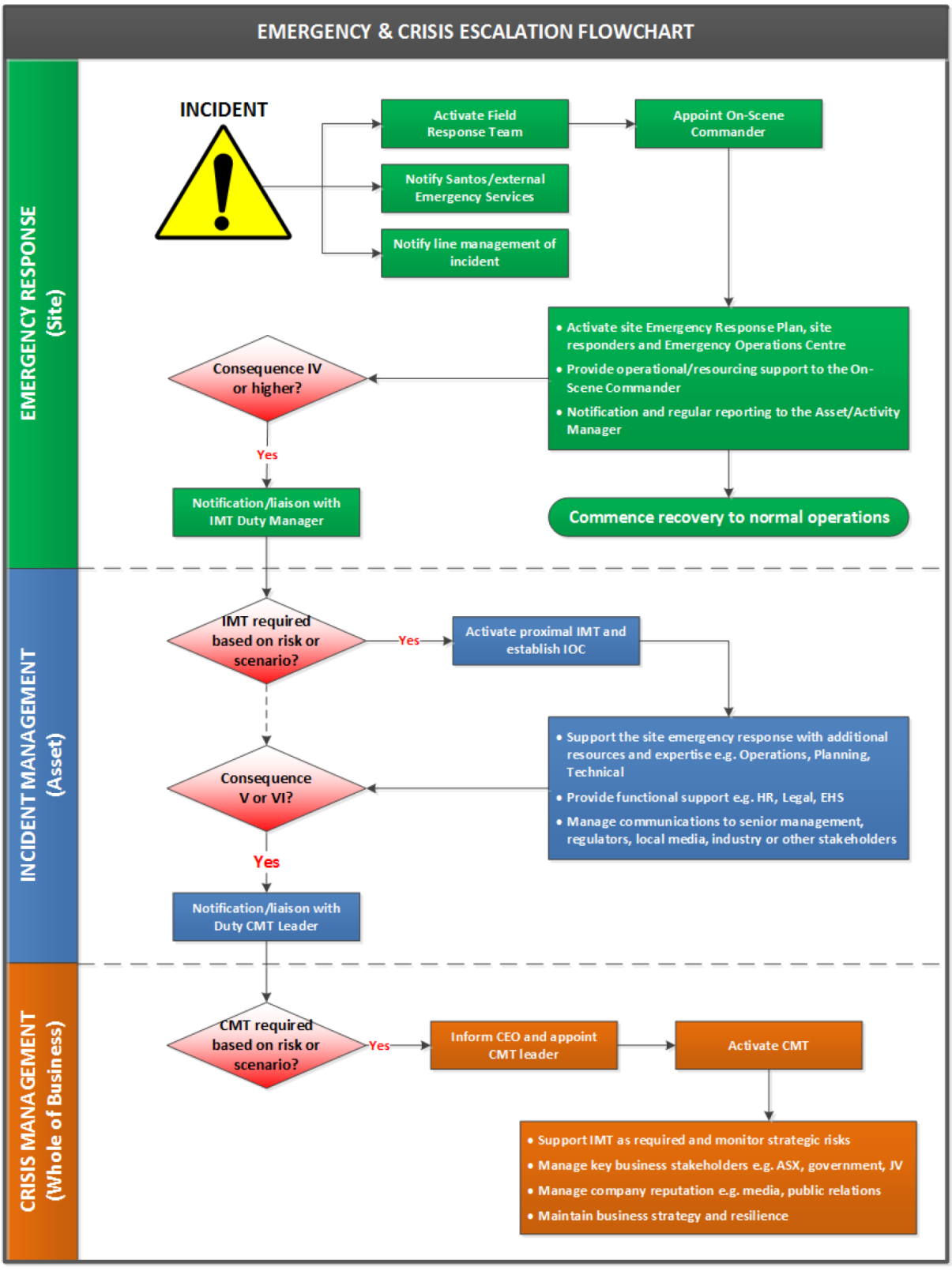

Figure 7-3: Detailed Emergency Response Arrangements

7.6.8 Communication Plan

7.6.8.1 Communication to Personnel

Spill prevention and monitoring strategies will be communicated to personnel via:

