Biodiversity Assessment

TELLUS



Risks to Biodiversity Report

For

TELLUS

Tellus Holdings

Chandler Project

Prepared by: Low Ecological Services P/L

October 201

Low Ecological Services P/L

PO Box 3130, Alice Springs, NT 0871

Ph: (08) 89 555 222 Fax: (08) 89 555 722

Email: lowecol@lowecol.com.au

Web: www.lowecol.com.au

Frontispiece: Top: rocky hill overlooking the sandplain at the Chandler Facility Site, Bottom (left to right): *Crotalaria eremaea* (bluebush pea), *Varanus gouldii* (sand goanna) and *Solanum ellipticum* (bush tomato).

DISCLAIMER

This document has been prepared by Low Ecological Services (LES) for Tellus Holdings Ltd (Tellus) in accordance with an agreement with Tellus. LES has prepared this document using the skill and care expected from professional scientists to provide factual and technical information and reasonable solutions to identified risks. It does not constitute legal advice.

ACKNOWLEDGEMENTS

LES acknowledges the assistance of Sophy Townsend and Richie Phillips of Tellus, Central Land Council Santa Teresa rangers (Shannon, Petria, Bronwyn, Norbert, Gibson and Charlie) and Central Arrernte people, Marilyn Kenny, Peter Kenny and Dennis Kenny, from Walkabout Bore (60km NNW of Halfway Dam) for their assistance in field work. LES would like to acknowledge the assistance of other LES staff involved in the project, Roz Walden, Caitlin Conover, Nicci Hanrahan, Chris Watson, Damien Griffiths, Tim Dowling, Brody Smith and Emma Smith. LES would also like to recognise the assistance of the following external experts' Des Nelson (botanist), Dennis Matthews (bats), and Joe Benshemesh (marsupial moles) for their assistance with species identification and survey methodology.

DOCUMENT DETAILS

Name of Document:	Risks to Biodiversity Report
Authors:	Katie Degnian, Lauren Young, Bill Low, Brody Smith and Jeremy Snowdon-James
Client:	Tellus Holdings Ltd
Name of Project:	Chandler Salt Mine

DOCUMENT CONTROL

Approvals	**Name**	**Signature**	**Date**
Originator:	Low Ecological Services		04/10/2016
Reviewer:	Tellus Holdings Ltd	× S. Townsend	08/02/2017
Administrator:	Tellus Holdings Ltd	×	08/02/2017
Approver:	Department of of Primary Infrastructure and Resources	×	
Custodian:	Tellus Holdings Ltd	×	08/02/2017

PREFACE

This preliminary document will remain a working document until it is finalised as an operational document and can be used as such by operators in the field.

The final version will incorporate any comments or recommendations resulting from any government approval processes; it is not anticipated that any major changes to the document will be required.

All information on proposed operations contained in this document has been supplied by Tellus.

EXECUTIVE SUMMARY

Tellus Holdings Ltd proposes to construct and operate an underground rock salt mine and storage facility (the Chandler Facility), a rail siding with storage and transfer facilities (the Apirnta Facility) and haul and access roads. If approved, the Chandler Facility would be located on a current pastoral lease, Maryvale Station, approximately 120 km south of Alice Springs. The Apirnta Facility would be located approximately 30 km to the west of the Chandler Facility, also on a pastoral lease, Henbury Station. The haul road would span the western half of Maryvale Station and the access road would span the eastern half of Henbury Station along the southern boundary. Collectively, the two proposed facilities and the haul and access roads are referred to as "the Proposal".

The following Risks to Biodiversity Report has been prepared to address the Chandler Salt Mine Terms of Reference for the Preparation of an Environmental Impact Statement (EIS) (ToR) (September 2016), with regards to Biodiversity. The purpose of this report is to;

- Describe the existing environment in the Proposal area, determine the presence or likelihood of threatened flora species and ecological communities, threatened fauna species and migratory species in the Proposal area and identify any threatened fauna habitat within in the Proposal area;
- Conduct a risk assessment of the potential risks to threatened species and biodiversity as a whole as a result of construction and operational stages of the Proposal; and
- Provide mitigation techniques to avoid or mitigate potential risks to threatened species and biodiversity as a whole in accordance with best practice guidelines.

Methods

The assessment combines data from desktop surveys and field surveys over four years. Desktop surveys included searches of Commonwealth and Northern Territory Government databases, spatial data and aerial imagery and a review of relevant literature.

