Santos

Environment Management Plan: Dukas-1 – Conventional Gas Well

NT Exploration Permit (EP) 112 & 125

Document Number: MAB-PLN-006

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Abbreviations and Units

Acronym	Description
AAPA	Aboriginal Areas Protection Authority
ALARP	As low as reasonably practicable
CLC	Central Land Council
DoEE	Department of Environment and Energy
DPIR	Department of Primary Industries and Resources
EHS	Environment Health and Safety
EMP	Environmental Management Plan
EP	Exploration Permit
EPA	Environmental Protection Authority
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Cth)
EO	Environmental Outcomes
EPS	Environmental Performance Standards
ERA	Environment Risk Assessment
ESD	Ecologically Sustainable Development
GDE	Groundwater Dependent Ecosystem
ha	Hectares
HDPE	High Density Polyethylene
km	Kilometre
m	Metres
mbgl	Metres below ground level
MC	Measurement Criteria
MNES	Matters of National Environmental Significance
MoC	Management of Change
NT	Northern Territory
PMST	Protected Matters Search Tool
SMS	Santos Management System
TPWC Act	*Territory Parks and Wildlife Conservation Act 2014*
VSP	Vertical Seismic Profiling

Executive Summary

Introduction and Scope

Santos QNT Pty Ltd (Santos) is the operator of Exploration Permits (EP) 112 and 125, which are located approximately 200 km south-west of Alice Springs in the Northern Territory (NT) (Figure 1).

Santos has previously undertaken seismic surveys in the southern region of the Amadeus basin, acquiring 2D seismic in EPs 82, 105, 107, 112, and 125. The aim of the seismic survey was to produce detailed images of rock layers beneath the Earth's surface to determine the location and size of potential oil and gas traps.

Santos proposes to drill the Dukas-1 exploration well on one of the previous seismic survey lines, as shown in Figure 2 and Figure 4. The Exploration Program will require a number of civil preparatory works to be undertaken and a campsite to be developed, which will be removed on completion of the drilling program. The Dukas-1 well is situated on EP 112 and the access roads and borrow pits are on both EP 112 and 125. This Environmental Management Plan (EMP) is submitted to cover these new proposed works.

Activity Description, Location and Timing

Key activities for the drilling of the Dukas-1 well include:

- Civil works
- Water extraction and storage
- Drilling activities, including formation evaluation (open hole or cased hole wireline)
- Wellbore seismic evaluation (e.g. vertical seismic profiling or checkshot surveying)
- Production testing (drill stem test, extended production tests)
- Well integrity monitoring.

A location and infrastructure plan for the Drilling program is shown in ES1.

The project will be run in two stages. Stage 1 consists of preliminary civil works and water bore drilling and is required to facilitate the installation of a groundwater supply bore. Subject to the presence of the water, the bore will supply water for the project and provide a baseline water sample prior to the drilling of the Dukas-1 exploration well. Stage 2 consists of all activities associated with the drilling and competition of the Dukas-1 exploration well as well as well suspension, maintenance and rehabilitation works. A location and infrastructure plan for the Drilling program is shown in ES1.

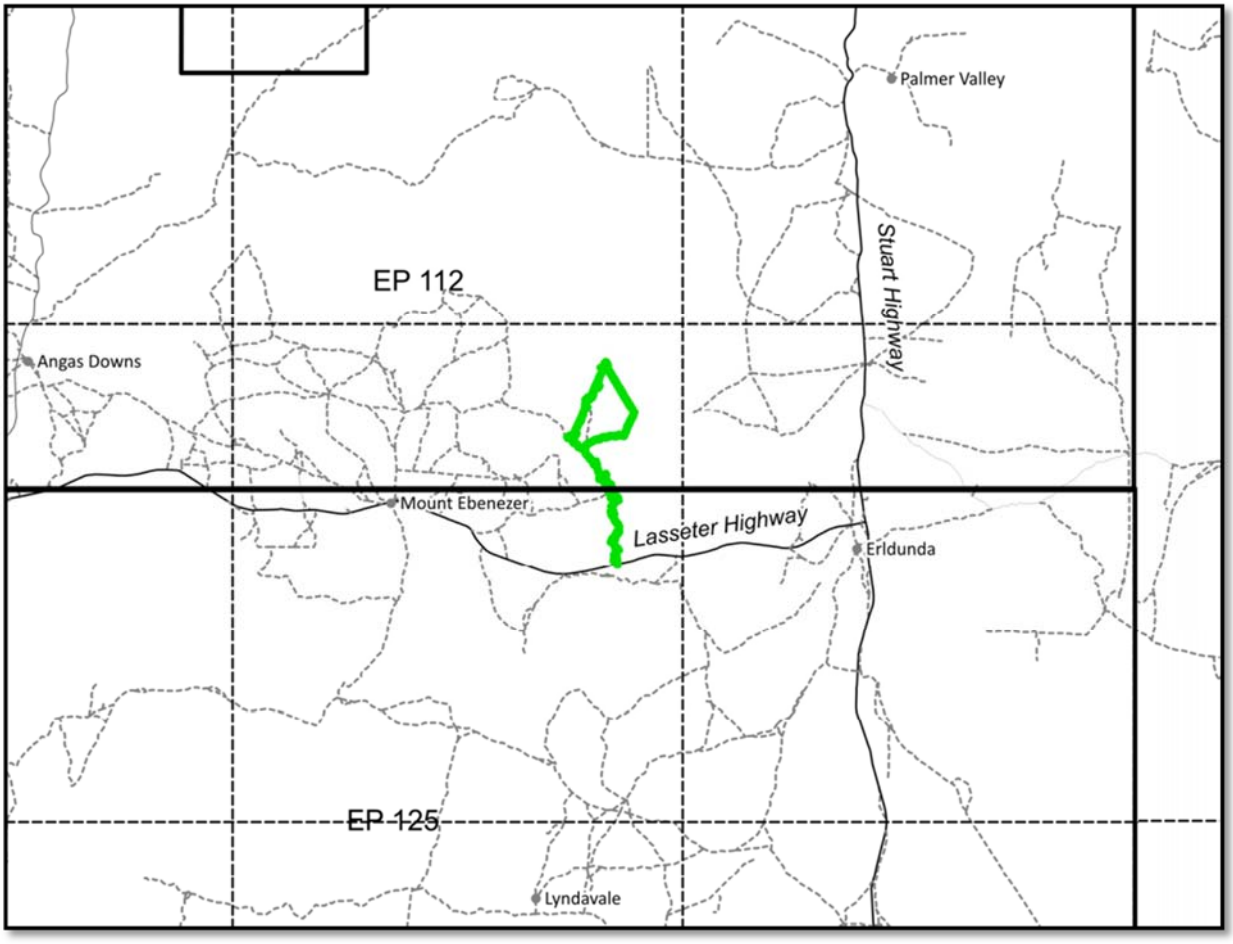


Figure ES-1 Location of Dukas-1 Project Area

The project is scheduled to be undertaken in 2019. An indicative project schedule is provided in Table ES1.

Table ES1: Indicative project schedule

Stage	Activity	Estimated duration	Estimated timing
Stage One	Civil works	6 weeks	January-February 2019
	Water bore installation	2 weeks	January 2019
Stage Two	Mobilisation of drilling equipment	4 weeks	February-May 2019
	Drilling and Completion of well	9 weeks	February-May 2019
	Well Suspension	< 1 week	April-May 2019
	Demobilisation of equipment	2-4 weeks	April-May 2019
	Well Testing	12 weeks	June – August 2019
	Rehabilitation post well completion	1-2 weeks	May-June 2019
	Rehabilitation post decommissioning of infrastructure/site	2-4 weeks	• Commence within 12 months of decommissioning

Stage	Activity	Estimated duration	Estimated timing
	Post-rehabilitation monitoring	2 weeks per monitoring event	• Immediately after rehabilitation works completed post decommissioning • Following first wet season • One year after rehabilitation • Three years after rehabilitation

Description of the Receiving Environment

The proposed Dukas-1 well is located within the arid zone of Central Australia that experiences low and variable rainfall and high diurnal and seasonal temperature fluctuations. The mean annual rainfall for Alice Springs is 284 mm, with most of rainfall in summer. Temperatures vary from very hot in summer to below freezing in winter and frosts occur regularly during the winter months.

The proposed Dukas-1 well is located within the eastern, central and southern Amadeus Basin, an east-west trending sedimentary basin extending across the southern part of the Northern Territory and into Western Australia. This basin covers an area of approximately 207,000 km² and contains up to 9100 m of late Proterozoic and Palaeozoic sediments. It is bound in the north by the Arunta complex and in the south by the Musgrave-Mann complex, both containing granite, gneiss and schists, with amphibolite and quartzite

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

Table ES-2 Environmental Values and Sensitivities in the vicinity of the project area

Environmental Receptor	Summary
Groundwater/ water courses	The project area does not intersect any mapped watercourse or drainage feature (**Figure 10**). Ground water baseline assessment across bores on Mt Ebenezer station recorded water levels below ground level between 15m and 82m. The pH of the samples ranged between 6.85 – 7.24.
Native fauna	Despite the lack of surface water, the region provides important habitat for a range of wildlife including a variety of small mammals, reptiles and birds. There are a number of listed species of birds, mammals and reptiles with the potential to be found within 10 km of the project area, however there is no area of particular sensitivity in the region.
Native flora / habitat	The project area is covered by the Finke Bioregion. The vegetation within the project area is considered to be representative of the broader region. There are no TECs identified in the project area.
Environmentally sensitive sites	There are no protected or conservation areas within the vicinity of the project area.
Culturally sensitive sites	The project area and surrounds has the potential for Aboriginal sites with cultural value. However, sacred sites clearance will be obtained prior to any activity.

Environmental Receptor	Summary
Landholders	There are a number of pastoral properties with livestock and infrastructure in the vicinity.

Major Environmental Risks/Impacts and Controls

The planned and potential interactions between the activity, the aspects triggered and the environment represent a source of risk (or impact) which has potential to affect the environment. Planned / routine aspects include: atmospheric emissions, light emissions, noise, physical disturbance and water use. Unplanned / non-routine aspects include: chemical spills and leaks, disturbance to stakeholders, fauna interaction, fire, introduction of pests and waste.

For each aspect, receptors were identified and the risk or impact was assessed based on the likelihood of occurrence and the severity of potential consequences, and a pre-treatment risk ranking was identified to assist with the determination of the level of controls required to reduce the risk or impact. Control measures were identified in accordance with defined environmental performance outcomes, to eliminate, prevent, reduce or mitigate consequences associated with each of the identified environmental risks or impacts. A final residual risk ranking was undertaken to determine impact and risk acceptability and demonstrate the impact and risks have been reduced to as low as reasonable practicable (ALARP).

Management Approach

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). This EMP includes EOs that address the risks that are identified. For each EO, there is 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.

Environmental outcomes in relation to the activity

All impacts and risks associated with project activities are considered a decision “Type A”, meaning that they are well-understood and that are established practices in place to manage these risks. Through implementation of control measures, all project risks and impacts have been managed to ALARP; the residual risk rankings for all project risks /impacts have been reduced to a either a Level 1 or Level 2. Control measures have been identified using the Santos hierarchy of controls; a process which moves from risk elimination through to protection, in descending order of effectiveness, until a control measure(s) can be identified.

Implementation Strategy

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 SMS includes Code of Conduct and Policies, Management Standards Processes, Procedures and Tools.

Stakeholder consultation

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. In preparation for the 2018 / 2019 program of works, relevant stakeholders were identified and engaged such that they could be informed of the proposed activities, and have their specific issues considered and addressed. Stakeholders include:

- Community

- Landholders
- Traditional Owners and Aboriginal Peoples
- Elected representatives
- Northern Territory Government departments

During both the planning and operational phase of the project, Santos will have a field based member of the Land Access team in the region. They will be the primary point of contact for all landholders and community members during these phases. During the operational phase of the project the Santos Field Representative will also manage day to day activities and communications with respect to the landholders to ensure they are consistently updated on the status of the project.

Contact details of the interest holder's nominated liaison personnel

Table ES-3 provides details of the permit titleholder and titleholder nominated liaison person.

Table ES-3 Details of Titleholder and Nominated Liaison Person

Titleholder Details	Liaison Person Details
Name: Santos QNT Pty Ltd 60 Flinders Street, Adelaide, SA 5000 Telephone number: 08 8116 5000 ACN: 083 077 196	Name: David Close Position: Exploration Manager – Onshore NT, QLD & NSW Company: Santos Ltd Address: 60 Flinders Street, Adelaide, SA 5000 Phone : 08 8116 7897 Email: David.Close@santos.com

1.0 Introduction

1.1 Scope of this EMP

Santos is the operator of Exploration Permits (EP) 112 and 125, which are located south-west of Alice Springs in the Northern Territory (NT) (**Figure 1**). Santos has previously undertaken a seismic survey in the southern region of the Amadeus basin, acquiring 2D seismic in EPs 82, 105, 107, 112, and 125. The aim of the seismic survey was to produce detailed images of rock layers beneath the Earth's surface to determine the location and size of potential oil and gas traps.

Santos proposes to drill the Dukas-1 exploration well located approximately 180km south-west of Alice Springs. The Exploration Program will require a number of civil preparatory works to be undertaken and a campsite to be developed, which will be removed on completion of the drilling program. The location of the well and associated infrastructure is here in referred to the Project Area (See **Figure 2**).This Environmental Management Plan (EMP) has been submitted to cover these new proposed works.

1.2 Titleholder details

Table 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 the Department of Primary Industry and Resources (DPIR) and provide the updated details.

Table 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 & NSW Company: Santos Ltd Address: 60 Flinders Street, Adelaide, SA 5000 Phone : 08 8116 7897 Email: David.Close@santos.com

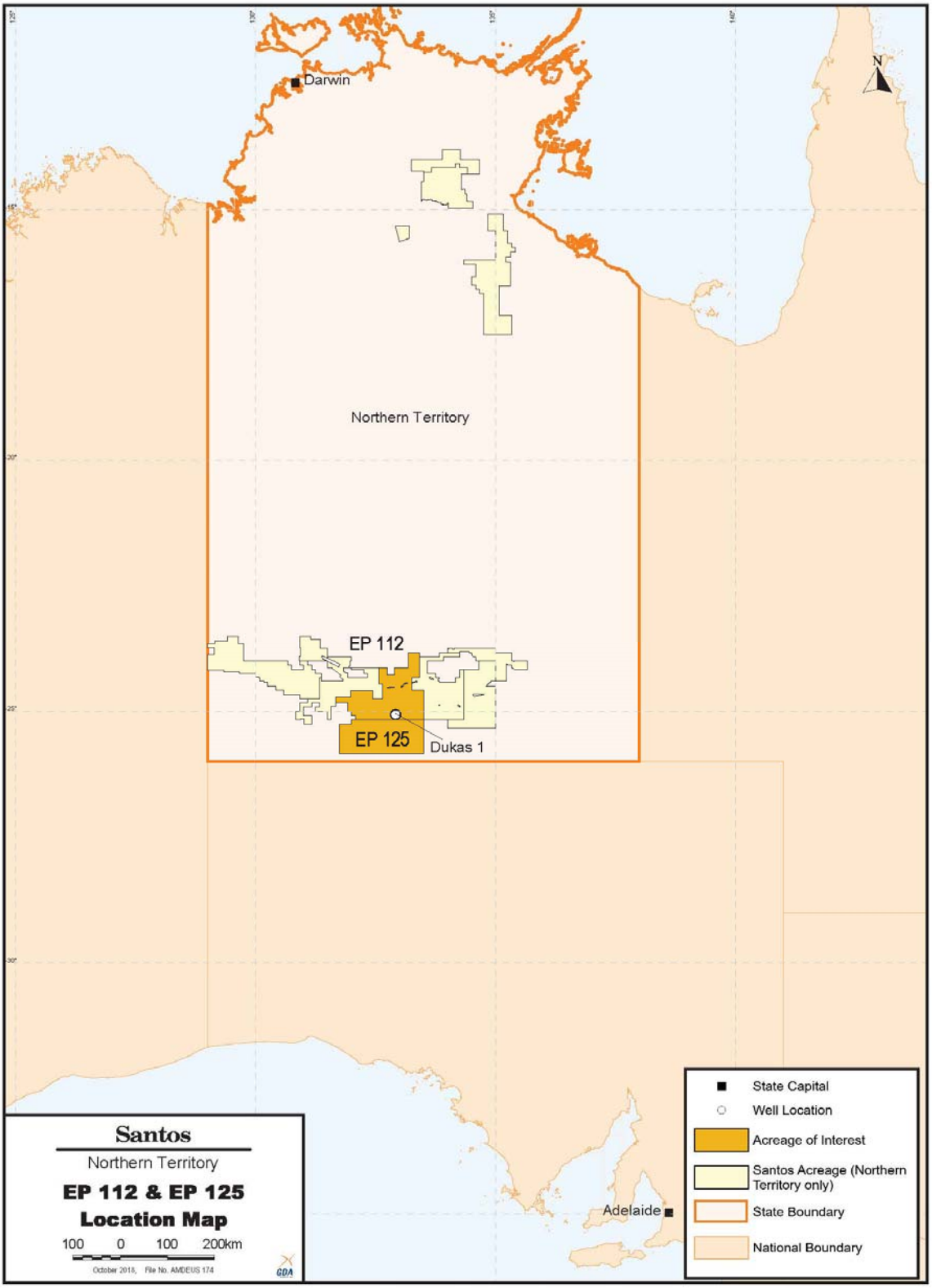


Figure 1: Santos' acreage in the NT

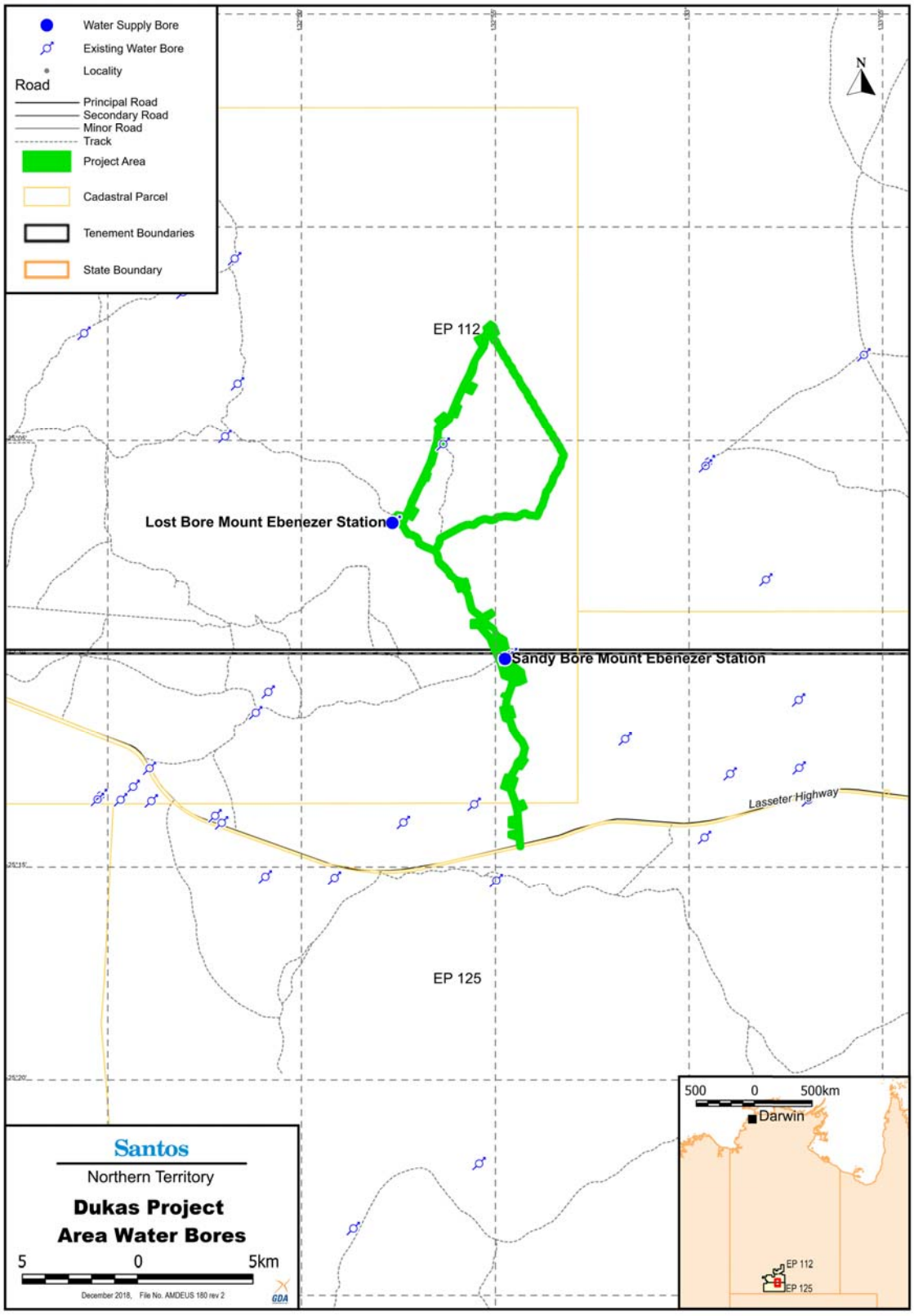
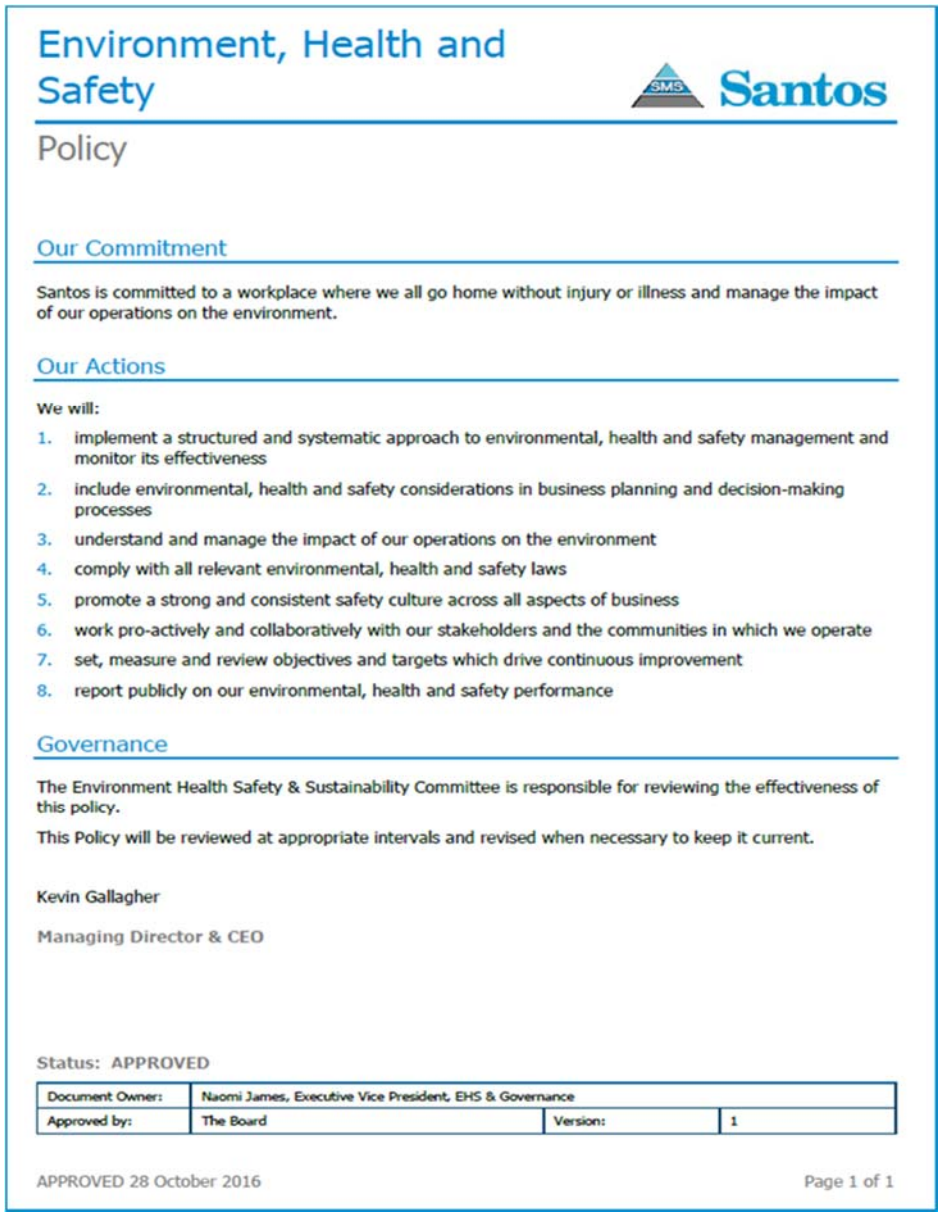


Figure 2: Location of project area

1.3 Corporate Environment Policy

The Santos Corporate Environmental Policy is provided in Figure 3. The policy is Santos' public declaration to understanding and managing the environmental impacts and risks associated with its operations and complying with all relevant environmental, health and safety laws.

The Santos Environmental Policy was endorsed by the Managing Director and Chief Executive Officer and approved by the Board. All personnel are responsible for the environmental performance of their activities and for complying with the general environmental duty as outlined in the Santos Environment, Health and Safety Policy.



Environment, Health and Safety

Santos

Policy

Our Commitment

Santos is committed to a workplace where we all go home without injury or illness and manage the impact of our operations on the environment.

Our Actions

We will:

1. implement a structured and systematic approach to environmental, health and safety management and monitor its effectiveness
2. include environmental, health and safety considerations in business planning and decision-making processes
3. understand and manage the impact of our operations on the environment
4. comply with all relevant environmental, health and safety laws
5. promote a strong and consistent safety culture across all aspects of business
6. work pro-actively and collaboratively with our stakeholders and the communities in which we operate
7. set, measure and review objectives and targets which drive continuous improvement
8. report publicly on our environmental, health and safety performance

Governance

The Environment Health Safety & Sustainability Committee is responsible for reviewing the effectiveness of this policy.

This Policy will be reviewed at appropriate intervals and revised when necessary to keep it current.

Kevin Gallagher

Managing Director & CEO

Status: APPROVED

Document Owner:	Naomi James, Executive Vice President, EHS & Governance		
Approved by:	The Board	Version:	1

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Figure 3: Santos' Environment, Health and Safety Policy

2.0 Environment 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)
- 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.

There are other legislation, agreements and codes of practice relevant to the project, which are detailed in sections

2.1 Key Legislation Overview

The key Commonwealth and NT legislation and international agreements relevant to the project are described in Table 2.

Table 2: Key Legislation and International Agreements

Act / Instrument	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.
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.
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). Land Councils may issue Sacred Sites Clearance Certificates under the Act.
Environmental 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). Under the EPBC Act, any petroleum activity that has, or will have, the potential to have a significant impact on a MNES must be referred to the Department of the Environment and Energy (DoEE) for assessment. This includes any activity covered by the following nine (9) controlling provisions: • world heritage properties; • national heritage places; • wetlands of international importance (often called 'Ramsar' wetlands after the international treaty under which such wetlands are listed); • nationally threatened species and ecological communities; • migratory species; • Commonwealth marine areas; • the Great Barrier Reef Marine Park; • nuclear actions (including uranium mining); • a water resource, in relation to coal seam gas development and large coal mining development. It is considered that the proposed activities will not adversely impact MNES. Therefore, the project has not been referred for assessment and 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	
Aboriginal Land Act 2013	This Act regulates access to Aboriginal land, certain roads bordered by Aboriginal land and the seas adjacent to Aboriginal land and provides for permits to enter onto or remain on Aboriginal land or use a road.

Act / Instrument	Summary
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.
Biological Control Act 2011	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 2015	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 2015	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 2013	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. Petroleum developments that may have a significant environmental impact must be assessed under the Act. It is considered that the proposed activities will not have a significant impact and therefore, the project will not be referred for assessment and approval under the Act. .
Environmental Offences and Penalties Act 2011	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.
Fire and Emergency Act 2016	Provides provisions for the establishment of Northern Territory Fire and Rescue Service and emergency response groups and their role in dealing with fires and other emergencies. The Act also provides for restrictions on lighting fires and the responsibilities of occupiers of land in relation to fires.
Heritage Act 2016	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 2013	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.
Petroleum Act 2016	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

Act / Instrument	Summary
	to develop petroleum production so that the optimum value of the resource is returned to the NT. The Act is supported by the Petroleum Regulations (Regulations) and the Schedule of Onshore Petroleum Exploration and Production Requirements 2012 (Schedule). The 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 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, Regulations and Requirements are administered by the Northern Territory Petroleum 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.
Petroleum (Prospecting & Mining) Regulations 2001	Provides that annual rent prescribed by the Petroleum Act is increase to cover GST in respect of a period after 30 June 2000.
Planning Act 2017	Provides for appropriate and orderly planning and control of the use and development of land. The Act establishes the NT Planning Scheme and provides for a development approval process, provides for interim development control, provides for an appeals regime and enforcement and establishes the Development Consent Authority.
Plant Health Act 2015	The objects of this Act are to ensure appropriate actions can be taken for the control of pests and to facilitate the production and trading of plants and plant products that are free from pests.
Public and Environmental Health Act 2016	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.
Schedule of Onshore Petroleum Exploration & Production Requirements 2017 (under the Petroleum Act 2016)	Petroleum titleholders are directed to comply with the Schedule of Onshore Petroleum Exploration and Production Requirements 2017 ("Schedule") under Sections 71 and 72 of the Petroleum Act. The Schedule provides general requirements for safety and systems integrity, drilling, well re-entry and workover operations, production operations, geophysical and geological surveys and the reporting requirements for petroleum interests
Soil Conservation and Land Utilisation Act 2016	Makes provisions for the prevention of soil erosion and soil conservation and reclamation. It also 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 2014 (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

Act / Instrument	Summary
	not be developed. Flora and fauna can also be declared as threatened species under the Act.
Waste Management and Pollution Control Act 2016	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 Act does not apply within the petroleum permit area.
Water Act 2016	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. The Water Act currently exempts gas companies from the need to get a water extraction licence under the Water Act, but is currently undergoing reform, and a water extraction licence may be required in the future.
Weeds Management Act 2013	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 land holders, land managers and land users must comply with the declaration classification. The following are the three classes of declared weeds in the NT: All Class A and Class B weeds are also Class C weeds.
Work Health and Safety (National Uniform Legislation) Act 2014	The 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.

2.2 Relevant Agreements and Operating Consents

A number of agreements and operating consents are required prior to commencement of the activity. Santos will ensure that CLC (Central Land Council) Agreements and Landholder Access and Compensation Agreements have been identified, obtained and are in place prior to commencement of on ground activity.

Santos has an Indigenous Land Use Agreement for EP-112 and EP-125, signed on 18 July 2007. This agreement, between the Central Land Council and Central Petroleum Ltd, Helium Australia Pty Ltd, Frontier Oil and Gas Pty Ltd and Ordiv Petroleum Pty Ltd, refers to obligations under the *Native Title Act 1993* (Cth). It details financial obligations payable to the CLC for exploration and production activities in addition to other obligations including; CLC expenses, notification of activities, Advisory committee, employment, training and business opportunities, and instruction on Aboriginal culture.

2.3 Codes of Practice and Relevant Guidelines

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).
- Northern Territory Government Petroleum (Environment) Regulations: Explanatory Guide (1 December 2017).

2.4 Further referral of the project

2.4.1 Referral under the Environmental Protection and Biodiversity Conservation Act 1999

The *Environmental Protection and Biodiversity Conservation Act 1999* provides for the protection of the environment and conservation of biodiversity, particularly matters of national environmental significance. 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. It is considered that the proposed activities will not adversely impact MNES. Therefore, the project has not been referred for assessment and approval under the EPBC Act.

2.4.2 Referral under the Environmental Assessment Act (EA Act)

Petroleum activities that could reasonably be considered to be capable of having a significant effect on the environment are referred to the NT Environment Protection Authority (NTEPA), pursuant to Section 7 of the Environmental Assessment Act (EA Act). Using the NTEPA guideline REFERRING A PROPOSAL TO THE NTEPA: A guide for proponents and referral agencies, a detailed review of and assessment against each prescribed environmental objectives for each environmental factor was conducted in relation to the Dukas-1 exploration well project (the proposed activity) and is tabulated below. It is evident from this review that referral to the NTEPA is not required as the Dukas-1 well is unlikely to have the potential to have a significant effect on an environmental factor.

Table 3: NTEPA Environmental Factors and Objectives Assessment

Environmental Factor	Significant Effect	Environmental Objective	Relevance to the Application
LAND			
Factor 1. Terrestrial Flora and Fauna	×	Protect NT's flora and fauna so that biological diversity and ecological integrity are maintained.	As described throughout Section 5.2, the proposed activities are likely to result in only minor localised impacts to non-sensitive vegetation, and have the potential to result in only occasional localised impacts to native fauna through planned atmospheric emissions, light emissions, noise and physical disturbance; and unplanned chemical spills and leaks, fauna interactions, fire, introduced pests, and waste and chemical spills and leaks. The control measures outlined in Section 5.2, particularly those to mitigate the impacts of, physical disturbances, introduced pests and fauna interaction, will be employed to ensure these risks and impacts are managed and further mitigated. Accordingly, biological diversity and ecological integrity will be protected and biological diversity and ecological integrity will be maintained.
Factor 2. Terrestrial Environmental Quality	×	Maintain the quality of the land and soils so that environmental values are protected.	As described in Section 5.2.1 and 5.2.2, the proposed activities have the unlikely potential to result in localised medium term disturbance to land and soil resources through planned physical disturbance; and unplanned, chemical spills and leaks and waste. The control measures outlined in, Tables 32, 41 and 61 will be employed to ensure these potential risks and impacts are managed and further mitigated. Given this, and that the area of actual ground disturbance proposed is relatively small, the quality of the land and soils values are protected maintained and protected.
Factor 3. Landforms	×	Conserve the variety and integrity of distinctive physical landforms so that environmental values are protected.	The project area occurs in Dunefields with parallel linear dunes, reticulate dunes and irregular or aligned short dunes. The flat to undulating sandplains with low reticulate dunes become more frequent in the northern region. Given the extensive occurrence of the dunefields landform in the region, the minimal size of the project footprint and the control measures outlined in Section 5, 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			
Factor 1. Aquatic Ecosystems	×	Protect aquatic ecosystems to maintain the biological diversity of flora and fauna and the ecological functions they perform.	As discussed in Section 4.2 and 4.3, there are no watercourses within the project area. Given this lack of watercourses and terrestrial GDEs in the project area vicinity, the minimal vegetation clearing required and the small scale of proposed disturbance it is unlikely aquatic ecosystems will be impacted by the proposed activities. Furthermore, the general control measures outlined in Section 5, particularly the controls to manage waste and reduce risks and impacts of unwanted chemical spills, will be employed to ensure potential risks and impacts are managed and further mitigated. Accordingly, there would be no potential for a significant effect on aquatic ecosystems.

Environmental Factor	Significant Effect	Environmental Objective	Relevance to the Application
Factor 2. Inland Water Environmental Quality	×	Maintain the quality of groundwater and surface water so that environmental values including ecological health, land uses, and the welfare and amenity of people are protected.	As discussed in Section 4.2 and 4.3, the proposed activities have the unlikely potential to result in localised and short term disturbance to inland water quality through unplanned chemical leaks and spills and waste management. Given the lack of surface waters, in conjunction with the controls outlined in Table 41 and 61 to mitigate chemical leaks and spills and waste (including limiting the quantity of chemicals brought to site), 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.
Factor 3. Hydrological Processes	×	Maintain the hydrological regimes of groundwater and surface water so that environmental values are protected.	As discussed in Section 4.2 and 4.3, it is unlikely hydrological regimes of ground waters or surface waters will be altered by the proposed activities, given 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 the lack of permanent surface waters in the project area vicinity. Furthermore, the control measures outlined in Tables 36, 41 and 59 will be employed to ensure that these potential risks and impacts are managed and further mitigated. Accordingly, hydrological processes will be maintained.
SEA			
Factor 1. 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, benthic communities and habitats, marine environmental quality and coastal processes.
Factor 2. Benthic Communities and Habitats		Protect benthic communities and habitats so that biological and functional diversity and ecological integrity are maintained.	
Factor 3. Marine Environmental Quality		Maintain the quality and productivity of water, sediment and biota so that environmental values are protected.	
Factor 4. Coastal Processes		Maintain the geophysical and hydrological processes that shape coastal morphology so that the environmental values of the coast are protected.	
AIR			

Environmental Factor	Significant Effect	Environmental Objective	Relevance to the Application
Factor 1. Air Quality and Greenhouse Gases	×	Maintain air quality and minimise emissions and their impact so that environmental values are protected.	As described in Section 5.2.1.1, the proposed activities have the potential to result in localised, short term minor impacts to air quality through planned atmospheric emissions that will be negligible. The control measures outlined in Table 20, will be employed to ensure these potential risks and impacts are managed and further mitigated. Given this, and the relatively small nature of operations, the proposed activities would maintain air quality. Accordingly, there would be no potential for a significant effect to air quality and greenhouse gases.
PEOPLE AND COMMUNITIES			
Factor 1. Social, Economic and Cultural Surroundings	×	Protect the rich social, economic, cultural and heritage values of the Northern Territory.	As described throughout Section 5.2, the proposed activities have the unlikely potential to result in disturbance to culturally sensitive sites and/landholders through noise, physical disturbance, chemical spills and leaks, disturbance to stakeholders, fire and introduced pests. The control measures outlined in Section 5.1 and 5.2, will be employed to ensure that these potential risk and impacts are managed and mitigated. Furthermore, as the areas proposed to be disturbed have been surveyed for sacred sites and cultural heritage significance, the risk of impacts to any sites of cultural significance has been mitigated. Given this, and the relatively small nature of operations and proposed actual ground disturbance, the proposed activities will protect the social, economic, cultural and heritage values of the Northern Territory.
Factor 2. Human Health	×	Ensure that the risks to human health are identified, understood and adequately avoided and/or mitigated.	As described in Section 5.2.2, the proposed activities have the unlikely potential to result in human health impacts if humans consume surface water or groundwater contaminated due to unplanned waste and chemical leaks and spills, or through poor waste management. The control measures outlined in Section 5, Tables 41 and 59 will be employed to ensure that these potential risks and impacts are managed and further mitigated. Accordingly, there would be no potential for significant effect to human health.

3.0 Description of the Activity

3.1 Overview

NT Exploration Permits 112 and 125 are located in the Amadeus basin in the south of the Northern Territory (refer to **Figure 2**). Santos is the operator of EP 112 and proposes to drill the Dukas-1 exploration well in EP 112. The access track and supporting infrastructure such as borrow pits required for this activity will occur across both EP 112 and 125. The objective of the Dukas-1 exploration well is to obtain sub-surface geological and petrophysical data to:

- Determine if a hydrocarbon accumulation is present in the deep subsurface at the well location
- Build on the regional technical understanding of the Amadeus Basin
- Further evaluate petroleum prospectivity within the permit.

A location and infrastructure plan for the Drilling program is shown in **Figure 4** and the well layout plan for Dukas-1 is shown in **Figure 5**. Key activities for the drilling of the Dukas-1 well include:

- Civil works
- Water extraction and storage
- Drilling activities, including formation evaluation (open hole or cased hole wireline)
- Wellbore seismic evaluation (e.g. vertical seismic profiling or checkshot surveying)
- Production testing (drill stem test, extended production tests)
- Well integrity monitoring.

The estimated total project footprint is approximately 87 ha (or 0.0062% of the total area of EP 112). The project extent of the footprint by activity is shown in Table 4 below.