- This Plan
- The EMP
- Site Inductions
- Safety Meetings
- Tool Box Talks
- Daily Meetings

Communications about a spill will be undertaken in accordance with the Emergency Communications section of the Emergency Response Plan. This includes the following steps:

- Incident Management Team Leader (IMTL) informed of incident and establishes contact with affected site to be provided with details of the incident, understanding of severity and response resource requirements
- Assessment of the emergency and severity is made (based on information from the affected site) and an emergency/incident response level determined
- IMT activated to provide support to the affected site or facilities
- IMTL maintains open communications with the affected site - On-Scene Commander (OSC)
- Affected site OSC supervises the Field Response Team (FRT)
- Other personnel (roles) may be conscripted into the IMT as required

7.6.8.2 Petroleum (Environment) Regulations Incident Reporting and Recording

In the case of any inconsistencies, the reporting requirement of the Petroleum (Environment) Regulations trump any requirements listed in this plan.

Spills will be reported to the Minister in accordance with Part 3 of the Petroleum (Environment) Regulations. .

Notice of a reportable incident

Santos must give the Minister notice of a reportable incident in accordance with this regulation. A reportable incident means an incident, arising from a regulated activity that has caused or has the potential to cause material environmental harm or serious environmental harm. A notice of the reportable incident must be given to the Minister as soon as practicable but not later than 2 hours after the incident first occurred or if the incident was not detected at the time it first occurred – the time the interest holder became aware of the reportable incident.

Report about reportable incident

An initial report about a reportable incident will be given to the Minister as soon as practicable but not later than 3 days after the reportable incident first occurs; and must include comprehensive details about the following:

- 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.

- the nature and extent of the material environmental harm or serious environmental harm that the incident caused or had the potential to cause
- 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

A report about recordable incidents must relate to each reporting period for the regulated activity and must be given as soon as practicable but not later than 15 days after the end of the reporting period. The report must contain:

- a record of all recordable incidents that occurred during the reporting period
- all material facts and circumstances concerning the recordable incidents that the interest holder knows or is able, by reasonable search or enquiry, to find out
- any action taken to avoid or mitigate any environmental impacts and environmental risks of the recordable incidents
- the corrective action that has been taken, or is proposed to be taken, to prevent similar recordable incidents.

Reporting will occur at a period agreed in writing between the interest holder and the Minister or each 90 day period after the day on which the environment management plan is approved.

Recordable incident means an incident arising from a regulated activity that has resulted in an environmental impact or environmental risk not specified in the current plan for the activity; or has resulted in a contravention of an environmental performance standard specified in the current plan for the activity; or is inconsistent with an environmental outcome specified in the current plan for the activity. A recordable incident is not a reportable incident.

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 civil and seismic 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 (EPS).

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 EOs, EPS and MC for the Civils and Seismic program are described in Table 8-1