Six intensive field surveys were undertaken by Low Ecological Services (LES) of the mine lease area, the proposed rail siding and storage and transfer facility and proposed access roads and haul road, between October 2012 and May 2016. Direct observation, secondary sign, bird, landscape and vegetation surveys were carried out at 69 sites in total, with trapping undertaken at 32 of these sites. Methods for vegetation surveys and landscape description are consistent with the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst, et al., 2007) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, et al., 2004). Survey methodology for fauna is consistent with the *Standard terrestrial vertebrate survey methods used by the DLRM* (in Northern Territory Environmental Protection Agency, 2013) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, et al., 2004). Survey methods used to determine the presence of threatened species followed those suggested in the *Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, Environment, Water, Population and Communities, 2011a), *Survey Guidelines for Australia's Threatened Reptiles* (Department of Sustainability, Environment, Water, Population and Communities, 2011b) and *Survey Guidelines for Australia's Threatened Birds* (Department of Environment, Water, Heritage and the Arts, 2010). Targeted searches were conducted for threatened species identified by the Protected Matters Search tool as potentially occurring within the area of interest, including:

- Great desert skink (*Liopholis kintorei*) ;
- Slater's skink (*Liopholis slateri slateri*) ;
- Desert sandskipper (*Croitana aestiva*) ;
- Australian painted snipe (*Rostratula australis*);
- Night parrot (*Pezoporus occidentalis*) ;
- Princess parrot (*Polytelis alexandrae*) ;
- Crest-tailed mulgara (*Dasycercus cristicauda*;
- Brush-tailed mulgara (*Dasycercus blythi)*;
- Thick-billed grasswren (*Amytornis modestus*);
- Black-footed rock-wallaby (*Petrogale lateralis,* MacDonnell Ranges race);
- Central rock-rat (*Zyzomys pendunculatus*) ;
- Greater bilby (*Macrotis lagotis*) ; and
- Southern marsupial mole (*Notoryctes typhlops*).

Existing environment

The Proposal is located in the Finke Bioregion and the climate of the Proposal area is characterised by distinct hot summers and cold winters with a wide range in diurnal temperature. Vegetation in the Proposal area has been mapped at a scale of 1: 1, 000 000 in the Vegetation Survey of the Northern Territory (Wilson, et al., 1990) and there are six vegetation communities across the site that are typical of central Australia. The dominant vegetation community across the Proposal area is vegetation type 83 (*Triodia* low hummock grassland), along with vegetation type 108 and 110 (*Maireana* low open chenopod shrubland and *Atriplex* low open shrubland) and smaller areas of vegetation type 66 (*Acacia* tall open shrubland).

Threatened flora

No threatened flora species were recorded within the Proposal area.

One flora species listed as near threatened (Nt) and two species listed as data deficient (DD), under the *Territory Parks and Wildlife Conservation Act* (TPWC Act) were recorded during the surveys. An additional five Nt or DD species have a moderate to high likelihood of occurring in the Proposal area (Table 1). The data deficient species are not considered to be significant in the Proposal area due to either limited habitat availability or widespread occurrence of the species in widely available habitat in the region. There are no threatened ecological communities or sensitive vegetation communities, such as groundwater dependent ecosystems, within the Proposal area.

Table 1: Near threatened or data deficient flora species listed under the TPWC Act recorded during on-ground surveys, or with a high to moderate likelihood of occurring within the proposal area. Nt: near threatened, DD: data deficient.

Scientific Name	Common name	TPWC	EPBC	Recorded during surveys	Likelihood of occurrence
Ixiochlamys nana	Small fuzzweed	DD	-	No	Moderate
Brachyscome ciliaris	Variable daisy	DD	-	No	High
Maireana carnosa	Cottony bluebush	Nt	-	Yes	High
Sclerolaena longicuspis	-	Nt	-	No	Moderate
Crotalaria eremaea	Bluebush pea	DD	-	Yes	High
Acacia oswaldii	-	DD	-	No	High
Calandrinia remota	-	DD	-	Yes	High
Synapthantha tillaeacea	-	DD	-	No	Moderate

Threatened fauna

Two threatened fauna species were recorded in the Proposal area during the on ground surveys:

- *Notorcytes typhlops* (southern marsupial mole), listed as vulnerable under the TPWC Act, was recorded on the eastern and western banks of the Finke River approximately 800 m north of the Henbury Access Road; and
- *Dasycercus* sp. (mulgara) - *Dasycercus cristicauda* (crest-tailed mulgara), listed as vulnerable under the both the *Environment Protection and Biodiversity Conservation Act* (EPBC Act) and TPWC Act)/ *Dasycercus blythi* (brush-tailed mulgara), listed as vulnerable under the TPWC Act. Mulgara tracks were recorded outside the mine lease, approximately 0.5 km north of the proposed Chandler Haul Road route, although it was not possible to identify these to the species level, there is suitable habitat for both *D. blythi* and *D. cristicauda* in the Proposal area.