Table 4: Project Disturbance Footprint by Activity

Activity	Project Footprint (ha)	Estimated Disturbance Area (ha)
Access Track	31.8	10.32
Borrow Pits	46.8	46.8
Laydowns	1.0	0.7
Well Lease Pad	1.8	1.8
Camp	4.6	4.6
Water Bore Pads	1.0	0.5
Total Project Footprint	87.0	64.72

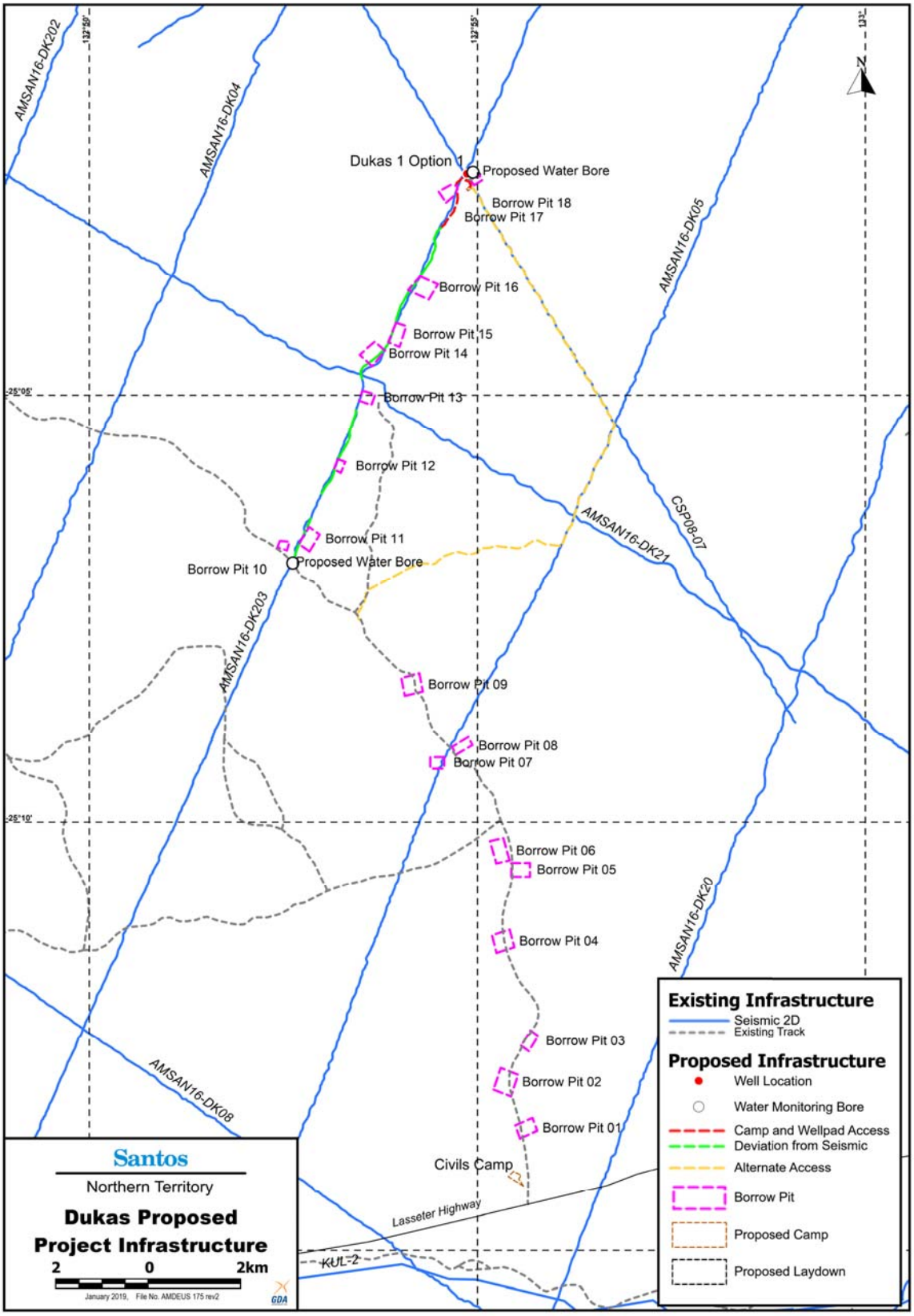

Figure 4: Proposed Project Infrastructure

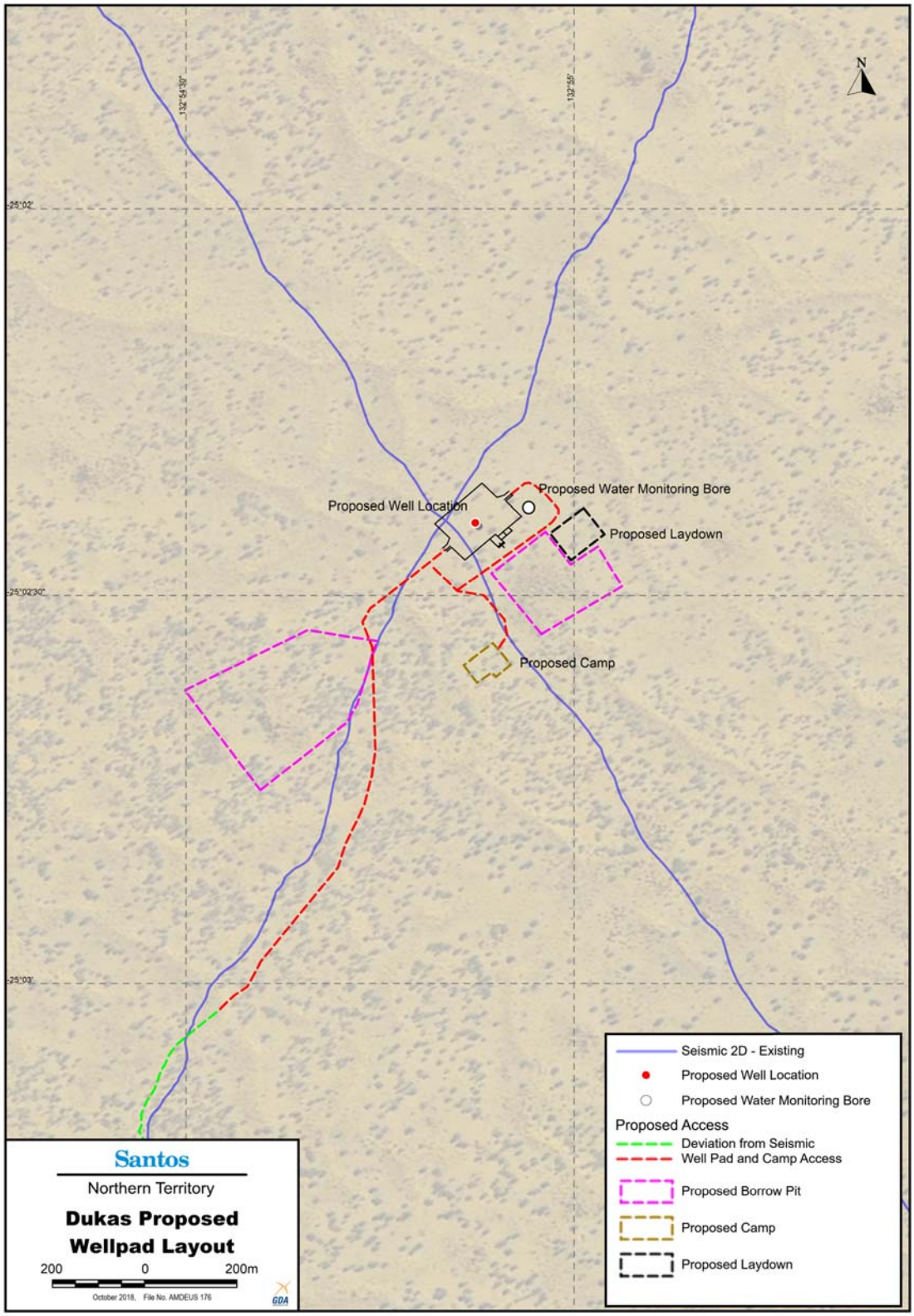

Figure 5: Well Layout for Dukas-1

3.2 Project Staging

The project will be run in two stages. Stage 1 consists of preliminary civil works and water bore drilling required to facilitate the installation of two water supply bores, one being at the Dukas-1 location. If the drill site water bore encounters water in the shallow subsurface, a baseline water data set will be acquired prior to the drilling of the Dukas-1 exploration well. Stage 2 consists of all activities associated with the drilling and competition of the Dukas-1 exploration well, as well as well suspension, maintenance and rehabilitation works.

3.3 Duration and Timing

The project is scheduled to be undertaken in 2019. An indicative project schedule is provided in Table 5.

Table 5: Indicative project schedule

Stage	Activity	Estimated Duration	Estimated Timing
Stage One	Civil works	6 weeks	January-February 2019
	Water bore installation	2 weeks	January 2019
Stage Two	Mobilisation of drilling equipment	4 weeks	February-May 2019
	Drilling and Completion of well	9 weeks	February-May 2019
	Well Suspension	< 1 week	April-May 2019
	Demobilisation of equipment	2-4 weeks	April-May 2019
	Well Testing	12 weeks	June-August 2019
	Rehabilitation post well completion	1-2 weeks	May-June 2019
	Rehabilitation post decommissioning of infrastructure/site	2-4 weeks	• Commence within 12 months of decommissioning
	Post-rehabilitation monitoring	2 weeks per monitoring event	• Immediately after well completion • Immediately after rehabilitation works completed post decommissioning • Following first wet season • One year after rehabilitation • Three years after rehabilitation

The project will operate seven days a week. Civil works, mobilisation and demobilisation of equipment, rehabilitation and post-rehabilitation will take place in daylight hours only, however the drilling and completion of the well and associated suspension and well testing scope will be carried out 24 hours a day.

3.3.1 Civil works

The civil activities required for the proposed drilling program are:

- Vegetation clearing
- Construction and upgrade of approximately 27 km of access track from Lasseter Highway to wellsite

- Construction of borrow pits (18 potential borrow pit areas have been identified)
- Site preparation including vegetation clearing and site establishment for a wellsite, construction of fenced pits, and signage
- Site preparation for two laydown areas for equipment storage and campsite
- Upgrade of existing water bores and potential construction of two new water bores
- Construction of firebreaks

Ongoing maintenance will be required to maintain the roads, campsite, laydown areas and wellsite consisting of grading, watering (sourced from bores) and minor patching.

3.3.2 Access road

A 27 km access road from the Lasseter Highway to the Dukas-1 well location will be constructed. Approximately 17 km of this road is an existing access track built by the landholder. The remaining 10 km of road will consist of new track or be located on existing seismic tracks. The length (km) of each access track type is provided in Table 6 and the location of the access track is shown in **Figure 4**.

Table 6: Access track type

Access track type	Length (km)
Existing Landholder Access Track	16.7
New track	8.6
Existing Seismic line	1.6
Total Project Footprint	**26.9**

3.3.2.1 Existing Landholder Access Track

The first four km is owned by the Erldunda Stations, after which a very narrow gate is passed where the Mt Ebenezer Station is then entered. The first six km is in relatively good condition, however, after 6.0 km, majority of the road requires capping. There are a number of low dune crossings, and soft corners. At approximately 8.7 km “New Bore” is located, and additionally sharp corners which go around the Landowners stockyards and at approximately 14.7 km along this access road, there is a large - intersection.

3.3.2.2 Seismic Track and New Track

Access includes using the existing DK203 seismic line. Access extends from where DK203 intersects the existing landholder track up until the Dukas-1 well location (See **Figure 4**). Work on the junction will be required to widen and create a T-intersection. This section of the access track is uncapped, and very soft sand. There are a number of high dune crossings and where final road location should deviate from the original seismic shot line to avoid high dune crossings or desert Oaks is shown in in **Figure 4**.

The final alignment has been selected to minimise damage to priority trees (Desert Oaks) and reduce the number of dune crossings. A second alternate access route is shown **Figure 4**. However, use of this alternate access is unlikely.

The track will be constructed to Santos Class C specification. A typical class C road cross section is shown in **Figure 6**. The Class C specifications require:

- Clearing, grubbing and stripping of full depth (min 100 mm) of topsoil within the road right of way
- Side batter slopes shall be 4 horizontal to 1 vertical in cut and fill.
- Formation elevated to provide stable running surface no provision for drainage
- Average width of disturbance including cut and fill is 12 m. Proposed road surface widths are normally six metres, extending to eight metres where sand dune, culvert, or floodway are traversed.

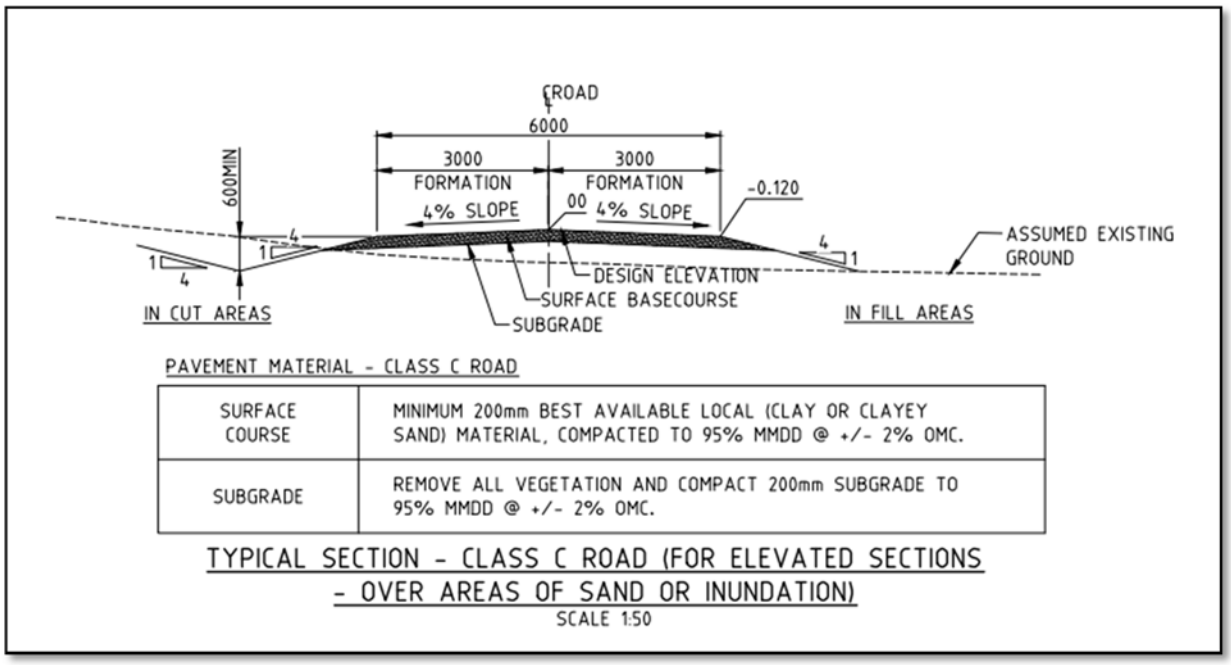

Figure 6: Typical Road Cross Section (Class C)

The access road will be constructed with sufficient width to enable the safe ingress/egress of the rig and associated equipment, materials and service vehicles.

Turn around points for construction & road maintenance plant will be required along the proposed access road. The turnarounds will not be capped with clay, and compacted areas will be scarified to promote vegetation re-growth at completion of works. Turnarounds will be sited along the access road at borrow pit locations and track intersections at a frequency of approximately every 2km.

During access track construction, care will be undertaken to maintain or restore surrounding surface drainage and to install erosion control structures where required.

Preliminary speed limits were discussed with the Landowners, these are proposed in Table 7. Road signage will need to be included in the scope of works to include these speed limit signs, and also some additional “Junction” and “Sharp Corner” signs. These limits have been defined with the following in mind:

- road condition;
- potential presence of livestock;
- road width (~ 6 m wide, i.e. one lane); and
- frequency of turns and bends.

These limits can be further confirmed and defined once the final condition of the road has been assessed.

Table 7: Proposed Speed Limits on Access Roads

Area / Vehicle	Speed limit
Light Vehicle- All Roads	60 km/hr
Trucks/Heavy Vehicles – All Roads	40 km/hr
Around Stock Yards (give way to stock)	20 km/hr

3.3.3 Borrow Pits

Borrow pits will be a maximum area of 2.5 ha each (approximately 250 m x 100 m), with a 200 m access road. The locations have been selected to minimise disturbance to vegetation and significant trees, minimise the amount of overburden and for optimal quality and quantity of material available. Where appropriate, existing facilities will be utilised in preference to creating a new borrow pit. Eighteen potential borrow pits have been identified adjacent to the access road between Lasseter Highway and the Dukas-1 well site. It is expected that approximately:

- 5,000 m^3 of material will be required for the construction of the wellsite pad
- 28,000 m^3 of material will be required for the construction of the access road
- 10,000 m^3 of material will be required for the laydown areas and campsite.

Borrow pits will be constructed with a maximum horizontal: vertical slope of 3:1 and a maximum depth of 3 m. Any removed topsoil, vegetation and seed stock will be stockpiled separately. Stockpiled topsoil can be used as the diversion bund if required.

3.3.4 Wellsite Pad

A larger area will be surveyed to allow the wellsite pad to be sited to minimise the amount of vegetation to be cleared and the amount of cut and fill required. The wellsite pad is approximately 120 m x 150 m. It will have dual access and loop roads and will require cut to fill to between 2 – 4 m. On the wellsite pad, a well cellar will be installed with a cement floor and a conductor pipe into the hardstand. A second cellar and conductor pipe will be installed for well re-spud if this becomes necessary during the early stages of drilling. A plan for the Ensign well rig layout, with shows details of the rig, site camp, flare pits and sumps is included in Appendix A. Other civil works at the wellsite pad that may be required to support the drilling program include:

- Drilling of a new water bore casing screens and headworks supply, surface equipment and construction of a 30 m x 30 m clay or plastic lined holding ponds for storage and loop road for access. A licenced water bore driller will undertake drilling of the water bore, in accordance with the Water Act 2018, and the minimum standards and good industry practice provided by *Minimum Construction Requirements for Water Bores in Australia* (Australian Government National Water Commission, 2012) including the isolation of overburden formations with steel surface casing, steel production casing, and cement. The water bore will be registered.
- Levelling of the campsite area (approximately 90 m x 60 m)

- Excavation of cuttings pit and liner installation
- Excavation of flare pit
- Excavation of small pit if required to contain the seismic source for wireline seismic evaluation
- Level and cap of one 100 m x 100 m dual access laydown area

The wellsite pad, access roads, campsite and laydown areas will be capped with compacted clay.

Pits will be of sufficient volume to contain discharges and will be located to not interfere with the surface drainage systems. The Bureau of Meteorology's historic rainfall data at the Alice Springs Airport indicates highest recorded monthly rainfall is 357mm (March 1983). The freeboard on the pits would exceed this level at all times. Given the annual evaporation rate is >2,800mm, this level of freeboard is conservative.

Holding ponds will be constructed with compacted clay and lined with a High Density Polyethylene (HDPE) liner. The purpose of these ponds is to store the required volumes of water for project activities (civil works, drilling and camp use).

3.3.5 Other supporting infrastructure

Other civil works that will be required to support the drilling program (as shown in **Figure 4** and **Figure 5**) include:

- level and cap of an additional 100 m x 100 m dual access laydown areas on the existing seismic camp site
- use of existing cleared laydown areas
- construct and/or repair holding ponds and loop roads around 2 existing water bores ("Sandy Bore" & "Lost Bore") suitable for Road Train access (approximately 1 km around each bore)
- a new water bore close to Borrow Pit 10 (See **Figure 4**). This bore will have an estimated 150 m depth casing screens and headworks supply, surface equipment and construction of a 30 m x 30 m clay or plastic lined holding pond for storage and loop road for access. A licenced water bore driller will undertake drilling of the water bore, in accordance with the Water Act 2018, and the minimum standards and good industry practice provided by *Minimum Construction Requirements for Water Bores in Australia* (Australian Government National Water Commission, 2012) including the isolation of overburden formations with steel surface casing, steel production casing, and cement. The water bore will be registered.

3.4 Drilling and Completion activities

3.4.1 Drilling of the well

The well will be drilled using a water-based mud or air with foam additives as required to suit formation properties. The well will be drilled to a notional total depth of ± 4200 metres below ground level (mbgl). The well will be drilled using an Ensign Australia Ltd ADR 1500 drilling rig and the Material Safety Data Sheets for all the chemicals will be provided as part of the Drilling Project Applications to the DPIR.

The proposed Dukas-1 well is prognosed to intersect a thin veneer of surficial alluvium material. Underlying the surficial cover, the Pertnjara and Pertaoorta group sediments are expected to be present above the main Petermann Unconformity expected at 500-800 mbgl. Neoproterozoic age formations are expected below the Petermann Unconformity.

The primary target of Dukas-1 well is the Heavitree Formation which is prognosed to range from ±3200 m to ±3700 m depth. The well will reach a total depth of ±4200 mbgl, after intersecting basement rocks.

3.4.1.1 Drill cuttings

The formation cuttings are lifted out of the hole by the drilling fluid (mud or air) which is pumped down the inside of the well.

Cuttings during the underbalanced drilling process will be ejected down the blooie line to the cuttings/flare pit. If an overbalanced fluid is utilised (for example to mitigate a subsurface drilling hazard) then the drilling fluid returns will go through a shale shaker to separate the cuttings from the drilling mud, with cuttings ejected into a skip for disposal into the cuttings pit.

The exact amount of drill cuttings produced is dependent upon a number of factors, including the depth and diameter of the hole being drilled, however approximately 260 m^3 is anticipated.

Given the local geology it is unlikely substantial organic rich rocks (which tend to be where metals and/or radioactive elements are concentrated) will be encountered, and is expected to be <2% of the total cuttings. Halite (NaCl) may be encountered in the deeper sedimentary succession, and final concentration in the drill cuttings may be up to 10%.

However a precautionary principle has been applied and the drill cuttings will be stored in a lined sump. The sump will be lined with a HDPE liner. Baseline soil sampling will occur prior to the production of drill cuttings and sampling of the sump fluid post drilling will occur and inform rehabilitation measures.

When drilling and associated activities have been completed on the site, the sumps and flare pit are left to dry out before backfilling. Testing of the cuttings will be undertaken to determine suitability for backfilling, or if removal and offsite disposal is required. The decision on disposal of the sump contents will be made in consultation with, and on the advice of, an independent environmental consultant.

3.4.1.2 Associated Water

During underbalanced drilling, any water will be initially produced down the blooie line into the cuttings/flare pit. Production of water will be minimised by either balancing formation pressure with sufficiently using a foam fluid, or using an overbalanced drilling fluid (water-based mud).

Santos' sustainable approach to water management revolves around a hierarchy of avoidance and reduction using advanced rig technologies and reduction and recycling through use of the associated water for dust suppression, civil works and drilling activities where water quality is suitable. Where required, water will be treated prior to reuse or responsible disposal to evaporation pits.

3.4.1.3 Drilling mud composition

There are various drilling fluid systems used in the oil and gas industry. The term 'mud' is frequently used interchangeably with the term 'fluid'. The term 'mud' is used because of the thick consistency of the fluid system. In general, drilling muds are used during the drilling of oil or gas wells to:

- Carry cuttings from the hole
- Cool and clean the drill bit
- Reduce friction
- Maintain the stability of the bore
- Maintain down-hole hydrostatic pressure
- Prevent damage to the formation.

Drilling fluids used are water based, a homogenous blend of water, clays and other chemical additives. Additives used have various purposes such as:

- Treating bacteria
- Adjusting pH
- Controlling viscosity
- Reducing fluid loss to the formation
- Inhibiting equipment corrosion.

It is not necessary to use all of these chemicals for every well. Specific chemicals are selected during drilling, depending upon the particular requirements or any difficulties encountered. Of the total volume used, only small volumes are lost to the formations due to the filter cake properties of the mud. Drilling fluids are recirculated through the mud system on the drill rig during drilling operation and are disposed to the sump when operations are complete. Drilling muds will be formulated in-situ by mixing the different additives in a dedicated above-ground storage tank.

All chemicals used in Australia must be approved for use by the Commonwealth Government, Department of Health and listed on the Australian Inventory of Chemical Substances which is maintained under the National Industrial Chemicals Notification and Assessment Scheme. No drilling muds or additives that are used in the process contain benzene, toluene, ethylbenzene and xylene.

Where possible the well will be drilled underbalanced to facilitate faster drilling rates, with air or foam as the hole cleaning medium. If mud is required, the proposed drilling mud is comprised of predominately water with the remaining made up of salts and fluid additives. It is anticipated that approximately 1 ML will be required. The Material Safety Data Sheets for all the chemicals will be provided as part of the Drilling Project Applications to the DPIR.

3.4.2 Well logging and flow testing

Where possible, drill core and/or cutting samples will be collected for geological assessment and analysis. Wireline logs will be acquired over the open hole section as per Santos and Northern Territory Government requirements.

Flow testing may be conducted with the drilling rig on location prior or post open hole logging activities. If successful reservoir results are seen, then the well will likely be put on extended flow test for 90 days to determine the deliverability of the reservoir. This will include monitoring of flow rates, pressure and temperatures during the flow testing. The specific requirements and details of both the short-term flow test with the rig on site and the 90 day extended flow test are detailed below

Flow test with rig onsite:

- Short term (<2 days) gas flow testing with the rig onsite will be via the blooie line into the flare pit.
- Bentonite is currently used as a leachate barrier in landfill and as a pond or dam base liner – it provides an effective impermeable barrier, minimising the passage of the wetting front in the flare pit
- A bentonite compacted liner will be installed in the flare pit to provide an effective impermeable barrier. The liner will be repaired if gaps form (refill with bentonite and wet)
- Low levels of condensate will be flared (maximum 2 day flow test) and no flow test will be undertaken in the extremely unlikely event that oil is encountered.
- Testing of cuttings in the flare pit will be undertaken to determine suitability for backfilling, or if removal and offsite disposal is required. The decision on disposal of the flare pit contents will be made in consultation with, and on the advice of, an independent environmental consultant.

90 day flow test:

- Flow during the 90 day flow test will pass through a three phase separator. High volumes of condensate are not expected. The current plan is for a condensate tank with a capacity of ~100 barrels (15,000 litres). If well results indicate a higher condensate composition than currently expected, or the presence of an oil zone in the reservoir, additional onsite tank storage capacity will be arranged for the 90 day flow test. Any condensate or oil produced will be transported to a treatment facility.
- The water storage tanks associated with the flow test spread have a capacity of approximately 1000 barrels (~160,000 litres).
- Suspension fluid totalling a maximum 200 barrels (~32,000 litres) will be produced at the commencement of the flow period.
- Water of condensation for the anticipated reservoir conditions is < 1 barrel (159 litres)/million standard cubic feet of gas produced. Assuming a high case gas flow rate of 10 million standard cubic feet of gas per day, this equals a maximum 900 barrels (~143,000 litres) of water over the 90 day flow period.
- During the flow test produced water will be managed using the water storage tanks and lined sump. If onsite storage is filled the well will be shut in until the fluid is removed from site for disposal at an approved treatment facility, and onsite storage capacity is restored.
- During the flow test oil will be handled in the same way as condensate. A low volume of oil production can be trucked to Moomba. In the unlikely event a high volume of oil is produced, the well will be shut in, and the flow test terminated. In the case of material and sustained formation water production, the flow test will be terminated.
- Recovered fluids will be sampled and analysed.
- At the end of the flow test, produced water in the storage tanks will be transferred to the lined sump for evaporation.

3.4.3 Zero-Offset VSP

The wireline logging program may include a zero-offest W vertical seismic profile (VSP) or checkshot surveying. These geophysical techniques are similar to surface seismic exploration, but where the detectors (geophones) are located in the well bore, rather than at the surface, and the surface source is stationary.

The geophone array comprises one to several geophones on a wireline. The surface seismic energy source is either an airgun (in a water filled drum and pit) or a small vibrator truck located as close as is safe and practical to the well bore – hence “zero offset”. The geophone array is run to the bottom of the hole on the wireline, and is then moved up the hole at regular intervals (e.g. 15 meters) and the stationary surface source is triggered. The geophones record the time it takes for the seismic energy from the surface source to arrive downhole at the geophone. The data recorded provides accurate velocity information and is processed to produce a seismic wavelet well-tie, such that the well can be “tied” to the 2D seismic line on which it is located.

The location of VSP checkshot within the lease pad as well as a cross section of the VSP pit is detailed within the lease design provided in Appendix A. For this project, only one single pit is required.

3.4.4 Well suspension / plugging and abandonment

The well is an exploration well with uncertainty on reservoir outcome. The following activities may occur post logging evaluation:

- The well will be suspended with open hole completion and then put on extended flow test if a successful reservoir outcome is achieved. Subsequently the well will be suspended; or
- The well will be suspended with cemented liner completion for future re-entry; or

- The well will be decommissioned with permanent cement plugs installed in the well as per regulatory requirements.

As part of the well suspension process, wellbore barriers will be put in place as per Santos and Northern Territory regulatory requirements. A well integrity monitoring plan will be put in place for any suspended well for monitoring of wellbore barriers. Once suspended the well pad will be decreased in size to facilitate natural rehabilitation and revegetation process.

As part of well decommissioning process, cement plugs will be permanently placed in the well, the wellhead removed, leases and roads rehabilitated and signed properly as per Northern Territory regulatory requirements.

3.4.5 Site Rehabilitation Activities

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 requests infrastructure to remain in place, the proposed infrastructure must be signed off with both the Pastoral land board and the DPIR. Otherwise, after well suspension, the following activities will be undertaken:

- Removal and off-site disposal of pit liners
- Removal of fencing
- Back filling of pits, specifically:
    - Cuttings pits to be levelled off, mixed with dry stockpiled fill material and capped with at least 750 mm of dry stockpiled fill material;
    - Flare pit filled with stockpiled fill material
    - Water bore holding ponds to be drained of liquids
- Removal of steel cellar box and backfilling of the drill cellar
- Lightly scarifying or rolling all disturbed areas to break up consolidated surfaces
- Spreading of stockpiled topsoil material and trees, shrubs and grasses across the lease pad and areas not needed for future monitoring and maintenance.
- Ripping and spreading of stockpiled vegetation 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.

All rehabilitation activities including the plugging and abandonment will be conducted in accordance with DPIR's Environmental Closeout Procedures for Petroleum Activities. A third party rehabilitation document is required as part of these procedures.

3.4.6 Rehabilitation Monitoring Activities

Photo points are established at the wellsite, laydown areas, campsite, borrow pits and at nominally 5 km intervals along the access road to document pre-disturbance and post-restoration condition. Each photo point is geo-referenced and is captured digitally to ensure consistency. By establishing a number of photo points, it provides a balanced representation of the various landform and vegetation types encountered and enables rehabilitation success to be effectively monitored.

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

3.5 Operations Support Facilities

3.5.1 Campsite

A campsite will be required to provide accommodation for the operations personnel. The camp is located adjacent to the lease pad, borrow pits and laydown areas, approximately 200m from the proposed Dukas-1 well. The camp accommodation in the project area may include:

- One temporary 16 person camp for civil activities located at the previous seismic campsite or
- One 40 person camp for drilling activities at the wellsite.

The drilling campsite requires approximately 90 m x 50 m and will be located at the wellsite, as shown in **Figure 5**. Domestic wastes generated at the temporary campsite require storage prior to transportation for recycling or disposal to a licensed waste management facility. Storage will consist of 4-6 covered skip bins located adjacent to the camp area. The sealed bins will be transported regularly for waste disposal at the Alice Springs Town Council Waste Depot, with contaminated waste (including oil, etc) being disposed via Cleanaway, also in Alice Springs. Waste streams will be segregated onsite where appropriate to maximise opportunities for waste recovery, reuse and recycling. Rubbish loads are covered during transport, and additional skip bins will be sought as and if required.

The temporary camp will be equipped with a fully self-contained sewage treatment plant (STP) 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.

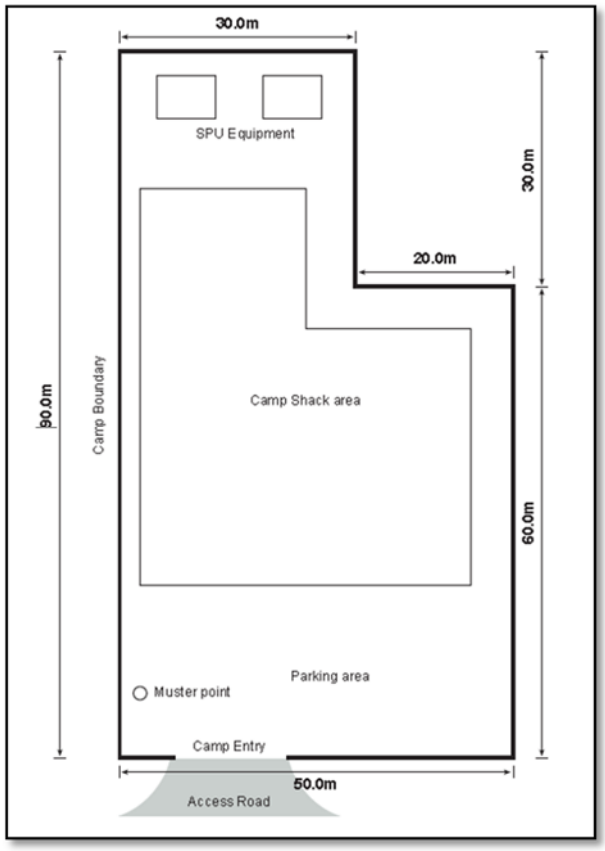

Figure 7: Ensign Camp Detail Plan

3.5.2 Waste Management

Domestic and industrial waste will be disposed by using the methods outlined in **Table 8**. Key waste contractors and waste disposal locations are listed in **Table 9**. If waste contractors and/or waste disposal locations not listed below are utilised, Santos will ensure these contractors and disposal locations are NT EPA licensed for the appropriate waste material.

Table 8: Waste and Disposal method

Type of waste	Waste Type	Disposal Method
Domestic Waste	Sewage & Grey Water	Onsite treatment with portable treatment systems prior to irrigation to land in accordance with the *Public and Environmental Health Regulations 2018* Sludge removed from site and disposed of at an appropriately licenced facility
	Food waste, paper and plastic	Collected at rig/campsite for disposal to approved landfill
	Glass and cans	Collected at rig site for transport to approved receiving or recycling facility
Industrial Waste	Chemical bags and cardboard packaging materials	Compacted and collected at rig site for disposal to approved landfill
	Scrap metals	Collected in designated skip for transport to approved receiving or recycling facility
	Used chemical and fuel drums	Collected in designated skip for recycling
	Chemical wastes	Collected in approved containers for disposal at approved landfill
	Timber pallets (skids)	Collected at site and recycled or disposed of at approved landfill
	Vehicle tyres	Shredded and disposed to approved landfill
Drilling Activity Waste	Oily rags, filters	Collected in suitable containers for disposal at approved landfill
	Drilling cuttings (cuttings mixed with drilling fluids)	Cuttings burial or removal subject to sampling results. The decision on disposal of the sump contents will be made in consultation with, and on the advice of, an independent environmental consultant and DPIR (see Section 3.5.2.1 below)
	Associated water (groundwater mixed with drilling fluids)	Refer to text above

3.5.2.1 Testing of Sumps/Pits

Following the sampling results, a decision on disposal of the sump contents will be made in consultation with, and on the advice of, an independent environmental consultant who will provide pre-blend toxicity volume estimates and a post blend toxicity assumption. All mud sump sampling is to have the chemical data and reports sent to the DPIR before backfilling and mixing to occur. Should the mixing occur and the chemical data interpretation from the 3rd party say applicability is not acceptable for the environment, then, the contents of the mud sump will be disposed of by a company licensed to handle and dispose of this waste and all affected areas will be remediated.

Table 9: Waste Contractors and Waste Disposal Locations

Type of Waste	Waste Contractor	Disposal Location
General and food	JJ Richards	Alice Springs, NT
Empty IBCs	JJ Richards	Alice Springs, NT
Metal and plastic drums	JJ Richards	Alice Springs, NT
Waste material	Alice Metal Recyclers	Alice Springs, NT
Batteries and tyres	Cleanaway 6	Alice Springs, 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.	

3.5.3 Water Supply and Use

Water for the program will be sourced from two exiting water bores, “Sandy bore” (RN012340) and “Lost bore” (RN015829) on the Mt Ebenezer Station; and two new water bores will be drilled as part of the civil works program. In selecting the location for the water bores, the following parameters have been considered:

- Proximity to proposed well location
- Proximity to areas of proposed borrow pit or campsite
- Proximity to existing water bores (i.e. known water supply).

Locations are pending detailed on-ground inspection and approvals for cultural heritage and sacred site clearances and environmental suitability.

Water will be stored at the bore in the fenced holding ponds and then trucked to the wellsite pad where it will be stored in tanks before use in the drilling campaign. It is anticipated that 27.5 ML of water will be required for the entire civil works and drilling program. Of that, 0.72 ML of water will be required for camp use (based on approximately 200L/day/person over expected maximum duration of 90 days of the drilling program). A breakdown of the water use volumes is provided in **Table 10**. The water required for the project will be sourced from four potential water bores:

- Sandy Bore (RN012340)
- Lost Bore (RN015829)
- New Bore 1 (RN TBC)
- New Bore 2 (RN TBC)

The exact water consumption and extraction volume breakdown between water bores will depends on results following the completion of the new bore/s and is unknown at this stage.. More detailed water consumption and extraction amounts will be submitted to DPIR upon completion of the drilling program.

Table 10: Estimated Water Use Volumes

Use	Scope	Feb	Mar	Apr	May	Total Use
Civil - Access	Upgrade and maintenance of pastoral access roads	5	3	3	2.5	13.5
Civil - Well Lease Construction	All enabling works for Dukas-1 well site (construction of all well lease facilities, civils temp. camp use and vehicle washdowns)	3	5	2	1	11
Drilling Program	Drilling program (including drilling temp. camp use, vehicle washdowns, cementing)					3
Total		**8**	**8**	**5**	**3.5**	**27.5**

3.6 Workforce and Contractors

A maximum of 40-50 personnel (both Santos and contractors) are anticipated to be at the Dukas-1 well at any one time during drilling activities, the workforce number will fluctuate depending on the operations. The temporary campsite to accommodate the drilling operations will be situated as shown in **Figure 5**.

The primary machinery and equipment used throughout the civil works and drilling program is detailed in **Table 11**. Note this is not an exhaustive listing an additional equipment may be required on an ad hoc basis. Table 9 also details key contractors that will be engaged to assist with the completion of the project schedule. Rigorous pre-qualification criteria are used, including technical and operational competence requirements, in the selection of contractors for all field operations. Additional contractors are likely to be required.

Table 11: Potential Machinery and Equipment

Stage of Project	Contractor	Machinery and Equipment
Civil works	Orange Creek Station	1 x Caterpillar D8 Bulldozer 1 x Caterpillar 140G or equivalent 1 x Caterpillar 140G or equivalent 1 x Caterpillar 623 or equivalent 16.8 m^3 soil capacity self elevating scraper 1 x 12 kl rigid water tanker 1 x 25 kl semi water tanker, 1 x Float for infield moves 1 x 16 m^3 Side Tipper 1 x 25 tonne excavator or Front end loader with Forklift, Bucket & Jib Crane attachments 1 x Off road capable mechanical workshop service and mechanic 1 x supervisor with 4x4 1 x 4x4 crew vehicle 1 x Office with Satellite access to Data and phone
Drilling Activities		1 x Ensign 965 Rig Package with Well Site Accommodation*

Stage of Project	Contractor	Machinery and Equipment
	Ensign Drilling Australia Haliburton Australia Hunting Energy Services Cactus Wellheads Weatherford Smith Bits and Drilling Tools Baker Hughes (GE Company)	1 x Volvo L120 Front End Loader 1 x Nissan Patrol Crew Truck 1 x 4WD Toyota/Nissan Crew Wagon/Utility 1 x Rig Mini-Camp (8 persons) 1 x Campsite (up to 40 persons)
		Multiple Crew Vehicles (assume 6 x 4WD Vehicles) 1 x Cementing Unit 3 x 40 tonne Pressurised Cement Bulkers 1 x Wireline Logging Truck 1 x Mudlogging shack 1 x Underbalanced Drilling package including 5 x compressors, booster, mist pump. 3 x Water tanks (500bbl each)
		100 legal road train loads from Moomba to Dukas-1 Well mobilised over a 30 day period Equipment at Dukas-1 well for unloading:, 6 x bed truck, 15 x prime movers, 2 x water tanker trailer
		3-4 x 4WD crew vehicles

4.0 Description of the Existing Environment

This section describes the physical, biological, cultural and socio-economic environment and identifies any relevant values and sensitivities of the environment that may be affected by the activity.