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

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
Terrestrial Flora and Fauna	Planned clearing and loss of habitat impacts on flora and fauna due to physical disturbance	Majority of the project footprint area preferentially located in previously disturbed areas. Where possible, existing tracks, roads or seismic lines will be used for access. Site selection surveys to be undertaken prior to on-ground disturbance. Mature trees selected for preservation are to be flagged to ensure their protection. Cleared vegetation will be either stockpiled and respread during rehabilitation or mulched and spread as a sediment control technique to reduce erosion. Along the seismic lines, if light grading is necessary, flora rootstock will be left intact to promote regeneration. Hollow timber/trees that may be nesting/roosting sites for fauna will not be cleared. Where possible branches will be pruned in preference to total tree removal	Compliance with Santos Field Clearing Checklist	Santos Field Clearing Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards. All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. Results of rehabilitation monitoring undertaken demonstrate that habitat has been no long-term loss of habitat due to project activities.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
Terrestrial Flora and Fauna	Clearing and vehicle and plant movements creating dust	For the seismic line blade work will not be undertaken on naturally smooth surfaces or flat easy terrain. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Water trucks will be used to manage dust emissions from vehicle movement and civil operations on the site	No off-road driving. Vehicle speeds do not exceed 80 km/hr on unsealed roads. , 40 km/hr on seismic lines. Dust measures implemented	Santos Field Environmental Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards All personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan. Number of exceedances of specified vehicle speed limits recorded in the In-Vehicle Monitoring Systems.
Terrestrial Flora and Fauna	Vehicle movements and seismic equipment generating noise and vibration	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices	Engines/machinery maintained in accordance with manufacturers specifications and frequencies as detailed in the Santos maintenance system. Engines/machinery fitted with noise suppression devices.	Audit of engines and machinery to ensure compliance with required maintenance schedule and fitted with noise suppression devices prior to work commencing.
Terrestrial Flora and Fauna	Lighting from camp	Reduce disturbance to native flora and fauna Minimise light pollution through task focused lighting and positioning camp boundary lighting inwards.	Task focused lighting employed. All camp boundary lighting positioned inwards at all times.	Weekly audit of lighting at the camp to ensure inward-facing lights adequate for safe operations.
Terrestrial Flora and Fauna	Vehicle movements and seismic equipment causing fauna strike at night and fauna entrapment in open pits and dams	Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Driving is only permitted on designated access roads and seismic lines. Pits and dams will be fenced Daily checks of pits and dams once constructed	No off-road driving. Vehicle speeds do not exceed 80 km/hr on unsealed roads. , 40 km/hr on seismic lines. Pits and dams fenced and checked daily Borrow pits backfilled upon completion	No exceedances of specified vehicle speed limits recorded in the In-Vehicle Monitoring Systems All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. Daily inspection records shows fences are intact and no livestock entrapment No fauna deaths as result of vehicle strike or entrapment recorded in the Incident Management System.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
		Borrow pit excavations will be backfilled with overburden once borrow removal has been completed.		
Terrestrial Flora and Fauna	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through clearing and vehicle movements.	Weed Management Plan developed	Compliance with DENR approved Weed Management Plan.	Daily field checklist confirms mitigation measures described in the Weed Management Plan will be implemented. Results of weed monitoring demonstrates that there has been no weed incursions as a results of project activities.
Terrestrial Flora and Fauna	Ignition sources from plant and machinery Inappropriate disposal of cigarettes	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:	Staff trained in use of fire-fighting equipment. Fire-fighting equipment available and serviced as per manufacturer's specifications. Spread, intensity and duration of fires are appropriately controlled. All staff inducted to this EMP.	Training records verify that operations personnel are trained and competent in spill response All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. Weekly checklist confirms firefighting equipment and procedures are in place in accordance with the Environmental Performance Standards Weekly audit of toolbox meetings to confirm fire risk level and fire risk management breaches and remedial actions discussed Weekly audit of records and toolbox meetings confirms a permit to burn was sought in a Fire Danger Period.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
		• 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. Prior to conducting a controlled burn during a Fire Danger Period, a permit to burn will be obtained from Bushfires NT		
Terrestrial Flora and Fauna	Waste stored inappropriately attracting native fauna	Routine inspections of waste storage areas to ensure all waste are in the appropriate place. Waste removed by an approved NT EPA contractor.	All waste segregated and stored Appropriately in accordance with this EMP. Only waste from approved wastewater systems and grey water disposed of to land. Licenced waste contractor used for any offsite transfer or disposal.	Weekly check of waste receptacles to ensure they are fauna proof. Weekly audit of waste records confirms storage and disposal of waste on and off site meets Environmental Performance Standards.
Terrestrial Environmental Quality	Physical disturbance including clearing and vehicle and plant movements	The project area, including access tracks have been preferentially located in previously disturbed areas. Existing, landholder access tracks have been utilised where possible to minimise soil compaction. Grading will be minimised where feasible. Along the seismic lines, if light grading is necessary, flora rootstock will be left intact to promote regeneration.	Santos Field Clearing Checklist Compliance with DENR approved Erosion and Sediment Control Plan	Santos Field Clearing Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards. Weekly inspection checklist confirms mitigation measures described in the Erosion and Sediment Control Plan have been implemented.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
		An ESCP has been developed by a CPESC in consultation with DENR		
Terrestrial Environmental Quality	Inappropriate storage or handling of hazardous substances. Poor refuelling or fuel transfer practices result in spills or leaks	Spill kits available to treat spills in-situ. Minimise fuel transfer where possible. Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940	Spill kits, spill containment, and appropriate bunding in all relevant areas. All spills and leaks are remediated as soon as possible. Compliance with the Code of Practice for Petroleum Activities in the Northern Territory. Compliance with the Spill Management Plan (Section 7.6).	Weekly inspection checklist confirms all hazardous materials and stored and managed in accordance with the Environmental Performance Standards. Records of spills and completed remediation in Incident Management System.
Hydrological processes	Alteration of drainage contours through clearing processes	All major creek crossings and floodways intersected by the access tracks will be subject to rocking to avoid and minimise erosion. Mitre drains and flow control banks (whoa boys) will be installed across access roads where required.	Compliance with DENR approved Erosion and Sediment Control Plan.	Audit of constructed roads to confirm roads have been designed in accordance with the Environmental Performance Standards.