Five threatened fauna species were not recorded during the on-ground surveys but have a low – moderate likelihood of occurring within the Proposal area (Table 1). Six fauna species listed as Nt or DD under the TPWC Act were recorded during on-ground surveys and an additional seven species have a moderate or high likelihood of occurring within the Proposal area. These species are not considered to have conservation significance in the Proposal area (Table 2). Three species listed as migratory and marine under the EPBC Act were recorded in the Proposal area during surveys and an additional five species have a moderate to high likelihood of occurring (Table 3).

Table 1: Threatened fauna species recorded during on-ground surveys, or with a high to moderate likelihood of occurrence within the Proposal area.
Vu: vulnerable, En: endangered, Cr: critically endangered, ER: extinct regionally *likelihood of occurring after high rainfall, #Tracks of *Dasycercus* sp. recorded.

Group	Species name	Common name	Status		Recorded during suveys	Likelihood of occurrence
			TPWC	EPBC		
Bird	*Amytornis modestus indulkana*	Thick-billed grasswren (north western subspecies)	Cr	Vu	No	Low -moderate
	Polytelis alexandrae	Princess parrot	Vu	Vu	No	Low-moderate*
	Rostratula australis	Australian painted snipe	Vu	En	No	Low-moderate*
Mammal	*Dasycercus blythi*	Brush-tailed mulgara	Vu	-	Yes#	High
	Dasycercus cristicauda	Crest-tailed mulgara	Vu	Vu	Yes#	High
	Notoryctes typhlops	Southern marsupial mole	Vu	-	Yes	High
Reptile	*Liopholis kintorei*	Great desert skink	Vu	Vu	No	Low- moderate
	Liopholis slateri slateri	Slater's skink	Vu	En	No	Low-moderate

Table 2: Near threatened or data deficient species listed under the TPWC Act recorded during on-ground surveys or with a high to moderate likelihood of occurrence within the Proposal area.
Nt: near threatened, DD: Data deficient, *likelihood of occurring after high rainfall.

Group	Species name	Common name	Status		Recorded during surveys	Likelihood of occurrence
			TPWC	EPBC		
Bird	*Amytornis striatus*	Striated grasswren	Nt	-	No	Low - moderate
	Ardeotis australis	Australian bustard	Nt	-	Yes	High
	Burhinus grallarius	Bush stone-curlew	Nt	-	Yes	High
	Calyptorhynchus banksii samueli	Red-tailed black cockatoo	Nt	-	Yes	High
	Conopophila whitei	Grey honeyeater	DD	-	No	High
	Cinclosoma castanotum	Chestnut quail-thrush	Nt	-	No	High
	Dromaius novaehollandiae	Emu	Nt	-	Yes	High
	Elanus scriptus	Letter-winged kite	Nt	-	No	High*
	Lophoictinia isura	Square-tailed kite	Nt	-	No	High
	Neophema splendida	Scarlet-chested parrot	Nt	-	Yes	High*
	Pyrrholaemus brunneus	Redthroat	Nt	-	Yes	High
Mammal	*Antechinomys laniger*	Kultarr	Nt	-	No	High
Reptile	*Pseudechis australis*	King brown snake	Nt	-	Yes	High

Table 3: Migratory fauna species listed under the EPBC Act recorded during on-ground surveys or with a high to moderate likelihood of occurrence within the Proposal area.
Mi: Migratory; Ma: Marine J: Japan-Australia Migratory Bird Agreement; C: China-Australia Migratory Bird Agreement; R: Republic of Korea-Australia Migratory Bird Agreement; B: Bonn Convention

Scientific name	Common name	Status	International Agreements	Recorded during surveys	Likelihood of Occurrence
		EPBC			
Apus pacificus	Fork-tailed swift	Mi, Ma	J, C, R	No	Moderate
Ardea modesta	Eastern great egret	Mi, Ma		No	Moderate
Calidris acuminata	Sharp-tailed sandpiper	Mi, Ma	B, J, C, R	No	High
Charadrius veredus	Oriental plover	Mi, Ma	B, J, C, R	No	Moderate
Glareola maldivarum	Oriental pratincole	Mi, Ma	J, C, R	No	Moderate
Merops ornatus	Rainbow bee-eater	Mi, Ma		Yes	High
Tringa nebularia	Common greenshank	Mi, Ma	B, J, C, R	Yes	High
Tringa stagnatilis	Marsh sandpiper	Mi, Ma	B, J, C, R	Yes	High

Introduced species

Seven introduced species were recorded in the Proposal area. Of these species, one species, *Tamarix aphyll*a (athel pine), is a Weed of National Significance (WoNS) and declared weed (Class B and Class

C) in the NT. Additionally, two of these species are declared weeds in the NT; *Datura leichardtii* (native thorn apple) (Class C) and *Tribulus terrestris* (caltrop) (Class B).