The information has been sourced using Santos' and publicly available information as well as the Australian Government Protected Matters Search Tool (PMST) (Appendix B) and NT NRM Report (Appendix C). The identified environmental values and / or sensitivities with the potential to occur within the project area are summarised in **Table 12**

Table 12: Environmental Values and Sensitivities potentially occurring in the vicinity of the project footprint

Environmental Receptor	Summary
Groundwater/ water courses	The project area does not intersect any mapped watercourse or drainage feature (**Figure 10**) Ground water baseline assessment across bores on Mt Ebenezer station reordered water levels below ground level between 15m and 82m. The pH of the samples ranged between 6.85 – 7.24.
Native fauna	Despite the lack of surface water, the region provides important habitat for a range of wildlife including a variety of small mammals, reptiles and birds. There are a number of listed species of birds, mammals and reptiles with the potential to be found within 10 km of the project area, however there is no areas of particular sensitivity in the region.
Native flora / habitat	The project area is covered by the Finke Bioregion. The vegetation within the project area is considered to be representative of the broader region. There are no TECs identified in the project area.
Environmentally sensitive sites	There are no protected or conservation areas within the vicinity of the project area.
Culturally sensitive sites	The project area and surrounds has the potential for Aboriginal sites with cultural value. However, sacred sites clearance will be obtained prior to any activity.
Landholders	There are a number of pastoral properties with livestock and infrastructure in the vicinity.

4.1 Natural Environment

4.1.1 Climate

The proposed Dukas-1 well is located within the arid zone of Central Australia that experiences low and variable rainfall and high diurnal and seasonal temperature fluctuations.

Table 13 shows a summary of climate records for Alice Springs Airport (Station 015590), which is located approximately 140 kilometres (km) north of the Dukas-1 well (Bureau of Meteorology [BoM] 2014).

The mean annual rainfall for Alice Springs is 284 mm, with most of rainfall in summer. Temperatures vary from very hot in summer to below freezing in winter, and frosts occur regularly during the winter months.

Average evaporation exceeds average rainfall for each month of the year and by some 1000% over an average year. The mean annual evaporation rate at Alice Springs is 3066 mm. The dominant wind directions are southeast to northeast with little seasonal variation.

Table 13: Temperature and rainfall records for BoM Station #015590

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean Daily Max (°C)	36.4	35.1	32.6	28.2	23.0	19.8	19.7	22.6	27.3	30.9	33.6	35.4	28.7
Mean Daily Min (°C)	21.5	20.7	17.5	12.6	8.2	5.0	4.0	6.0	10.3	14.8	17.9	20.2	13.2
Mean monthly rainfall (mm)	38.5	43.9	31.8	17.3	18.7	13.6	15.4	9.0	8.4	21.1	28.7	36.8	284.0

4.1.2 Geology

The proposed Dukas-1 well is located within the Amadeus Basin, an east-west trending sedimentary basin extending across the southern part of the Northern Territory and into Western Australia. This basin covers an area of approximately 207,000 km² and contains up to 9100 m of late Proterozoic and Palaeozoic sediments. It is bound in the north by the Arunta complex and in the south by the Musgrave-Mann complex, both containing granite, gneiss and schists, with amphibolite and quartzite. The geology in the region is shown in **Figure 8**

The surface geology consists of sandstones that form resistant strike ridges and less resistant siltstones, commonly covered by superficial sediments. Known hydrocarbons in the basin occur in sandstones and fractured basement (Mount Kitty-1) at depths ranging between 1200 and 2500 m.

The Amadeus Basin is a large intracratonic sedimentary basin that was initiated as part of the Central Australian Superbasin and was substantially affected by the intraplate tectonics. Whilst it is generally unmetamorphised, minor highly deformed rocks interleaved with basement in the north-east and southwest are greenschist to amphibolite facies (Weste 1994).

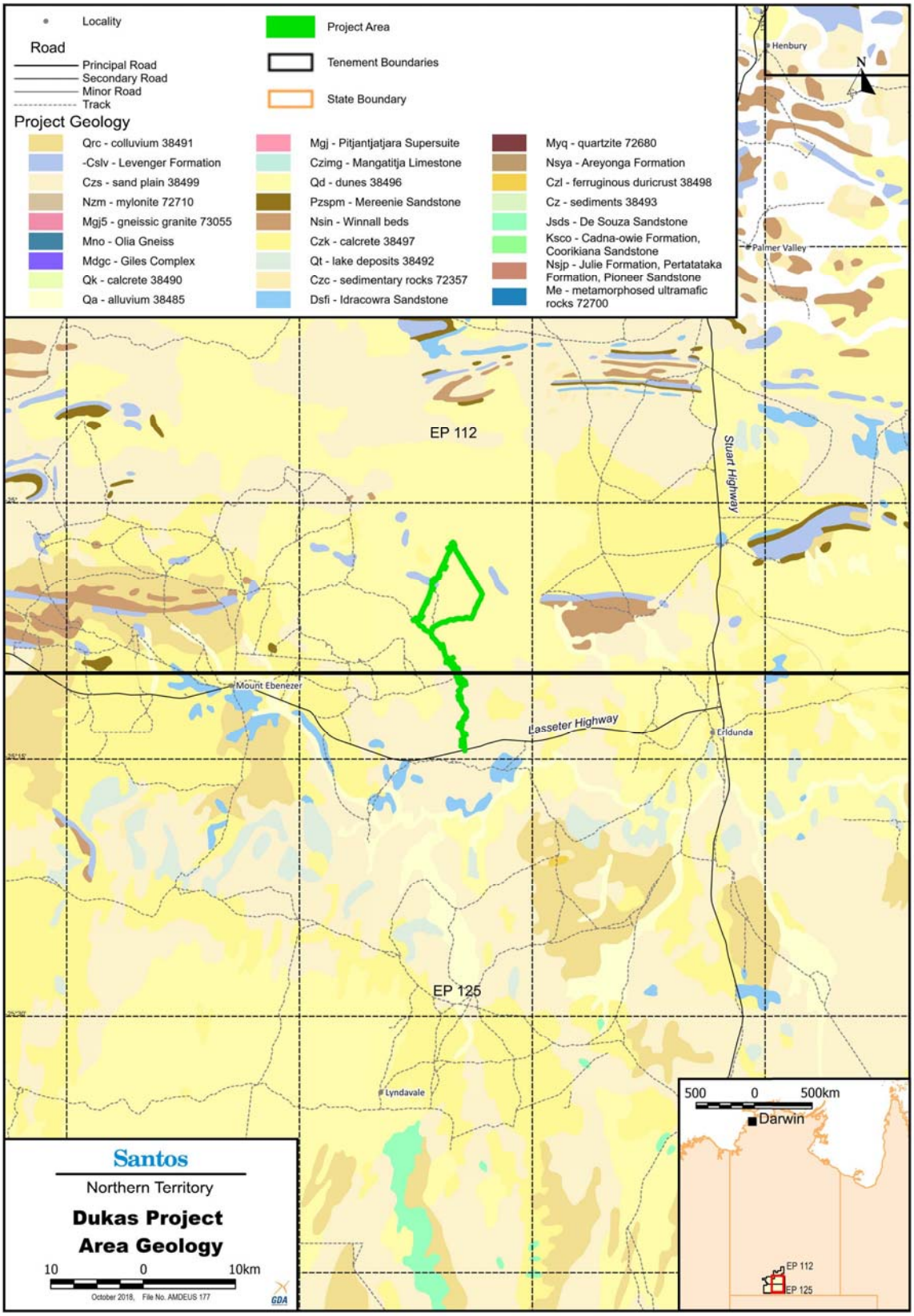

Figure 8: Geology in the region of the project area

4.1.3 Soils

The landscape of northern and central Australia is ancient and highly weathered. Soil types are susceptible to erosion given that the region experiences long dry periods followed by intense rainfall. In this environment, the soils become disturbed and easily eroded.

The project area soils are dominated by tenosols soils, with some sodosols to the south and rudosols to the east of the project area (NTG 2018).

- Tenosols are weakly developed or sandy soils, commonly shallow (slightly more developed than Rudosols), although they can include the deep sand dunes of beach ridges, granitic soils and sand dunes of deserts. Tenosol soils show some degree of soil profile organisation (minor colour or soil texture changes in subsoil).
- Rudosols are very shallow soils or those with minimal soil development and includes very shallow rocky and gravely soils across rugged terrain.
- Sodosols soils are generally high in sodium with an abrupt increase in clay content from the topsoil to subsoil. They are dispersive and restricted to small occurrences in the southern region of the NT.

The following land systems and their total area and percentage within the project area are detailed in **Table 14**, and shown in **Figure 9**

Table 14: Percentage of land systems and total area within the project area

Land System	General Terrain Description	Area (ha) within project area	% of Total
Desert dunefields	Dunefields with parallel linear dunes, reticulate dunes and irregular or aligned short dunes; red sands	87	100

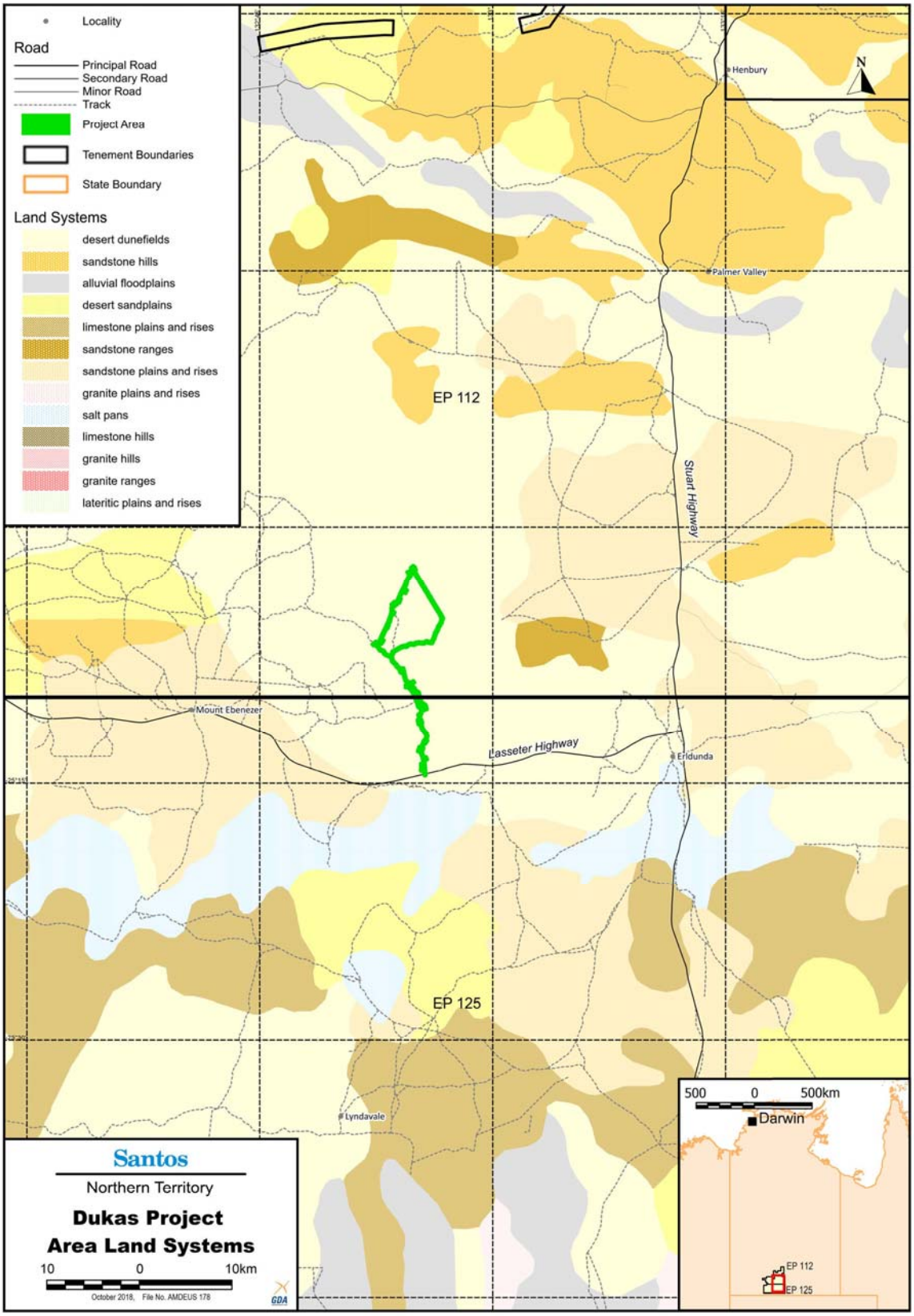

Figure 9: Land Systems in the region of the project area

4.2 Baseline Methane and Water Conditions

4.2.1 Methane

Baseline methane monitoring will be conducted to monitor and measure background methane levels and rate of change in methane levels using mobile survey technology. The methane monitoring will be conducted by CSIRO using the methodology established by the Gas Industry Social and Environmental Research Alliance (GISERA). Data collected during this monitoring will be made available to DPIR and DENR when it is available.

4.2.2 Hydrology

All catchments within the Amadeus Basin region drain internally towards Lake Eyre (in South Australia). All surface water including rivers, streams and drainage lines are ephemeral and subject to short flow duration and high turbidity. The dominant basin is associated with the Finke River system and its associated tributaries and feeder rivers. There are no watercourses within the project area, as shown in **Figure 10**

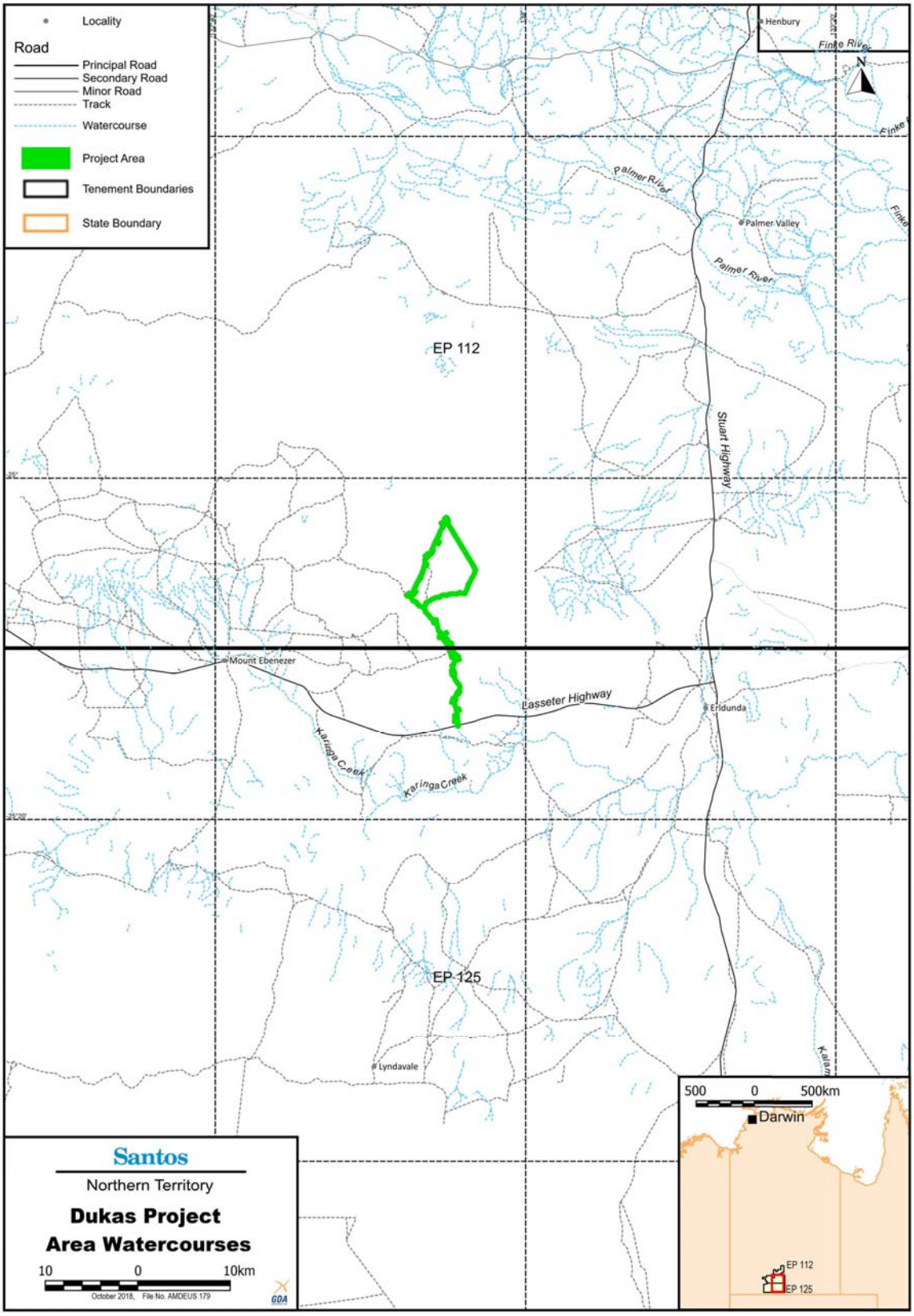

Figure 10: Surface Water in the region of the project area

4.2.3 Groundwater

Fulton (2018) undertook a baseline assessment to locate and survey existing groundwater bores in the vicinity of the project area. This assessment was conducted to assist Santos to develop its conceptual hydrogeological understanding and to identify representative bores for long-term groundwater level and quality monitoring. Fulton (2018) found 30 bores in the vicinity of the proposed Dukas-1 well and of these nine are suitable for a long-term monitoring program. Water levels were collected at 11 bores and water levels below ground level ranged between 15m and 82m. Water samples were collected at 13 bores in the vicinity of the project area. The pH of the samples ranged between 6.85 – 7.24 and both the Total Hardness and Total Dissolved Solids are in excess of the Australian Drinking Water Guidelines.

In stage one of this program, two groundwater supply bores will be drilled. Subject to the presence of the water, the bore will supply water for project needs and provide a baseline water sample prior to the drilling of the Dukas-1 exploration well.

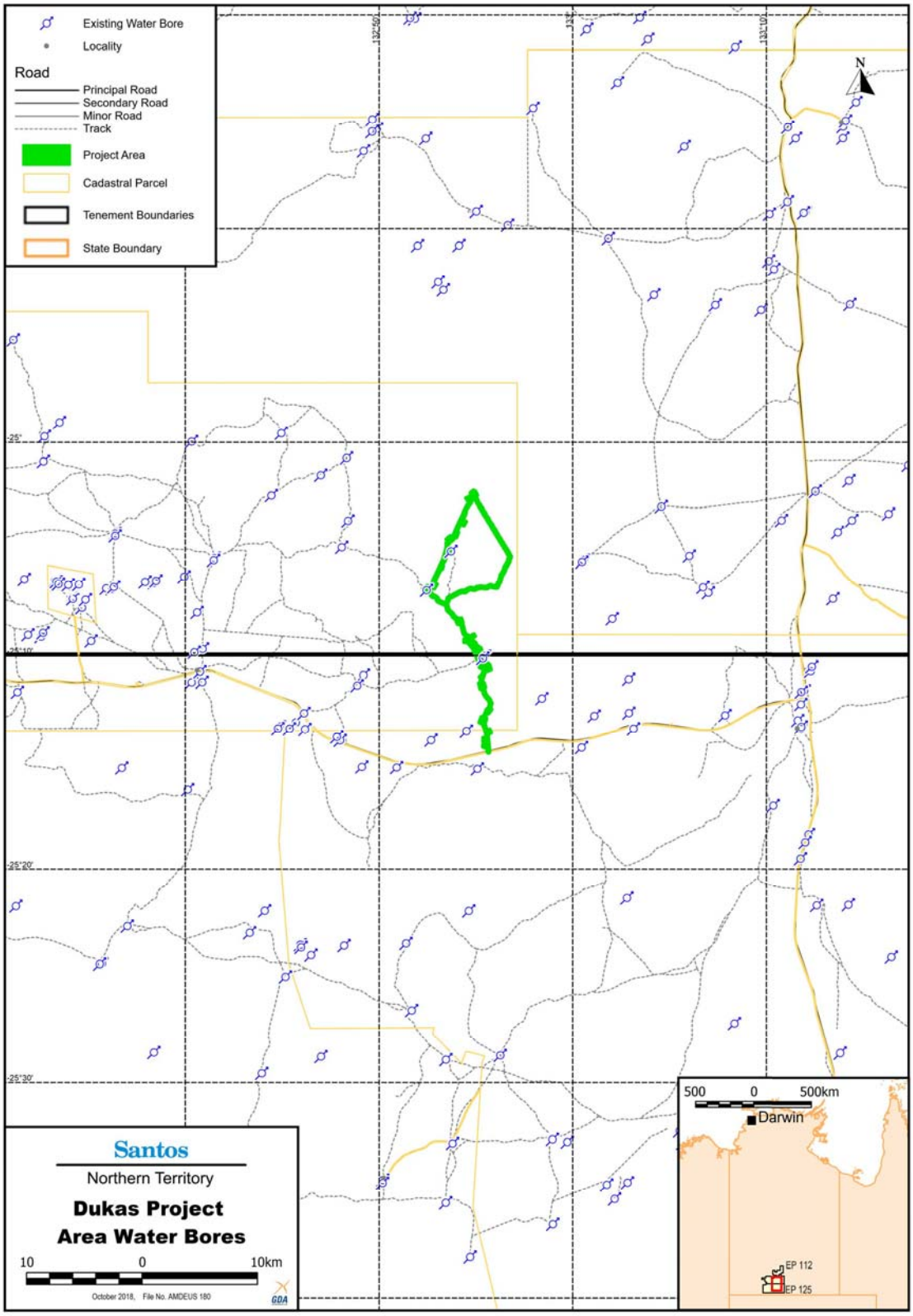

Figure 11: Groundwater bores in the region

4.3 Biodiversity

4.3.1 Bioregions

The Arid Lands region covers 49% of the land area of the Northern Territory (658,000 km). It includes all the MacDonnell Ranges and Burt Plain bioregions, the Territory sections of the Great Sandy Desert, Simpson Strzelecki Dunefields, Finke, Central Ranges, Channel Country and Stony Plains bioregions, most of the Territory section of the Tanami bioregion and parts of Sturt Plateau, Mitchell Grass Downs and Davenport Murchison Ranges bioregions.

The project area is covered by the Finke Bioregion, which covers an area of 73,800 km^2. The main land types are arid sandplains with dissected uplands and valleys, including some major rivers (Finke, Hugh and Palmer rivers).

The bioregion is dominated by mulga taking different forms on different soil types. The mulga is made up of various Senna, Eremophila and Acacia species *(S. nemophila, S. desolate, E. freeelingii, E. gilesii, A. kempeana, A. tetregonphylla*).

The bioregion includes eucalypt low woodland with tussock and hummock grass understorey, acacia woodland, hummock grassland, and chenopod shrubland, associated with salt plains and floodouts on sand plains. The dominant chenopods are bluebush (*Maireana astroricha*) and bladder saltbush (*Atriplex vesicaria*).

4.3.2 Vegetation and Flora Species

The vegetation in the project area is classified as hummock grassland (NTG 2018a) and shown in **Figure 12**. Hummock grasslands are the most widely distributed biome on the Australian continent.

On the 1st and 2nd of October 2018 a field assessment was completed by Tom Ewers-Reilly, Senior Ecologist at EcOz in Alice Springs. The scope of the field assessment included confirming and mapping discrete units that clearly delineate areas that support similar vegetation communities, landform characteristics and surface soil types. Approximately 70 sites were surveyed as part of this assessment and the following eight discrete units have been delineated for the Project Area:

1. Shallow sandplain with mixed tussock grassland and sparse shrubs.
2. Undulating sandplain with Blue Mallee over mixed shrubs, Hard Spinifex, annual grasses and forbs.
3. Sandplain and low dunes with a variable shrubland of Mann Range Mallee, Mulga, Sticky Hopbush and Desert Cassia over Hard Spinifex, annual grasses and forbs.
4. Reticulate dunes with a shrubland of Desert Heath Myrtle, Rattlepod Grevillea, Sticky Hopbush and Umbrella Bush over Hard Spinifex. Desert Oak in interdune sandplains.
5. Red earth depressions and plains with Mulga and Witchetty Bush over Hard Spinifex, annual grasses and forbs.
6. Calcareous plains and rises with mixed tussock grassland and Copper Burr species.
7. Clay pan with sparse vegetation.
8. Silcrete-capped rocky ridge with Mulga and Silver Cassia over tussock grasses.

The project area occurs in flat to undulating sandplains with low reticulate dunes becoming more frequent in the northern region. The southern sandplains (units 1 and 2) likely have sandy soils that occur as a thin layer (~ 1 m thick) over peneplain / calcrete plains. These sandplains are extensive in the region and are formed where aeolian (i.e. wind-blown) sand material has been distributed / deposited across the land surface. The northern sandplains and dune fields (units 3 and 4) likely have a deep sand layer, and in some areas have been arranged into low reticulate dunes, with relief of up to 10 m. This unit is widespread throughout the region.

A search of the NT Flora Atlas was completed to determine the flora species within 10 km of the project area. The search identified 219 native flora records within project area (DENR, 2007) consisting of 810 native flora species, representing 76 genera. None of the species are listed under the TPWC Act. In addition, field surveys, did not identify any threatened flora species, sensitive vegetation types or Threatened Ecological Communities (EcOz 2018)

A detailed threatened species 'likelihood of occurrence' assessment was undertaken following the preliminary ecological survey and baseline weed assessment. A number of data sources were used to generate a list of threatened species for the assessment (See Appendix D). Four of the 26 threatened species compiled for the likelihood of occurrence assessment are listed flora species: Sweet Quandong (*Santalum acuminatum*), Latz's Wattle (*Acacia latzii),* Rainbow Valley Fuchsia Bush (*Eremophila prostrata*) and *Frankenia plicata*.

All four listed flora species assessed in the likelihood assessment are considered as 'unlikely to occur' within the project area (Appendix D).

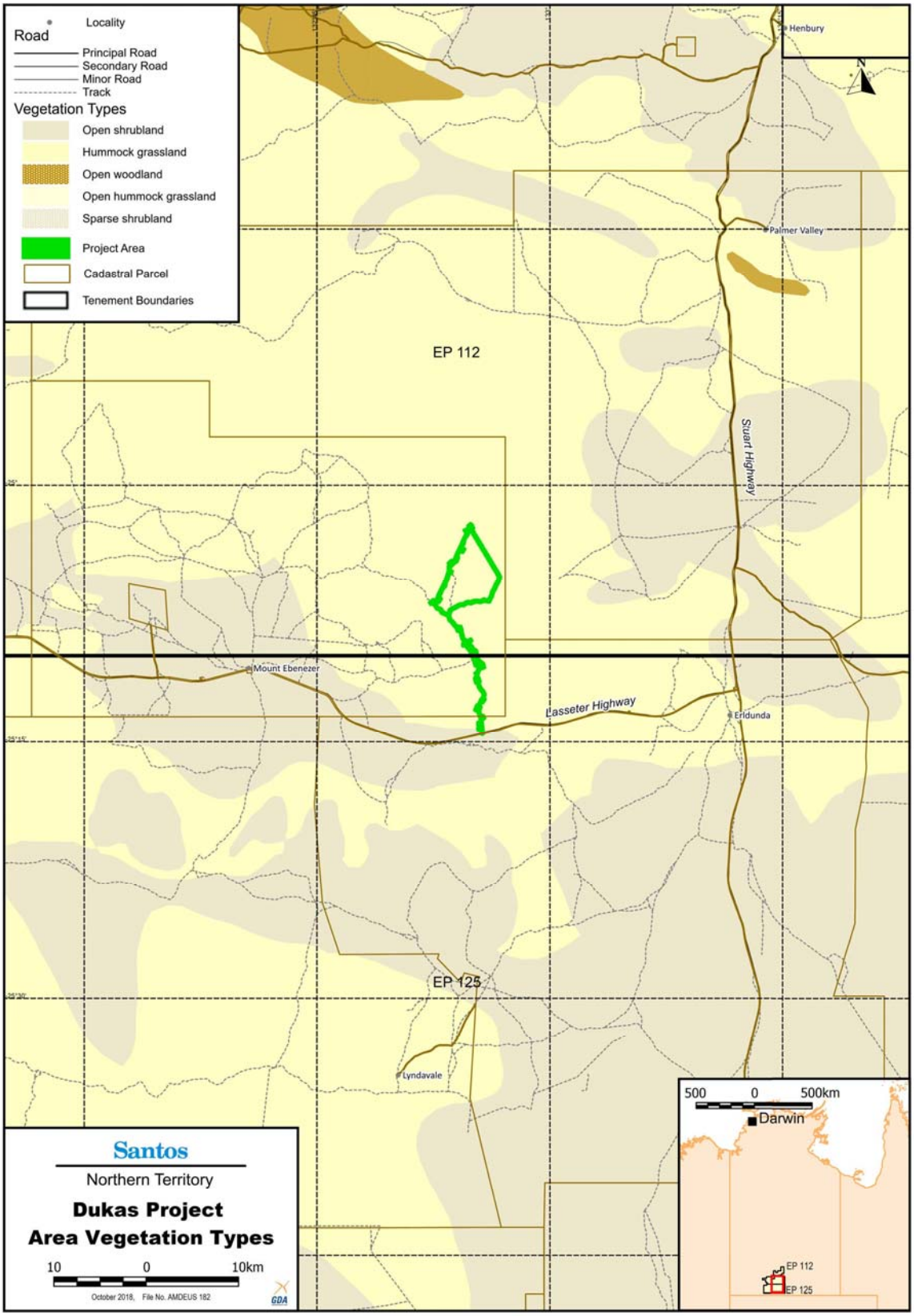

Figure 12: Vegetation types the region

4.3.3 Groundwater dependent Ecosystems

The National Groundwater Dependent Ecosystems (GDE) Atlas shows the potential for groundwater interaction use for river/spring/wetland ecosystems across Australia. There was no data available for the subterranean or terrestrial GDEs in the project footprint and an unclassified potential GDE for aquatic GDEs (BOM 2012).

4.3.4 Fauna species

Despite the lack of surface water, the bioregions provide important habitat for a range of wildlife including a variety of small mammals, reptiles and birds that are likely to be mobile across the region.

The Northern Territory Fauna atlas currently includes all known terrestrial vertebrate records for the NT. A search of the NT Fauna Atlas was completed to determine the fauna species within the approximately 10 km of the project area of the permit area. The search found 51 native fauna records, of which four were listed as vulnerable under the TWPC Act (NTG 2018).

Field assessments identified habitat types within the project area including dune fields, sandplains, clay pans, calcrete rises and one isolated rocky hill (with outcrop) situated within the dunes. Tracking and active searching for fauna was conducted throughout the project area, with a focus on identifying evidence of threatened species and / or habitat suitability for threatened fauna. No evidence of threatened flora and fauna species at Dukas-1 was observed during field surveys.

A detailed threatened species 'likelihood of occurrence' assessment was undertaken following the preliminary ecological survey and baseline weed assessment. A number of data sources were used to generate a list of threatened species for the assessment (See Appendix D). Twenty-two of the 26 threatened species compiled for the likelihood of occurrence assessment are listed fauna species. Two birds, two mammals and one reptile may occur within the project area, as detailed in **Table 15** (Ecoz 2018). The remaining 17 species are considered as 'unlikely to occur' within the project area.

Table 15: Threatened fauna species that may occur within 10 km of the project area

Type	Scientific Name	Common Name	Status under EPBC Act	Status under TWPC Act
Bird	*Falco hypoleucos*	Grey Falcon	-	VU
	Polytelis alexandrae	Princess Parrot	VU	VU
Mammal	*Notoryctes typhlops*	Southern Marsupial Mole		VU
	Dasycercus blythi	Brush-tailed Mulgara		VU
Reptile	*Liopholis kintorei*	Great Desert Skink	VU	VU

The full threatened species 'likelihood of occurrence' assessment is provided in Appendix D.

4.3.5 Pest Plant and Animals

Pest plant and animal control is a significant land management issue in the Northern Territory.

While the Amadeus Basin region is relatively free of pest plant species, the Alice Springs Regional Weed Management Plan 2013-2018 (DLRM 2013) identifies Priority Weeds that have been determined using expert local knowledge of the Alice Springs Regional Weed Reference Group.

A baseline weed assessment identified there were no declared weeds (Ecoz 2018). The assessment was conducted after a prolonged dry spell, which is not ideal for weed identification. However, the Alice Springs Regional Weed Management Plan 2013-2018 (DLRM 2013) highlights that four priority weeds are applicable for the region – Athel Pine (*Tamarix aphylla*), Cacti group (*Opuntia* spp. and

Cylindropuntia spp.), Parkinsonia (*Parkinsonia aculeata*) and Rubber Bush (*Calotropis procera*). Field surveys confirmed that these priority species are not present within the project area, which can be stated with high confidence as these species are typically 'detectable' during dry periods (Ecoz 2018).

Two non-declared weeds were recorded in the southern extent of the project area:

- Buffel Grass (*Cenchrus ciliaris*)
- Paddymelon (*Citrullus colocynthis*).

Weed distribution is more often related to environmental disturbances caused by the construction of roads and tracks, cattle grazing and feral animals. Weeds are most prevalent on land under pastoral lease with infestations generally concentrated around infrastructure such as water points, fence lines and tracks, and along the banks of watercourses where cattle and feral animals tend to congregate.

The PMST Report identified four weeds potentially occurring within 10 km of the project area; Buffel-grass, Prickly Pears, Parkinsonia (*Parkinsonia aculeate*) and Athel Pine (*Tamaris aphylla*). The PMST Report identifies 10 introduced feral animal species are also identified as a potentially occurring within 10 km of the project area. Pest animals identified in the region are the Rock Pigeon, House Sparrow, Domestic Cattle, Camel, Domestic Dog, Horse, Domestic Cat, House Mouse, Rabbit and Fox.

4.3.6 Fire regime

Aboriginal people have traditionally used fire as a tool during hunting and gathering. These fires have 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 during the warmer seasons.

Fire management or controlled burns within the Alice Springs fire management region are a common occurrence. Controlled burns are undertaken to reduce the possibility of uncontrolled fires and to assist in land management. Fire management in the region considers the various land uses including pastoral use, tourism and other industry including oil and gas activities. Advice from Bushfires NT will be sought prior to the commencement of the Dukas-1 drilling program.

4.4 Cultural Environment

4.4.1 Historic and Natural Heritage

An assessment of cultural heritage values for the project area was undertaken and it was confirmed that there are no areas within the permit area listed on the National Heritage List (DoEE 2018a) or NT Heritage Register (DIPL 2018). In addition, the PMST Report showed no MNES including World Heritage Properties and National Heritage Places (DoEE 2018b).

4.4.2 Sacred Sites

Areas of significance for indigenous cultural heritage is considered through the process of securing a sacred site clearance certificate from the Central Land Council (CLC)). This process aims to prevent damage to, and interference with Aboriginal sacred sites, by setting out the conditions in relation to entering and working on the land. A sacred site clearance certification has been sought and secured for the project area and sacred sites clearance will be obtained prior to any activity.

4.5 Socioeconomic environment

The Amadeus Basin supplies gas within the Northern Territory and oil to South Australia. There is a range of current land uses throughout the area including conservation, tourism, oil and gas production and pastoral activities. While the regional population has decreased with time, tourist numbers are

consistent with tourism centres such as Alice Springs and Yulara continuing to be the key destinations of interest.

About 55% of the Arid Lands subregion is Aboriginal freehold and about 36% pastoral leases, on which cattle are grazed. Though accounting for a small total area, horticulture is an important land use in the Arid Lands subregion. The region remains generally undeveloped in terms of infrastructure and roads.

4.5.1 Settlements

The closest major community to the project area is Alice Springs, approximately 200 km north-east of the project area (Figure 4). Cadastral parcels in the vicinity of the project area are shown in **Figure 13**.

4.6 Key environmental values and sensitivities

4.6.1 Protected or Conservation Areas

Current and proposed protected areas make up 36% of the Arid Lands subregion; the majority of this is as proposed Indigenous Protected Areas. No protected areas are within the proposed project area. The closest protected or conservation areas in the vicinity of the project area include:

- Finke Gorge National Park (84 km from project area)
- Rainbow valley conservation reserve (106 km from project area)
- Owen springs reserve (101 km from project area)

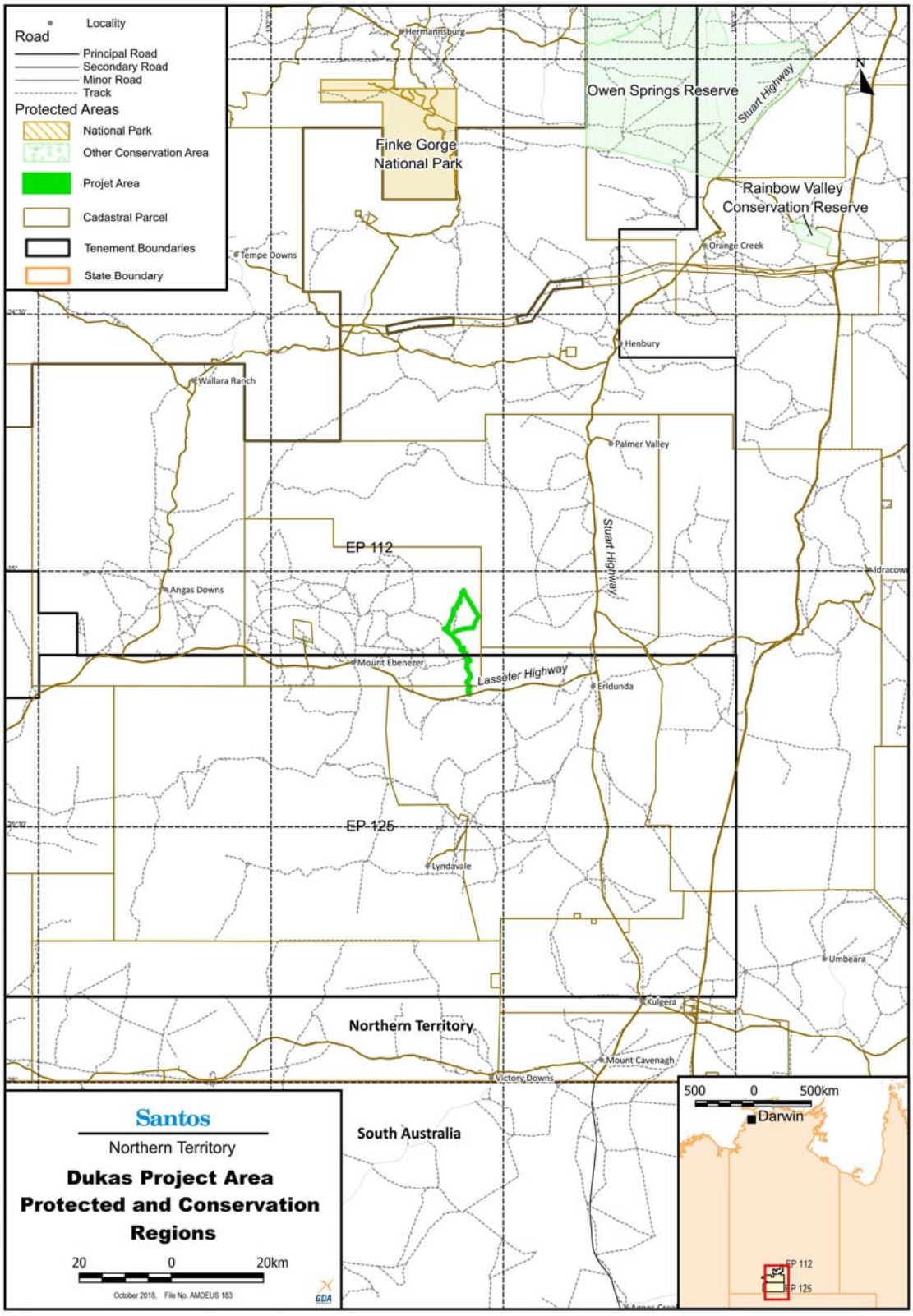

Figure 13: Protected or Conservation Areas in the region

4.6.2 Protected Species

Interrogation of databases and a review of published material indicate that a number of threatened species have been recorded within the region. The PMST Report was undertaken to identify nationally listed threatened flora or fauna that may occur or are likely to occur (DoEE 2018b). These searches identified six birds, four mammals, two reptiles, in addition to two species of plant and a number of migratory species (all birds) that may or are likely to occur within the project area (Search results provided in Appendix B).

No threatened species or any Threatened Ecological Communities were observed during the 2018 field ecological assessment. A detailed threatened species 'likelihood of occurrence' assessment was undertaken following the preliminary ecological survey and baseline weed assessment. A number of data sources were used to generate a list of threatened species for the assessment (See Appendix D). The threatened species 'likelihood of occurrence' assessment identified five threatened species that 'may occur' at Dukas 1, summarised below:

- ***Princess Parrot*** – the presence of mature Desert Oaks provides potential for nesting opportunities; however, no hollows were observed in mature trees within the disturbance area at the Dukas 1 well site (via ground-based observations). Species could be present in area – but there are very few records of the species in the Henbury sub-region. The access roads and well site infrastructure have been placed in an area that minimises disturbance to mature Desert Oaks (refer to Figure 2-3), which subsequently minimises impacts to potential nesting sites for Princess Parrot.
- ***Southern Marsupial Mole*** – may occur within dune fields; however, there is no evidence that it occurs in the region (this may be due to lack of survey effort rather than absence). No tracks observed during the field survey.
- ***Brush-tailed Mulgara*** – may occur within dune fields and sandplains; however, there is no evidence that it occurs in the region (may be due to lack of survey effort rather than absence).
- ***Grey Falcon*** – only foraging individuals may occur, no nesting/breeding habitat for this species.
- ***Great Desert Skink*** – may occur within sandplain and dune swales; however, there is no evidence that it occurs in the region (may be due to lack of survey effort rather than absence). No burrows attributable to this species observed during the field survey.