Hydrological processes	Use of groundwater for project activities	No long-term impacts to groundwater resources in the area.	Compliance with groundwater extraction licence approval conditions (i.e. volume limits will not be exceeded).	Records to confirm groundwater extraction volumes and evidence of providing information to DPIR and DENR. Results of groundwater monitoring to demonstrate that there has been no change in hydrological regimes as a results of project activities
Social, Economic and Cultural Surroundings	Removal of vegetation exposing cultural sensitive site	Disturbance is restricted to subject land and avoids the restricted work areas as detailed in the AAPA Authority Certificate. Known sites of sacred or cultural significance are identified and avoided. Any new sites identified during the activity will be reported to the NT Heritage Branch.	Compliance with requirements of AAPA certificate	Santos Field Clearing Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards. Audit of Santos GIS database to confirm it includes known cultural heritage sites and project area.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
		Maintain GIS database of project area and cultural heritage sites including details of any works conditions		Records of cultural heritage finds in Incident Management System All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan.
Social, Economic and Cultural Surroundings	Reduction in groundwater available for other users	No long-term impacts to groundwater resources in the area.	Compliance with groundwater extraction licence approval conditions (i.e. volume limits will not be exceeded).	Records to confirm groundwater extraction volumes and evidence of providing information to DPIR and DENR Results of groundwater monitoring to demonstrate that there has been no change in hydrological regimes as a results of project activities.
Social, Economic and Cultural Surroundings	Clearing and vehicle and plant movements creating dust	For the seismic line blade work will not be undertaken on naturally smooth surfaces or flat easy terrain. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Water trucks will be used to manage dust emissions from vehicle movement and civil operations on the site	No off-road driving. Vehicle speeds do not exceed 80 km/hr on unsealed roads. , 40 km/hr on seismic lines. Dust measures implemented.	Santos Field Environmental Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards. All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. Number of exceedances of specified vehicle speed limits recorded in the In-Vehicle Monitoring Systems.
Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment generating noise and vibration	Engines/Machinery will be maintained as per planned maintenance systems. Engines/machinery will have noise suppression devices Noise complaints from vehicle movements and drilling activities minimised through active stakeholder engagement and complaints management through CLC	Engines/machinery maintained in accordance with manufacturers specifications and frequencies as detailed in the Santos maintenance system. Engines/machinery fitted with noise suppression devices. No noise nuisance to users of adjacent land. Amicable resolution of complaints	Audit of engines and machinery to ensure compliance with required maintenance schedule and fitted with noise suppression devices prior to work commencing. Stakeholder engagement records show active consultation with surrounding stakeholders on any potential noise increase and results of these consultations.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment generating light at night. Lighting from camp.	Reduce disturbance to native flora and fauna Minimise light pollution through task focused lighting and positioning camp boundary lighting inwards.	Task focused lighting employed. All camp boundary lighting positioned inwards at all times.	Weekly audit of lighting at the camp to ensure inward-facing lights adequate for safe operations.
Social, Economic and Cultural Surroundings	Vehicle movements and seismic equipment causing fauna strike at night	Disturbance, injury or death to livestock from vehicle movements and drilling activities minimised through active stakeholder engagement. Gates left in the condition in which they were found. Speeds on unsealed roads will be limited to a maximum 80 km/hr. Prohibit livestock access by fencing all pits and dams. Routine daily inspection pits and dams to ensure no trapped livestock.	No injury or death to livestock. Amicable resolution of complaints. Vehicle speeds do not exceed 80 km/hr on unsealed roads. No livestock access to pits and dams.	Records landholder complaints due to gates not being opened/closed in Incident Management System No exceedances of specified vehicle speed limits recorded in the In-Vehicle Monitoring Systems All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. No fauna deaths as result of vehicle strike recorded in the Incident Management System Daily inspection records shows fences are intact and no livestock entrapment.
Social, Economic and Cultural Surroundings	Plant and vehicles carrying weeds from outside the project area. Spread of weeds in project area through clearing and vehicle movements.	Weed Management Plan developed.	Compliance with DENR approved Weed Management Plan.	Daily field checklist confirms mitigation measures described in the Weed Management Plan have been implemented. Results of weed monitoring demonstrates that there has been no weed incursions as a results of project activities.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
Social, Economic and Cultural Surroundings	Ignition sources from plant and machinery. Inappropriate disposal of cigarettes	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. Prior to conducting a controlled burn during a Fire Danger Period, a permit to burn will be obtained from Bushfires NT	Staff trained in use of fire-fighting equipment. Fire-fighting equipment available and serviced as per manufacturer's specifications. Spread, intensity and duration of fires are appropriately controlled. All staff inducted to this EMP.	Training records verify that operations personnel are trained and competent in spill response. All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan. Weekly checklist confirms firefighting equipment and procedures are in place in accordance with the Environmental Performance Standards. Weekly audit of toolbox meetings to confirm fire risk level and fire risk management breaches and remedial actions discussed.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
Social, Economic and Cultural Surroundings	Vehicle and plant movements throughout the project area	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 – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Seismic sources are not to operate within the distance defined by Santos standards, of any pipeline, utility, installation or building. No camps to be established less than 1 km from the PWC groundwater bores.	No land disturbance to users of adjacent land. Amicable resolution of complaints No off-road driving. Vehicle speeds do not exceed 80 km/hr on unsealed roads, 40 km/hr on seismic lines.	Adherence to the communications procedure with landholders Records of landholder/public complaints in Incident Management System Records of damage to landholders tracks and fences in Incident Management System Records landholder complaints due to gates not being opened/closed in Incident Management System. All personnel have completed site inductions in accordance with section 8 of this Environmental Management Plan Records of project area to confirm activities have occurred in compliance with Santos standards and PWC groundwater bores 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.
Human Health	Clearing and vehicle and plant movements creating dust	For the seismic line blade work will not be undertaken on naturally smooth surfaces or flat easy terrain. Driving is only permitted on designated access roads and seismic lines. Speeds on unsealed roads will be limited – maximum 80 km/hr on unsealed roads, 40 km/hr on seismic lines.	No off-road driving. Vehicle speeds do not exceed 80 km/hr on unsealed roads, 40 km/hr on seismic lines. Dust measures implemented.	Santos Field Environmental Checklist confirms clearing activities are being undertaken in accordance with the Environmental Performance Standards All personnel have completed site inductions in accordance with section 7 of this Environmental Management Plan. Number of exceedances of specified vehicle speed limits recorded in the In-Vehicle Monitoring Systems.