Seven introduced fauna species were recorded during on-ground surveys of the Proposal area. These include *Bos taurus* (domestic cattle), *Camelus domaradius* (camel), *Canis lupis familiaris* (domestic dog), *Equus asinus* (donkey), *Equus caballus* (horse), *Felis catus* (cat), *Mus musculus* (house mouse), *Oryctolagus cuniculus* (rabbit) and *Vulpes vulpes* (red fox).

Assessment of significance of impact

The potential for significant impacts on 14 threatened, migratory and marine species listed under the EPBC Act and TPWC Act recorded during on-ground surveys, or those that have a low-moderate to high likelihood of occurring in the Proposal area were assessed using the criteria set out in the *Significant Impact Guidelines 1.1-Matters of National Environmental Significance* (Department of Environment, 2013). Species assessed include:

- *Rostratula australis* (Australian Painted Snipe) (En EPBC Act, Vu TPWC Act);
- *Liopholis slateri slateri* (Slater's Skink) (En EPBC Act, Vu TPWC Act);
- *Amytornis modestus indulkana* (thick-billed grasswren) (Vu EPBC Act, Cr TPWC Act);
- *Polytelis alexandrae* (princess parrot) (Vu EPBC Act, Vu TPWC Act);
- *Dasycercus cristicauda* (crest-tailed mulgara) (Vu EPBC Act, Vu TPWC Act);
- *Liopholis kintorei* (great desert skink) (Vu EPBC Act, Vu TPWC Act);
- *Apus pacificus* (fork-tailed swift) (Mi, Ma EPBC Act);
- *Ardea modesta* (eastern great egret) (Mi, Ma EPBC Act);
- *Caladris acuminata* (sharp-tailed sandpiper) (Mi, Ma EPBC Act);
- *Charadrius veredus* (oriental plover) (Mi, Ma EPBC Act);
- *Glareola maldivarum* (oriental pratincole) (Mi, Ma EPBC Act);
- *Merops ornatus* (rainbow bee-eater) (Mi, Ma EPBC Act);
- *Tringa nebularia* (common greenshank) (Mi, Ma EPBC Act);
- *Tringa stagnatilis* (marsh sandpiper) (Mi, Ma EPBC Act);
- *Dasycercus blythi* (crest-tailed mulgara) (Vu TPWC Act); and
- *Notoryctes typhlops* (southern marsupial mole) (Vu TPWC Act).

As a result of the assessments of significance it was concluded that there would be no significant impact as a result of the Proposal on the threatened species recorded in the Proposal area (*D. cristicausda*, *D. blythi* and *N. typhlops*) and there would be no significant impact to the eight species listed as migratory and marine under the EPBC Act. For the remaining five threatened species with a moderate likelihood of occurring within the Proposal area, there would be no significant impact on three of these species if they did occur in the Proposal area. Two of the species, *A. m. indulkana* and *L. s. slateri*, both with a low-moderate likelihood of occurring in the Proposal area were identified as having a potential to be significantly impacted as a result of the Proposal if the species did occur in the Proposal area:

Although the closest records of *A. m. indulkana* are approximately 167 km south east, potentially suitable habitat for *A. m. indulkana* occurs in a number of areas on the Henbury Access Road. Despite considerable survey effort, the species was not recorded during on-ground surveys. However due to the cryptic nature of the species and the difficulty associated with recording the species and the presence of suitable habitat, there is a low-moderate likelihood *A. m. indulkana* could occur in the proposal area. As a population of *A. m. indulkana* would meet the criteria for being an important population, there is the potential for significant impact on this species from reduction of the occupancy of this population, fragmentation or the disruption of the breeding cycle. If this species is found to be present, significant impacts would be avoided through changes to the alignment of the Henbury access road, or alternatively through trapping and translocation. If significant impacts could not be avoided, the need for offsets would be discussed with the DoEE.