4.6.3 Significant Habitat

The PMST Search Report identified one nationally important wetland being the Karinga Creek Palaeodrainage System. This wetland system occurs south of the Lasseter Highway and will not be impacted by the project.

In the NT there have been 67 sites identified as the most important sites for biodiversity conservation that need further protecting. None of these are in the within 10 km of the project area.

Habitat types within the project area included dune fields, sandplains, clay pans, calcrete rises and one isolated rocky hill (with outcrop) situated within the dunes. No significant ecological areas occur within, or surrounding, the Dukas 1 project area. All vegetation types present at Dukas 1 are ubiquitous within the region – and no specific protection measures are required.

5.0 Environmental Risk Assessment

5.1 Overview of the Environmental Risk Assessment Process

The Regulations are based on 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. 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.

5.1.1 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.

For the EMP to be accepted by the Minister for Primary Industry and Resources, it must be demonstrated 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 5.2 details the outcomes of this process.

5.1.2 Identification of Environmental Aspects

Environmental aspects are identified as elements of the activity which can interact with the environment. Environmental aspects were identified for planned and unplanned aspects and described in Section 5.0.

5.1.3 Identification of the environment that may be affected

Following the identification of environmental aspects, the likely extent of each aspect is considered and the environment which may be affected determined, which is described within Section 4.0.

5.1.4 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 12** provides a summary of these values and sensitivities. These were used to inform the risk assessment as they provide the potential worst-case consequence.

5.1.5 Identification and Evaluation of Potential Environmental Impacts

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

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

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

5.1.7 Control Measure Identification and ALARP Decision

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.

5.1.7.1 ALARP Decision Framework

When determining whether the risk or impact has been reduced to ALARP, consideration is given as to whether environmental risks can be lowered further without a grossly disproportionate increase in impost.

Santos' approach to this decision is based on the Oil and Gas UK's 'Guidance on Risk Related Decision Making' (**Figure 14**). 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 14**.

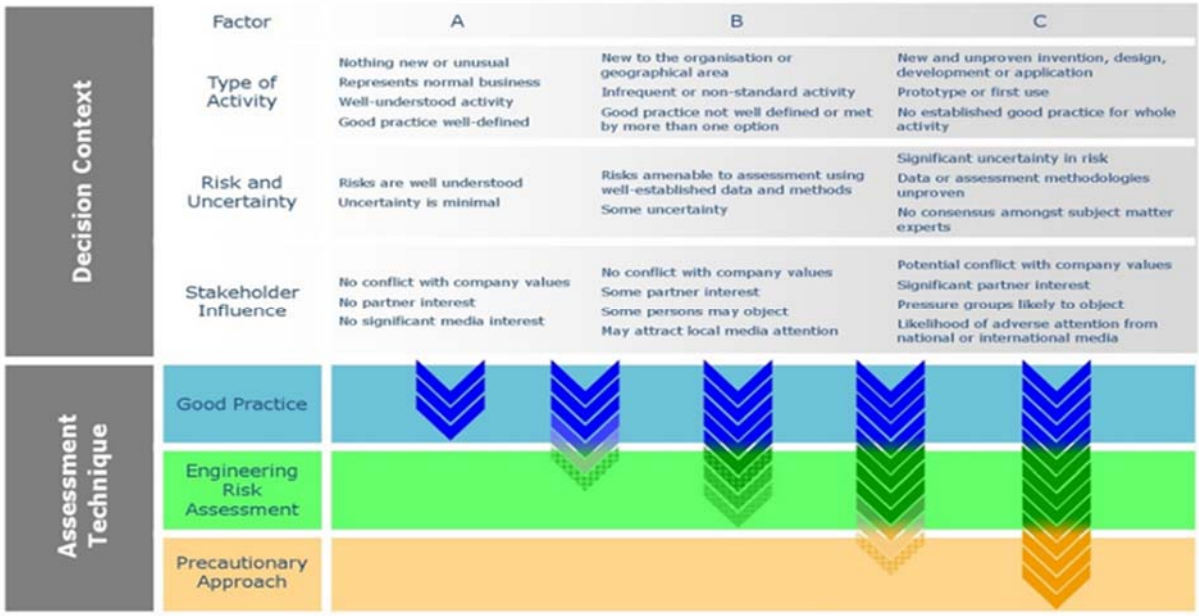

Figure 14: Impact and Risk 'Uncertainty' Decision Making Framework

Table 16: ALARP decision-making based upon level of certainty

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: 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.

Decision type	Description	Decision-making tools
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.

5.1.7.2 Control measure identification

Control measures were identified to eliminate each aspect or otherwise minimise the risks and impacts to ALARP. The process of identifying control measures involved:

- Identifying a risk control
- Assessing the risk control
- Deciding whether residual risk levels are tolerable
- If not tolerable, identifying a new risk control and
- Assessing the effectiveness of that control.

The Santos hierarchy of control is illustrated in Table 17. This process moves from risk elimination through to protection, in descending order of effectiveness, until control measures can be identified.

Environmental Outcomes, Environmental Performance Standards and Measurement criteria are established in line with the control measure(s). Terms used for measuring the environmental performance for each risk are defined as:

- *Control measure* – a system, an item of equipment, a person or a procedure that is used as a basis for managing environmental impacts and risks.
- *Environmental Outcome* –An outcome that will be achieved if the environmental impacts and environmental risks of a regulated activity are reduced to a level that is ALARP and acceptable (as defined in the Petroleum (Environment) Regulations).
- *Environmental Performance Standard* – A standard is that; relates to the management of environmental impacts and environmental risk of a regulated activity; and applies to persons, systems, equipment or procedures involved in carrying out the activity acceptable (as defined in the Petroleum (Environment) Regulations). .
- *Measurement Criteria* – The criteria to be used in determining whether an Environmental Outcome or Environmental Performance Standard has been met (as defined in the Petroleum (Environment) Regulations).

Table 17: Santos hierarchy of control

Control	Effectiveness	Example
Eliminate		*Removal of the risk.* Refuelling of vehicles at the terminal eliminates the risks of an onsite refuelling.
Substitute		*Change the risk for a lower one* . The use of low-toxicity chemicals that perform the same task as a more toxic additive.
Engineering		*Engineer out the risk.* The use of oil traps and interceptor drains to reduce the contaminant discharged.
Isolation		*Isolate people or the environment from the risk*. The use of bunding for containment of bulk liquid materials.
Administrative		*Provide instructions or training to people to lower the risk.* The use of Job Hazard Analysis to assess and minimise the environmental risks of an activity.
Protective		*Use of protective equipment.* Containment and recovery of spilt hydrocarbons.

5.1.8 Determination of Severity of Consequence

The potential level of impact (consequence) was assessed and assigned, in line with potential risks and receptors, using the 'Santos Environmental Consequence Classification' (**Table 18**) from the Santos Operational Risk Matrix. The consequence level for each hazard is documented in the risk assessment tables in Section 5.0.

Table 18: Santos Environnent 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.

Level	Environment
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

5.1.9 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 from the Santos Operational Risk Matrix described in **Table 19**.

Table 19: Santos Likelihood descriptors

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

5.1.10 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 20**) 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 21**) 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 5.0.

Table 20: 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 21: 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 residual risk to level 4 or lower - Dedicated multi-disciplinary incident investigation team - Management involvement in the investigation
4	- Assess risk to determine if ALARP - If ALARP, activities related to maintenance of controls/ barriers prioritised & managed - If not ALARP, improve existing controls and/or implement new control/s - Dedicated multi-disciplinary incident investigation team
3	- Assess risk to determine if ALARP - If ALARP, activities related to maintenance of controls/ barriers prioritised & managed - If not ALARP, improve existing controls and/or implement new control/s - Full incident investigation
2	- Assess risk to determine if ALARP - If ALARP, activities related to maintenance of controls/ barriers prioritised & managed - If not ALARP, improve existing controls and/or implement new control/s - Incident investigations using simple tools
1	- Managed as stipulated by the related work processes - No incident investigation required

5.1.11 Determination of Impact and Risk Acceptability

The model Santos used for determining acceptance of residual risk is detailed in Figure 15. 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

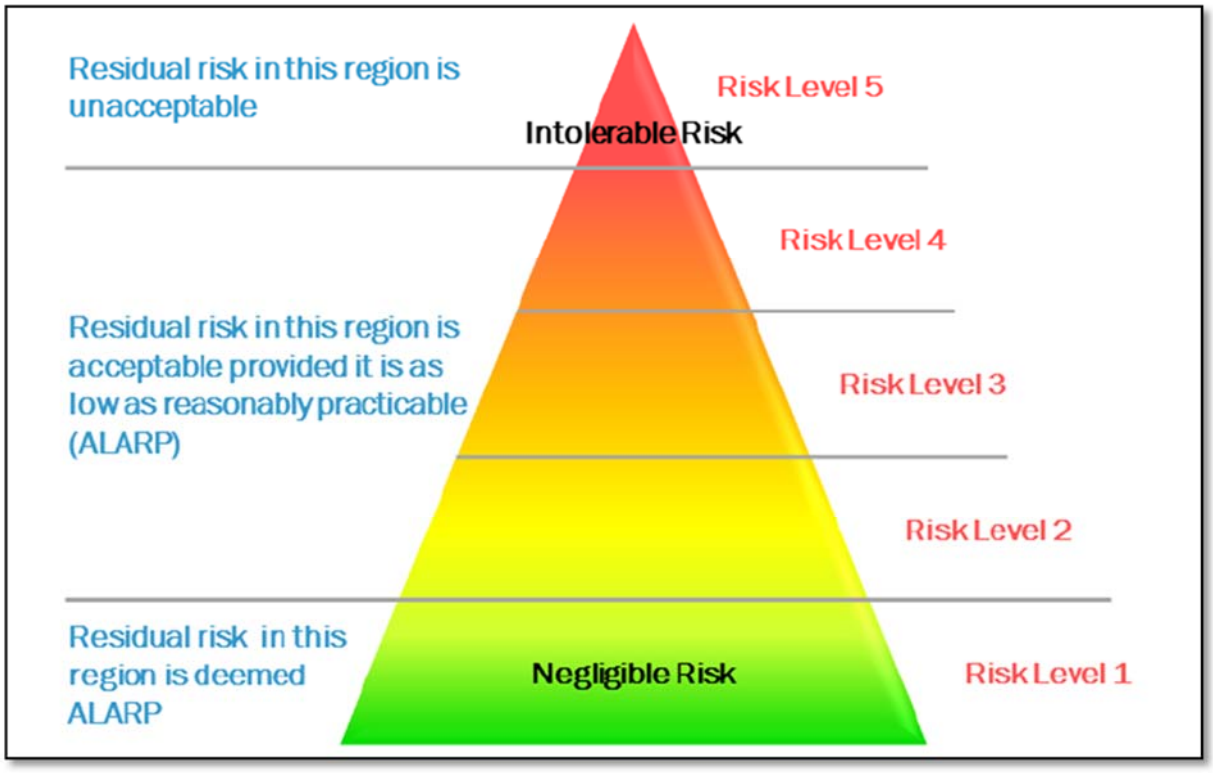

Figure 15: Santos Residual Risk Acceptance Model

5.2 Risk Assessment for the Dukas-1 Well

The planned and unplanned interactions between the described activity, the aspects triggered and the described environment represent a source of risk (or impact) which has potential to affect the described environment. A risk assessment for planned and unplanned aspects for the proposed activity was conducted.

5.2.1 Planned activities

The aspects which are likely to be triggered for the key activities proposed to be undertaken for the Dukas-1 well drilling program are:

- Atmospheric Emissions
- Light
- Noise
- Physical disturbance
- Water Use

A summary of the receptors likely to be triggered by various aspects are given in Table 22.

Table 22: Summary Table Aspects and Receptors

Aspect	Receptor	Potential impacts or risk
Atmospheric Emissions	Air quality	Reduction in air quality
	Native Fauna	Disruption to native fauna
	Native Flora	Disruption to native flora
	Livestock, pastoral infrastructure and landholders	Loss of amenity, disturbance to livestock
Light	Native Fauna	Disturbance to native fauna
Noise	Native Fauna	Disturbance to native fauna
	Livestock, pastoral infrastructure and landholders	Loss of amenity
Physical disturbance	Native Flora	Loss of vegetation and habitat
	Native Fauna	Disturbance to native fauna
	Livestock, pastoral infrastructure and landholders	Disturbance to livestock, pastoral infrastructure and landholders
	Air quality	Reduction in air quality
	Cultural Heritage	Disturbance to culturally sensitive site
	Soil	Erosion of exposed soil surfaces
Water Use	Native flora	Loss of vegetation and habitat
	Groundwater	Draw down effects

5.2.1.1 Atmospheric Emissions

The civil activities being undertaken for the drilling program include creating a road through existing uncleared dune areas, which will generate dust for a two-week duration of this program. Dust will also be generated through general vehicle and equipment movements throughout the program, to a lesser extent. These movements of vehicles and equipment will also generate exhaust emissions, contributing to greenhouse gas emissions and these will be throughout the 30 weeks of the drilling program.

5.2.1.1.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in **Table 23**

Table 23: Atmospheric Emissions risks and impacts

Receptor	Potential Impact
Air quality	Reduction in air quality
Native Fauna	Disruption to native fauna
Native Flora	Disruption to native flora
Livestock, pastoral infrastructure and landholders	Loss of amenity

5.2.1.1.2. Evaluation of Environmental Impacts

Air quality

Air quality may be impacted by dust and emissions from vehicles and plant. Vehicles and plant such as generators used throughout the project will emit air emissions. The majority of dust will be generated in the civil activities, which have a two-week duration at the beginning of the program. Therefore the result will be a short-term and localised impact to air quality in the project area.

Native Fauna

Dust may disrupt fauna in the immediate vicinity of the project site, as fauna may not like to consume dust-covered vegetation or breathe in dust. These impacts are likely to be isolated to the immediate areas surrounding the project area where dust settles or be temporary until dust disperses.

Native Flora

Dust generated by vehicle movements will initially be airborne; however, particles will quickly settle in the surrounding area as dust particles settle out of the air column. This has the potential to cover flora and can potentially decrease vegetation growth by smothering leaves and cause localised loss of native flora.

The composition of dust particles is dependent on the nature of the source material. Topsoil is homogenous within the project footprint; therefore, negligible variation is expected in the dust generated between different parts of the project footprint.

5.2.1.1.3. Livestock, pastoral infrastructure and landholders

Landholders may be impacted by dust generation due to reduced amenity or through health impacts. Dust is generated naturally throughout the region due to the low rainfall levels and fine sediment size, therefore the sensitivity to dust from landholders is likely to be low. In addition, the project footprint is remote therefore, the likelihood of landholders in the vicinity to be impacted by any temporary reduction in amenity is low. The closest homestead to the project area is Mount Ebenezer, approximately 27 km to the west.

It is expected that cattle could leave the area if reduced air quality is temporarily a nuisance.

Table 24 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to atmospheric emissions.

Table 24: atmospheric emissions pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Air quality	Reduction in air quality	Possible	II	2	Landholders
Native Fauna	Disruption to native fauna	Unlikely	I	1	NT Government
Native Flora	Smothering of undisturbed vegetation	Possible	I	1	NT Government
Livestock, pastoral infrastructure and landholders	Impact on human health	Likely	I	1	Landholders

5.2.1.1.4. *Control Measures*

To manage atmospheric emissions and mitigate potential risks and impacts, the control measures outlined in **Table 25** will be implemented.

Table 25: Controls to reduce risk and impacts of atmospheric emissions

Receptor	Control
All	Blade work is banned on naturally smooth surfaces or flat easy terrain. Minimal blade work is permitted elsewhere for access
	Where possible, existing tracks, roads or seismic lines will be used for access
	No driving off designated access roads
	Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for trucks and heavy vehicles.
	Water trucks will be used for dust suppression as required.
Air quality	All vehicles, plant and the drill rig will be in good working order. Engines and machinery are maintained in accordance with the maintenance schedule

5.2.1.1.5. *Post treatment risk*

Given the location of the project and the relatively short time frame, together with the proposed controls, the potential for atmospheric emissions is reduced to an acceptable level. With the application of controls described in Table 25, the overall risk ranking is Level 2.

5.2.1.1.6. *ALARP Discussion*

The impacts and risks associated with atmospheric emissions is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.1.1.7. *Statement of acceptability*

The residual risk for atmospheric emissions is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 26: Atmospheric Emissions Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Air quality	Reduction in air quality	2	Minimise emissions to air	Unlikely	II	*2*	Type A	Demonstrated	Y
Native Fauna	Disruption to native fauna	1	Minimise disturbance to native fauna	Possible	I	1	Type A	Demonstrated	Y
Native Flora	Smothering of undisturbed vegetation	1	Minimise disturbance to native vegetation	Possible	I	1	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Impact on human health	1	Minimise the impact on human health	Possible	I	1	Type A	Demonstrated	Y

5.2.1.2 Light emissions

The campsite and drilling operations will generate light that will be visible outside the project footprint. Civil works, mobilisation and demobilisation of equipment, rehabilitation and post-rehabilitation will take place in daylight hours only, however the drilling and completion of the well, associated suspension and well testing scope will be carried out 24 hours a day, seven days a week for 22 weeks.

5.2.1.2.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Light emissions may potentially result in impacts within the project area. Based upon the receptors identified in Section 5, those known to be impacted by light are shown in Table 27.

Table 27: Light emissions risks and impacts

Receptor	Potential Impact
Native Fauna	Disturbance to native fauna
Livestock, pastoral infrastructure and landholders	Disturbance to livestock

5.2.1.2.2. Evaluation of Environmental Impacts

Native Fauna and Livestock, pastoral infrastructure and landholders

The behaviour and movement of terrestrial fauna may be affected by anthropogenic light emissions from the project. Light emissions will attract insects and terrestrial fauna that feed on insects and may temporarily alter feeding habits and increase predation. Increased concentrations of terrestrial fauna around the project area may also have secondary impacts such as increased incidence of fauna interaction (see section 5.2.2.3).

In general, the impacts from light emissions will not be significant, given the project area is relatively small and the activities temporary.

Table 28 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to light emissions.

Table 28: Light emissions pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking
Native Fauna	Disturbance to native fauna	Likely	I	2
Livestock, pastoral infrastructure and landholders	Disturbance to livestock	Occasional	I	1

5.2.1.2.3. Control Measures

To manage light emissions and mitigate potential risks and impacts, the control measures outlined in **Table 29** will be implemented.

Table 29: Controls to reduce risk and impacts of Light emissions

Receptor	Control
All receptors	All boundary lighting will be positioned to face inwards to provide adequate lighting for safe operations, without excessive overspill
	Ensure site environmental inductions for all site personnel and contractors include the issue of noise, vibration and light and protective measures to prevent disturbance
	Lighting used on drill site to minimise offsite disturbance, while maintaining safety standards

5.2.1.2.4. Post treatment risk

Given the location of the project and the relatively small project footprint, together with the proposed controls, the potential for light emissions is reduced to an acceptable level. With the application of controls described in Table 29, the overall risk ranking is Level 1 (Table 30).

5.2.1.2.5. ALARP Discussion

The impacts and risks associated with light emissions is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.1.2.6. Statement of acceptability

The residual risk for light emissions is Level 1. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 30: Light emissions Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Native Fauna	Disturbance to native fauna	2	Minimise disturbance to native fauna	Possible	I	1	Type A	Demonstrated	Y
Settlements - Pastoral properties	Disturbance to livestock	**1**	Minimise disturbance to livestock, pastoral infrastructure and landholders	Possible	I	1	Type A	Demonstrated	Y

5.2.1.3 Noise and Vibration

Noise and vibration emissions will occur during the day from civil activities, vehicle movements, as well as campsite infrastructure and supply logistics, which will occur during daylight hours only. The drilling and completion of the well, associated suspension and well testing scope which includes seismic evaluation will be undertaken 24 hours a day for a duration of 22 weeks.

5.2.1.3.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by noise are shown in Table 31.

Table 31: Noise risks and impacts

Receptor	Potential Impact
Native Fauna	Disturbance to native fauna
Livestock, pastoral infrastructure and landholders	Loss of amenity Disturbance to livestock

5.2.1.3.2. Evaluation of Environmental Impacts

Native fauna

Noise and vibration from the activities are likely to cause temporary localised fauna behaviour changes adjacent to the civil activities, drilling activities and the campsites. Initially fauna may move away from the area but then as they become more accustomed to the low-level noises will likely relocate back to the area. As the drilling and completion of the well and the associated suspension and well testing scope will take place at night, this may also impact nocturnal fauna species in the area.

Livestock, pastoral infrastructure and landholders

The project is located on Mt Ebezener and Erldunda Stations. Santos will have agreements in place with landholders and maintain ongoing communications during operations. Based on previous operational experience in the area, impacts to landowners (reduced amenity) due to noise and vibration are unlikely as any emissions are localised and short term in nature and are generally remote from any homesteads or outstations.

It is likely that livestock will be found in close proximity to the project footprint, however, it is anticipated that they will move away from the area should they be temporarily disturbed by noise and vibration. Any impacts are likely to be localised and short term. Table 32 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to noise

Table 32: Noise pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Native Fauna	Disturbance to fauna	Occasional	I	2	NT Government
Livestock, pastoral infrastructure and landholders	Loss of amenity	Occasional	I	2	Landholders
	Disturbance to livestock	Likely	I	2	Landholders

5.2.1.3.3. Control Measures

To manage noise and mitigate potential risks and impacts, the control measures outlined in **Table 33** will be implemented.

Table 33: Controls to reduce risk and impacts of Noise

Receptor	Control
All	Existing noise attenuation devices fitted to drill rig and other machinery used on site will be maintained in good working order
	Engines and machinery are maintained in accordance with the maintenance schedule
Landholders	Maintain communications during operations with relevant landholders

5.2.1.3.4. Post treatment risk

Given the location of the project and the relatively small and linear nature of operations, together with the proposed controls, the potential for noise is reduced to an acceptable level. With the application of controls described in **Table 33**, the overall risk ranking is Level 1 (**Table 34**).

5.2.1.3.5. ALARP Discussion

The impacts and risks associated with noise is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.1.3.6. Statement of acceptability

The residual risk for noise is Level 1. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 34: Noise Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Fauna	Disturbance to native fauna	2	Minimise disturbance to native fauna	Possible	I	1	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Loss of amenity	2	Minimise disturbance to landholders	Possible	I	1	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Disturbance to livestock	2	Minimise disturbance to livestock	Possible	I	1	Type A	Demonstrated	Y

5.2.1.4 Physical Disturbance

5.2.1.4.1. Physical disturbance will occur during the civil activities, drilling activities and campsite construction that is limited to the project footprint described in Section 3.0. The estimated maximum extent of the project is approximately 87.0 ha (or 0.0062% of the total area of EP 112); however, approximately 22.28 ha of this area is already disturbed land.Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in **Table 35**.

Table 35: Physical disturbance risks and impacts

Receptor	Potential Impact
Native flora	Loss of native flora
Native fauna	Disturbance to native fauna
Soil	Damage to soil (compaction) and exposure
Cultural heritage	Disturbance to culturally sensitive sites

5.2.1.4.2. Evaluation of Environmental Impacts

Native flora

The proposed Dukas 1 well site is located in an interdune sandplain. The access road follows existing station tracks or seismic lines (with some minor deviations) to avoid additional land clearing where possible. Project components have been preferentially located in areas to minimise disturbance / removal of large Desert Oaks.

Some vegetation will still be required to be cleared as part of the civil activities, which will result in a loss of vegetation in the project footprint. In addition, the seed bank in the area is exposed to impacts as a result of prolonged stockpiling. The vegetation community types that will be disturbed are represented within the immediate project are vicinity and more widely in the Bioregion. No sensitive vegetation types will be disturbed. Therefore there will be localised impacts to native flora in the project footprint. In addition the small areas of disturbance and any loss of a productive seed bank will be offset by recruitment of seeds from the nearby native flora. Native fauna

The project activities are likely to cause direct disturbance to some fauna species through loss of fauna habitat. The level of disturbance is relatively small, in the context of the availability of similar habitat in the immediate vicinity of the project footprint, therefore will result in occasional localised impacts to native fauna.

Field assessments identified habitat types within the project area including dune fields, sandplains, clay pans, calcrete rises and one isolated rocky hill (with outcrop) situated within the dunes. Tracking and active searching for fauna was conducted throughout the project area, with a focus on identifying evidence of threatened species and / or habitat suitability for threatened fauna.

No evidence of threatened flora and fauna species at Dukas 1 was observed during field surveys.

Soil

The soils of project area are susceptible to erosion given that the region experiences long dry periods Project activities have the potential to result in localised soil compaction through heavy vehicle movements, stockpiling of soils and storage of equipment. Compaction of soil has the potential to negatively affect plant root growth, soil moisture potential, soil quality, vegetation establishment, surface

and subsurface drainage, runoff and soil erosion. Many factors will affect the potential for soil to compact including the soil type and characteristics. Soil types within the project area are mostly sandy, and will potentially compact particularly if wet.

The Dukas-1 well site has been positioned on an interdune sandplain located within extensive dune fields. The access road crosses multiple dune crests; however, the alignment aims to minimise the number of dune intersections. Where it is necessary to cross dunes, a low, gently inclined section will be selected.

Cultural heritage

A search of the NT Heritage Register indicates that there are no recorded NT listed heritage items or places are present in the project footprint.

Areas of significance for indigenous cultural heritage is considered through the process of securing a sacred site clearance certificate from the Central Land Council (CLC)). This process aims to prevent damage to, and interference with Aboriginal sacred sites, by setting out the conditions in relation to entering and working on the land. A sacred site clearance certification has been sought and secured for the project area and sacred sites clearance will be obtained prior to any activity.

Known culturally sensitive sites will be avoided by the drilling program however, it is possible that disturbance to culturally sensitive area could occur and impacts would be long-term as remediation would be difficult.

Table 36 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to physical disturbance.

Table 36: Physical disturbance pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Native flora	Loss of vegetation	Likely	II	3	NT Government
Native fauna	Disturbance to native fauna and loss of habitat	Occasional	II	2	NT Government
Soil	Damage to soil through compaction and exposure	Occasional	II	2	Landholders
Cultural heritage	Disturbance or damage to culturally sensitive site	Possible	IV	3	Aboriginal groups

5.2.1.4.3. Control Measures

To manage physical disturbance and mitigate potential risks and impacts, the control measures outlined in **Table 37** will be implemented.

Table 37: Controls to reduce risk and impacts of Physical disturbance

Receptor	Control
General controls	All personnel are given environmental and cultural heritage inductions prior to commencing work. Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues
	Activities to be planned to minimise new land disturbance by utilising previous disturbed areas or existing tracks (where possible), and through operational practices including weaving
	Staying within designated work areas and on approved roads
	Preference to use previously disturbed areas. Where possible, existing tracks, roads or seismic lines will be used for access
Native Flora	Mature trees selected for preservation are to be flagged to ensure their protection
	Cleared vegetation will be respread during rehabilitation
	Branches will be pruned in preference to total tree removal
Native fauna	Hollow timber/trees that may be nesting/roosting sites for fauna will not be cleared.
Soil	Grading will be minimised where possible. If light grading is necessary, flora rootstock will be left intact to promote regeneration.
	An Erosion and Sediment Control Plan will be developed by a Certified Professional in Erosion and Sediment Control (CPESC). This plan will be implemented.
	Inversion of the soil profile will be minimised where possible
Cultural Heritage	Disturbance is restricted to areas which have CLC clearance
	A sacred site clearance certification will be obtained prior to any activity.
	Known sites of sacred or cultural significance are identified and avoided.
	Any new sites identified during the activity will be reported to the Santos Cultural Heritage Team and avoided.
	Maintain GIS database of project footprint and cultural heritage sites including details of any Restricted Work Areas.

5.2.1.4.4. Post treatment risk

Given the location of the project and the relatively small project footprint, together with the proposed controls, the potential for physical disturbance is reduced to an acceptable level. With the application of controls described in **Table 37**, the overall risk ranking is Level 2 (**Table 38**).

5.2.1.4.5. ALARP Discussion

The impacts and risks associated with physical disturbance is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.1.4.6. Statement of acceptability

The residual risk for physical disturbance is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 38: Physical disturbance Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Native flora	Loss of vegetation	3	Minimise disturbance to native vegetation	Possible	II	2	Type A	Demonstrated	Y
Native fauna	Disturbance to native fauna and loss of habitat	2	Minimise disturbance to native fauna	Possible	II	2	Type A	Demonstrated	Y
Surface Hydrology	Disturbance to natural drainage patterns	2	Minimise disturbance to drainage patterns	Unlikely	III	2	Type A	Demonstrated	Y
Soil	Damage to soil through compaction and exposure	2	Minimise disturbance to soil resources.	Possible	II	2	Type A	Demonstrated	Y
Cultural heritage	Disturbance or damage to culturally sensitive site	3	Avoid disturbance to sites of cultural, sacred and heritage significance	Unlikely	III	2	Type A	Demonstrated	Y
Landholders	Disturbance to livestock, pastoral infrastructure and landholders	1	Minimise disturbance to livestock, pastoral infrastructure and landholders	Possible	I	1	Type A	Demonstrated	Y

5.2.1.5 Water use

Water for the drilling program will be sourced from groundwater, utilising two existing groundwater bores with a potential to drill two additional water bores in the vicinity of the project area. Approximately 2 ML of water will be required for the project.

5.2.1.5.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in **Table 39**.

Table 39: Water use risks and impacts

Receptor	Potential Impact
Groundwater	Drawdown of water table

5.2.1.5.2. Evaluation of Environmental Impacts

Groundwater users

The extraction of groundwater can lead to drawdown effects, which can lead to a reduction in groundwater that is available for environmental purposes and for extraction by pastoralists.

Environment

The extraction of groundwater can lead to a reduction in environmental water availability and associated impacts on flora and fauna species and vegetation communities/ecosystems.

The project footprint is located in an area of low recharge however given the small volumes of water required for the proposed drilling program, impacts due to the extraction of groundwater are considered unlikely.

Table 40 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to water use.

Table 40: Water use pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Groundwater	Groundwater extraction affecting groundwater users.	Unlikely	3	2	Landholders
	Groundwater extraction affecting the environment	Unlikely	4	2	NT Government

5.2.1.5.3. Control Measures

To manage water use and mitigate potential risks and impacts, the control measures outlined in Table 41 will be implemented.

Table 41: Controls to reduce risk and impacts of Water use

Receptor	Control
Groundwater	Groundwater impact risk assessment for the proposed extraction rates and durations will be undertaken and will determine if monitoring is required
	Ensure groundwater take is limited to the small volumes required by the project
	Ensure appropriate licences are obtained prior to drilling program and that planned extraction is sustainable
	If local water resources are used, bore numbers and estimated extraction volumes will be provided to DPIR

5.2.1.5.4. Post treatment risk

Given the location of the project and the relatively small amount of groundwater extraction proposed, together with the proposed controls, the potential for water use is reduced to an acceptable level. With the application of controls described in Table 41, the overall risk ranking is Level 1 (Table 42).

5.2.1.5.5. ALARP Discussion

The impacts and risks associated with water use is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.1.5.6. Statement of acceptability

The residual risk for water use is Level 1. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 42: Water use Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Groundwater	Groundwater extraction affecting groundwater users.	2	Minimise draw down effects to groundwater	Unlikely	1	1	Type A	Demonstrated	Y
	Groundwater extraction affecting the environment	2	Minimise draw down effects to groundwater	Unlikely	2	1	Type A	Demonstrated	Y

5.2.2 Unplanned activities

The aspects which are likely to be triggered for the key activities proposed to be undertaken for the Dukas-1 well drilling program are:

- Chemical spills and leaks
- Fauna interaction
- Fire
- Introduced pests
- Waste

To identify and assess the impacts of the activities, the potential for an aspect to impact the receptors present has been undertaken, and a summary of this provided in **Table 43**.

Table 43: Summary Table Aspects and Receptors

Aspect	Receptor	Potential impacts or risk
Chemical spills and leaks	Surface Water	Reduction in surface water quality
	Groundwater	Reduction in groundwater quality
	Soil	Reduction in soil quality
Disturbance to Stakeholders	Livestock, pastoral infrastructure and landholders	Unplanned interaction with or disturbance to other land users
Fauna interaction	Native Fauna	Disturbance, injury or death to native fauna
	Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock
Fire	Native Flora	Introduction and or spread of weeds, pest plants, animals and pathogens.
	Native Fauna	Disturbance, injury or death to native fauna
	Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock
Introduced pests	Native flora	Reduction in air quality
	Native fauna	Disturbance to culturally sensitive site
	Livestock, pastoral infrastructure and landholders	Disturbance to livestock, pastoral infrastructure and landholders
Waste	Native fauna	Disturbance, injury or death to native fauna
	Groundwater	Reduction in groundwater quality
	Soil	Reduction in soil quality

5.2.2.1 Chemical spills and leaks

A number of chemicals and hydrocarbons will be handled, stored and transported for the project. The potential impact of a spill or leak is dependent on the type and volume of material released. Due to the remote location of the project, chemicals will be transported by road and stored on site prior to use. When the well is being drilled, there is a risk of a well blow-out.

5.2.2.1.1. *Sensitive Environmental Receptors with the Potential to occur within the project footprint*

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in Table 44.

Table 44: Spills and leaks risks and impacts

Receptor	Potential Impact
Surface Water	Reduction in surface water quality
Groundwater	Reduction in groundwater quality
Soil	Reduction in soil quality

5.2.2.1.2. *Evaluation of Environmental Impacts*

Groundwater

During the drilling program, there is the risk of a well blow out which would contaminate the groundwater. The contaminants can then follow the groundwater flow and the impacts can be at a regional rather than local scale. Chemicals and fuels used during the drilling program have the potential to impact shallow or perched aquifers and degrade water quality through aquifer contamination. However, the presence of shallow groundwater at well site is low.

Surface Water

Spills to surface waters such as ephemeral watercourses and creeks have the potential to degrade water quality and potentially impact native fauna or stock that access the water. There is also a risk of a well blow out which would release contaminates to the surface that could contaminate the surface water. The contaminants can then follow the surface water flows and the impacts can be at a regional scale. The project area is located in a dune system devoid of surface watercourses and surface water is only present after significant rainfall events. Transport incidents outside the project area would have the potential to impact surface water however; the risk of this is small.

Soil

The desert dune soil types within the project area are sandy, with high levels of permeability. For smaller spills and leaks, contamination 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 soils to depth and potentially reach shallow groundwater, if shallow groundwater is present.

Table 45 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to chemical spills and leaks.

Table 45: Chemical spills and leaks pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Surface Water	Reduction in surface water quality	Possible	III	2	Landholder

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Groundwater	Reduction in groundwater quality	Possible	IV	3	Landholder
Soil	Reduction in soil quality	Occasional	III	3	Landholder

5.2.2.1.3. Control Measures

To manage chemical spills and leaks and mitigate potential risks and impacts, the control measures outlined in **Table 46** will be implemented.

Table 46: Controls to reduce risk and impacts of Chemical spills and leaks

Receptor	Control
All	Drivers will be appropriately qualified
	Vehicles will have appropriate spill kits and staff will be trained in emergency response
	Travel Management Procedures are in place
Groundwater	Well bore integrity assessed prior to commencing drilling test
	Blow-out preventer in well
	Cement bond logging completed
	Well control procedures are in place including The Santos Drilling And Completions Technical Standards 7 - Well Control Onshore
	Well design and weighted mud system in place and are known.
	Real time monitoring of conditions during drilling including drilling monitoring & gas detection monitoring
Soil	Riser & diverter will be used to prevent mud spills
	Pre-spud checks / Pre-job checks when transferring mud
	Appropriate bunding in use for storage of chemicals and where required adherence to standards (e.g. Storage and Handling of Workplace Dangerous Goods National Standard [NOHSC:1015(2001))
	Drilling muds will be mixed in tanks
	Spill kits available to treat spills in-situ
	Minimise fuel transfer where possible
	Use of drip trays for transfers.
	Any spills will be contained and remediated.
	Any spills will be remediated to the satisfaction of the landholder, fenced, soil removed to appropriate facility and signed off by land holder in accordance with the access
	Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940.

5.2.2.1.4. Post treatment risk

Given the location of the project and the relatively small size of disturbance, together with the proposed controls, the potential for chemical spills and leaks is reduced to an acceptable level. With the application of controls described in Table 46, the overall risk ranking is Level 2 (Table 47).

5.2.2.1.5. ALARP Discussion

The impacts and risks associated with chemical spills and leaks is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.1.6. Statement of acceptability

The residual risk for chemical spills and leaks is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 47: Chemical spills and leaks Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Surface Water	Reduction in surface water quality	2	Minimise disturbance to surface water	Unlikely	3	2	Type A	Demonstrated	Y
Groundwater	Reduction in groundwater quality	3	Minimise disturbance to groundwater	Unlikely	3	2	Type A	Demonstrated	Y
Soil	Reduction in soil quality	3	Minimise reduction in soil quality	Unlikely	3	2	Type A	Demonstrated	Y

5.2.2.2 Disturbance to stakeholders

The presence of the project could cause disturbance to landholders such as damage to signage, fencing or other infrastructure, temporary exclusion from land areas and increased vehicle traffic throughout the 22-week drilling program.

5.2.2.2.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by disturbance to stakeholders are shown in Table 48

Table 48: Disturbance to stakeholders risks and impacts

Receptor	Potential Impact
Livestock, pastoral infrastructure and landholders	loss of productivity, loss of stock or a loss of amenity values

5.2.2.2.2. Evaluation of Environmental Impacts

Landholders

There are a number of pastoral properties within the vicinity of the project footprint and the project footprint is located on two cattle grazing properties. The project footprint was selected to enable Santos to explore while allowing normal grazing operations would continue, however the presence of vehicles, plant and personnel has the potential to disturb the activities and amenity of the landholders and potentially other surrounding landholders in the area. Landholder consent and consultation is required prior to activities to ensure that impacts are managed to acceptable levels and as agreed. Any disturbance / interaction that does occur would be temporary and short-term.

Table 49 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to disturbance to stakeholders.

Table 49: Disturbance to stakeholders pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Livestock, pastoral infrastructure and landholders	loss of productivity, loss of stock or a loss of amenity values	Likely	I	2	Landholders

5.2.2.2.3. Control Measures

To manage disturbance to stakeholders and mitigate potential risks and impacts, the control measures outlined in Table 50 will be implemented.

Table 50: Controls to reduce risk and impacts of disturbance to stakeholders

Receptor	Control
Landholder	Relevant landowners and occupiers are notified prior to civil and drilling activities.
	Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues.

Receptor	Control
	All litter is to be managed and disposed of correctly.
	System is in place for logging landholder complaints to ensure that issues are addressed as appropriate.
	Damage to station tracks is avoided and reported if does occur.
	All gates are left in the condition in which they were found
	Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for trucks and heavy vehicles and 20 km/hr around stock yards
	When necessary, all fences are restored to satisfaction of landowner / managers.

5.2.2.2.4. Post treatment risk

Given the location of the project and the relatively small area of disturbance, together with the proposed controls, the potential for disturbance to stakeholders is reduced to an acceptable level. With the application of controls described in Table 50, the overall risk ranking is Level 1 (Table 51).

5.2.2.2.5. ALARP Discussion

The impacts and risks associated with disturbance to stakeholders is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.2.6. Statement of acceptability

The residual risk for disturbance to stakeholders is Level 1. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 51: Disturbance to stakeholders Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Livestock, pastoral infrastructure and landholders	Unplanned interaction with or disturbance to other land users	2	No unplanned interactions or disturbance to landholders	Possible	I	1	Type A	Demonstrated	Y

5.2.2.3 Fauna interaction

Vehicle collision with native fauna/livestock could occur as vehicles move around the project footprint and mobilising and demobilising to and from the project footprint. Where groundwater and produced water and cuttings are being stored above-ground, this may attract fauna to the area and they can sustain injury/death in the ponds.

5.2.2.3.1. Sensitive Environmental Receptors with the potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in Table 52.