Environmental Value	Risk Sources	Key Environmental Outcomes	Environmental Performance Standard	Measurement Criteria
		Water trucks will be used to manage dust emissions from vehicle movement and civil operations on the site		
Inland Water Environmental Quality	Inappropriate storage or handling of hazardous substances Poor refuelling or fuel transfer practices	Spill kits available to treat spills in-situ. Minimise fuel transfer where possible. Use of drip trays for transfers. Any spills contained and remediated. Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940	Spill kits, spill containment, and appropriate bunding in all relevant areas. All spills and leaks are remediated as soon as possible. Compliance with the Code of Practice for Petroleum Activities in the Northern Territory. Compliance with the Spill Management Plan.	Weekly inspection checklist confirms all hazardous materials and stored and managed in accordance with the Environmental Performance Standards. Records of spills and completed remediation in Incident Management System.
Air Quality and Greenhouse Gas	Vehicle and plant movements creating air emissions	No decrease in air quality due to increased inefficient vehicle and plant emissions.	Vehicles and fixed plant maintained as per in accordance with manufacturers specifications and frequencies. Vehicles compliant with Northern Territory Motor Vehicle registry regulation and work health and safety regulations.	Audit of engines and machinery to ensure compliance with required maintenance schedule and fitted with noise suppression devices prior to work commencing.