There is suitable habitat for *L. s. slateri* on the proposed Henbury Access Road on the Finke River floodplain, on which makes up approximately 10 ha of theproposed disturbance area. If the species is present in the Proposal area, it is possible that an isolated population of the species would be significantly impacted through habitat loss and by the potential encroachment of buffel grass into suitable habitat following the removal of vegetation. Targeted surveys would be undertaken of the proposed access road alignment prior to construction. If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. Alternatively, a program of trapping and relocating would be implemented to avoid significant impacts to individuals of the species. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE.

The risk to biodiversity assessment identifies the potential hazards to biodiversity and a risk rating for these hazards based on their level of likelihood and potential consequences. Scientific evidence, knowledge and experience, where possible, have informed the risk assessment to reduce the uncertainty in the rating; where this is not possible, the level of uncertainty has been stipulated. This risk assessment has identified the following four key risks with regards to biodiversity as a result of construction and operations of the Proposal:

- Weed spread and introduction;
- Increase in population size of introduced fauna species;
- Increased predator species; and
- Fire.

Following the risk assessment, mitigation and monitoring measures were developed to reduce these risks to an acceptable level. Risk reduction would be measured by comparable survey effort resulting in no change to:

- The populations of threatened flora and fauna species,
- Prevalence and spread of introduced weeds and invasive species;
- Abundance of predators;
- Numbers of individuals of introduced fauna species;
- Erosion and sedimentation;
- Hydrology;
- Groundwater quality and standing water level (SWL);
- Fire;
- Habitat availability, fragmentation or edge effects;
- Vegetation community abundance and condition; and
- Long-term stability of the surrounding environment.

Mitigation and monitoring measures that would be implemented for the four key risks listed above are provided in Figure 9-1.

As the assessments of significance found there would be no significant impact on threatened species recorded in the Proposal area, no offset policy is deemed necessary for the Proposal. Should a population of *A. m. indulkana* and *L. s. slateri* be found in subsequent site surveys, then this would be re-assessed.

Based on assessments of significance, it can be concluded that with the application of the recommended avoidance, mitigation and monitoring techniques the remaining risks to biodiversity as a result of construction and operations at the Proposal are negligible. The conservation status, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels in the Proposal area and adjacent areas would be maintained. Tellus would implement best practice avoidance, mitigation and management techniques to prevent the introduction and/or spread of invasive and pest species. The Proposal is highly unlikely to result in significant impact to threatened species, communities and migratory species listed under the EPBC Act, and species listed under the TPWC Act.

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LIST OF ABBREVIATIONS

Abbreviation	Definition
AAPA	Aboriginal Areas Protection Authority
ALARP	As low as reasonably possible
ASC	Australian Soil Classification
BMP	Biodiversity Management Plan
BFMP	Bush Fire Management Plan
BoM	Bureau of Meteorology
CLC	Central Land Council
Cr	Critically endangered
DD	Data deficient
DENR	Department of Environment and Natural Resources (Northern Territory)
DLRM	Department of Land Resource Management (Northern Territory)
DME	Department of Mines and Energy (Northern Territory)
DoE	Department of Environment (Commonwealth), now Department of Environment and Energy
DoEE	Department of the Environment and Energy (Commonwealth)
DoSEWPC	Department of Sustainability, Environment, Water, Population and Communities (Commonwealth), Department of the Environment and Energy
DPIR	Department of Primary Industries and Resources (Northern Territory)
EA Act	Environmental Assessment Act 1982 (Northern Territory)
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EL	Exploration Licence
En	Endangered
EPBC Act	Environment Protection and Biodiversity Conservation Act (Commonwealth)
ER	Extinct Regionally
ESCP	Erosion and Sediment Control Plan
FESA	Fire and Emergency Services Association
FFMP	Flora and Fauna Management Plan
GDE	Groundwater Dependent Ecosystem
HS&E	Health, Safety and Environment
IBRA	Interim Biogeographic Regionalisation of Australia
IECA	International Erosion Control Association
JHA	Job Hazard Analysis
km	Kilometres
LES	Low Ecological Services
Ma	Marine
Mi	Migratory
MM Act	Mine Management Act

MMP	Mine Management Plan
MNES	Matters of National Environmental Significance
MP	Management Plan
MSDS	Material Safety Data Sheet
MtDNA	Mitochondrial deoxyribonucleic acid
NA	Not applicable
NEPM	National Environmental Protection Measure
Nt	Near Threatened
NT	Northern Territory
NSW	New South Wales
NT EPA	Northern Territory Environment Protection Authority
NTVIS	Northern Territory Vegetation Information System
PMST	EPBC Protected Matters Search Tool
PPL	Perpetual Pastoral Lease
Qld	Queensland
RoM	Run of Mine
SoBS	Sites of Botanical Significance
SoCS	Sites of Conservation Significance
SA	South Australia
SWL	Standing water level
Tellus	Tellus Holdings Ltd.
TO	Traditional Owner
ToR	Terms of Reference
TPWC Act	Territory Parks and Wildlife Conservation Act
Vu	Vulnerable
WA	Western Australia
WoNS	Weed of National Significance