Table 52: Fauna interaction risks and impacts

Receptor	Potential Impact
Native Fauna	Disturbance, injury or death to native fauna
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock

5.2.2.3.2. Evaluation of Environmental Impacts

Native fauna

Native fauna is typical of desert environments, and likely to include small, fast moving species of mammal and reptile. Fauna are likely to be most active during dawn and dusk, when temperatures are lower, with many nocturnal species; therefore, in the phases of the project which are 24 hour operations, native fauna will be susceptible to interaction with vehicles. Fauna can also be attracted to the cuttings pits and water bore ponds where they may sustain injury or death. Any project-attributable impacts to fauna will be on an individual rather than population scale.

Livestock

In comparison to native fauna, livestock are more sensitive to vehicle collision. Livestock animals are likely to be grazers, larger and slower than native animals and more likely to be mobile during the day. It is likely that livestock will be found in prescribed areas of the project footprint, mostly gathered in herds, allowing drivers to be fully aware of their presence long before potential for a collision is realised. Vehicles will also be restricted to defined routes / locations, and generally low levels of traffic are expected.

Table 53 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to fauna interaction.

Table 53: Fauna interaction pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Native fauna	Disturbance, injury or death to native fauna	Likely	II	2	NT Government
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock	Likely	I	2	Landholders Aboriginal groups

5.2.2.3.3. *Control Measures*

To manage fauna interaction and mitigate potential risks and impacts, the control measures outlined in **Table 54** will be implemented.

Table 54: Controls to reduce risk and impacts of Fauna interaction

Receptor	Control
All receptors	No driving off designated access roads
	Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for trucks and heavy vehicles and 20 km/hr around stock yards.
Native fauna	Pits and water bore ponds will be fenced
	Routine checks of pits during construction and throughout the drilling program
Livestock	Relevant landowners and occupiers are notified prior to civil and drilling activities.
	All gates are left in the condition in which they were found
	When necessary, all fences are restored to satisfaction of landowner / managers.

5.2.2.3.4. *Post treatment risk*

Given the location of the project and the relatively small size fauna interaction, together with the proposed controls, the potential for fauna interaction is reduced to an acceptable level. With the application of controls described in Table 54, the overall risk ranking is Level 2 (Table 55).

5.2.2.3.5. *ALARP Discussion*

The impacts and risks associated with fauna interaction is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.3.6. *Statement of acceptability*

The residual risk for fauna interaction is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 55: Fauna interaction Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Native fauna	Disturbance, injury or death to native fauna	2	Minimise disturbance to native fauna	Likely	I	2	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock	2	Minimise disturbance to livestock, pastoral infrastructure and landholders	Occasional	I	2	Type A	Demonstrated	Y

5.2.2.4 Fire

Fires can start due to various factors such as heat from vehicle exhausts, sparks from machinery or careless disposal of cigarettes. A fire caused by the drilling program would be started within or adjacent to the project footprint.

5.2.2.4.1. Sensitive Environmental Receptors with the Potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in **Table 56**.

Table 56: Fire risks and impacts

Receptor	Potential Impact
Native flora	Loss of vegetation
Native fauna	Loss and disturbance to habitat, injury or death
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to livestock Damage/loss of infrastructure and pasture

5.2.2.4.2. Evaluation of Environmental Impacts

Native flora

Bushfires are a natural occurrence in areas of bush and scrubland and are an essential part of the life cycle for many native flora, promoting reproduction and growth in the long term. Uncontrolled man-made fires, however, can be devastating to large areas of vegetation, resulting in mid-term impacts to flora.

Most native flora in bush/ scrub habitats implement survival strategies to protect tissue from heat which would otherwise destroy them. Fire resistance and tolerance is exhibited through bark thickness, other vegetative insulation, above-ground re-sprouting, underground roots and stems.

Following a fire event, change in conditions such as increased light availability and changes to nutrient levels can result in a temporary/semi-permanent change to floral assemblage in the area. This is not necessarily a negative impact, as post-fire plant responses include increased productivity and flowering, fire stimulated seed release and dispersal, and improved seedling germination.

Overall, negative impacts associated with fire on native flora could be widespread, however in the absence of altered long-term fire regimes, populations are likely to recover over time.

Native Fauna

As with native flora, most native fauna species in fire-risk areas are adapted to tolerate or respond to fire in a way that aids survival. Survival responses include moving away from the area, burrowing to escape heat, and active use of the fire and burnt areas for feeding opportunities (such as birds of prey targeting rodents flushed from undergrowth by heat). Mortality resulting from fire is generally low, as most animals are able to move away from the affected area, however higher levels of mortality can be seen in flightless invertebrates and insects in vulnerable stages of development.

Dispersal from an area has ongoing impacts to the post-fire habitat, as animals will return at different rates resulting in a constantly evolving food chain. Changes to vegetation will also affect fauna, changing food sources for herbivores and omnivores.

In the absence of altered long-term fire regimes, any impacts would be temporary, with fauna quickly returning to an area post-fire.

Livestock, pastoral infrastructure and landholders

Although livestock are mobile and able to move away from bushfire, they are often limited by the boundaries of landowners' land. Fences / ditches can hinder movement of livestock, effectively trapping them within the fire path.

Livestock are considerably more vulnerable to bushfire than native fauna, as their escape is limited and they have not adapted to the natural environment.

Landowners are impacted by any impacts on livestock, as this will affect the viability of the operations. Bushfires will impact on the pasture available to livestock and given the low rainfall in the area, this will take time to be restored. Similarly, a loss of infrastructure such as fencing and buildings would have an impact on the livelihood of landowners. In extreme cases, a bushfire could result in loss of life.

Table 57 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to fire.

Table 57: Fire pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Native flora	Loss of vegetation	Possible	II	2	NT Government
Native fauna	Loss and disturbance to habitat, injury or death	Possible	II	2	NT Government
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to Livestock	Possible	II	2	Landholders
	Damage/loss of infrastructure and pasture	Possible	IV	3	Landholders

5.2.2.4.3. Control Measures

To manage fire and mitigate potential risks and impacts, the control measures outlined in **Table 58** will be implemented.

Table 58: Controls to reduce risk and impacts of Fire

Receptor	Control
All	Well site fire management protocol will be in place with monitoring
	Fire-fighting equipment and competent fire-fighting personnel will be used
	Include fire season education as part of the induction.
	Appropriate fire prevention procedures in place.
	Appropriate firefighting gear available to the crew.
	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 fully operational VHF and / or UHF radio transceivers.

Receptor	Control
	Smoking will only be permitted in areas clear of vegetation, and there will be no littering of cigarette butts permitted. Cigarette butts will be stubbed out and put into suitable receptacles for disposal.
	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
	The flare pit will be monitored during flaring

5.2.2.4.4. Post treatment risk

Given the location of the project and the relatively small size fire, together with the proposed controls, the potential for fire is reduced to an acceptable level. With the application of controls described in, the overall risk ranking is Level 2 (Table 59).

5.2.2.4.5. ALARP Discussion

The impacts and risks associated with fire is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.4.6. Statement of acceptability

The residual risk for fire is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 59: Fire Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Native flora	Loss of vegetation	2	Minimise disturbance to native fauna	Unlikely	II	1	Type A	Demonstrated	Y
Native fauna	Disturbance, injury or death	2	Minimise disturbance to native flora	Unlikely	II	1	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Disturbance, injury or death to Livestock	2	Minimise disturbance to livestock	Unlikely	II	1	Type A	Demonstrated	Y
	Damage/loss to dwellings, infrastructure	3	Minimise disturbance to landowners	Unlikely	IV	2	Type A	Demonstrated	Y

5.2.2.5 Introduced pests

Weeds are an increasing threat to the region's natural, cultural and economic assets (NTG 2017). Pests can be transported to the project footprint via vehicles, equipment and personnel. Locally established weeds can also be spread due to increased vehicle traffic, and vehicles through the project footprint. Ecoz (2018) undertook a survey of the project area and did not find any occurrences of declared weeds.

5.2.2.5.1. Sensitive Environmental Receptors with the potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in Table 60.

Table 60: Introduced pests risks and impacts

Receptor	Potential Impact
Native flora	Introduction and or spread of weeds, pest plants and animals.
Native fauna	Introduction and or spread of weeds, pest plants and animals
Livestock, pastoral infrastructure and landholders	Disturbance to Livestock

5.2.2.5.2. Evaluation of Environmental Impacts

Native flora and soils

Weeds threaten the survival of native vegetation if they outcompete flora for nutrients, habitat and sunlight. Once established, weed species often produce large quantities of seeds, allowing them to spread quickly and efficiently. Once established, weeds can be difficult to manage and therefore preventing initial introduction and spread of certain species is the most effective form of weed management.

Native fauna and livestock

Pest animals can have a detrimental effect on native fauna and livestock through competition for food and habitat, as well as direct predation of native species. Some pests cause changes to natural habitats through selective grazing of favoured plant species, or degradation of land by uprooting plants and burrowing.

Table 61 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to introduced pests.

Table 61: Introduced pests pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Native flora	Introduction and or spread of weeds, pest plants and animals	Likely	IV	4	NT Government
Native fauna	Introduction and or spread of weeds, pest plants and animals	Occasional	IV	3	NT Government

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Livestock, pastoral infrastructure and landholders	Disturbance to Livestock	Possible	III	2	Landholders

5.2.2.5.3. Control Measures

Given that the project area is free of declared weeds, the focus will be on minimising the chance of weed introductions. To manage introduced pests and mitigate potential risks and impacts, the control measures outlined in **Table 62** will be implemented.

Table 62: Controls to reduce risk and impacts of Introduced pests

Receptor	Control
All	Weed wash-down certification for vehicle and machinery from interstate.
	Ensure site environmental inductions for all site personnel and contractors include vehicle weed hygiene requirements and information on exotic invasive ants.
	All vehicle and equipment movements to stay on formed access tracks, well leases and camp areas.
	Ensure vehicles, machinery and equipment entering the permit areas have been cleaned and are free of soil and vegetative matter, or have a valid weed hygiene certificate.
	A baseline weed assessment has been completed prior the commencement of works covered in this EMP. This baseline assessment will be used to provide benchmarks for post-project monitoring.
	To minimise spread of buffel grass from the south to the north of the project area, road works will be completed in the northern areas first and transporting soil material from the south to the north will be minimised
	Baseline data will be collected in consultation with the Department of Environment and Natural Resources (DENR) and data will be provided to DENR in a format to be specified by them.
	Areas of priority weeds identified will be marked.
	If infestations of priority weed species are identified during baseline assessment they will be avoided via a detour around the infestation if within line tolerance.
	If infestations are unavoidable, infestations will be crossed at the narrowest point and midline wash downs will be conducted once exiting the infestation.
	To minimise pest fauna interactions, municipal wastes and putrescible food wastes will be stored sealed containers that limit access from Rock Doves and Sparrows
	All water storages will be fenced to exclude large herbivorous fauna (Camels and Donkeys)

5.2.2.5.4. Post treatment risk

Given the location of the project and the relatively small size introduced pests, together with the proposed controls, the potential for introduced pests is reduced to an acceptable level. With the application of controls described in **Table 62**, the overall risk ranking is Level 2 (**Table 63**).

5.2.2.5.5. ALARP Discussion

The impacts and risks associated with introduced pests is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.5.6. Statement of acceptability

The residual risk for introduced pests is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 63: Introduced pests Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Native flora	Introduction and or spread of weeds, pest plants and animals.	4	Minimise disturbance to native fauna	Unlikely	IV	2	Type A	Demonstrated	Y
Native fauna	Introduction and or spread of weeds, pest plants and animals.	3	Minimise disturbance to native flora	Unlikely	IV	2	Type A	Demonstrated	Y
Livestock, pastoral infrastructure and landholders	Disturbance to Livestock	2	Minimise disturbance to livestock	Unlikely	IV	2	Type A	Demonstrated	Y

5.2.2.6 Waste

Putrescible and municipal waste will be generated by the project and will be stored in skips adjacent to the camp area, with recyclables being segregated and transported to an approved facility. Skips will be transported regularly for disposal of waste to a licensed landfill. Industrial waste, such as chemical containers and used tyres, will be collected and disposed at a licenced facility. Domestic wastewater and sewage will be treated in-situ, with sludge transported offsite. Produced water, drilling cuts and drilling muds will be stored in cutting pits on the wellsite pad.

5.2.2.6.1. Sensitive Environmental Receptors with the potential to occur within the project footprint

Based upon the receptors identified in Section 5, those known to be impacted by physical disturbance are shown in Table 64.

Table 64: Waste risks and impacts

Receptor	Potential Impact
Surface Water	Reduction in surface water quality
Groundwater	Reduction in groundwater quality
Soil	Reduction in soil quality
Native fauna	Attraction to inappropriately stored waste

5.2.2.6.2. Evaluation of Environmental Impacts

Native Fauna

When waste is stored incorrectly, it can attract native fauna in to the campsite. This can lead to impacts to native fauna when interacting with operations personnel. Due to the short-term nature of operations and relatively small levels of waste, this impact is likely to be short-term and localised

Surface Water and Soil

In an extreme weather event, these cuttings pits can overflow and impact on the surface water and soil. Given the geological target the content of cuttings pits are expected to be saline and may contain organics leaching of these compounds may impact surface water and soil.

Groundwater

Cuttings pits can leach their contents if the lining is not intact causing groundwater contamination. Groundwater contamination may impact on the beneficial uses of the groundwater resource which could include stock watering or human consumption.

Table 65 provides a summary assessment of the potential risk of unmitigated impacts to environmental receptors due to waste.

Table 65: Waste pre-treatment risk ranking

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Surface Water	Reduction in surface water quality	Possible	III	2	Landholder

Receptor	Potential Impact	Likelihood	Consequence	Risk Ranking	Relevant Stakeholders
Groundwater	Reduction in groundwater quality	Possible	IV	3	Landholder
Soil	Reduction in soil quality	Possible	III	2	Landholder
Native fauna	Attraction to inappropriately stored waste	Likely	I	2	NT Government

5.2.2.6.3. Control Measures

To manage waste and mitigate potential risks and impacts, the control measures outlined in **Table 66** will be implemented.

Table 66: Controls to reduce risk and impacts of Waste

Receptor	Control
Surface Water Soil Groundwater	Pits will have sufficient storage capacity to ensure there is an adequate freeboard, ensuring the highest recorded monthly rainfall can be accommodated.
	Sump and flare pit levels will be monitored for overflow during and after high rainfall at all times while drilling
	Soil sampling will include a baseline sample to drilling, sampling sump fluid post drill and sampling cuttings when dried out
	Cuttings burial or removal subject to sampling results. The decision on disposal of the sump contents will be made in consultation with, and on the advice of, an independent environmental consultant.
	Cuttings pit will be constructed with a liner
	Cuttings pit will be inspected to check the integrity of the liner
	Cuttings pit liner will be removed at the completion of project activities during demobilisation and rehabilitation activities prior to being backfilled.
	If groundwater is encountered, monitoring will be undertaken to ensure leaching has not occurring.
Native fauna	Waste will be segregated on site and all putrescible waste material will be held in fauna proof containers.

5.2.2.6.4. Post treatment risk

Given the location of the project and the relatively small size waste, together with the proposed controls, the potential for waste is reduced to an acceptable level. With the application of controls described in **Table 66**, the overall risk ranking is Level 2 (**Table 67**).

5.2.2.6.5. ALARP Discussion

The impacts and risks associated with waste is considered a decision 'Type A', meaning that they are well-understood and that are established practices in place to manage these risks. With implementation of the control measures, it is considered that the risks and impacts of physical disturbance have been reduced to ALARP.

5.2.2.6.6. Statement of acceptability

The residual risk for waste is Level 2. Using Santos' model for acceptance, this is considered to be acceptable providing that ALARP has been achieved and is demonstrated.

Table 67: Waste Residual Risk Ranking

Receptor	Risk or Impact	Pre-treatment Risk Ranking	Environmental Outcome	Likelihood	Consequence	Risk Ranking	ALARP	Acceptability	Accept Y/N
Surface Water	Reduction in surface water quality	2	Minimise disturbance to surface water	Unlikely	III	2	Type A	Demonstrated	Y
Groundwater	Reduction in groundwater quality	3	Minimise disturbance to groundwater	Unlikely	III	2	Type A	Demonstrated	Y
Soil	Reduction in soil quality	2	Minimise reduction in soil quality	Unlikely	III	2	Type A	Demonstrated	Y
Native fauna	Attraction to inappropriately stored waste	2	Minimise disturbance to native fauna	Unlikely	I	1	Type A	Demonstrated	Y

6.0 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 Environmental outcomes that address the risks that are identified in section 5.0. The Environmental Outcomes must address 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 EPSs. These Measurement Criteria (MC) must enable a determination to be made on whether the EOs and EPSs are being consistently met. The EOs, EPSs and MC for the Dukas-1 Well drilling program are described in **Table 68**.

Table 68: Environmental Outcomes, Environmental Performance Standards and Measurement Criteria

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
Atmospheric Emission	Minimise emissions to air Minimise disturbance to native fauna Minimise disturbance to native vegetation Minimise the impact on human health	Blade work is banned on naturally smooth surfaces or flat easy terrain. Minimal blade work is permitted elsewhere for access	Daily checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		Where possible, existing tracks, roads or seismic lines will be used for access.	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Field Representative
		No driving off designated access roads	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Field Representative
		Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for trucks and heavy vehicles.	In-vehicle Monitoring System (IVMS) weekly reports	Santos Field Representative
		Water trucks will be used for dust suppression as required.	Dust minimised and inconsequential. No flora death due to dust accumulation.	Santos Field Representative
	Minimise emissions to air	All vehicles, plant and the drill rig will be in good working order. Engines and machinery are maintained in accordance with the maintenance schedule	Engines and Machinery are maintained in accordance with the maintenance schedule	Santos Field Representative
Light Emissions	Minimise disturbance to native fauna	All boundary lighting will be positioned to face inwards to provide adequate lighting for safe	Inspection of lighting in the camp area	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
	Minimise disturbance to livestock, pastoral infrastructure and landholders	operations, without excessive overspill.		
		Ensure site environmental inductions for all site personnel and contractors include the issue of noise, vibration and light and protective measures to prevent disturbance.	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		Lighting used on drill site to minimise offsite disturbance, while maintaining safety standards.	No lighting other than that required for maintaining safety standards	Santos Field Representative
Noise	Minimise disturbance to native fauna Minimise disturbance to landholders Minimise disturbance to livestock	Existing noise attenuation devices fitted to drill rig and other machinery used on site will be maintained in good working order.	Audit of machinery and drill rig to ensure compliance	Santos Field Representative
		Engines and machinery are maintained in accordance with the maintenance schedule.	Audit of machinery and drill rig to ensure compliance	Santos Field Representative
	Minimise disturbance to landholders	Maintain communications during operations with relevant landholders.	Adherence to the communications procedure with landholders	Santos Field Representative
Physical Disturbance	Minimise loss of vegetation Minimise disturbance to native fauna and loss of habitat Minimise damage to soil through compaction and exposure Minimise disturbance or damage to culturally sensitive site	All personnel are given environmental and cultural heritage inductions prior to commencing work. Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		Activities to be planned to minimise new land disturbance by utilising previous disturbed areas or existing tracks (where possible), and through operational practices including weaving.	Daily checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		Staying within designated work areas and on approved roads.	Daily checklist confirms that only approved access roads used.	Santos Field Representative
		Preference to use previously disturbed areas. Where possible, existing tracks, roads or seismic lines will be used for access.	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
	Minimise loss of vegetation	Mature trees selected for preservation are to be flagged to ensure their protection	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		Cleared vegetation will be respread during rehabilitation	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		Branches will be pruned in preference to total tree removal	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
	Minimise disturbance to native fauna and loss of habitat	Hollow timber/trees that may be nesting/roosting sites for fauna will not be cleared.	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
	Minimise damage to soil through compaction and exposure	Grading will be minimised where possible. If light grading is necessary, flora rootstock will be left intact to promote regeneration.	Checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		The Erosion and Sediment Control Plan developed by a Certified Professional in Erosion and Sediment Control (CPESC) will be implemented.	Audit of the Erosion and Sediment Control Plan controls	Santos Field Representative
		Inversion of the soil profile will be minimised where possible	Daily checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
	No disturbance or damage to culturally sensitive site	Disturbance is restricted to areas which have CLC clearance	GIS database that includes project areas and cultural heritage sites	Santos GIS Coordinator
		Ensure a sacred site clearance certification will be obtained prior to any activity.	No activity prior to the granting of a sacred site clearance certificate.	Santos Environmental Lead
		Known sites of sacred or cultural significance are identified and avoided.	Details of sacred and cultural significant sites included in GIS database and utilised when determining project footprint (and provided to project personnel as part of induction)	Santos GIS Coordinator
		Any new sites identified during the activity will be reported to the	Details of new heritage sites included in GIS database	Santos GIS Coordinator

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		Santos Cultural Heritage Team and avoided.		
		Maintain GIS database of project footprint and cultural heritage sites including details of any Restricted Work Areas.	GIS database that includes project areas and cultural heritage sites	Santos GIS Coordinator
Water Use	No groundwater extraction impacting existing groundwater users/environment	Groundwater impact risk assessment for the proposed extraction rates and durations will be undertaken and will determine if monitoring is required	Compliance with groundwater risk assessment documentation	Santos Environment Lead
		Ensure groundwater take is limited to the small volumes required by the project.	Record of groundwater extraction volume limited to the volumes l the EMP	Santos Field Representative
		Ensure appropriate licences are obtained prior to drilling program and that planned extraction is sustainable.	Record of groundwater extraction licence (and compliance with licence requirements)	Santos Field Representative
		If local water resources are used, bore numbers and estimated extraction volumes will be provided to DPIR.	Daily record of bore number and extraction values. Record/s of correspondence with DPIR on groundwater extraction	Santos Environment Lead
Chemical Spills and Leaks	Minimise disturbance to surface water Minimise disturbance to groundwater Minimise reduction in soil quality	Drivers will be appropriately qualified and will be trained in emergency response	Training records to confirm appropriate training for drivers	Santos Field Representative
		Vehicles will have appropriate spill kits and staff trained in emergency response	Audit of vehicles and mobile plant and staff training	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		Travel Management Procedures are in place	Audit of travel management procedure	Santos Field Representative
		Well bore integrity assessed prior to commencing drilling test	Audit of well integrity testing	Santos Field Representative
		Blow-out preventer in well	As-built specifications of well	Santos Field Representative
		Cement bond logging completed	As-built specifications of well	Santos Field Representative
		Well control procedures are in place including The Santos Drilling And Completions Technical Standards 7 - Well Control Onshore	Compliance with the technical standard	Santos Field Representative
		Well design and weighted mud system in place and are known.	Audit of well integrity testing	Santos Field Representative
		Real time monitoring of conditions during drilling including drilling monitoring & gas detection monitoring	Audit of results of real time monitoring determines results compliant with standards	Santos Field Representative
		Riser & diverter will be used to prevent mud spills	As-built specifications of well and civils met	Santos Field Representative
		Pre-spud checks / Pre-job checks when transferring mud	Checklist confirms checks have been completed	Santos Field Representative
		Appropriate bunding in use for storage of chemicals and where required adherence to standards (e.g. Storage and Handling of Workplace Dangerous Goods National Standard [NOHSC:1015(2001))	As-built specifications of well and civils met	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		Real time monitoring of conditions during drilling.	Audit of drilling operations	Santos Field Representative
		Drilling Muds will be mixed in tanks.	Audit of drilling operations	Santos Field Representative
		Spill kits available to treat spills in-situ	Weekly checklist confirms all hazardous materials stored and managed and spill kits available	Santos Field Representative
		Minimise fuel transfer where possible.	Weekly audit of fuel transfers	Santos Field Representative
		Use of drip trays for transfers.	Weekly checklist confirms all hazardous materials stored and managed and drip trays used for transfers	Santos Field Representative
		Any spills contained and remediated.	No records in the Incident Management System	Santos Field Representative
		Any spills will be remediated to the satisfaction of the landholder, fenced, soil removed to appropriate facility and signed off by land holder in accordance with the access.	Landholder complaints logged in complaints register	Santos Field Representative
		Fuel and other lubricants will be appropriately stored and managed, in accordance with AS1940.	Checklist confirms all hazardous materials stored and managed in accordance with Environmental Performance Standards	Santos Field Representative
Disturbance to Stakeholders	Unplanned interaction with or disturbance to other land users	Relevant landowners and occupiers are notified prior to civil and drilling activities.	Consultation records demonstrate notification	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		Inductions for all employees and contractors cover pastoral, conservation, legislation and infrastructure issues.	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		All litter is to be managed and disposed of correctly.	No records in the Incident management systems	Santos Field Representative
		System is in place for logging landholder complaints to ensure that issues are addressed as appropriate.	Landholder complaints logged in complaints register	Santos Field Representative
		Damage to station tracks is avoided and reported if does occur.	No records in the Incident management systems	Santos Field Representative
		All gates are left in the condition in which they were found	No records in the Incident management systems	Santos Field Representative
		Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for trucks and heavy vehicles and 20 km/hr around stock yards	IVMS weekly reports demonstrate no exceptions	Santos Field Representative
		When necessary, all fences are restored to satisfaction of landowner / managers.	No records in the Incident management systems	Santos Field Representative
Fauna Interaction	Minimise disturbance to native fauna Minimise disturbance to livestock, pastoral infrastructure and landholders	No driving off designated access roads	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		Speeds on unsealed roads will be limited – maximum 60 km/hr for light vehicles, 40 km/hr for	IVMS weekly reports demonstrate no exceptions	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		trucks and heavy vehicles and 20 km/hr around stockyards.		
	Minimise disturbance to native fauna	Pits and water bore ponds will be fenced	As-built pit specifications met	Santos Field Representative
		Routine checks of pits during construction and throughout the drilling program	Daily checklist ensures pits are checked	Santos Environment Lead
	Minimise disturbance to livestock, pastoral infrastructure and landholders	Relevant landowners and occupiers are notified prior to civil and drilling activities.	Notice of Entry completed before works undertaken	Santos Field Representative
		All gates are left in the condition in which they were found	No records in the Incident management systems	Santos Field Representative
		When necessary, all fences are restored to satisfaction of landowner / managers.	No records in the Incident management systems	Santos Field Representative
Fire	Minimise disturbance to native fauna Minimise disturbance to native flora Minimise disturbance to livestock Minimise disturbance to landowners	Well site fire management protocol will be in place with monitoring	Weekly checklist confirms all firefighting equipment and procedures are in place in accordance with Environmental Performance Standards s	Santos Field Representative
		Fire-fighting equipment and competent fire-fighting personnel will be used	Training register to confirm personnel have appropriate training	Santos Field Representative
		Include fire season education as part of the induction.	All project staff undertaken am environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		Appropriate fire prevention procedures in place.	Weekly checklist confirms all firefighting equipment and	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
			procedures are in place in accordance with Environmental Performance Standards	
		Appropriate firefighting gear available to the crew.	Weekly checklist confirms all firefighting equipment and procedures are in place in accordance with Environmental Performance Standards	Santos Field Representative
		All vehicles will be equipped with portable fire extinguishers.	Weekly checklist confirms all firefighting equipment and procedures are in place in accordance with Environmental Performance Standards	Santos Field Representative
		Machinery and vehicles should be parked in areas of low fire risk and be free of any combustible material	IVMS weekly reports demonstrates no exceptions	Santos Field Representative
		Any petrol motor vehicles or petrol-powered pumps will be fitted with spark arresters.	Weekly checklist confirms all firefighting equipment and procedures are in place in accordance with Environmental Performance Standards	Santos Field Representative
		All vehicles will be equipped with operational VHF and / or UHF radio transceivers.	Weekly checklist confirms all firefighting equipment and procedures are in place in accordance with Environmental Performance Standards	Santos Field Representative
		Smoking will only be permitted in areas clear of vegetation, and there will be no disposal of butts.	No records in the Incident management systems	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		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	All project staff undertaken an environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		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	Records of toolbox meetings, which indicate when there is a high fire risk in place.	Santos Field Representative
		The flare pit will be monitored during flaring	Audit of monitoring during flaring activity	Santos Field Representative
Introduced Pests	Minimise disturbance to native fauna Minimise disturbance to native flora Minimise negative impacts to soil quality Minimise disturbance to livestock	Weed wash-down certification for vehicle and machinery from interstate.	A register of vehicle / equipment / machinery cleaning is kept.	Santos Field Representative
		Ensure site environmental inductions for all site personnel and contractors include vehicle weed hygiene requirements and information on exotic invasive ants.	All project staff undertaken am environmental and cultural induction as recorded in the Santos Training Register	Santos Environment Lead
		All vehicle and equipment movements to stay on formed access tracks, well leases and camp areas.	All project staff undertaken an environmental and cultural	Santos Environment Lead

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
			induction as recorded in the Santos Training Register	
		Ensure vehicles, machinery and equipment entering the permit areas have been cleaned and are free of soil and vegetative matter, or have a valid weed hygiene certificate.	A register of vehicle / equipment / machinery cleaning is kept.	Santos Field Representative
		A baseline weed assessment has been completed prior the commencement of works covered in this EMP. This baseline assessment will be used to provide benchmarks for post-project monitoring.	Baseline Weed Assessment documentation delivered to DENR	Santos Environment Lead
		To minimise spread of buffel grass from the south to the north of the project area, road works will be completed in the northern areas first and transporting soil material from the south to the north will be minimised.	Daily checklist confirms all clearing is in accordance with Environmental Performance Standards	Santos Field Representative
		Baseline data will be collected in consultation with the Department of Environment and Natural Resources (DENR) and data will be provided to DENR in a format to be specified by them.	Baseline Weed Assessment documentation delivered to DENR	Santos Environment Lead
		Areas of priority weeds identified will be marked.	Maintain demarcation during operations and inspect (and rectify if needed) daily.	Santos Field Representative
		If infestations of priority weed species are identified during baseline assessment they will be	Maintain demarcation during operations and inspect (and rectify if needed) daily.	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
		avoided via a detour around the infestation if within line tolerance.		
		If infestations are unavoidable, infestations will be crossed at the narrowest point and wash downs will be conducted once exiting the infestation.	Maintain demarcation during operations and inspect (and rectify if needed) daily.	Santos Field Representative
		To minimise pest fauna interactions, municipal wastes and putrescible food wastes will be stored sealed containers that limit access from Rock Doves and Sparrows	Waste records	Santos Field Representative
		All water storages will be fenced to exclude large herbivorous fauna (Camels and Donkeys)	Bore design specifications	Santos Field Representative
Waste	Minimise disturbance to surface water Minimise reduction in soil quality	Pits will have sufficient storage capacity to ensure there is an adequate freeboard, ensuring the highest recorded monthly rainfall can be accommodated.	Pit design documents	Santos Field Representative
		Sump and flare pit levels will be monitored for overflow during and after high rainfall at all times while drilling	Monitoring during rainfall events	Santos Field Representative
		Soil sampling will include a baseline sample to drilling, sampling sump fluid post drill and sampling cuttings when dried out	Samples complete and documented	Santos Environment Lead
		Cuttings burial or removal subject to sampling results	Results of consultant report adhered to and DPIR notified	Santos Environment Lead
		Cuttings pit will be constructed with a liner	As-built pit specifications	Santos Field Representative

Aspect	Environmental Outcome	Environmental Performance Standard	Measurement Criteria	Responsible person
	Minimise disturbance to groundwater	Cuttings pit will be inspected to check the integrity of the liner	Daily checklist	Santos Environment Lead
		Cuttings pit liner will be removed at the completion of project activities during demobilisation and rehabilitation activities prior to being backfilled.	Demobilisation checklist	Santos Field Representative
		Groundwater monitoring will be undertaken to ensure leaching is not occurring.	Monitoring program	Santos Environment Lead
	Minimise disturbance to native fauna	Waste will be segregated on site and all putrescible waste material will be held in fauna proof containers.	Waste records	Santos Field Representative

7.0 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 risk of the Dukas-1 Well Drilling program. The strategy aims to ensure that the control measures, environmental performance outcomes and standards, detailed in Section 7, are implemented and monitored to ensure environmental impacts and risks are continually identified and reduced to a level that is ALARP and acceptable.

7.1 Santos Environment, Health and Safety 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 **Figure 16**.

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.

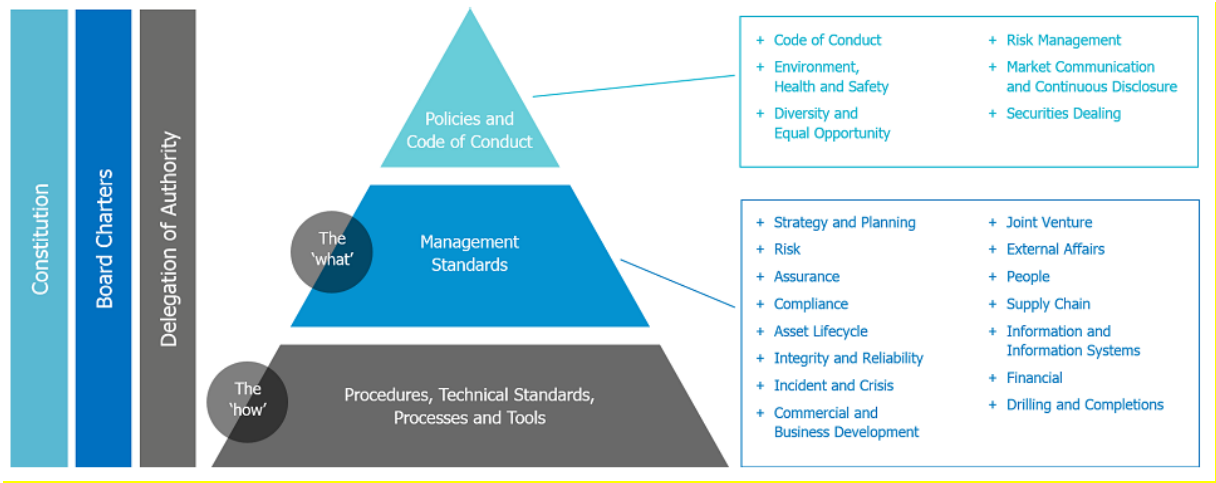

Figure 16: Santos Management System Framework

7.2 Roles and Responsibilities

Key roles and environmental responsibilities for the activity are detailed in Table 69 and will be communicated to these positions prior to the activity commencing and when any changes are made to these positions.

Table 69: Roles and Responsibilities for the drilling program

Role	Responsibilities
Santos NT Projects D&C Leader	To supervise drilling and/ or completions engineering, planning, designing, contracting and supporting operations within Santos, ensuring compliance with the Drilling and Completions Management Processes and SMS. To develop an environment that promotes innovation, collaboration and engineering excellence and manages engineering risk. Ensure adequate resources are in place to meet the requirements within the EMP. Ensure incidents and non-conformances are managed as per Section 8.6 and 8.7.4 respectively. Report environmental incidents to the Exploration Manager and ensure reporting (Table 8-2) and investigations undertaken. Ensure records and documents are managed so they are available and retrievable (Section 8.7.2). Ensure non-conformances identified are communicated, raised in Environment, Health and Safety (EHS) Toolbox and corrective actions completed (Section 8.7.4).
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 8.5). Ensure overall compliance with this 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 as detailed in Figure 8-2. • Audited to inform the EMP Performance Report. Ensure the EMP Performance Report is prepared and submitted to DPIR (Section 8.7.5).
Santos NT D&C Projects Senior Drilling Engineer	To provide drilling and/ or completion engineering support for the planning, designing, contracting and operations within Santos, ensuring compliance with DCMP and SMS. Design well barriers and verification methods to prevent cross flow between hydrocarbon and water zones, and surface as per DCMP barrier standards and include in Operations Programmes
Lead Operations and Well Integrity Engineer	Participate in design of well barriers and verification methods to prevent cross flow between hydrocarbon and water zones, and surface as per DCMP barrier standards and include in Operations Programmes. Monitor well barriers are in place at each stage of the drilling and/or completion operation as per approved Operations Programme. Manage Well Integrity interventions through life of well liaising with Santos Integrity Management Team guided by well specific Integrity Management Plans
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, control measures, performance standards, measurement criteria and requirements in the implementation strategy in this EMP to the NT Exploration Manager and NT Projects D&C Leader. Develop the environmental component of the activity induction (Section 8.3). Assess any environmentally relevant changes (Section 8.5). Review any non-conformances relevant to environment performance to ensure corrective actions are appropriate to prevent recurrence (Section 8.7.4).

Role	Responsibilities
	Prepare and submit the EMP Performance Report to DPIR within 3 months of the activity finishing (Section 8.7.5).

7.3 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
- Key receptors in the area
- Environmental impacts and risks, and associated controls to be implemented
- Management of change process
- Roles and responsibilities
- Incident and non-conformance reporting and management

Key roles for the activity, as detailed in Section 8.2, 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.

7.4 Emergency Response Plan

The Emergency and Well Control Response Plan (EWCRP) sets out the emergency response arrangements and requirements for Santos Onshore Drilling and Completions (Wellsite) operations to ensure an effective and timely response and recovery to emergency and well related events.

The EWCRP must be implemented when:

- An emergency exceeds wellsite resources
- Well controls events relating to:
    - Rig operations (drilling, completions, workover, other)
    - Non-rig operations (stimulation, coiled tubing, snubbing, electric line, slick line, other well interventions)
    - Producing or shutting in the well

Santos Incident Severity and Well Control Assessment and Activation Matrices are used to determine the level of team support required for an emergency based on the events potential.

For this standalone D&C operation, Santos has a three-tiered emergency response structure as per below.

1. Field Response Team (FRT – Northern Territory field location)
2. Incident Management Team (IMT - Adelaide)
3. Crisis Management Team (CMT - Adelaide)

The following Emergency Situation Checklists can be used by the On Scene Commander (OCR) and D&C IMT:

- Well Control
- Injury / Fatality
- Electric Shock
- Aircraft Accident
- Bomb / Terrorist / Security Threat
- Bushfire
- Fire / Explosion
- Confined Space
- Person / Vehicle Missing
- Evacuation
- Chemical / Gas Release
- Vehicle Accident
- Helicopter Search and Rescue (SAR)

The emergency response arrangements within the EWCRP 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

7.4.1 Spill Response

Small spills are typically managed locally at the site by the use of dedicated spill kits; which are readily available and appropriately stocked. Large spills, which are typically beyond the capability of site to complete the response. In these circumstances, the OCR is to notify the D&C Superintendent as shown in the Activation and Escalation flowchart in Figure 17, to provide incident details and initiate an appropriately response supported.