8.2 Santos EHS 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.

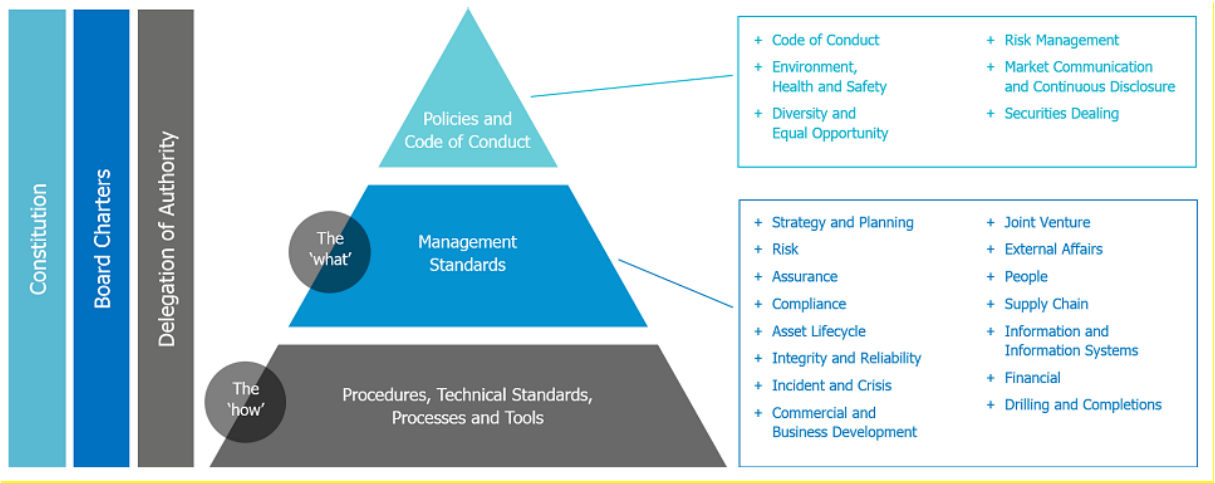

Table 8-2 Santos Management System Framework

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 NT Projects Civils Works Senior Supervisor/Santos Seismic Field Supervisor	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 7.1 Ensure incidents and non-conformances are managed as per Section 8.8 and 8.10.3 respectively. Report environmental incidents to the Exploration Manager and ensure reporting (Table 8-4) and investigations undertaken. Ensure records and documents are managed so they are available and retrievable (Section 8.10). Ensure non-conformances identified are communicated, raised in EHS Toolbox and corrective actions completed (Section 8.10.3).
NT Exploration Manager	Notify DPIR 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 DPIR (Section 8.11).
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 NT Projects Civils and Seismic Leaders. 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 8.10.3). Prepare and submit the Environmental Performance Report quarterly (unless otherwise determined by the Minister) to DPIR within 15 days of the quarter finishing (Section 8.11).

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 Emergency Response Plan

The Emergency Response Plan for the activity will be prepared by the civil and seismic contractors and will be provided to DPIR and made available upon request. If the Emergency Response Plan is updated, a revised version will be provided to DENR.

The emergency response arrangements within the Emergency Response Plan will be exercised early in the 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

8.6 Notice of Commencement

Santos will notify the Minister and the Tanumbirini station owner of the proposed date of commencement of construction 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.

In the event that the proposed change is a significant modification or new stage of activity, introduces a significant new environmental impact or risk, results in a significant increase to an existing environmental impact or risk, or, as a cumulative effect results in an increase in environmental impact or risk, this EMP will be revised and submitted for re-assessment and acceptance by the regulator.