LIST OF DEFINITIONS

Term	Definition
Airborne salt	Airborne salt refers to gaseous and/or suspended salt particles carried by the air.
Alluvial	Rock and soil that moved down slope due to hydrological forces.
Area of interest	The Proposal area including a 20 km buffer, used for desktop database searches.
Colluvial	Rock and soil that moved down slope due to gravitational forces.
Crepuscular	Fauna species that are active primarily during twilight ours, dawn and dusk.
Critically endangered	Critically endangered as defined in the EPBC Act or TPWC Act.
Data Deficient	Data deficient as defined in the TPWC Act.
Diurnal	Active during daytime hours.
Exploration lease	Area comprising Exploration Lease 29018 lodged with the Northern Territory Government by Tellus Holdings in year.
Endangered	Endangered as defined in the EPBC Act or TPWC Act.
Habitat fragmentation	The division of habitat into smaller and more isolated fragments.
Incidental observations	Flora or fauna observed incidentally during field trips.
Land systems	The delineation of areas or regions based on geographical, geological and/or ecological features. Mapping of the Alice Springs area by Perry, et al. (1960) available at a scale of 1:100,000.
Matters of National Environmental Significance	Nine defined areas under the EPBC Act including world heritage properties, Ramsar wetlands, nationally listed threatened species and ecological communities, listed migratory species, activities related to nuclear energy (including uranium mining), Commonwealth marine environment, national heritage places, the Great Barrier Reef Marine Park and water resource in relation to coal seam gas development and large coal mining development.
Mine lease	Area comprising Mineral Lease Application ML30612 lodged with the Northern Territory Government by Tellus Holdings in October 2014.
Near threatened	As defined in the TPWC Act.
Rehabilitation	The act of restoring an area to its original state after it has been damaged.
Secondary sign	Identifying fauna by secondary signs through observation of tracks, scats, scratches, burrows, tunnels, nests/roosts, feeding signs, hair/feathers and bones/carcasses.
Significant impact	An impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. As defined in *Matters of National Significance – Significant Impact Guidelines 1.1* (Department of Environment, 2013).
Sites of Botanical Significance (SoBS)	Sites that are considered important for plant conservation generally and specifically for conserving significant plant taxa.

Sites of Conservation Significance (SoCS)	Sites that are considered important for conservation of biodiversity in the Northern Territory.
Species of conservation significance	Species that are listed under the EPBC Act and/or TPWC Act.
Terms of Reference	Terms of Reference for the Preparation of an Environmental Impact Statement – Chandler Salt Mine (ToR) issued by the NT Environment Protection Authority (NT EPA) in August 2016 under the EA Act.
The Apirnta Facility	Tellus proposed rail siding, storage and transfer facility.
The area of interest	The Proposal area (development footprint) with an additional 20km buffer.
The Chandler Facility	The underground rock salt mine and storage facility.
The Chandler Haul Road	The haul road between the Chandler Facility and the Apirnta Facility.
The Henbury Access Road	The access road between the Stuart Highway and the Apirnta Facility.
The Proposal	The combined proposed project including the Chandler Facility, the Apirnta Facility and all associated development including the Chandler Haul Road, Henbury Access Road and other access tracks.
Proposal area	The area within the development footprint of the Proposal.
Threatened species	Species which are listed as vulnerable, endangered or critically endangered under the EPBC Act or TPWC Act.
Trapping	The use of Elliott, pit and funnel traps to capture and identify fauna.
Vulnerable	Vulnerable as defined in the EPBC Act or TPWC Act.

1 INTRODUCTION

1.1 Overview

Tellus Holdings Ltd (Tellus) propose to construct and operate an underground rock salt mine and storage facility (herein referred to as “the Chandler Facility”), a rail siding with storage and transfer facilities (herein referred to as “the Apirnta Facility”) and haul and access roads (herein referred to as “the Chandler Haul Road” and the “Henbury Access Road”, respectively). If approved, the Chandler Facility would be located on a current pastoral lease (the Maryvale Station) approximately 120 km south of Alice Springs in the Northern Territory (NT). The Apirnta Facility would be located approximately 30 km to the west of the Chandler Facility, also on a pastoral lease (the Henbury Station). The haul road would span the western half of Maryvale Station and the access road would span the eastern half of Henbury Station. Collectively, the two proposed facilities and the haul and access roads are referred to as “the Proposal”.