All spills will be managed in accordance with:

- Emergency Well Control and Response Plan
- Contractors Emergency Response Plan
- Santos Management System - MS1 Risk – ST13 Environmental Hazard Controls Procedure
- Incident & Crisis ST2 - Incident Reporting, Investigation and Learning Procedure
- Project Environment Plan (including regulatory reporting)

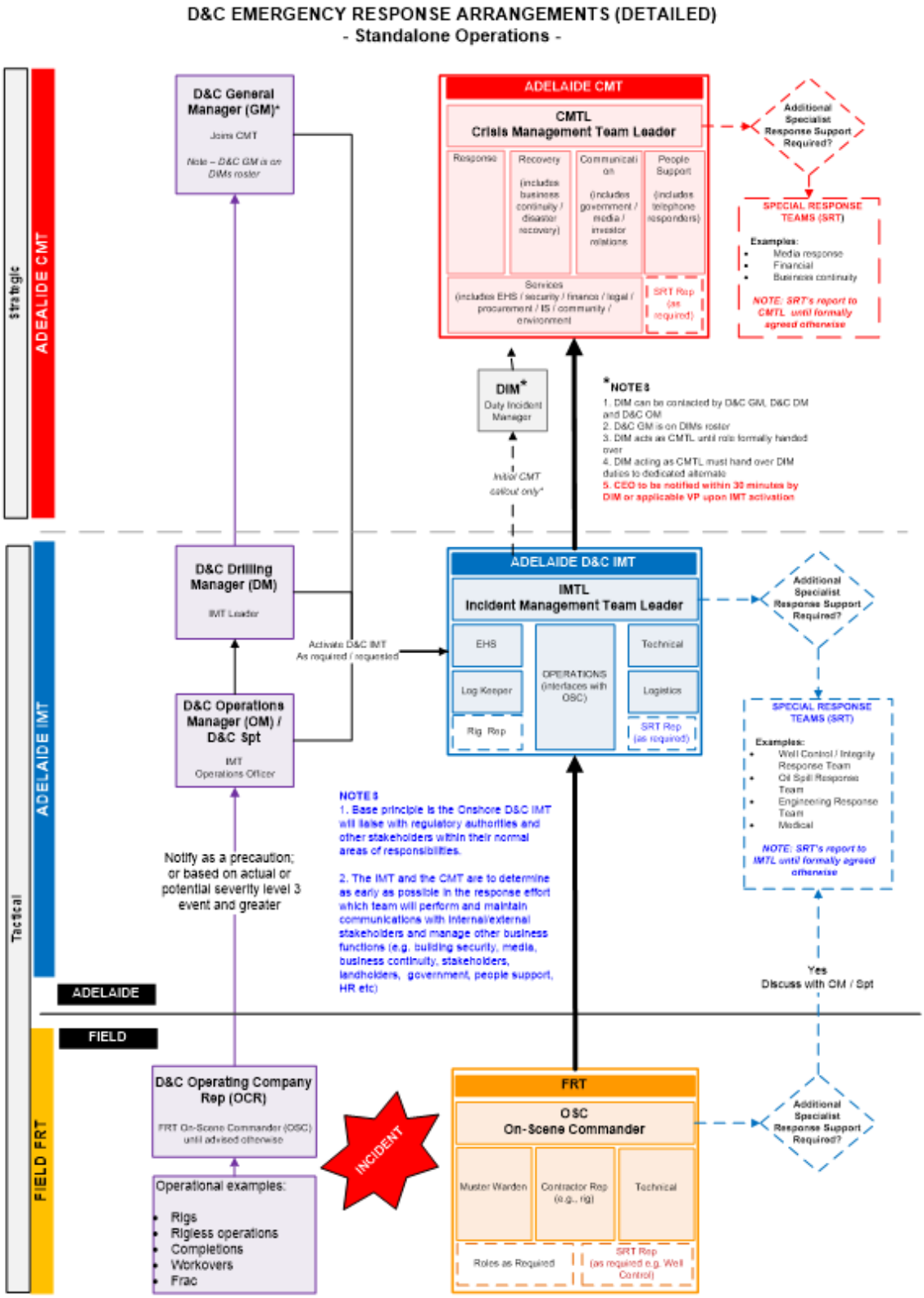

Figure 17 Emergency Activation Flowchart

7.5 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.

Section 1.2 details the permit titleholder, activity nominated liaison person and contact details for both. A change in any of these details are required to be notified to DPIR.

7.6 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 70 details the external incident notification, reporting requirements and timeframes for environmental incidents associated with the activity.

Table 70: Incident Reporting Requirements

Requirements	How and By When
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 (petroleum.operations@nt.gov.au)

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	within 15 days after the end of the reporting period.
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. Incidents should also be reported to NT DPIR if it has been reported to another government department or agency or there is the potential for media or stakeholder interest.	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 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 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.

7.7 Environmental Performance Monitoring and Reporting

7.7.1 Record Management

Key records for management relating to the activity include:

- Weed washdown records
- Induction records
- Photopoint records
- Records related to audits / inspections
- Records relating to investigation of incidents and noncompliance's.

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.

7.7.2 Audit

To ensure that the EMP requirements have been effectively implemented and that the performance outcomes and standards in the EMP have been met a desktop review – to ensure the EMP requirements have been appropriately communicated to relevant personnel as per Section 8.2 and procedures are in place to ensure EMP commitments can be met.

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 manger who receive notification of the overdue action.

In addition to the desktop assessment above, rehabilitation audits against the performance standards and measurement criteria set out in this EMP will be completed. This will be conducted by a suitable qualified person or internally during and after rehabilitation and will include a field inspection to ensure rehabilitation is tracking along its expected trajectory. The audit findings will identify areas of success as well as improvement initiatives to be discussed in context of the current proposed drilling operation as well as succeeding proposed drilling operations.

7.7.3 Management of Non-Conformances

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

- A breach of an environmental performance outcome or environmental performance standard (Section 7). This triggers the requirement to report as a "recordable incident" as per Section 8.6.
- Failure to implement a requirement in the implementation strategy.

Non-conformances are identified via:

- Audits and inspections
- Incident reporting and investigations

- Preparation of the Performance Report

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.
- Reported externally as per the requirements as detailed in Section 8.6.

7.7.4 Routine reporting

In accordance with Reg 11 (1), Santos will submit an annual report to DPIR which provides sufficient information to enable the regulator to determine that the Environmental Outcomes and Environmental Performance Standards in the EMP have been met. Given the limited scope of the activity, this will be a brief report outlining that all activities were undertaken in accordance with the Environmental Performance Standards to meet the Environmental Outcomes in the EMP. Should the activities be undertaken not in accordance with the Environmental Performance Standards detailed in the EMP, the report will provide further detail to the regulators requirements.

8.0 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.

Stakeholder identification was conducted prior to commencing the previous seismic surveys on EP 161 in 2003 and 2016 and is reviewed on an annual basis. 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 full list of the relevant stakeholders consulted is provided in Appendix E, including contacts details for each stakeholder.

Santos has continued to engage with these key stakeholders on an ongoing basis since initial identification, specifically with regard to this project. This includes providing an information sheet to key stakeholders. The information sheet provides some background on Santos' previous and planned exploration activities in the Amadeus Basin as well as some general information on drilling. The information sheet is provided as Appendix F to this management plan. On the 30 November 2018, this information sheet was provided to:

- Alice Springs Town Council
- MacDonnell Council
- Chansey Paech MLA
- Robyn Lambley MLA
- Dale Wakefield MLA]

In addition to the stakeholder consultation provided by way of the information sheet, other stakeholder engagement undertaken as part of the project has been document in the stakeholder log provided in Appendix E. Appendix E details the information that has been provided to these key stakeholders, including the type of information and date of engagement. For the most part, 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 civil construction and drilling operations commencing.

Consultation with other key stakeholders in relation to this project is elaborated below:

- Department of Primary Industry and Resources:
    - Ongoing consultation with James Pratt (Executive Director), Louis Gomatos (Senior Director) and Charles Dack (Environmental Engineer) regarding the project generally, and the contents and approval of this EMP.
- Department of Environment and Natural Resources (DENR):

    - Weed Management Branch – Chris Brown and Steve Mueller – were on site on the 1 October 2018 and conducted a weed inspection of the project area. Ongoing discussion with Weed Officers from DENR is expected throughout the life of the project.
    - Water group.
- Central Land Council (CLC):
    - Consultation regarding our operations along with the administration and implementation of the relevant exploration and indigenous land use agreements is ongoing. Work program (as per terms of the ILUA) has been lodged and Santos is currently working with the CLC regarding community consultation and site clearance requirements. We are also engaging with the CLC employment and training division regarding potential employment opportunities for this project.
- Barkly Regional Council:
    - Rhodri Johns spoke about the project generally at Barkly Regional Council meeting in Tennant Creek.

At present there has been no stakeholder objection or written responses have been received in relation to information that has been provided to stakeholders for this project. No objections, claims or disputes have been made about the anticipated environment impact of this project that has required resolution. If there are any disputes going forward, Santos will follow internal conflict resolution procedures. An assessment of the objection or claim will be recorded within the stakeholder consultation log (as discussed below) for future reference.

Santos will continue to engage with key stakeholders throughout operation, completion and decommissioning of project activities and infrastructure. A full stakeholder consultation log will be maintained by Santos, similar to the one provided in Appendix E. This will show all consultations and meetings with impacted stakeholders on the proposed activities and any resolutions or conflicts resolved through the process. All written responses from stakeholders will be maintained in this consultation log.

9.0 References

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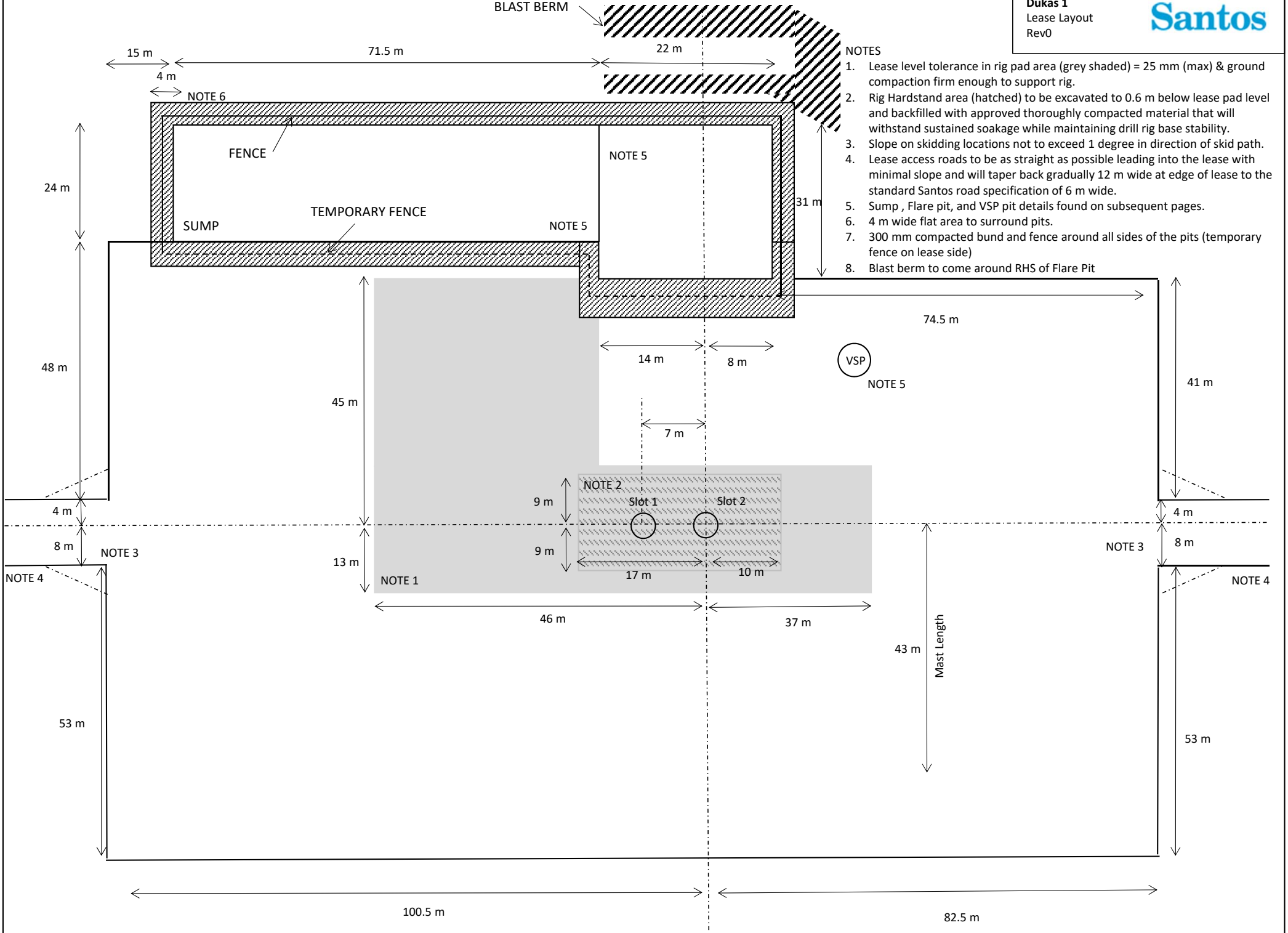
Appendices

Appendix A: Ensign Well Rig Layout

Dukas 1
Lease Layout
Rev0

Santos



NOTES

1. Lease level tolerance in rig pad area (grey shaded) = 25 mm (max) & ground compaction firm enough to support rig.
2. Rig Hardstand area (hatched) to be excavated to 0.6 m below lease pad level and backfilled with approved thoroughly compacted material that will withstand sustained soakage while maintaining drill rig base stability.
3. Slope on skidding locations not to exceed 1 degree in direction of skid path.
4. Lease access roads to be as straight as possible leading into the lease with minimal slope and will taper back gradually 12 m wide at edge of lease to the standard Santos road specification of 6 m wide.
5. Sump , Flare pit, and VSP pit details found on subsequent pages.
6. 4 m wide flat area to surround pits.
7. 300 mm compacted bund and fence around all sides of the pits (temporary fence on lease side)
8. Blast berm to come around RHS of Flare Pit

Dukas 1
Sump and Flare Pit Design
Rev0

Santos

BLAST BERM

PLAN VIEW

SUMP SPOIL

54.5 m | 2 m | 15 m | 3 m | 22 m

24 m

SUMP
Slot 1

SUMP
Slot 2

FLARE PIT
Slot 3

31 m

SIDE VIEW

FENCE

Top of Bund

BOND WALL

0.3 m

0.5 m

1.5 m

4 m

1:2 Slope

1:2 Slope

0.5 m

1:2 Slope

1:2 Slope

NOTE 1

1:2 Slope

1:2 Slope

3 m

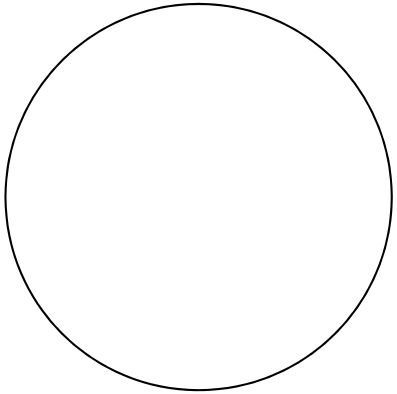
NOTE 1

NOTES
1. Sump (Slot 1 and 2) to be lined with Polypropylene Liner.
2. Liner will be keyed in 300 mm into the top of the bund

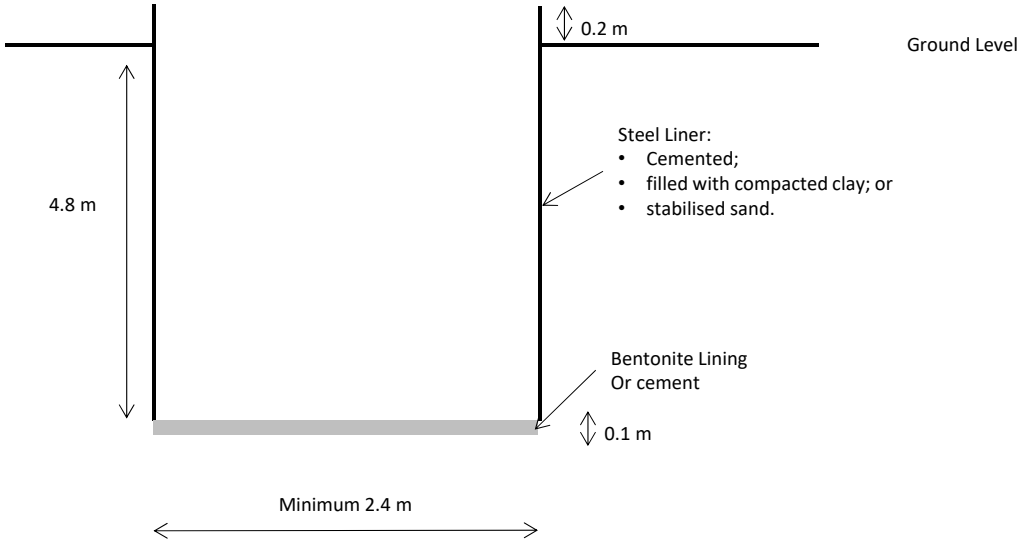
Dukas 1
VSP Pit
Rev0

Santos

PLAN VIEW



SIDE VIEW

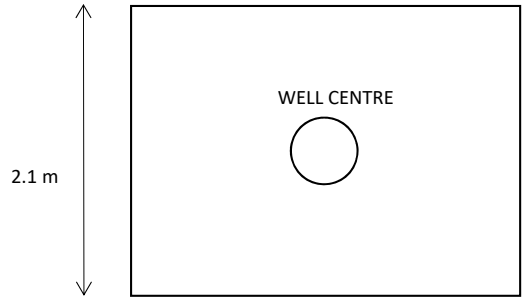


Dukas 1
Cellar Design
Rev0

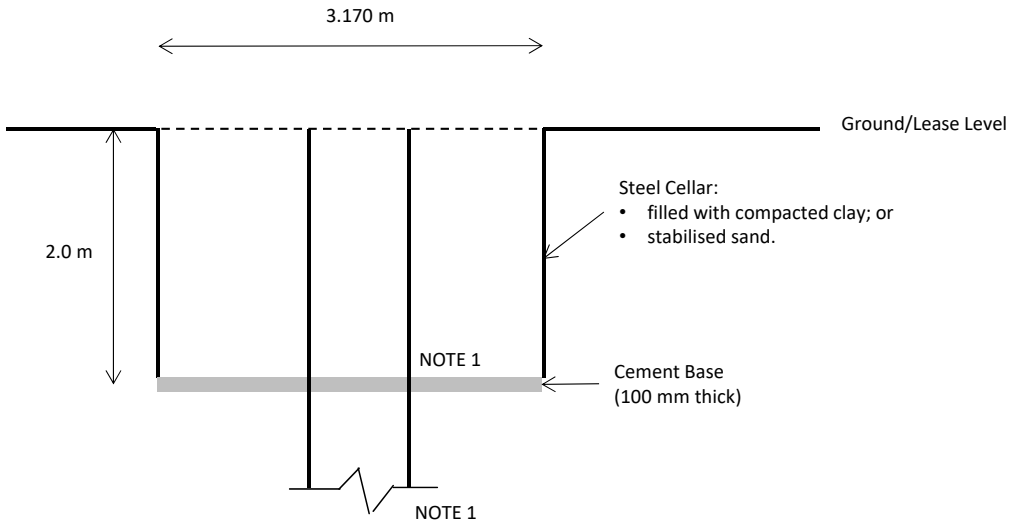
Santos

NOTES
1. 20" conductor to be set at ~16 – 24 m (two joints of conductor pipe)

PLAN VIEW



SIDE VIEW



Appendix B: EPBC Protected Matters Search Tool

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

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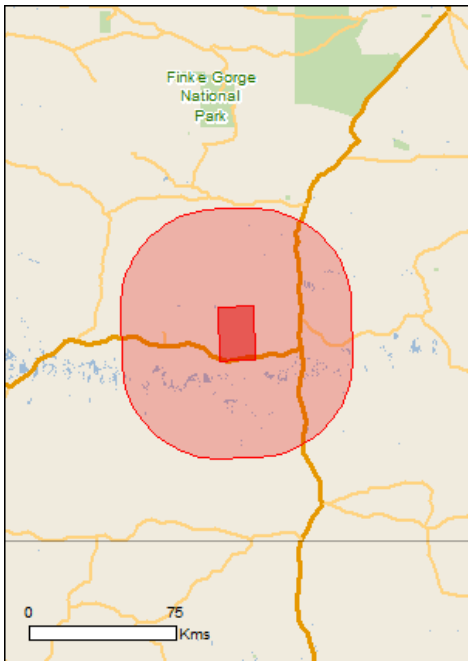
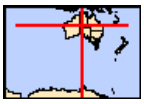


Coordinates
Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	13
Listed Migratory Species:	10

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	14
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Regional Forest Agreements:	None
Invasive Species:	14
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Species		[Resource Information]
Name	Status	Type of Presence
Birds		
Amytornis modestus Thick-billed Grasswren [84121]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Polytelis alexandrae Princess Parrot, Alexandra's Parrot [758]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Mammals		
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis MacDonnell Ranges race Warru, Black-footed Rock-wallaby (MacDonnell Ranges race) [66649]	Vulnerable	Species or species habitat may occur within area
Zyzomys pedunculatus Central Rock-rat, Antina [68]	Critically Endangered	Species or species habitat may occur within area
Plants		
Acacia latzii Latz's Wattle [14275]	Vulnerable	Species or species habitat known to occur within area
Frankenia plicata [4225]	Endangered	Species or species habitat may occur within area
Reptiles		
Liopholis kintorei Great Desert Skink, Tjakura, Warrarna, Mulyamiji [83160]	Vulnerable	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Liopholis slateri slateri		
Slater's Skink, Floodplain Skink [83163]	Endangered	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus		
Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Glareola maldivarum		
Oriental Pratincole [840]		Species or species habitat may occur within area
Pandion haliaetus		
Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat may occur within area
Chrysococcyx osculans Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Angas Downs	NT

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Camelus dromedarius Dromedary, Camel [7]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Equus caballus Horse [5]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area

Nationally Important Wetlands

[Resource Information]

Name	State
Karinga Creek Palaeodrainage System	NT

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-25.022712 132.984668,-25.244013 132.990848,-25.249603 132.828799,-25.023956 132.821933,-25.022712 132.984668

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix C: NT NRM Report

Territory Natural Resource Management

Northern Territory Government

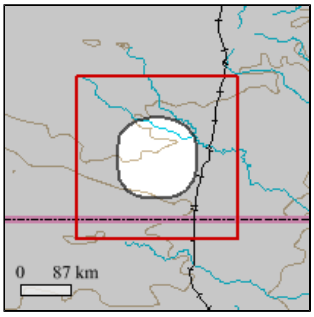
CHARLES DARWIN UNIVERSITY

Dukas 1

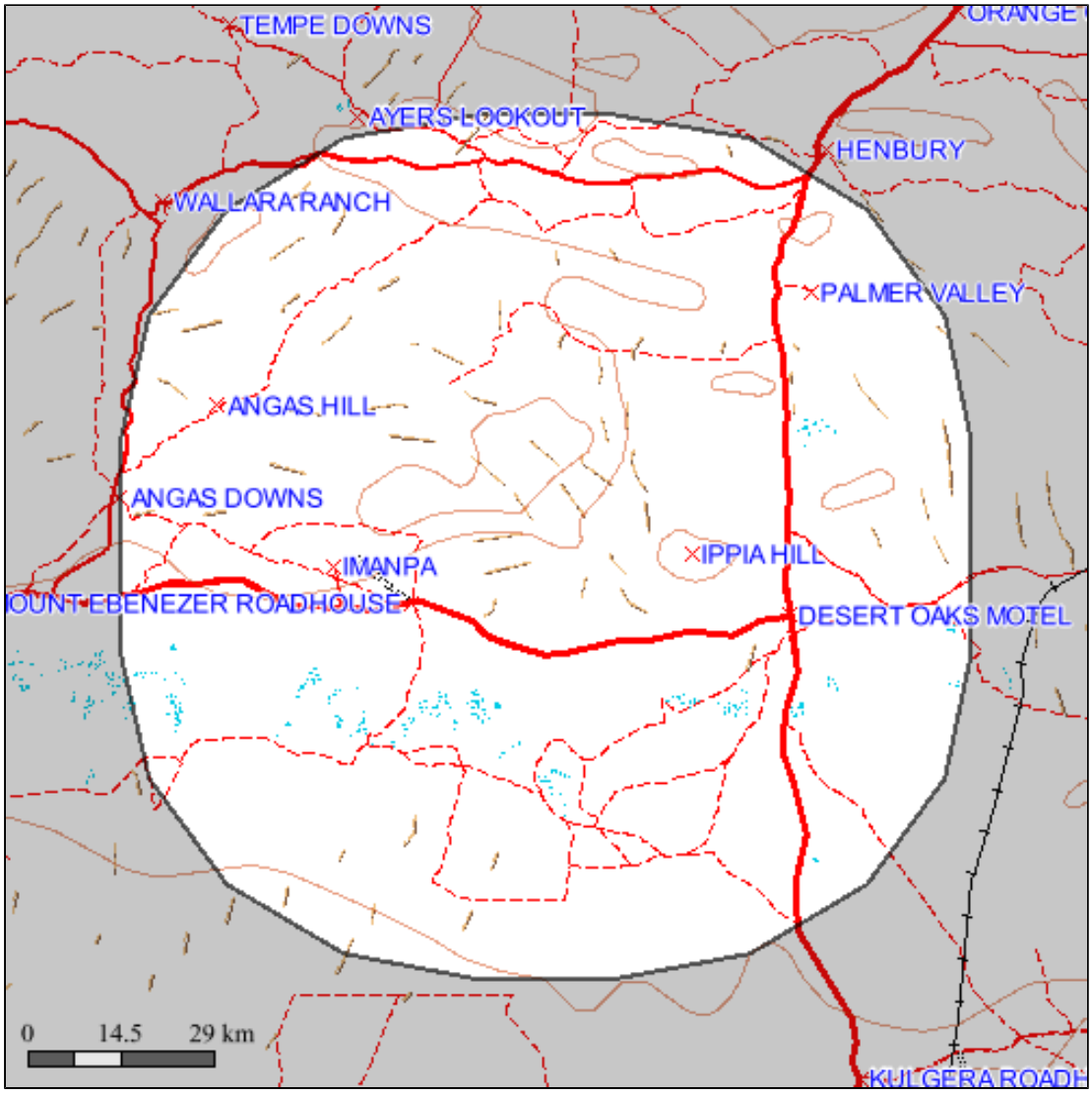
NT NRM Report

Dukas 1

Dukas 1 encompasses an area of 13397.62 sq km extending from 24 deg 30.0 min to 25 deg 42.0 min S and 132 deg 16.0 min to 133 deg 27.0 min E.
Dukas 1 is located in the Finke, bioregion(s)



Location of Dukas 1



Dukas 1 Threatened Species

Threatened species recorded in Dukas 1 (Records Updated: Sept 2013)

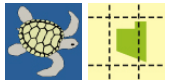
Group	Common Name	Scientific Name	NT Status	National Status	ID	#Observations (Latest)	#Specimens (Latest)	#Surveys (Latest)
Flowering Plants	Sweet Quandong	*Santalum acuminatum*	VU	.	347378	0 (Unknown)	7 (2011)	0 (Unknown)
Flowering Plants	Tjilpi Wattle	*Acacia latzii*	VU	VU	350915	0 (Unknown)	15 (2001)	0 (Unknown)
Snails	Land Snail	*Semotrachia esau*	VU	.	351985	0 (Unknown)	0 (Unknown)	0 (Unknown)
Reptiles	Great Desert Skink	*Liopholis kintorei*	VU	VU	351205	1 (1974)	1 (1974)	0 (Unknown)
Birds	Malleefowl	*Leipoa ocellata*	CR	VU	351805	2 (Unknown)	0 (Unknown)	0 (Unknown)
Birds	Grey Falcon	*Falco hypoleucos*	VU	.	.	1 (1995)	0 (Unknown)	0 (Unknown)
Birds	Plains-wanderer	*Pedionomus torquatus*	.	CE	247093	2 (1977)	0 (Unknown)	0 (Unknown)
Birds	Curlew Sandpiper	*Calidris ferruginea*	VU	CE	.	1 (1989)	0 (Unknown)	2 (2000)
Birds	Princess Parrot	*Polytelis alexandrae*	VU	VU	247138	3 (1998)	0 (Unknown)	0 (Unknown)
Mammals	Greater Bilby	*Macrotis lagotis*	VU	VU	177125	1 (Unknown)	0 (Unknown)	0 (Unknown)
Mammals	Southern Marsupial Mole	*Notoryctes typhlops*	VU	EN	352105	3 (1960)	3 (1960)	0 (Unknown)

EX = Extinct
EW = Extinct in the Wild
ER = Extinct in the NT
EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Dukas 1 Threatened Species Grid



Threatened species recorded in the grid cell(s) in which Dukas 1 occurs (Records Updated: Sept 2013)

Group	Family Name	Scientific Name	Common Name	NT Status	National Status	#Observations	Latest Observation Date	#Specimens	Latest Specimen Date	#Surveys	Latest Survey Record
Cycads	Zamiaceae	*Macrozamia macdonnellii*	MacDonnell Ranges Cycad		VU	0	Unknown	7	1996	0	Unknown
Flowering Plants	Arecaceae	*Livistona mariae*	Red Cabbage Palm	EN	VU	0	Unknown	28	2010	0	Unknown
Flowering Plants	Cyperaceae	*Baumea arthrophylla*	Swamp Twig-Rush	EN		0	Unknown	1	2012	0	Unknown
Flowering Plants	Cyperaceae	*Bolboschoenus caldwellii*	Caldwells Clubrush	EN		0	Unknown	4	2001	0	Unknown
Flowering Plants	Santalaceae	*Santalum acuminatum*	Sweet Quandong	VU		0	Unknown	20	2012	0	Unknown
Flowering Plants	Fabaceae	*Acacia latzii*	Tjilpi Wattle	VU	VU	0	Unknown	16	2011	0	Unknown
Flowering Plants	Asteraceae	*Minuria tridens*	Minnie Daisy	VU	VU	0	Unknown	11	2010	0	Unknown
Snails	Bulimulidae	*Bothriembryon spenceri*	Spencer's Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Snails	Camaenidae	*Basedowena squamulosa*	Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Snails	Camaenidae	*Divellomelon hillieri*	Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Snails	Camaenidae	*Semotrachia elleryi*	Ellery Gorge Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Snails	Camaenidae	*Semotrachia esau*	Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Snails	Camaenidae	*Semotrachia illarana*	Land Snail	VU		0	Unknown	0	Unknown	0	Unknown
Fish	Gobiidae	*Chlamydogobius japalpa*	Finke Goby	VU		0	Unknown	0	Unknown	0	Unknown
Reptiles	Pygopodidae	*Ophidiocephalus taeniatus*	Bronzeback Snake-Lizard	EN	VU	1	2008	0	Unknown	0	Unknown
Reptiles	Scincidae	*Liopholis kintorei*	Great Desert Skink	VU	VU	1	1974	1	1974	0	Unknown
Reptiles	Scincidae	*Liopholis slateri*	Slater`s Egernia	VU	EN	9	2004	4	1965	7	1998
Birds	Megapodiidae	*Leipoa ocellata*	Malleefowl	CR	VU	2	Unknown	0	Unknown	0	Unknown
Birds	Accipitridae	*Erythrotriorchis radiatus*	Red Goshawk	VU	VU	0	Unknown	1	Unknown	0	Unknown
Birds	Falconidae	*Falco hypoleucos*	Grey Falcon	VU		4	2001	1	Unknown	2	1995
Birds	Pedionomidae	*Pedionomus torquatus*	Plains-wanderer		CE	2	1977	0	Unknown	0	Unknown
Birds	Rostratulidae	*Rostratula australis*	Australian Painted Snipe	VU	EN	0	Unknown	0	Unknown	1	2002
Birds	Scolopacidae	*Calidris tenuirostris*	Great Knot	VU	CE	0	Unknown	6	1965	0	Unknown
Birds	Scolopacidae	*Calidris ferruginea*	Curlew Sandpiper	VU	CE	1	1989	0	Unknown	2	2000
Birds	Psittacidae	*Polytelis alexandrae*	Princess Parrot	VU	VU	3	1998	4	Unknown	0	Unknown
Mammals	Dasyuridae	*Dasycercus blythi*	Brush-tailed Mulgara	VU	VU	0	Unknown	2	1895	0	Unknown
Mammals	Dasyuridae	*Dasycercus cristicauda*	Crest-tailed Mulgara	VU	EN	1	Unknown	1	1894	0	Unknown
Mammals	Peramelidae	*Isoodon auratus*	Golden Bandicoot	EN	VU	0	Unknown	1	Unknown	0	Unknown
Mammals	Thylacomyidae	*Macrotis lagotis*	Greater Bilby	VU	VU	3	1896	2	1932	2	2001
Mammals	Phalangeridae	*Trichosurus vulpecula vulpecula*	Common Brushtail Possum (southern)	EN		1	1994	5	1933	1	1994
Mammals	Macropodidae	*Petrogale lateralis*	Black-footed Rock-wallaby		VU	2	Unknown	0	Unknown	295	2003
Mammals	Notoryctidae	*Notoryctes typhlops*	Southern Marsupial Mole	VU	EN	4	1960	7	1965	0	Unknown

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EN = Endangered
EN/VU = One Endangered subspecies/One Vulnerable subspecies
VU=Vulnerable
VU/- = One or more subspecies vulnerable EN/- = One or more subspecies endangered

Survey = this category refers to data collected using systematic survey methodology
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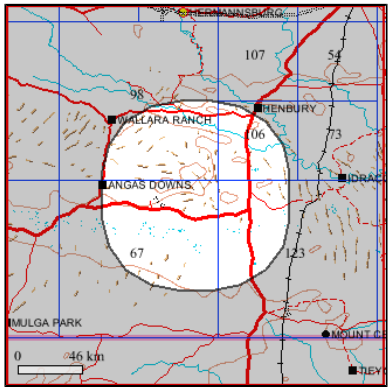
More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Species listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Dukas 1



Dukas 1 Weeds and Potential Weeds

 Introduced plants recorded in the grid cell(s) in which Dukas 1 occurs and that have been identified as problem weeds in one or more locations in northern Australia. Occurrence based on Northern Territory Government databases.

Family Name	Scientific Name	Common Name	NT Status	National Status	Other Status	#Surveys	Latest Record
Poaceae	*Andropogon gayanus*	Gamba Grass	*A C*	*WONS*	*MP K1 Q2 WA2 C&E G&M CYP*	0	Unknown
Brassicaceae	*Brassica tournefortii*	Mediterranean Turnip			*Gr*	71	2001
Asteraceae	*Carthamus lanatus*	Saffron Thistle	*B C*		*WA1 WA3 WA4 NSW*	0	Unknown
Poaceae	*Cenchrus ciliaris*	Buffel Grass			*MP Gr G&M DEU*	0	Unknown
Poaceae	*Cenchrus echinatus*	Mossman River Grass	*B C*		*NSW*	0	Unknown
Poaceae	*Cenchrus setiger*	Birdwood Grass			*DEU*	0	Unknown
Poaceae	*Chloris barbata*	Purpletop Chloris			*DEU*	0	Unknown
Poaceae	*Chloris virgata*	Feathertop Rhodes Grass			*DEU*	2	2001
Cucurbitaceae	*Citrullus lanatus*	Camel Melon			*G&M*	26	2001
Solanaceae	*Datura leichhardtii*	Native Thornapple	*C*		*WA1 WA3 WA4*	8	2001
Poaceae	*Echinochloa colona*	Awnless Barnyard Grass			*DEU*	1	1994
Boraginaceae	*Echium plantagineum*	Paterson`s Curse	*A C*		*WA1 WA3 WA4 NSW SA*	0	Unknown
Poaceae	*Eragrostis cilianensis*	Stinkgrass			*DEU*	1	2001
Malvaceae	*Malvastrum americanum*	Spiked Malvastrum			*DEU*	77	2001
Poaceae	*Melinis repens*	Red Natal Grass			*DEU*	0	Unknown
Fabaceae	*Parkinsonia aculeata*	Parkinsonia	*B C*	*WONS*	*MP K2 WA1 WA4 Q2 G&M CYP DEU NSW SA*	0	Unknown
Fabaceae	*Prosopis pallida*	Mesquite	*A C*	*WONS*	*K2 WA1 WA2 WA4 Q2 G&M NSW SA*	0	Unknown
Euphorbiaceae	*Ricinus communis*	Castor Oil Plant	*B C*		*MP CYP NSW*	2	2001
Anacardiaceae	*Schinus molle var. areira*	Peruvian Peppertree			*G&M*	0	Unknown
Fabaceae	*Senna occidentalis*	Coffee Senna	*B C*		*G&M DEU*	0	Unknown
Malvaceae	*Sida rhombifolia*	Paddy`s Lucerne	*B C*		*MP G&M DEU*	0	Unknown
Tamaricaceae	*Tamarix aphylla*	Athel Pine	*B C*	*WONS*	*WA1 Q3 C&E G&M NSW*	4	2001
Zygophyllaceae	*Tribulus terrestris*	Caltrop	*B C*		*CYP SA*	6	2001
Fabaceae	*Vachellia farnesiana*	Sweet Acacia			*DEU*	11	2001
Asteraceae	*Verbesina encelioides*	Crownbeard			*DEU*	0	Unknown

Status Codes:
1. NATIONAL STATUS CODES
Alert, Alert List for Environmental Weeds (Please call Exotic Plant Pest Hotline 1800 084 881 if you think you have seen this weed)
Sleeper, National Sleeper Weed
Target,Targeted for eradication. (www.landmanager.com.au/view/index.aspx?id=449837)
WONS, Weeds of National Significance

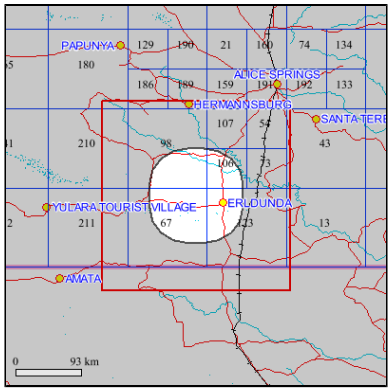
2. NT STATUS CODES
A, NT Class A Weed (to be eradicated)
B, NT Class B Weed (growth & spread to be controlled)
C, NT Class C Weed (not to be introduced) (www.landmanager.com.au/view/index.aspx?id=449869)

3. OTHER STATUS CODES
C&E, Csurhes, S. & Edwards, R. (1998) Potential Environmental Weeds in Australia. Candidate Species for Preventative Control. Environment Australia, Canberra (www.landmanager.com.au/view/index.aspx?id=394504)
CYP, Draft Cape York Peninsula Pest Management Plan 2006-2011 (www.landmanager.com.au/view/index.aspx?id=371200)
DEU, Plants listed as environmental weeds by the Desert Uplands Strategic Land Resource
Assessment (www.landmanager.com.au/view/index.aspx?id=332123)
G&M, Grice AC, Martin TG. 2005. The Management of Weeds and Their Impact on Biodiversity in the Rangelands. Cooperative Research Centre (CRC) for Australian Weed Management and CSIRO Sustainable Ecosystems. Commonwealth Australia (www.landmanager.com.au/view/index.aspx?id=163572)
Gr, Groves et al. 2003. Weed categories for natural and agricultural ecosystem management. Bureau of
Rural Sciences (www.landmanager.com.au/view/index.aspx?id=388018)
K0, High Priority Weeds not yet established in the Katherine region
K1, High Priority Weeds posing environmental threats in the Katherine region
K2, High Priority Weeds posing existing threats in the Katherine region, as described in the Katherine Regional Weed Management Strategy 2005-2010 (www.landmanager.com.au/view/index.aspx?id=130286)
MP, Northern Territory Parks & Conservation Masterplan (www.landmanager.com.au/view/index.aspx?id=144141)
NAQS, North Australian Quarantine Strategy Target List (www.landmanager.com.au/view/index.aspx?id=449416)
NSW, Declared Noxious Weed in NSW (www.landmanager.com.au/view/index.aspx?id=449983)
Q1, QLD Class 1 Weed (not to be introduced, kept or supplied-
Q2, Class 2 Weed (eradicate where possible, not to be introduced, kept or supplied)
Q3, Qld Class 3 Weed (to be controlled near environmentally sensitive areas- not to be supplied/sold without a permit) (www.landmanager.com.au/view/index.aspx?id=190714)
SA, Declared Plant in South Australia (www.landmanager.com.au/view/index.aspx?id=449996)
WeedsAus, Listed as a significant weed by Weeds Australia (www.landmanager.com.au/view/index.aspx?id=14576)
WA1, WA Weed Class P1 (movement prohibited)
WA2, WA Weed Class P2 (aim to eradicate)
WA3, WA Weed Class P3 (control infestations)
WA4, WA Weed Class P4 (prevent spread)
WA5, WA Weed Class P3 (control infestations on public land) (www.landmanager.com.au/view/index.aspx?id=449884).

Survey = this category refers to data collected using systematic survey methodology
Specimen = this category refers to museum or other records where a specimen has been collected and lodged
Observation = this category refers to all other incidental recordings where systematic methodology may not have been used consistently.

More species info: Go to www.landmanager.org.au/view/index.aspx?id=####
where #### is the ID number from the tables above for the species of interest.