Table 1-1 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 DENR and DPIR.

8.8 Incident Reporting

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

Table 8-4 details the external incident notification, reporting requirements and timeframes for environmental incidents associated with the activity under the Petroleum (Environment) Regulations 2016, the Waste Management and Pollution Control Act 1998.

Table 8-4 Incident Reporting Requirements

Requirements	How and By When
Petroleum (Environment) Regulations 2016	
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.	Submit written report to DPIR (the Environmental Performance Report) (petroleum.operations@nt.gov.au) within 15 days after the end of the reporting period. The reporting period is 90 days unless otherwise advised by the Minister.
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 DPIR Operations Team Emergency Number (**1300 935 250**) or in writing.
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; d) 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.

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; d) 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.
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 f) 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 2011	
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 a written report as soon as practicable but within seven days of discovery.

8.9 Environmental Performance Monitoring and Reporting

8.10 Monitoring

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	Frequency	Requirement Source	Reporting
Weed Monitoring	Ongoing during civil and seismic program Annual to coincide with the end of the wet season	Weed Management Plan The Code	Annual Report
Groundwater Monitoring	Ongoing	Northern Territory Government guidelines for groundwater monitoring for petroleum operations The Code	Annual Report
Rehabilitation Monitoring	Photo points established and revisited: - Prior to activities - After activities completed - Year one - Year two - Year four	Rehabilitation Management Plan The Code	Environment Reports submitted to DENR and DPIR

8.10.1 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.

8.10.2 Audit

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 Civils Works Senior Supervisor/Santos Seismic Field Supervisor. The checklist will ensure compliance with mitigation and management measures detailed in Table 6-1.

Audit / review findings including actions are 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.

8.10.3 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 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.

8.11 Routine Reporting

As detailed in Table 8-4, Santos will submit an Environmental Performance Report quarterly (unless otherwise advised by the Minister) to DPIR (unless otherwise agreed by the Minister) which provides information where there has been a breach of an Environmental Objective or Environmental Performance Standards detailed in this Environment Management Plan. The Environmental Performance Report will include actions taken to avoid or mitigate any adverse environment impacts of the recordable incidents and the corrective action proposed or undertaken to prevent similar recordable incidents.

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 G.

9.2 Stakeholder 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 2019 work program and approvals including the scope of this EMP was completed on 31 January 2019. Meeting involved staff from Department of Chief Minister, Department of Trade Business and Innovation, DPIR, DENR and AAPA.

A meeting to discuss 2019 program and approvals including the scope of this EMP was conducted on 6 December 2018 with staff from DPIR and DENR.

A meeting to discuss 2019 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 Tahnee Hill – Regional Weed Officer (Onshore Shale Gas Development) – DENR. This consultation has included a site visit in August 2018, review, and approval of weed management plans and procedures.

In addition, Santos has been actively engaged with the Pepper 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 senior 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 GISERA research which is being undertaken to support the development of a SREBA for the Beetaloo. We have provided the DENR with access to our existing groundwater monitoring data collected by CSIRO on our behalf over recent years, and have facilitated initial survey work by CSIRO for methane and in collaboration with DENR 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 traditional owners and aboriginal peoples has been ongoing throughout 2018. Major engagement events in addition to Sacred Sites Clearance Certifications and AAPA Certification applications and approvals include:

- 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: *Names Redacted*

- Presentation to Northern Land Council on the 2019 work program was conducted on 1 February 2019 (9.30 am – 11.00 am). Specifically this presentation identified 2019 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: *Names Redacted*

- Meeting with NLC to discuss future clearance requirements and resourcing on 2 April 2019
- Discussion with AAPA to discuss Authority Certificate applications and the 2019 proposed work program on 1 and 2 April 2019.

Other stakeholder engagement has involved engagement with landholders/managers as documented in Appendix G. Appendix G 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 the DPIR 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 throughout 2019 will be comprehensive. Prior to the 2019 program 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 on country work program meetings (scheduled for late February or early March)
- Annual Geosciences Exploration Seminar (AGES); Alice Springs in March
- Daly Waters Camp Draft (May)
- Northern Territory Government Departments

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