Figure 1-1 shows the location of the Proposal and Figure 1-2 shows the proposed Chandler Facility layout.

Approximately 750,000 tonnes of salt product would be exported per annum from the Chandler Facility. The proposed Chandler Facility would also provide for the safe and secure storage and permanent isolation of up to 400,000 tonnes of waste per annum. The Apirnta Facility would allow for the temporary storage during transport of up to 400,000 tonnes of waste.

The Proposal requires approval from both the NT Environmental Protection Authority (NT EPA) under the NT *Environmental Assessment Act 1982* (EA Act) and from the Commonwealth Department of Environment and Energy (DoEE) under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

This report has been prepared to address the requirements set out in the *Terms of Reference for the Preparation of an Environmental Impact Statement – Chandler Salt Mine* (the “Terms of Reference” or “ToR”) issued by the NT EPA in September 2016 under the EA Act.

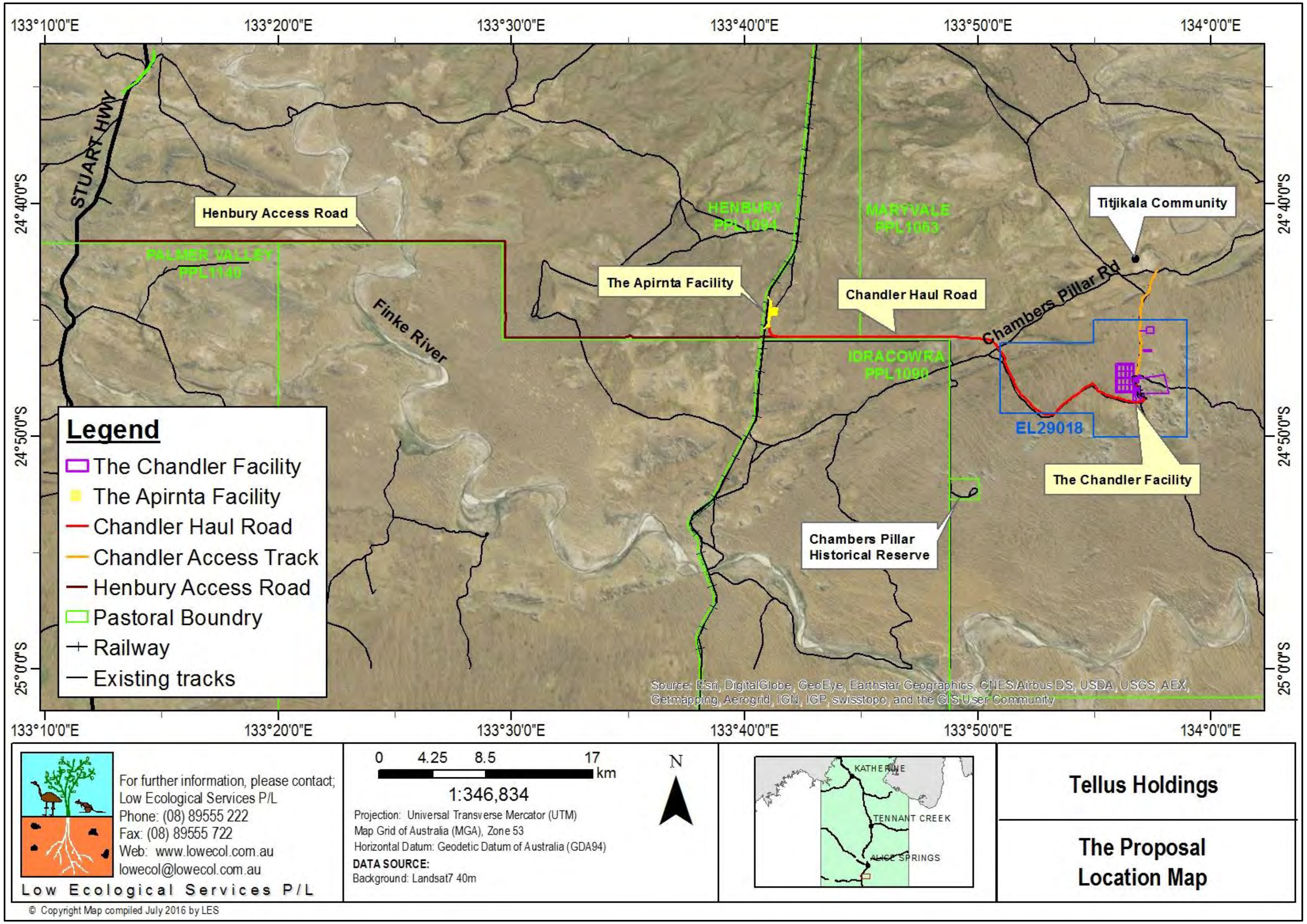


Figure 1-1: Location map of the Chandler Facility, Apirnta Facility, Henbury Access Road and Chandler Haul Road on Maryvale Station and Henbury Station