Plants listed in the table above were recorded from all the grid cells shown below (red/blue line) that overlap Dukas 1



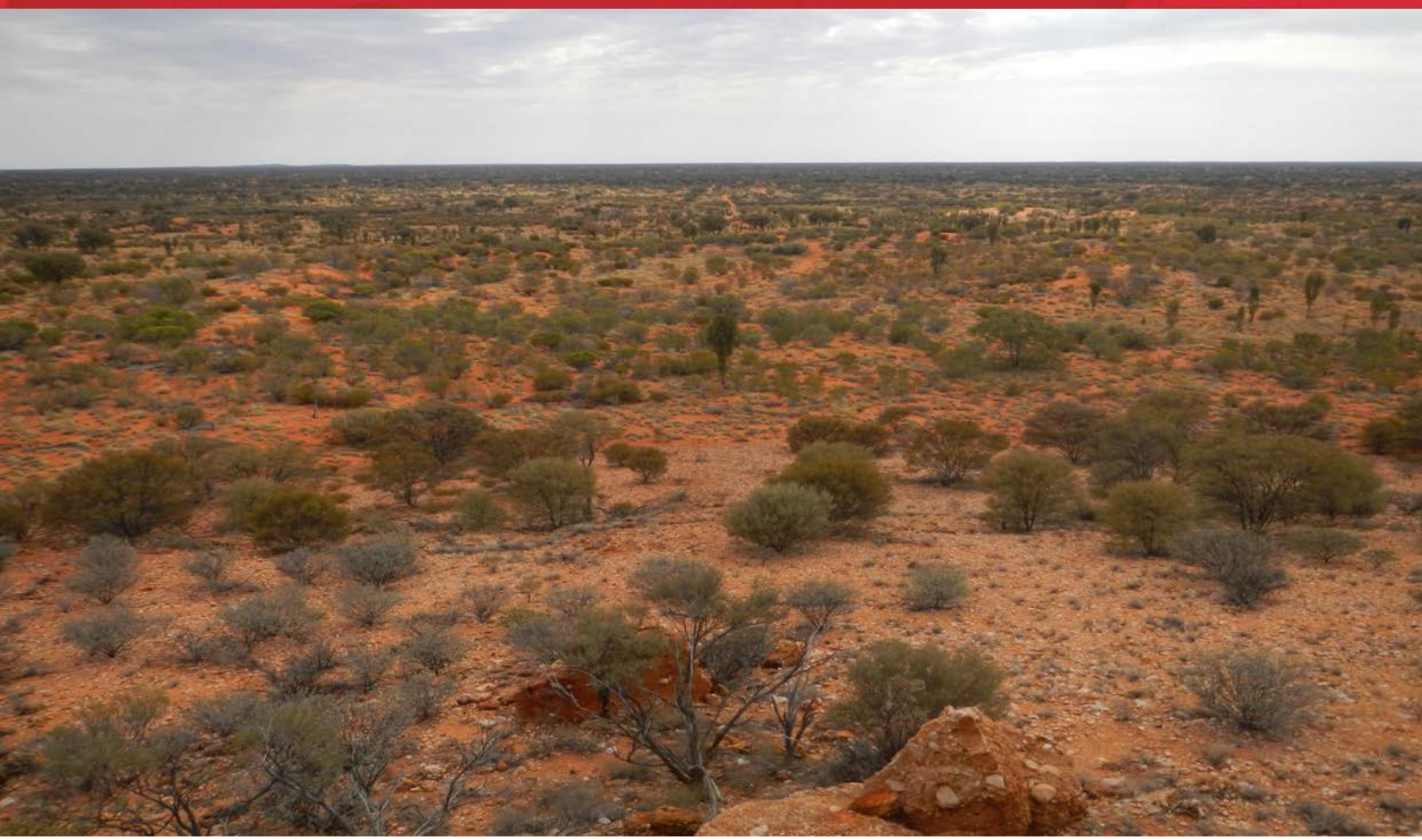
Soils and vegetation graphs and tables refer to area of soils and vegetation only. Fire graphs and tables refer to entire selected area including sea if present. Calculations are derived from map images or vector data, and should be taken as a guide only. Accuracy cannot be guaranteed. For small areas, figures should be rounded to the nearest whole number.

Fire map layers used in these reports have been updated in 2018 so their pixels are aligned to the same grid.

Appendix D: Dukas-1 Ecological Assessment Report

Ecological Assessment
Dukas 1 Project

SANTOS



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1	Mitch Bird (Santos)	Tom Ewers-Reilly	Santos (final)	30/10/2018

Recipients are responsible for eliminating all superseded documents in their possession.

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ACRONYMS

BOM	Bureau of Meteorology
DENR	Department of Environment and Natural Resources (Northern Territory) – formerly DLRM
DLRM	Department of Land Resource Management (Northern Territory) – now DENR
DoEE	Department of the Environment and Energy (Commonwealth)
EPBC Act	*Environment Protection and Biodiversity Conservation Act (1999)* (Commonwealth)
NT	Northern Territory
PMST	Protected Matters Search Tool
TPWC Act	*Territory Parks and Wildlife Conservation Act* (Northern Territory)
WoNS	Weeds of National Significance

1 INTRODUCTION

Santos propose to undertake a gas exploration project on Mt Ebenezer Station, approximately 180 km southwest of Alice Springs (see map inset, Figure 1-1). The proposed exploration well is known as 'Dukas 1', which requires the construction of a well pad, access road (involving widening of existing station tracks and seismic lines), camp site, laydown pad(s) and several borrow pits.

Santos engaged EcOz Environmental Consultants (EcOz) to complete the following tasks::

- Determine the presence or absence of Threatened Ecological Communities (listed under the *EPBC Act*) and sensitive vegetation (according to the *Northern Territory Land Clearing Guidelines*), and presence of any other significant areas.
- Threatened species likelihood of occurrence assessment.
- Baseline weed survey and assessment, with a focus on species declared under the *NT Weeds Management Act* and / or Weeds of National Significance (WoNS).
- Describe the soil erosion potential of the project area.

The following field surveys were conducted to address the scope described above:

- Vegetation (and landform) mapping (Section 2)
- Soil erosion potential assessment (Section 3)
- Weed survey to identify current weed infestation extent, and potential weed threats (Section 4)
- Identify the presence / absence of sensitive vegetation types (as defined by DNRETAS, 2010) and / or Threatened Ecological Communities (as per the EPBC Act), or any other significant ecological feature(s) (Section 5)
- Fauna track-plot surveys and habitat suitability assessment for potential threatened species (Section 6)

The survey extent encompassed the project area with a suitable buffer to ensure that ecological values are identified and appropriately described (Figure 1-1). Surveys were undertaken on the 1 and 2 October 2018 by Tom Ewers-Reilly (EcOz Senior Ecologist in Alice Springs), who has extensive experience in arid zone ecology.

This report details field work and results from these surveys, and includes management considerations to mitigate potential impacts, where relevant.

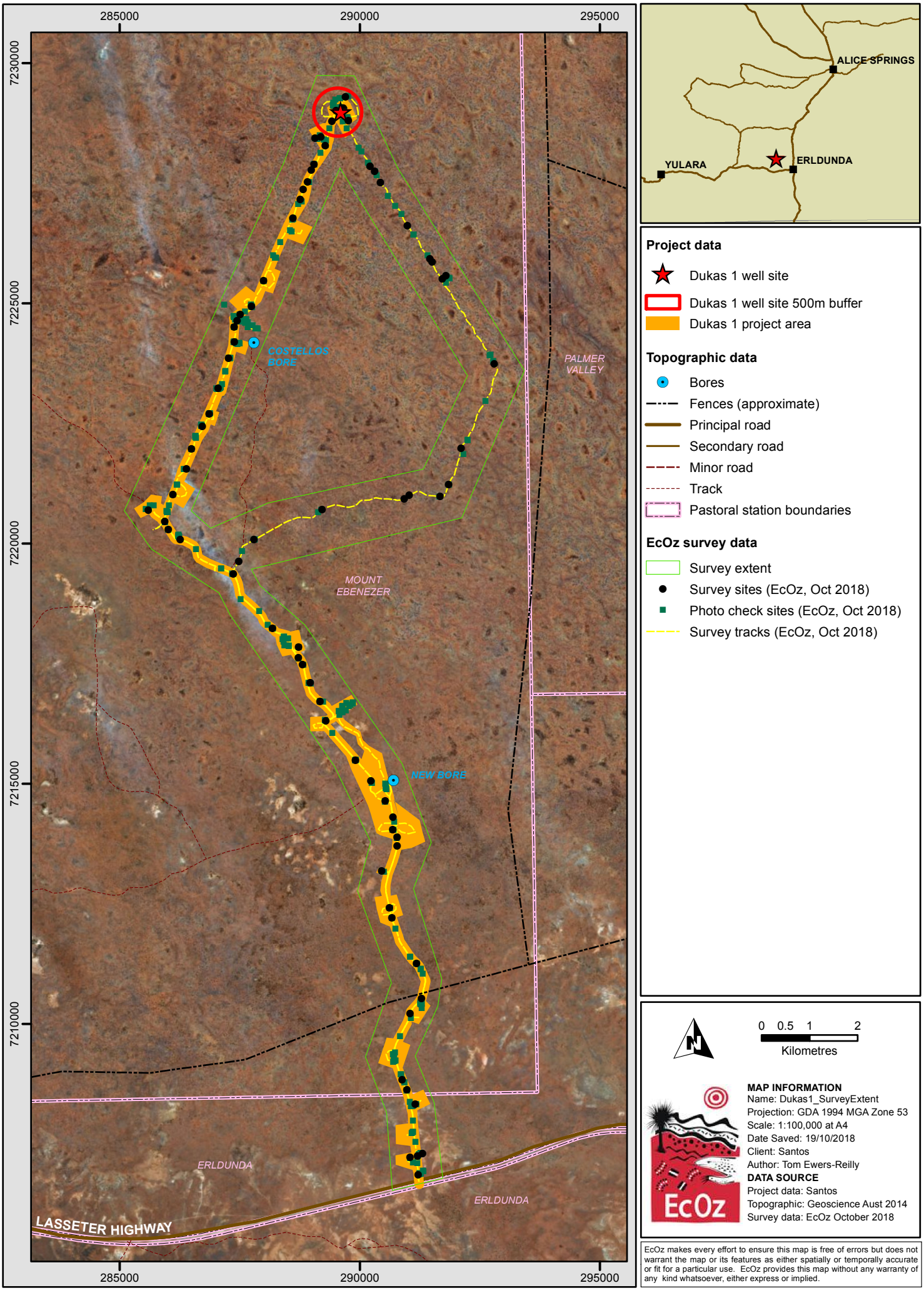

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FIGURE 1-1. Map of Dukas 1 project area, survey extent and survey sites

2 VEGETATION AND LANDFORM SURVEY

This survey aims to describe and map discrete units that clearly delineate areas that support similar vegetation communities, landform characteristics and surface soil type. This will provide a general environmental context for the Dukas 1 project area, and information can be used to inform soil erosion potential, weed risk species and threatened species habitat suitability.

2.1 Methodology

Prior to field work, existing land system data (Mt Ebenezer Station 1:250,000 mapping files only; no report reference was found during background research) and aerial imagery (DigitalGlobe 12 November 2014, sourced from ESRI Basemaps World Imagery) was reviewed at a scale of 1:10,000 (in conjunction with local knowledge of the area) to draft preliminary vegetation and landform units (referred to as units) that may potentially occur within the survey extent (i.e. a unit[1] refers to an area of similar vegetation, landform and soil type).

A field survey was conducted to confirm descriptions and ground-truth the extent of preliminary units by collecting data on vegetation, landform and soil type. Approximately 70 sites were surveyed as part of this assessment, plus numerous additional photo check sites visited during the survey (refer to Figure 1-1 for site locations). Multiple sites were surveyed within each unit to provide a suitable description of floristic variation and landform characteristics within each unit.

At each site, the following data was collected in a 50x50 m quadrat:

- Landform description
- Surface soil description
- Soil erosion potential (including whether existing erosion is present)
- Vegetation structure and description
- Dominant vegetation in upper, mid and ground strata

2.2 Vegetation and landform units

Eight discrete units have been delineated for the survey extent (Figure 2-2; full descriptions in Appendix A):

1. Shallow sandplain with mixed tussock grassland and sparse shrubs.
2. Undulating sandplain with Blue Mallee over mixed shrubs, Hard Spinifex, annual grasses and forbs.
3. Sandplain and low dunes with a variable shrubland of Mann Range Mallee, Mulga, Sticky Hopbush and Desert Cassia over Hard Spinifex, annual grasses and forbs.
4. Reticulate dunes with a shrubland of Desert Heath Myrtle, Rattlepod Grevillea, Sticky Hopbush and Umbrella Bush over Hard Spinifex. Desert Oak in interdune sandplains.
5. Red earth depressions and plains with Mulga and Witchetty Bush over Hard Spinifex, annual grasses and forbs.
6. Calcareous plains and rises with mixed tussock grassland and Copper Burr species.
7. Clay pan with sparse vegetation.
8. Silcrete-capped rocky ridge with Mulga and Silver Cassia over tussock grasses.

[1] A unit is similar to a land unit normally used in land resource studies in the Northern Territory; however, the current survey did not includes comprehensive detail on sub-soil characteristics, which is required as part of land unit mapping methodology in the NT.

The project area occurs in flat to undulating sandplains with low reticulate dunes becoming more frequent in the northern region. The southern sandplains (units 1 and 2) likely have sandy soils that occur as a thin layer (~ 1 m thick) over peneplain / calcrete plains. These sandplains are extensive in the region and are formed where aeolian (i.e. wind-blown) sand material has been distributed / deposited across the land surface. The northern sandplains and dune fields (units 3 and 4) likely have a deep sand layer, and in some areas have been arranged into low reticulate dunes, with relief of up to 10 m. This unit is widespread throughout the region.

The Dukas 1 well site has been positioned on an interdune sandplain located within extensive dune fields (unit 4) (Figure 2-3). The access road crosses multiple dune crests; however, the alignment aims to minimise the number of dune intersections. There are small occurrences of red earth depressions (unit 5), calcrete plains/rises (unit 6) and clay pans (unit 7), and one isolated silcrete-capped hill (unit 8). Some calcrete rises and red earth depressions are being targeted as borrow pits (of which several already have existing pits established associated with previous track construction in the area). There are no plans to disturb the silcrete-capped hill or clay pans. Representative photographs of the most widespread units within the project areas (units 1, 2, 3 and 4) are provided in Figure 2-1.

Shallow sandplain with tussock grass and sprase shrubs (unit 1)

Undulating sandplain with Blue Mallee (unit 2)

Sandplains and low dunes – with Red Mallee (unit 3)

Sandplains and low dunes – with Desert Cassia (unit 3)

Dune crest (occurs within units 3 and 4)

Desert Oak stand within interdune sandplain (unit 4)

Figure 2-1. Photographs of common units within the project area

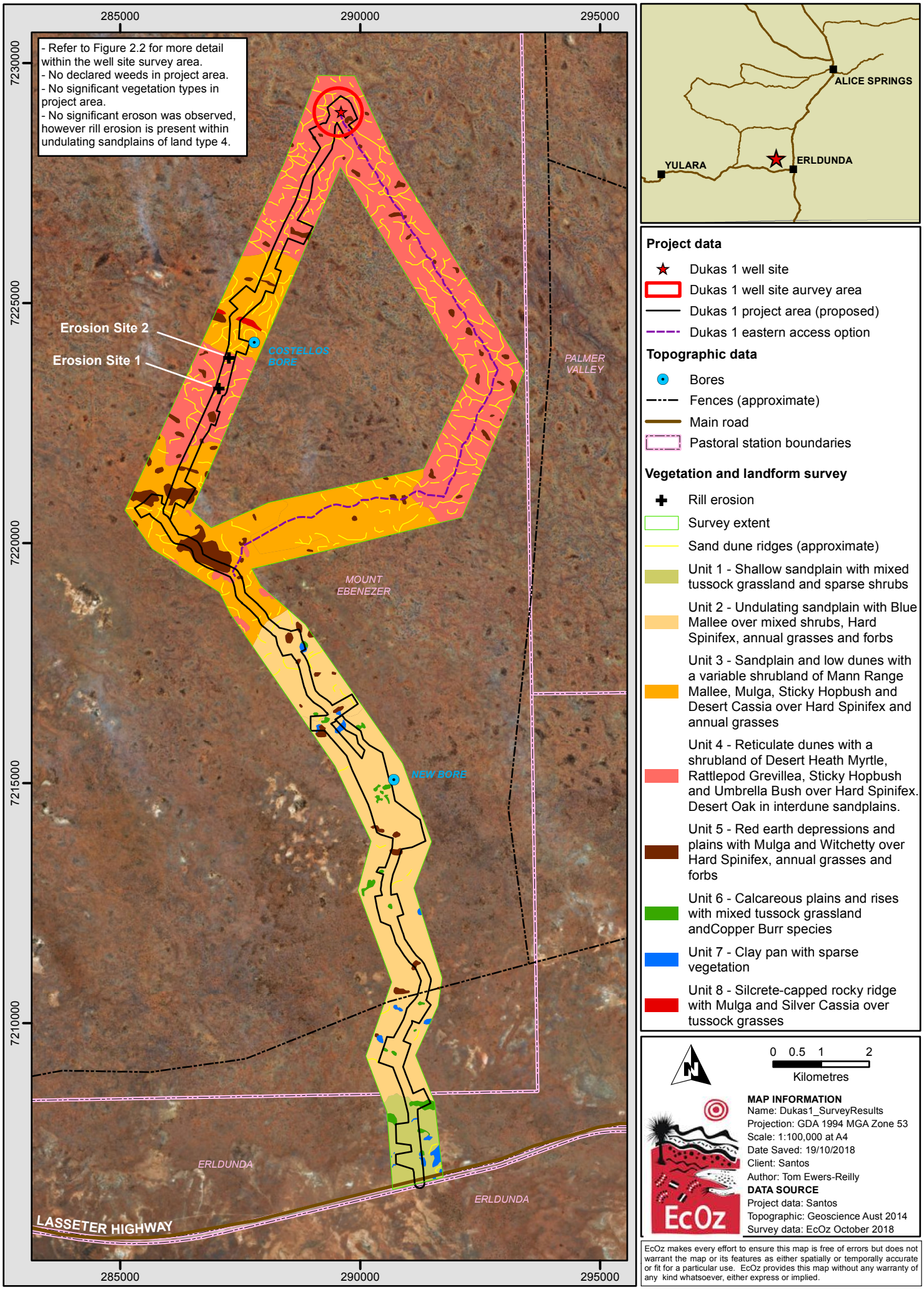
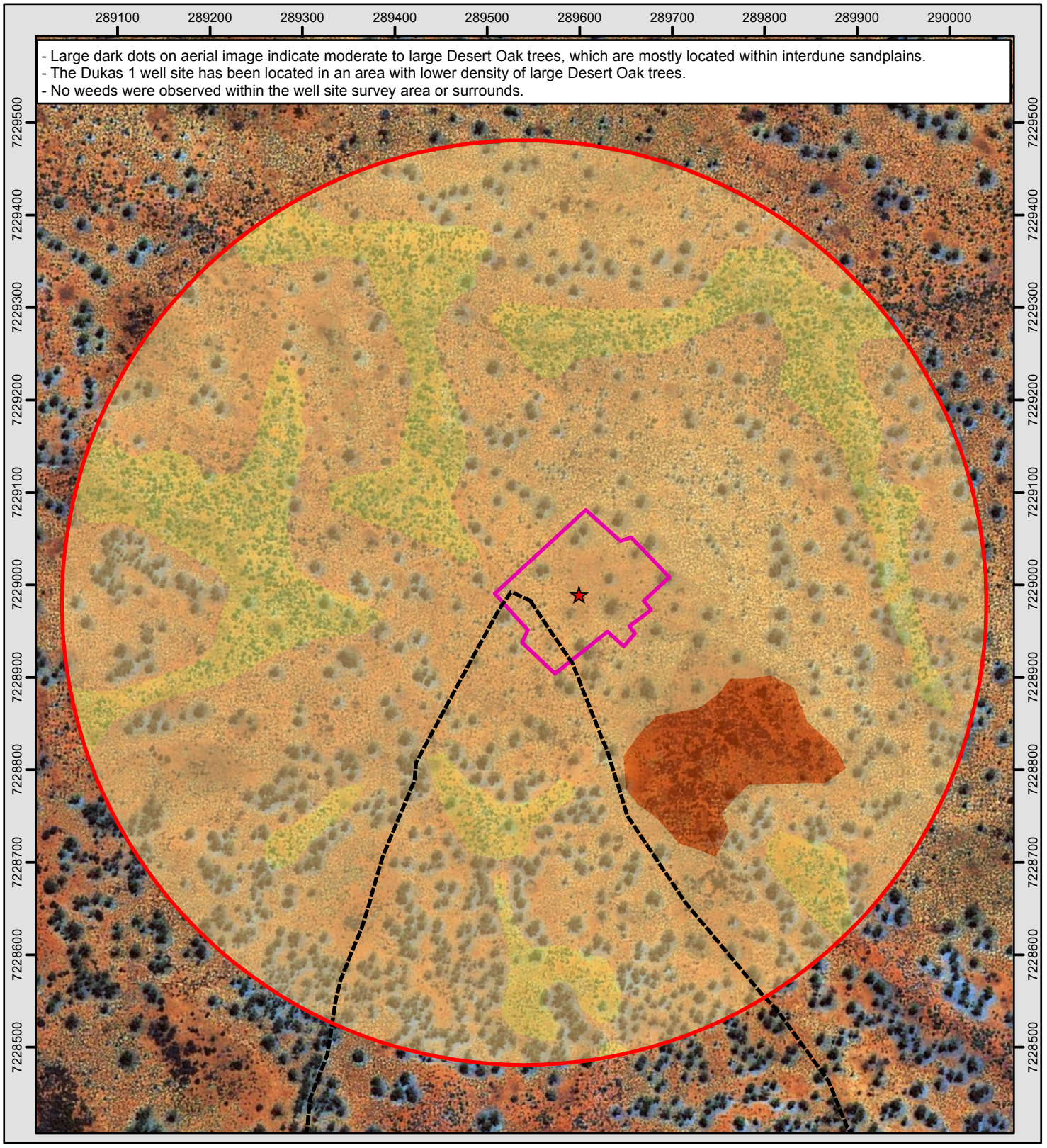


FIGURE 2-2. Map of vegetation and landform survey results within the Dukas 1 project area



Project data

- Dukas 1 well site
- Dukas1 well pad area (approximate)
- Dukas 1 well site survey area (500m radius from well site)
- Dukas 1 access tracks (existing)

Vegetation and landform units within the Dukas 1 well site area

- Unit 4a - sand dune with Rattlepod Grevillea, Sticky Hopbush, Umbrella Bush, Sandhill Fuschia over Hard Spinifex
- Unit 4b - flat to undulating interdune sandplain with stands of Desert Oak of variable density over sparse shrubs, Hard Spinifex, annual grasses and forbs
- Unit 5 - red earth depression with Mulga and Witchetty Bush over Hard Spinifex and annual grasses and forbs

N

0 50 100 200
Metres

MAP INFORMATION
Name: Dukas1_Results_WellSite
Projection: GDA 1994 MGA Zone 53
Scale: 1:5,000 at A4
Date Saved: 18/10/2018
Client: Santos
Author: Tom Ewers-Reilly

DATA SOURCE
Project data: Santos
Topographic: Geoscience Aust 2014
Survey data: EcOz October 2018

Path: C:\01. EcOz GIS Projects (TR)\EZ18173 - Dukas 1 Well Assessment (Santos)\01 Project Files\Dukas1_Results_WellSite.mxd

FIGURE 2-3. Map of survey results within the Dukas 1 well site (with a 500 m buffer)

3 SOIL EROSION ASSESSMENT

The purpose of this assessment is to provide general advice in regards soil erosion potential within the project area, which can be used as background information for any erosion and sediment control planning.

3.1 Methodology

Soil erosion potential was measured at vegetation and landform survey sites (described in Section 2) by qualitatively assessing a number of factors such as soil type and texture, rock cover, slope, surface crusting and vegetation cover. Areas of existing disturbance were also inspected for erosion (such as station tracks, fence lines, exploration seismic lines, borrow pits, dams and water bore pads).

3.2 Results

Soil erosion potential is considered as low for the majority of the project area, as the low relief and coarse textured soils provide high infiltration and good drainage, which makes most areas stable for construction of access roads and other cleared pads. The following observations were made for the project area:

- Concentration of runoff from disturbances (such as windrows or wheel ruts) may result in rilling or gullying. Most existing tracks or seismic lines in area have no or low windrows and little evidence of wheel rutting, which indicates good track construction and maintenance.
- Significant sheet and / or wind erosion is unlikely to be an issue due to the limited nature of vegetation clearing associated with the project. Nuisance dust may occur during construction.
- Flat to undulating sandplains (units 1, 2 and 3) have a low erosion potential due to coarse-textured surface soils and low relief.
- Interdune sandplains (within unit 4) have a low to moderate erosion potential, especially in areas that have clay loam soils and larger patch size (i.e. larger size generates longer surface runoff distances, increasing erosion risk). There was evidence of rill erosion at two locations within this unit, which mostly likely originated from water channelling along seismic line wheel ruts (locations shown in Figure 2-2; images in Figure 3-1). Rill erosion site 1 was approximately 170 m long, and some sections may be described as gully erosion (bank height up to 25 - 30 cm). Rill erosion site 2 was only 10 to 15 m long and bank height did not exceed 10 cm. Both locations had no impact on track condition.
- Sand dunes (in units 3 and 4) have a low water erosion potential due to high infiltration rates of the coarse textures soils. Access roads that intersect dunes are may become loose and boggy, and allow the crest to be mobilised by wind. Corrugations were encountered on dune crests as a result of vehicle traffic along seismic tracks, which can make trafficability difficult. Therefore, roads constructed on dunes will require stabilisation, and may benefit from cutting the dune to lower the slope of the road.
- Mulga red earth depressions (unit 5) have a low erosion potential due to low slopes and small patch size. However, soils may become sticky or boggy after rainfall due to higher clay content. Modification of surface drainage (e.g. by road construction) may interrupt water supply to the Mulga woodland, which may result in death of trees (over the medium to long term).
- Calcrete plains and rises (unit 6) have a low erosion hazard because of low relief, small patches and surface is protected from erosion by stone cover. In areas of higher relief, there is potential for disturbed soils to scour or gully; however, this was not observed in areas of existing disturbance within this unit.
- Clayey subsoil in clay pan (unit 7) is fairly stable however the land unit is not suitable for road or fence line placement as it is seasonally inundated and becomes sticky and untrafficable after only light rainfall events.

Erosion site 1 – deepest section of rill erosion line

Erosion site 1 – rill winding around vegetation

Erosion site 1 – track crossing is unimpacted

Erosion site 1 – end of rill in spinifex grassland

Erosion site 2 – minor rill

Erosion site 2 – track crossing is unimpacted

Figure 3-1. Photographs of rill erosion observed within interdune sandplains (in unit 4)

4 WEED SURVEY AND ASSESSMENT

The purpose of the weed assessment is to identify priority weed species applicable to the Dukas 1 project area, and to carry out field surveys to determine if there are infestations of declared weed species within the project area. Results will inform weed management activities applicable to the project area.

4.1 Weed categories

Three classes of weeds are declared under the NT *Weeds Management Act* (some of which are also considered Weeds of National Significance, WoNS), categorised based on the risks of harm they can cause and how difficult they are to control. Those categories are:

- Class A – to be eradicated
- Class B – growth and spread to be controlled
- Class C – not to be introduced into the NT.

Other introduced plants that are not declared weeds are referred to as 'environmental weeds', which are weed species that land managers are not obliged to control under current legislation.

4.2 Priority weed species for the project area

The project area falls within the *Alice Springs Regional Weed Management Plan 2013-2018* (DLRM 2013) area. The plan was developed by experts to support local weed management priorities, which includes identification of priority species, weeds considered significant threat species (but not declared under the *Weeds Management Act*), alert species and priority landscape areas that require particular protection. Four priority weeds are identified for the region – Athel Pine (*Tamarix aphylla*), Cacti group (*Opuntia spp*. and *Cylindropuntia spp*.), Parkinsonia (*Parkinsonia aculeata*) and Rubber Bush (*Calotropis procera*). These species require priority management attention if present on subject land. The plan also identifies three alert[2] species for the region – Mesquite (*Prosopis spp*.), Prickly Acacia (*Acacia nilotica*) and Fountain Grass (*Cenchrus setaceus*).

NT Government weed records[3] were also reviewed for the general area surrounding Dukas 1 (100 km radius from centre point), and the following species were identified (there were no records within the project area):

- Saffron Thistle (*Carthamus lanatus*) (Class B/C)
- Mossman River Grass (*Cenchrus echinatus*) (Class B/C)
- Paterson's Curse (*Echium plantagineum*) (Class A/C)
- Parkinsonia (*Parkinsonia aculeata*) (Class B/C and WoNS)
- Athel Pine (*Tamarix aphylla*) (Class B/C and WoNS)
- Caltrop (*Tribulus terrestris*) (Class B/C)

Several environmental weeds are also known to occur in the area (based on weed records), with records for Buffel Grass (*Cenchrus ciliaris*), Ruby Dock (*Acetosa vesicaria*), Couch Grass (*Cynodon dactylon*), Sow Thistle (*Malva parviflora*), Khaki Weed (*Alternanthera pungens*) and Pitted Lovegrass (*Eragrostis barrelieri*).

[2] An alert weed is a species not yet naturalised in the region, that has the potential to have a high level of impact in the region should it become established, and the likelihood of the species naturalising and spreading in the region is perceived to be high.

[3] NT Weed records accessed on the 15 October 2018

4.3 Baseline weed survey

A baseline weed survey was undertaken on the 1 and 2 October 2018 by Tom Ewers-Reilly (EcOz Senior Ecologist), who has extensive experience in surveying weeds and vegetation in the NT arid zone. The weed survey focused on priority weeds that are of concern within the region (see Section 4.2).

Timing of the weed survey was not ideal due to below average rainfall conditions throughout the region (171.4 mm during the past 12 months, Curtain Springs 015511, BOM 2018 http://www.bom.gov.au/). Therefore, annual or short-lived perennial species may not have been visible, but could be present as tubers or in the soil seedbank. However, the four priority weed species identified in the *Alice Springs Regional Weed Management Plan 2013-2018* (DLRM 2013) are all perennial shrubs or trees, and are clearly detectable during surveys if present within the project area.

Methodology

Weed survey included checks along proposed access roads (noting that access roads are located along existing station tracks or previous seismic lines), within each planned borrow pit area and within a 500 m radius of the proposed Dukas 1 well site. Inspections also occurred at existing disturbed areas, such as borrow / gravel pits, dams, fence lines, station tracks and along the roadside of Lasseter Highway – as these existing disturbance areas are often prone to weed infestation.

Proposed access roads were surveyed via vehicle (driving slowly, 20 km per hour maximum) and the surveyor carefully checked plants established on roadsides. If a suspected weed was observed, the vehicle was stopped, species was confirmed and data recorded using data collection method explained below.

Weed searches also occurred at sites surveyed as part of vegetation and landform surveys (Section 2) (Figure 1-1). Walked transects were undertaken at each proposed borrow pit location (Figure 1-1).

All weed species (and associated infestations) were recorded and described; however the focus of the survey was on species declared as Class A, B or C under the NT *Weeds Management Act* (or WoNS). If declared species were encountered, the following information was recorded for each infestation (according to those outlined in the *Weed Data Collection Manual* (Weed Management Branch 2015) – species name, patch size (5 m^2, 20 m^2, 50 m^2, 100 m^2), density (1 = 0%; 2 = <1%; 3 = 1-10%; 4 = 11-50%; 5 = >50%), and seed occurrence.

Results

No priority and / or declared weed species were recorded within the survey area, or in surrounding areas (therefore no detailed weed infestation data was required to be collected).

Two environmental weed species were recorded in sandplains in the far south of the survey extent:

- Buffel Grass (*Cenchrus ciliaris*) – one of the dominant species within unit 1.
- Paddymelon (*Citrullus colocynthis*) – two small plants on road sides within unit 1.

No weeds were observed at the Dukas 1 well site (including a 500 m buffer), nor in the northern areas where deeper sandplains and dunefields occur.

Weed Officers from the Department of Environment and Natural Resources (DENR) Weed Management Branch – Chris Brown and Steve Mueller – also conducted a weed inspection of the project area on the 1 October 2018. Their inspections resulted in the same conclusions as above (i.e. no occurrence of declared weed species and Buffel Grass restricted to the southern part of the project area) (pers. comm. Chris Brown Oct 2018 – discussion in the field).

5 SIGNIFICANT ECOLOGICAL AREAS

Significant ecological areas are identified by government that support high biodiversity significance (at either a bioregional, national or international scale) that require conservation and protection to preserve ecological values. This section identifies potential significant ecological areas within the region, and determines whether the Dukas 1 project is likely to impact these areas.

5.1 Definition of significant ecological areas

For the purposes of this assessment, significant ecological areas are defined by following:

- Sensitive vegetation (according to NT Land Clearing Guidelines, NRETAS 2010). These are distinct and limited in extent or support important ecological values, and include monsoon rainforest (wet rainforest and vine thickets on drier sites), riparian vegetation along river and stream margins, mangrove forests along sheltered coasts and estuaries, sandsheet heath and old-growth forest.
- Threatened Ecological Communities (TEC) are communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as being at risk or threatened with extinction.
- Site of Conservation Significance (SOCS) are areas that have been identified by the Northern Territory Government as the most important areas for biodiversity conservation.
- Site of Botanical Significance (SOBS) are areas that are important for plant conservation generally and specifically for conserving the rare, restricted range or endemic plant taxa. These areas have botanical features that distinguish them from the surrounding landscape, and the conservation of the vegetation should receive special attention.
- Protected areas – such as existing or proposed national parks, public or private reserves or conservation reserves.

5.2 Occurrence within Dukas 1 project area

Field surveys (described in Section 2) combined with existing mapping information confirmed that no significant ecological areas occur within the project area, for the following reasons:

- The only sensitive vegetation expected to occur in the local region is riparian vegetation. No watercourses occur within or surrounding the project area. The closest watercourse is located 10 km to the south (Karinga Creek), which is ephemeral and collects run-off from the Basedow Range (20 km to the west of project area). Minor tributaries and drainages are located close-by; however, none intersect the project area nor do they support riparian vegetation.
- The only listed TEC in the Northern Territory is associated with the Arnhem Land region (located in the Top End), which will not be affected as part of the project area.
- The project area does not intersect any SOCS. The Karinga Creek palaeodrainage system SOCS (Site number 63) falls 20 km south of the Dukas 1 well site.
- The project area does not intersect any SOBS. The Karinga Creek SOBS occurs to the south of the project area, which is of bio-regional significance.
- No protected areas occur within or adjacent to the project area.

6 THREATENED SPECIES LIKELIHOOD OF OCCURRENCE ASSESSMENT

This section outlines the procedure and results of the threatened species likelihood of occurrence assessment conducted for Dukas 1. This assessment was undertaken using available desktop information, database searches (for existing records and potential species) and results from ecological field work conducted in October 2018.

The purpose of this assessment is to identify those species that require consideration as part of project specific environmental risk assessment(s), and those that can be reasonably excluded from further assessment because they are unlikely to occur within the project footprint. Please note that this process is not a risk assessment as it does not take into account project operations and potential impacts.

6.1 Threatened species definition

The International Union for the Conservation of Nature (IUCN) nominates a set of criteria used to identify species at risk of extinction. These criteria are used to define categories of risk (see Figure 6-1) which are used by the Northern Territory (NT) Government to determine which threatened species are listed under the *Territory Parks and Wildlife Conservation Act* (*TPWC Act*), and by the Commonwealth Government to determine which threatened species are listed under the *Environment Protection and Biodiversity Conservation Act* (*EPBC Act*). This report focusses on species that are listed as Vulnerable, Endangered or Critically Endangered under the *TPWC Act,* the *EPBC Act* or both.

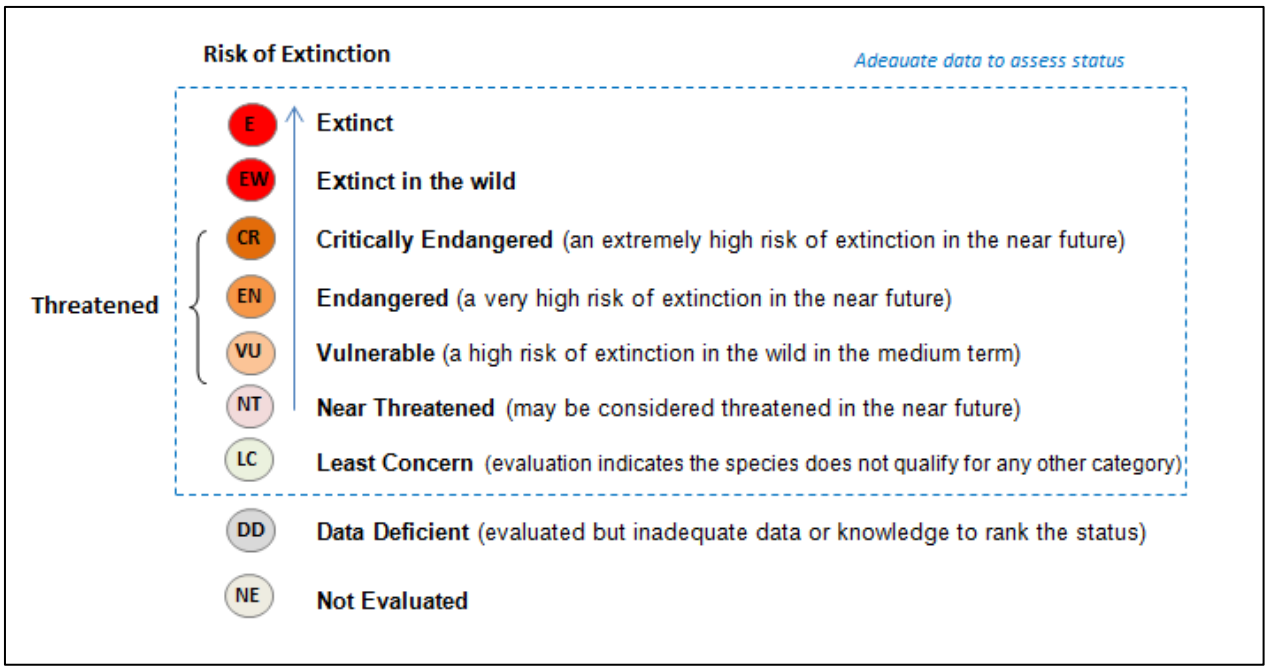


Figure 6-1. Species status categories used in the Northern Territory

6.2 Procedure

The following procedure was used to determine which threatened species have potential to occur in the Dukas 1 project area:

- The following data sources were used to generate a list of threatened species for the assessment:
  - Species records from the latest version of the NT Department of Environment and Natural Resources (DENR) Flora & Fauna Atlas (often referred to as the NT Atlas) were clipped to the Henbury sub-region (part of the broader Finke bioregion). Bioregions (and their sub-regions) give a broad area with largely similar habitat characteristics and species assemblages. Clipping data to the Henbury sub-region provides a broad selection of species from which to undertake project-specific likelihood of occurrence assessment.
  - EPBC Protected Matters Search Tool (PMST) was used to generate a report using a 50 km buffer from the Dukas 1 project area. This PMST is an online enquiry tool managed by the Commonwealth Department of the Environment and Energy (DoEE) which interrogates a range of existing flora and fauna data, as well as predictive modelling to speculate on the presence of species within a search area. The PMST uses a grid system to determine which protected matters it encapsulates for a particular search. The PMST report for Dukas 1 (Appendix B) was generated on 3 October 2018.
  - Advice from DENR experts and / or other experts.
- For each threatened species, a likelihood of occurrence assessment was conducted (for the Dukas 1 project area) using desktop information that relates to habitat requirements, distribution, number and dates of proximate records, and ecological information collected during the field survey (Section 2). Likelihood ratings were defined as follows:
  - KNOWN TO OCCUR – species has been recorded recently within the project area or immediate surrounds. These species will need to be considered during risk assessment activities for the project, and may require further studies in order to assess potential impacts.
  - LIKELY TO OCCUR – species is expected to occur within the project area because of the presence of suitable habitat, and/or there are recent proximate records. These species will need to be considered during risk assessment activities for the project, and may require further studies in order to assess potential impacts.
  - MAY OCCUR – there is potential that the species occurs within the project area as there is suitable habitat, however, there are no recent proximate records. Further studies are not considered necessary and standard best practice environmental management should be adequate to mitigate potential impacts to the species (however, some targeted mitigations may be necessary).
  - UNLIKELY TO OCCUR – apart from the occasional transient, there is strong evidence that this species will not occur within the project area, as there is no suitable habitat for the species and/or populations of the species in the region are known to have become extinct.

6.3 Data source results

A total of 26 threatened species were compiled for the Dukas 1 likelihood of occurrence assessment (see Table 6-1), including 21 animals, 4 plants and 1 invertebrate. Species counts for each data source are:

- NT Fauna Atlas bioregion search – 17 species
- NT Flora Atlas bioregion search – 3 species
- EPBC PMST search – 11 fauna species, 2 flora species
- Additional species based on advice from experts – 1 species (Brush-tailed Mulgara)

6.4 Track-plot and habitat survey

Habitat types within the project area included dune fields, sandplains, clay pans, calcrete rises and one isolated rocky hill (with outcrop) situated within the dunes. Descriptions of vegetation, landform and soils are provided as part of surveys explained in Section 2.

Tracking and active searching for fauna was conducted throughout the project area, with a focus on identifying evidence of threatened species and / or habitat suitability for threatened fauna.

No evidence of threatened flora and fauna species at Dukas 1 was observed during field surveys.

The following fauna species were recorded during the field survey; all are common and widespread species in the region:

- Sand Goanna (*Varanus gouldii*) - numerous tracks, diggings and burrows in dunes and sandplain.
- Perentie (*Varanus giganteus*) - one sighting in isolated low rocky hill within dune field.
- Thorny Devil (*Moloch horridus*) - three sightings in dune field, plus numerous tracks and burrows.
- Panther Skink (*Ctenotus pantherinus*) - one sighting in dune swale.
- Red Kangaroo (*Macropus rufus*) - scats and tracks relatively common in sandplain.
- Spinifex Hopping Mouse (*Notomys alexis*) - tracks on dunes, only a few recorded.
- Dingo (*Canis lupus dingo*) - tracks and scats observed in sandplains and dune field, uncommon.
- Dragon lizards (likely numerous species) - burrows and tracks common in sandplains and dunes.
- Feral Cat (*Felis catus*; introduced) - tracks observed in dune field and sandplain.
- Rabbit (*Oryctolagus cuniculus*; introduced) - scats common on isolated low rocky hill.
- One-humped Camel (*Camelus dromedarius*; introduced) - tracks in dune field, uncommon.
- Cattle (*Bos taurus*; introduced) - common in the southern areas where tussock grasses were higher in density, very scarce evidence in spinifex sandplains and dune habitats.
- Mole Cricket tracks - common within dune field.
- Insect tracks - present on dunes, indicating good tracking conditions.
- Bird tracks - present on dunes, indicating good tracking conditions.

In general, fauna activity on the sandplains and dunes was relatively low, particularly in terms of small mammals (assessment based on low amount of tracks, despite good tracking conditions i.e. no recent rainfall and low winds).

Specific habitat suitability information for threatened species (such as food resources) is provided (where relevant) within the likelihood of occurrence assessment below.

Figure 6-2. Photographs of Thorny Devil and Perentie taken during track-plot survey

6.5 Likelihood of occurrence assessment

The results from the threatened species likelihood of occurrence assessment are provided in Table 6-1. In summary, of the 26 species interrogated as part of the assessment, none were considered as 'known to occur' or 'likely to occur' within the Dukas 1 project area.

There is potential that five species 'may occur' at Dukas 1, summarised below:

- **Princess Parrot** – the presence of mature Desert Oaks provides potential for nesting opportunities; however, no hollows were observed in mature trees within the disturbance area at the Dukas 1 well site (via ground-based observations). Species could be present in area – but there are very few records of the species in the Henbury sub-region.

  Nonetheless, access roads and well site infrastructure have been placed in an area that minimises disturbance to mature Desert Oaks (refer to Figure 2-3), which subsequently minimises impacts to potential nesting sites for Princess Parrot.

- **Southern Marsupial Mole** – may occur within dune fields; however, there is no evidence that it occurs in the region (this may be due to lack of survey effort rather than absence). No tracks observed during the field survey.

- **Brush-tailed Mulgara** – may occur within dune fields and sandplains; however, there is no evidence that it occurs in the region (may be due to lack of survey effort rather than absence).

- **Grey Falcon** – only foraging individuals may occur, no nesting/breeding habitat for this species.

- **Great Desert Skink** – may occur within sandplain and dune swales; however, there is no evidence that it occurs in the region (may be due to lack of survey effort rather than absence). No burrows attributable to this species observed during the field survey.

The remaining 21 species identified as part of the likelihood assessment are considered as 'unlikely to occur' within the project area.

Table 6-1. Threatened species likelihood of occurrence assessment

CR = Critically Endangered; EN = Endangered; VU = Vulnerable; DD = EX = Extinct; NL = not listed

THREATENED SPECIES LIKELIHOOD OF OCCURRENCE ASSESSMENT							DUKAS 1, OCTOBER 2018
Common name	Status		Data source			Likelihood Rating	Reasoning
	TPWC	EPBC	NT Atlas	PMST	Other		
Great Desert Skink *Liopholis kintorei*	VU	VU		✓		MAY OCCUR	• No records in Henbury sub-region, however there are some nearby records at Angus Downs (60 km west) and also known populations at Uluru – Kata Tjuta National Park (200 km west). • Potentially suitable (but widespread) habitat is present at Dukas 1 (sandplain and swales); however the absence of other characteristic habitat features for the species (such as palaeodrainage channels and laterite sandplains) reduces the likelihood of occurrence. • Tracking surveys within a representative area of the disturbance footprint did not locate evidence of this species (with a survey focus on multiple entrance burrows with characteristic latrines).
Princess Parrot *Polytelis alexandrae*	VU	VU	✓	✓	✓	MAY OCCUR	• Known to occur in the region, however there are only three records within the Henbury sub-region. • Suitable habitat – dune fields with stands of Desert Oaks and typical associated shrubs (*Eremophila*, *Grevillea* and *Hakea* spp.) is widespread throughout Dukas 1 (and surrounds). • Despite potential nesting sites (i.e. large Desert Oaks) being present in the dune swales, the field survey did not record any tree hollows or sighting of the species.
Grey Falcon *Falco hypoleucos*	VU	NL	✓			MAY OCCUR	• Scattered records within the Henbury sub-region (and surrounds), mostly concentrated in areas associated with ranges in close vicinity to major drainage systems. • No nesting habitat (i.e. lightly-timbered lowland plains close to drainage systems) proximate to the project area. • Species highly mobile, and may occur in project area as a transient.
Southern Marsupial Mole *Notoryctes typhlops*	VU	NL	✓		✓	MAY OCCUR	• Although there are no recent records within the Henbury sub-region, suitable habitat (dune fields and sandplains) for the species is present. • Survey effort has likely been insufficient to detect this highly cryptic species. There are records to the west with some connectivity to dune fields at Dukas 1. • Recent tracking surveys did not record any evidence of the species; however, this is not the most effective method for detection of the species. To more conclusively determine the presence or absence of this species, surveys using systematic trenching are required. • If present, species is mostly likely to occur on dunes.
Brush-tailed Mulgara *Dasycercus blythi*	VU	NL			✓	MAY OCCUR	• No records within the Henbury sub-region. • There is suitable habitat (dune fields and sandplains) for the species. A known population occurs approximately 100 km to the west within Uluru - Kata Tjuta National Park, in dune field habitat similar to that at Dukas 1. • Despite suitable habitat, tracking surveys within proposed disturbance area did not record evidence of the species, and generally recorded a low level of small mammal activity.

THREATENED SPECIES LIKELIHOOD OF OCCURRENCE ASSESSMENT							DUKAS 1, OCTOBER 2018
Common name	Status		Data source			Likelihood Rating	Reasoning
	TPWC	EPBC	NT Atlas	PMST	Other		
Slater's Egernia *Liopholis slateri*	VU	EN	✓	✓		UNLIKELY TO OCCUR	• Few recent records in the Henbury sub-region (and surrounds), all at least 100 km north of Dukas 1. • Species is not known to occur in dune fields, such as those present within the Dukas 1 project area.
Night Parrot *Pezoporus occidentalis*	CR	EN		✓	✓	UNLIKELY TO OCCUR	• New survey techniques (such as acoustic recorders) have resulted in recent detections at scattered sites in arid and semi-arid Australia; however, none have been reported in the Henbury sub-region. • The spinifex clumps at Dukas 1 are relatively small and are not considered as preferred habitat for the species (Night Parrot prefers large, old hummocks often with samphire/chenopod shrublands). • If present in the region, the species is more likely to occur in the Karinga Creek palaeodrainage system situated to the south of the project area.
Plains-wanderer *Pedionomus torquatus*	DD	EN	✓			UNLIKELY TO OCCUR	• There are no confirmed records in the NT; however, there are two suspected records from 1976 near Erldunda Station. • This species prefers sparse low grasslands on plains, which do not occur at Dukas 1.
Curlew Sandpiper *Calidris ferruginea*	VU	CR	✓	✓		UNLIKELY TO OCCUR	• Species is rarely observed far from the coast. • If present in the region, species would be migrants in passage to coastal areas; however, short-term stop overs are limited to freshwater wetlands, which do not occur at Dukas 1.
Bar-tailed Godwit *Limosa lapponica*	VU	NL	✓			UNLIKELY TO OCCUR	• Species is rarely observed far from the coast. • If present in the region, species would be migrants passing through to coastal areas; however, short-term stop overs are limited to freshwater wetlands, which do not occur at Dukas 1.
Thick-billed Grasswren *Amytornis modestus modestus*	EX	VU	✓	✓		UNLIKELY TO OCCUR	• Species (MacDonnell Ranges subspecies) extinct in the NT. • NT Atlas records are historic records only (pre-1970).
Red Goshawk *Erythrotriorchis radiatus*	VU	VU		✓		UNLIKELY TO OCCUR	• Though there are some isolated recent records of the species from central Australia, none occur within the Henbury sub-region. • Species requires riverine habitat, which does not occur at Dukas 1.
Australian Painted Snipe *Rostratula australis*	VU	EN		✓		UNLIKELY TO OCCUR	• There are no records of the species in the Henbury sub-region. • Species requires freshwater wetlands with dense fringing vegetation, which do not occur at Dukas 1.
Greater Bilby *Macrotis lagotis*	VU	VU	✓	✓		UNLIKELY TO OCCUR	• No populations are currently known to occur in the region of Dukas 1. • Though suitable habitat is present, field surveys did not identify any evidence of the species (via track plot surveys) nor any typical food resources.
Black-footed Rock-wallaby *Petrogale lateralis*	NT	VU	✓	✓		UNLIKELY TO OCCUR	• The closest populations were at Uluru - Kata Tjuta National Park - which are now extinct. • Species requires rocky range habitat, which does not occur at Dukas 1.
Golden Bandicoot *Isoodon auratus*	EN	VU	✓			UNLIKELY TO OCCUR	• Historic records only, as species is now extinct from the arid zone (and mainland NT).

THREATENED SPECIES LIKELIHOOD OF OCCURRENCE ASSESSMENT							DUKAS 1, OCTOBER 2018
Common name	**Status**		**Data source**			**Likelihood Rating**	**Reasoning**
	TPWC	**EPBC**	**NT Atlas**	**PMST**	**Other**		
Central Rock-rat *Zyzomys pedunculatus*	EN	EN	✓	✓		UNLIKELY TO OCCUR	• Currently, all known populations are located within the MacDonnell Ranges associated with rocky ridges, cliffs, scree, hills and valley floors (approximately 140 km from Dukas 1). • No suitable habitat present at Dukas 1.
Pale Field-rat *Rattus tunneyi*	VU	(NL)	✓			UNLIKELY TO OCCUR	• Historic records only in arid Australia. • Species has retracted to higher rainfall areas in the Top End / northern Australia
Ghost Bat *Macroderma gigas*	NT	VU	✓			UNLIKELY TO OCCUR	• Populations in arid Australia are now extinct. • Species is now only recorded throughout northern Australia (and the Pilbara).
Common Brushtail Possum (South NT) *Trichosurus vulpecula vulpecula*	EN	NL	✓			UNLIKELY TO OCCUR	• One historic record in Henbury sub-region. • Species requires riverine habitat associated with large rocky ranges, which does not occur at Dukas 1.
Plains Mouse *Pseudomys australis*	EN	VU	✓			UNLIKELY TO OCCUR	• Only one record in Henbury sub-region from 2008 on Andado Station (which is located in gibber clay plains approximately 150km to the east). • Species occurs on stony gibber plains, cracking clays with minor drainages, which are not present at Dukas 1.
Bednall's Land Snail *Sinumelon bednalli*	NT	CR	✓			UNLIKELY TO OCCUR	• The few records in the Henbury sub-region are all associated with the MacDonnell Ranges, greater than 100 km north of Dukas 1. • This is a restricted range species that occurs under Fig trees often in rocky ranges and gullies, which do not occur at Dukas 1.
Rainbow Valley Fuchsia Bush *Eremophila prostrata*	VU	VU	✓			UNLIKELY TO OCCUR	• Numerous records occur in the Henbury sub-region; however none occur within 100 km of Dukas 1. • Potentially suitable habitat occurs at Dukas 1 - sandplains and lower dune slopes that support hummock grasses and a variety of shrubs and trees including *Grevillea*, *Hakea*, *Acacia*, and Desert Oaks – however, populations typically occur near the base of rocky ranges, which are not present at Dukas 1. • Species was not observed during vegetation surveys within the proposed disturbance locations.
Latz's Wattle *Acacia latzii*	VU	VU	✓	✓		UNLIKELY TO OCCUR	• Species only known from two localities, one of which is approximately 50 km north of Dukas 1. • Species is known to occur on silcrete-capped mesas and low stony hills (shale and siltstone). • There is one low stony hill close to Dukas 1 that was considered as potential habitat for the species; however field surveys did not identify species occurrence. The hill is also located outside of the Dukas 1 disturbance area.
Sweet Quandong *Santalum acuminatum*	VU	NL	✓			UNLIKELY TO OCCUR	• Only a few records of the species in the sub-region, approximately 80 km to the west of Dukas 1. • Potentially suitable habitat exists at Dukas 1 (notably dune swales); however, the species was not observed during vegetation mapping surveys.
Frankenia plicata	NL	EN		✓		UNLIKELY TO OCCUR	• Species is not known to occur within the NT • No suitable habitat at Dukas 1.

7 CONCLUSIONS AND MANAGEMENT

This report includes assessment of the following environmental aspects related to the Dukas 1 project area:

- Vegetation and landform mapping (see Section 2)
- Soil erosion potential (see Section 3)
- Baseline weed survey (see Section 4.3)
- Significant ecological areas (see Section 5)
- Threatened species likelihood of occurrence (see Section 6)

Vegetation and landform mapping

Eight units were delineated for the project area (Figure 2-2), which largely consists of sandplains and reticulate dunes further to the north (units 1, 2, 3 and 4), with patches Mulga red earth depressions (unit 5). Small areas of calcrete plains and rises (unit 6) and clay pans (unit 7) occur within the southern half of the project area. One rocky ridge (unit 8) occurs within the survey extent.

The proposed Dukas 1 well site is located in an interdune sandplain that falls within unit 4 (which has been mapped as unit 4b within the well-site survey area – Figure 2-3). The access road(s) follow existing station tracks or seismic lines (with some minor deviations), which traverse all mapped units – with the exception of silcrete-capped rocky ridge. Borrow pits are located to target clay and gravel sources within Mulga red earth (unit 5) and calcrete plains and rises (unit 6). The camp and laydown areas will mostly likely be positioned on flat sandplain areas within unit 1 and 2.

Significant ecological areas

No significant ecological areas occur within, or surrounding, the Dukas 1 project area. All vegetation types present at Dukas 1 are ubiquitous within the region – and no specific protection measures are required.

Soil erosion potential

Soil erosion potential is low for the majority of the project area, as coarse textured soils through most units provide good drainage and make most areas stable for construction of access roads and cleared pads. The main erosion risk is related to access roads, as poor 'siting' and construction may lead to the development of rills and gullies. Sheet erosion and wind erosion is unlikely to be an issue due to the limited nature of vegetation clearing; however, nuisance dust may occur during construction activities.

Despite the low erosion potential, arid zone soil conservation techniques will be required, which include:

- Roads should be constructed with drainage to allow water to sheet across the road (i.e. avoid creating windrows or remove existing windrows as those structure often result in water channelling along road which can form rills and / or gullies)
- Where drains are required for roads, ensure they have very gentle slopes (0.1 – 0.3%) and that water drains away from roads and other disturbed areas (otherwise rills / gullies may form)
- In dune fields, where possible, locate roads within the interdune sandplain to avoid crossing dunes (as vegetation removal on dunes can result in wind erosion, and can become boggy).
- Where it is necessary to cross dunes, a low, gently inclined section should be selected (if present) and the alignment should be straight and perpendicular (i.e. at 90 degrees) to the incline.
- Should water concentrate in wheel ruts, use 'whoaboys' (trafficable diversion banks) to drain the water away from the road to surrounding undisturbed (i.e. stable) areas.

  https://nt.gov.au/__data/assets/pdf_file/0015/212253/diversion-banks.pdf

Threatened species

No threatened species are 'known to occur' within the project area; and the likelihood of occurrence assessment did not identify any species 'likely to occur' within the project area; however, five species 'may occur' within the project area, these species and potential mitigations are described below:

- Princess Parrot (*Polytelis alexandrae*)
  - May be periodically observed in area, and there is potential nesting habitat in mature Desert Oaks in unit 4 – dune fields. Project components should be located in areas to minimise disturbance / removal of large Desert Oaks; however, as there is extensive areas of Desert Oaks within the local area, removal of a few mature individuals is not expected to result in significant impact to the species (assuming that they are not actively being used for nesting – which was confirmed by surveys). The proposed positioning of the well pad is in an area that supports low density mature Desert Oaks (compared to surrounding areas) (Figure 2 3).
- Southern Marsupial Mole (*Notoryctes typhlops*)
  - May occur in dunes within units 3 and 4. Locate access road(s) in interdune sandplains to reduce the number of dune crossings. Habitat fragmentation via dune crossings is unlikely due to the reticulate nature of dunes, and sandy substrate within interdune sandplains – which provides a suitable network of habitat for movement of the species (i.e. will not be blocked by road construction or well pad construction).
- Grey Falcon (*Falco hypoleucos*)
  - Foraging / hunting individuals may occur as this is a widespread and naturally scarce species. Importantly, no nesting / breeding habitat is present within the project area. The project will not significantly impact foraging opportunities for the species. No mitigations required.
- Brush-tailed Mulgara (*Dasycercus blythi*)
  - May occur in dunes or interdune areas. Track-plot surveys did not detect this species. Ensure land disturbance kept to a minimum to reduce potential impacts.
- Great Desert Skink (*Liopholis kintorei*)
  - May occur within sandplains. Keep land disturbance to a minimum. Track-plot surveys within the current footprint did not record any evidence of this species.

Weeds

The weed survey was conducted after 12 months of below average rainfall (and 6 months of no substantial rain events), which is not ideal for weed identification. However, the *Alice Springs Regional Weed Management Plan 2013-2018* (DLRM 2013) highlights that four priority weeds are applicable for the region – Athel Pine (*Tamarix aphylla*), Cacti group (*Opuntia* spp. and *Cylindropuntia* spp.), Parkinsonia (*Parkinsonia aculeata*) and Rubber Bush (*Calotropis procera*). Field surveys confirmed that these priority species are not present within the Dukas 1 project area, which can be stated with high confidence as these species are typically detectable during dry periods (i.e. they are not annual or short-lived perennials).

No declared weed species were recorded within the survey area, or in surrounding areas.

Two environmental weed species were recorded, which occurred in the southern portion of the project area – Buffel Grass (*Cenchrus ciliaris*) and Paddy Melon (*Citrullus colocynthis*). No weeds were observed at the Dukas 1 well site (500m buffer), nor in the northern areas where spinifex sandplains and dunefields occur. NT Weed Branch inspections also resulted in the same conclusions.

Weed management should focus on minimising the chance of weed introductions – which can be managed via standard weed hygiene protocols for machinery, vehicles and equipment entering the site.

It is preferable that Buffel Grass is not spread along the road during road upgrade activities, as it is classed as a 'significant threat species' in the *Alice Springs Regional Weed Management Plan 2013-2018* (DLRM

2013) – due to biodiversity impacts and fire threat to infrastructure. This could be managed in a variety of ways – such as completing road works in the northern areas first (to reduce the chance of seed contamination of machinery), establishing washdown areas and not transporting soil material from the south to the north (as it may contain Buffel Grass seed).

Weed monitoring should occur as part of environmental checks and inspections, which will be important following rainfall events (particularly summer rainfall events). Weeds identified via monitoring and inspections should be promptly controlled (using appropriate methods, as per *NT Weed Management Handbook* https://nt.gov.au/__data/assets/pdf_file/0004/233833/NT-Weedmanagement_handbook_2018.pdf and advice from NT Weeds Branch).

8 REFERENCES

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APPENDIX A VEGETATION AND LANDFORM UNIT DESCRIPTIONS

Unit 1	Shallow sandplain with mixed tussock grassland and sparse shrubs

Landforms and soils:

Gently undulating plain with broad red sandy rises, with relief up to approximately 3 m. The unit has red earth soils that are well-drained and generate little run-off. Surface soils may be over shallow (~1 m) calcrete or peneplain. No drainage features present. Calcareous rises and clay pans occur throughout the area (larger areas are described separately as units 6 and 7, respectively).

Erosion potential:

Low water erosion potential due to coarse-textured surface soils and low relief. Wind erosion and sheeting may occur if vegetation cover is removed over wide areas without suitable erosion controls (e.g. via land clearing, grazing or fire), which may result in reduction / loss of topsoil. No areas of active erosion were observed.

Vegetation:

There is distinct floristic variation between the landforms within this unit; however, they have not been mapped separately as part of this survey, as it was not considered necessary in terms of the current scope.

The undulating plain supports a mixed low tussock grassland and Copper Burr (*Sclerolaena* spp.) species with scattered shrubs of Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*), Mulga (*Acacia aneura*), Witchetty Bush (*Acacia kempeana*) and Desert Cassia (*Senna artemisioides* spp. *filifolia*). No emergent trees were present in survey area. Tussock grasses included Limestone Oat Grass (*Enneapogon cylindricus*), Native Oat Grass (*Enneapogon avenaceus*), Erect Kerosene Grass (*Aristida holathera*), Bunched Kerosene Grass (*Aristida contorta*), Knottybutt Neverfail (*Eragrostis xerophila*), Buffel Grass (*Cenchrus ciliaris*, *introduced species), Hard Spinifex (*Triodia basedowii*) – noting that identification for some grass species was difficult due to dry conditions and absence of suitable seed material.

The red sandy rises support a shrubland to open shrubland of similar species to above (but at a higher density) with the addition of Harlequin Fuchsia Bush (*Eremophila duttonii*), and Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*) which was dense in some areas. Hard Spinifex (*Triodia basedowii*) was the most common ground cover; however numerous tussock grass and dried forbs were also present and sometimes became 'patchily' dominant.

Other species identified in this unit included Bush Tomato (*Solanum* sp.), Ruby Saltbush (*Enchylaena tomentosa*), Tumbleweed (*Salsola tragus*), Victory Wattle (*Acacia victoriae*), Long-leaf Emubush (*Eremophila longifolia*), Tall Yellow Top (*Senecio magnificus*), Colony Wattle (*Acacia murrayana*), Paddy Melon (*Citrullus colocynthis*, *introduced species), Cotton Bush (*Maireana aphylla*), Harlequin Fuchsia Bush (*Eremophila duttonii*) and Spiny Saltbush (*Rhagodia spinescens*).

Unit 2	Undulating sandplain with Blue Mallee over mixed shrubs, Hard Spinifex, annual grasses and forbs

Landforms and soils:

Undulating red sandplain with infrequent occurrence of low reticulate dunes. Soils are moderately deep sandy red earths that are well-drained. No obvious drainage features present. Clay pans, calcareous rises and red earth depressions are also present, these are described as units 5, 6 and 7, respectively.

Erosion potential:

Low water erosion hazard because runoff is low with the majority of water permeating into the sandy soils. Wind erosion may occur where spinifex has been removed. No areas of active erosion were observed.

Vegetation:

Undulating sandplains support a tall shrubland of Blue Mallee (*Eucalyptus gamophylla*) over Desert Cassia (*Senna artemisioides* spp. *filifolia*) and Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*) shrubs with a Hard Spinifex (*Triodia basedowii*) grassland. Red Mallee (*Eucalyptus socialis*) occurred in some areas as the dominant mallee. Other common shrubs included Mulga (*Acacia aneura*), Witchetty Bush (*Acacia kempeana*), Long-leaf Emubush (*Eremophila longifolia*) and Umbrella Bush (*Acacia ligulata*). Other groundcover species included Lifesaver Burr (*Sida platycalyx*) and Woollybutt (*Eragrostis eriopoda*). It is likely that a variety of annual ground cover species are also present throughout this unit; however, they were absent, senesced or in low densities as a result of dry conditions during the survey. Ironwood (*Acacia estrophiolata*) and Batswing Coral Tree (*Erythrina vespertilio*) were present as emergent trees.

Low sandy rises within the sandplain support a mixed shrubland with common species including Rattlepod Grevillea (*Grevillea stenobotrya*), Umbrella Bush (*Acacia ligulata*), Mann Range Mallee (*Eucalyptus mannensis*), Blue Mallee (*Eucalyptus gamophylla*), Mulga (*Acacia aneura*), Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*), Maitland's Wattle (*Acacia maitlandii*) over Hard Spinifex (*Triodia basedowii*). Occasional emergent Bloodwood (*Corymbia opaca*) trees – these were more common in the northern area where dunes are more prevalent. Desert Oak (*Allocasuarina decaisneana*) were scattered; when present they occurred on sandy rises or at the base of sand ridges.

Unit 3	Sandplain and low dunes with a variable shrubland of Mann Range Mallee, Mulga, Sticky Hopbush and Desert Cassia over Hard Spinifex, annual grasses and forbs

Landforms and soils:

An extensive sandplain with scattered low reticulate dunes (height up to 5 m). Dunes becoming larger and more frequent in the north. The deep red earth sands are well-drained (i.e. porous), with no drainage features present. Mulga red earth depressions are also present - described as unit 5.

Erosion potential:

Low erosion potential due to coarse textured soils and low clay content. Wind erosion can occur if vegetative cover is reduced. Tracks on dunes may become loose and boggy, and in severe cases allow the crest to be mobilised by wind. No areas of active erosion were observed.

Vegetation:

The undulating sandplains support an open to sparse shrubland of Mulga (*Acacia aneura*), Waxy Wattle (*Acacia dictyophleba*), Maitland's Wattle (*Acacia maitlandii*), Rattlepod Grevillea (*Grevillea stenobotrya*), Witchetty Bush (*Acacia kempeana*) and Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*) over Hard Spinifex (*Triodia basedowii*) and Woollybutt (*Eragrostis eriopoda*).

The low dunes support a fairly consistent open shrubland of Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*), Maitland's Wattle (*Acacia maitlandii*), Rattlepod Grevillea (*Grevillea stenobotrya*), Sandhill Fuchsia (*Eremophila willsii*) and Umbrella Bush (*Acacia ligulata*) over Hard Spinifex (*Triodia basedowii*). Bloodwood (*Corymbia opaca*) were often present.

The eastern areas of this unit support a tall open shrubland of Mann Range Mallee (*Eucalyptus mannensis*) with relatively dense lower shrub Desert Cassia (*Senna artemisioides* subsp. *filifolia*) over Hard Spinifex (*Triodia basedowii*). Blue Mallee (*Eucalyptus gamophylla*) and Red Mallee (*Eucalyptus socialis)* are also present.

Small stands of Desert Oak (*Allocasuarina decaisneana*) (mostly small trees) were present within this unit, typically located at the base of low dunes. The larger patches are described and mapped as unit 4.

Unit 4	Reticulate dunes with a shrubland of Desert Heath Myrtle, Rattlepod Grevillea, Sticky Hopbush and Umbrella Bush over Hard Spinifex; Desert Oak in interdune sandplains.

Landforms and soils:

Reticulate dunes (up to 10 m high) and undulating interdune sandplain. Deep sandy soils and red earth sands. Dunes have soft red siliceous sands with rapid drainage (i.e. porous), and interdune sandplain have loamy red earths (often capped with shallow red sands) that are moderately-well drained. No obvious drainage features. Mulga red earth depressions are also present - described in unit 5.

Erosion potential:

Dune flanks and crests have low erosion potential because of high infiltration rates; however, soils are highly susceptible to wind erosion where spinifex has been removed (i.e. due to land clearing or fire). Corrugations were observed on dune crests as a result of vehicle traffic along seismic tracks.

Interdune sandplains have a low to moderate erosion hazard, with the erosion hazard being higher in areas that have clay loam soils and larger patch size (i.e. larger size generates longer surface runoff distances, increasing erosion risk). Concentration of runoff from disturbances such as windrows or wheel ruts may result in rilling or gullying. Evidence of rill erosion was observed at two locations, which appears to originate from previously cleared seismic lines (see in Section 3).

Vegetation:

Dunes support an open shrubland with common species including Desert Heath Myrtle (*Aluta maisonneuvei*) (species sometimes present as a dominant patch), Rattlepod Grevillea (*Grevillea stenobotrya*), Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*), Waxy Wattle (*Acacia dictyophleba*), Umbrella Bush (*Acacia ligulata*), Sandhill Fuchsia (*Eremophila willsii*) over an open hummock grassland of Hard Spinifex (*Triodia basedowii*) and scattered areas of tussock grasses such as Woollybutt (*Eragrostis eriopoda*). Scattered Bloodwood (*Corymbia opaca*) trees are present. Desert Oak (*Allocasuarina decaisneana*) are uncommon on dune crests. Other species encountered on dunes include Sandhill Sage (*Newcastelia spodiotricha*) and Blue Mallee (*Eucalyptus gamophylla*). Mapped as unit 4a within the well-site survey area.

Interdune sandplains support stands of Desert Oak (*Allocasuarina decaisneana*) with numerous mature and immature trees – generally present as open tall woodland. Tussock grasses are established (fairly sparsely under canopies with common species including Erect Kerosene Grass (*Aristida holathera*), Woollybutt (*Eragrostis eriopoda*) and Mulga Grass (*Monachather paradoxa*). Sticky Hopbush (*Dodonaea viscosa* subsp. *angustissima*) and Desert Cassia (*Senna artemisioides* subsp. *filifolia*) shrubs are scattered within Desert Oak stands and become denser outside of canopies. Hard Spinifex (*Triodia basedowii*) also occurs as the dominant groundcover species in areas outside of Desert Oak canopies. Other species encountered with the dune swales include Mulga (*Acacia aneura*) and Long-leaf Emubush (*Eremophila longifolia*). Mapped as unit 4b within the well-site survey area.

Unit 5	Red earth depressions and plains with Mulga and Witchetty Bush over Hard Spinifex, annual grasses and forbs

Landforms and soils:

Shallow depressions / minor run-on areas that occur within sandplains. Red earth to heavy red earth soils (reasonably high clay content, but no heavy clays observed) that are moderately to poorly drained; areas with higher sand content have moderate-drainage potential. Patchy occurrence throughout the survey extent.

Erosion potential:

Low erosion potential due to low slopes and small patch size. Soils may become sticky or boggy after rainfall due to higher clay content. Modification of surface drainage (e.g. by road construction) may interrupt water supply to the Mulga woodland, which may result in death of trees (over the medium to long term).

No areas of active erosion were observed, including at sites associated with existing disturbances.

Vegetation:

Low woodland to shrubland dominated by Mulga (*Acacia aneura*) and Witchetty Bush (*Acacia kempeana*) generally over sparse cover of tussock grasses, including Erect Kerosene Grass (*Aristida holathera*). Hard Spinifex (*Triodia basedowii*) was patchily dominant, often when the canopy was more open and sandier soils were present. Other species include Long-leaf Emubush (*Eremophila longifolia*), Native Fuchsia (*Eremophila latrobei*), Desert Cassia (*Senna artemisioides* spp. *filifolia*) and Ironwood (*Acacia estrophiolata*).

Unit 6	Calcareous plains and rises with mixed tussock grassland and Copper Burr

Landforms and soils:

Calcareous plains and low rounded calcrete rises with high cover of surface gravel. Rock outcrops rarely observed, if present only minor. Rapidly drained soils. No obvious drainage features (surface run-off via sheet flow). Many of these areas have been used for borrow / gravel pits for local track construction

Erosion potential:

Low erosion hazard because of low relief, small patches and surface is protected from erosion by stone cover. In areas of higher relief, there is potential for disturbed soils to scour or gully.

Vegetation:

Calcrete rises support a mixed tussock grassland and Copper Burr (*Sclerolaena* spp.) species and sparse shrubs including Dead Finish (*Acacia tetragonophylla*), stunted Witchetty Bush (*Acacia kempeana*) and Cassia's (*Senna* spp.). No trees were observed. Tussock grasses were difficult to identify due to dry conditions and absence of suitable seed material – species present likely include Limestone Oat Grass (*Enneapogon cylindricus*), Native Oat Grass (*Enneapogon avenaceus*), Erect Kerosene Grass (*Aristida holathera*) and Bunched Kerosene Grass (*Aristida contorta*).

Unit 7	Clay pan with sparse vegetation

Landforms and soils:
Flat run-on areas with heavy clay soils, some with minor level of surface cracking. Poorly drained soils. Patchy occurrence throughout the project area. Some clay pan areas had surface calcrete gravel.

Erosion potential:
The clayey subsoil is fairly stable however the land unit is not suitable for road or fence line placement as it is seasonally inundated and becomes sticky and untrafficable after only light rainfall events.

Vegetation:
Sparsely vegetated, and mostly comprising annuals which were senesced at the time of survey. Copper Burr's (*Sclerolaena* spp.) and Caltrop (*Tribulus* sp.) were present with some patches of low (and grazed) tussock grasses. Shrubs are very scarce and trees are absent.

Unit 8	Silcrete-capped rocky ridge with Mulga and Silver Cassia over tussock grasses

Landforms and soils:

Isolated low rocky linear ridge with relief up to 20 m, located within sandplains and dunefields (units 3 and 4). Rocky outcrops present with numerous conglomerate formations with a variety of rock types (silcrete, calcrete, sandstone, quartz). Rocky scree slope on the northern side of the ridge. High surface gravel and pebble cover. Shallow (skeletal) loamy gritty soils. Surface water rapidly drains off rocky surface. Some minor drainage gullies are present, situated on the northern face of the low ridge (due to steeper slopes).

Erosion potential:

The rocky / gravelly surface lowers the potential for water erosion; however, windrows on a road or cleared line can channel water which can lead to gully erosion. This unit is only located in one location within the project area. Road construction in the vicinity of the ridge will need to consider increased water velocities and stormwater run-off generated from the ridge.

Vegetation:

Open shrubland of Mulga (*Acacia aneura;* likely a few varieties present) over Silver Cassia (*Senna artemisioides* subsp. *artemisioides*), Native Fuchsia (*Eremophila latrobei*) over scattered tussocks, forbs and daisies. Other species included Rock Fuchsia Bush (*Eremophila freelingii*), Cassia (*Senna artemisioides* subsp. *alicia*), Horse Mulga (*Acacia ?ramulosa*,), Silver Tails (*Ptilotus obovatus*) and Hard Spinifex (*Triodia basedowii*).

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Appendix E: Stakeholder Engagement Records

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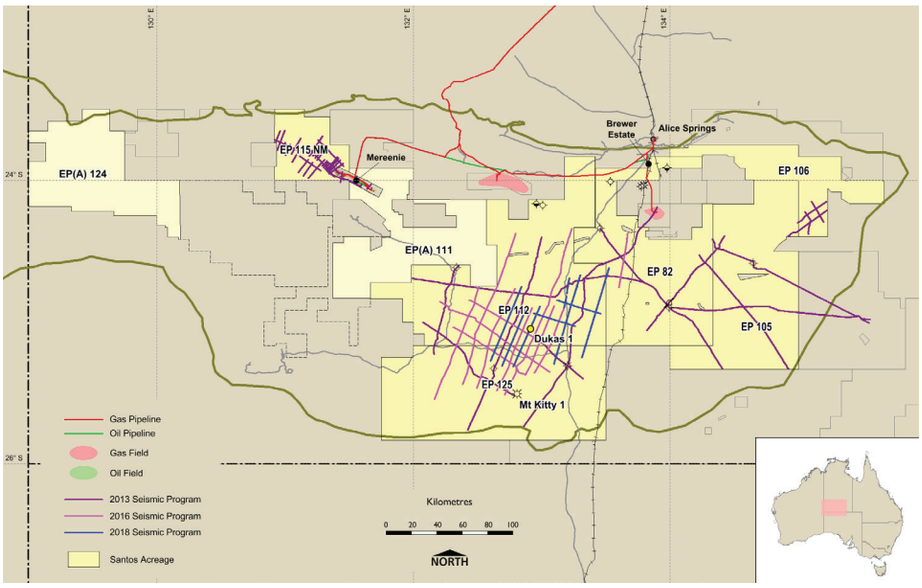
Appendix F: Dukas-1 Information Sheet

Santos Amadeus Basin Exploration

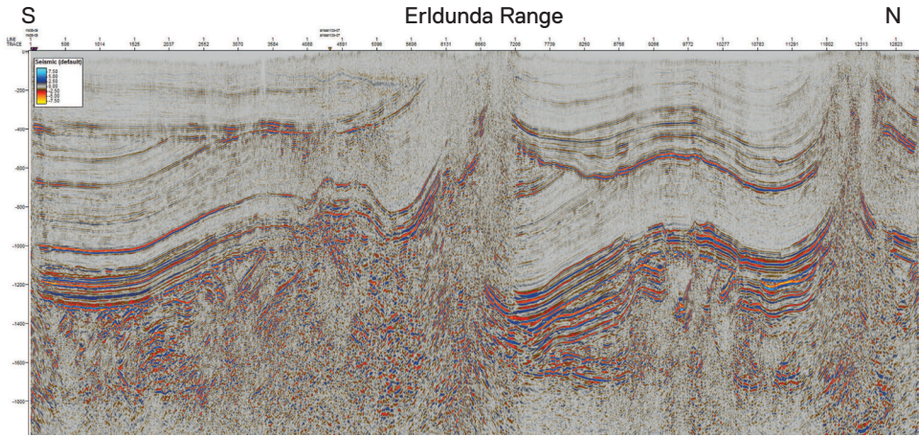
Santos



Mt Kitty-1, 2014

Seismic acquisition, 2013

S Erldunda Range N



Seismic acquisition, 2013

Exploration Timeline: Past Present Future

2012	2013	2014	2015	2016	2017	2018	2019
Farm-in	1932km 2D Seismic	Mt Kitty-1 Well	Studies	Studies	934 km 2D Seismic	403 km 2D Seismic	Dukas-1 Well

Natural Gas in the NT:
Exploration to development

Santos

Ensign Rig 965

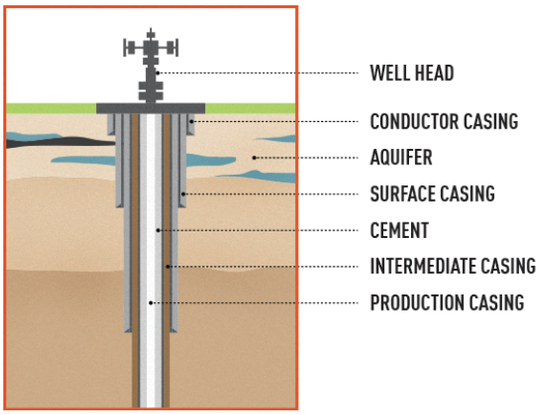
Exploration

Explorers conduct above ground geophysical surveys known as seismic surveys.
An energy source creates sound (sonic) waves that travel into the earth and reflect off subsurface geological features.
The 'reflections' are recorded by geophone receivers (like microphones) placed on the surface along the seismic line; this is similar to how bats 'see' with sound.
The recorded information is displayed so that geoscientists can identify subsurface structures that may hold oil or gas.
A survey can take from a few weeks to several months.
If the geoscientists identify subsurface structures or 'targets' that may hold oil or gas, the drilling team moves in to drill the wells.

Drilling a well

A borehole or well is initially drilled straight down through the earth. Most wells continue straight down (i.e. vertical) until they reach a target; this could be at depths of between 1 and 4 kilometres. Some wells, however, can deviate from vertical and some are drilled through the target horizontally. Most wells in the Amadeus Basin are vertical wells.

Aquifers are protected using steel casing and cement to line the hole, ensuring oil and gas cannot enter the fresh water aquifers.



Cement and steel casing form an impermeable protective barrier between the borehole and the geological formations (example)

There are three drilling phases.

Phase 1
Exploration Drilling

An exploration well is the first well drilled in an area. Generally a well in the NT would be up to 4 kilometres deep. As the well is drilled, rock cuttings and other information is assessed by specialists to determine if oil or gas is present.

If oil or gas is found this is known as a 'discovery'.

Phase 2
Appraisal Drilling

If oil or gas is discovered further wells, known as appraisal wells, may be drilled to estimate the quantity and quality of the oil or gas.

Phase 3
Development Drilling

If sufficient quantities of oil or gas are found, and they can be economically and safely recovered, further wells are drilled. The oil or gas produced is processed and delivered to customers.

A producing oil or gas well has a wellhead on the surface that contains barriers, valves and seals. It allows the pressure of the well and the flow of fluids to be controlled at the surface.