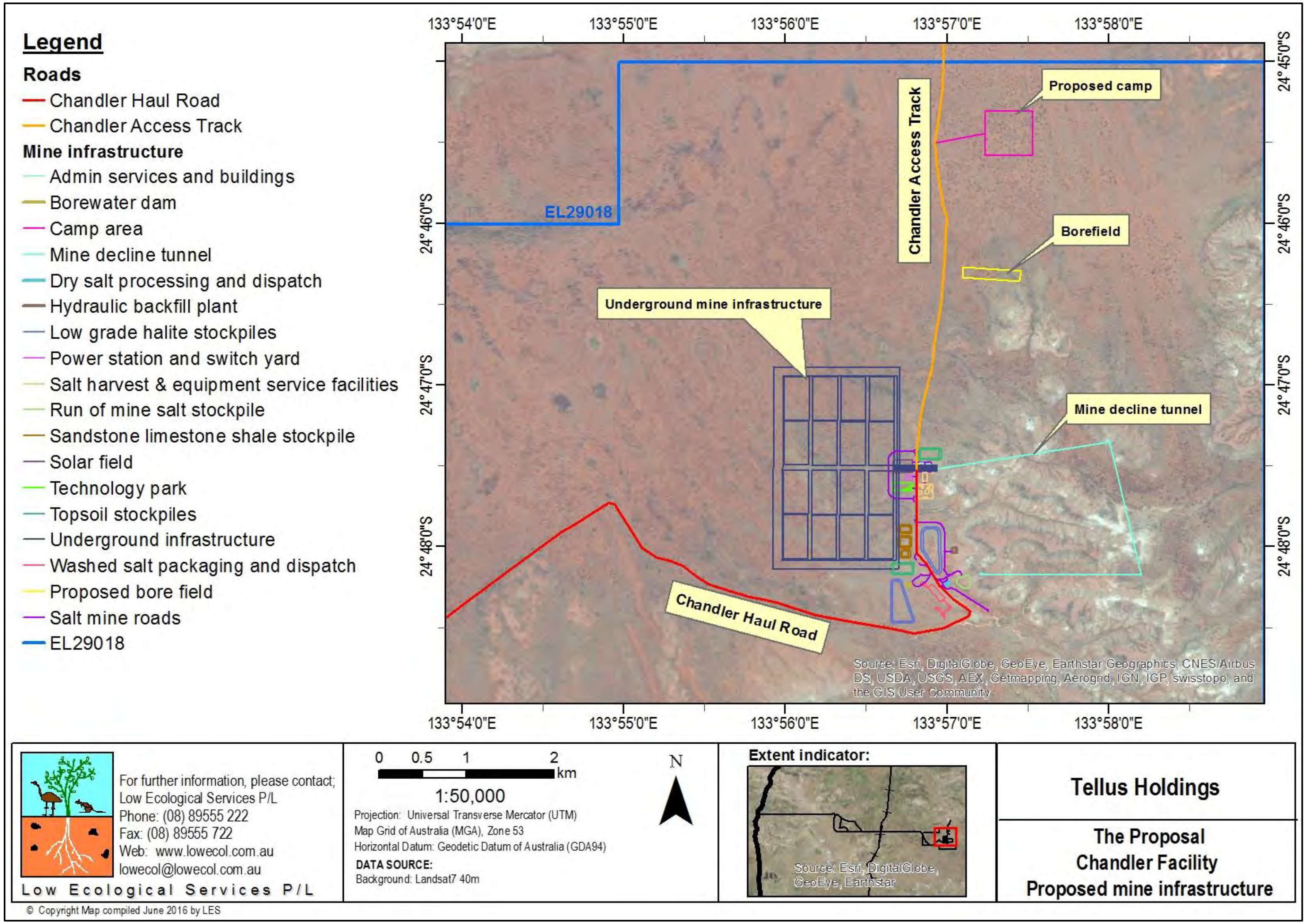


Figure 1-2: Location map of Chandler Facility infrastructure.

Note the decline descends from the surface at the SW end to about 800 m below ground.

1.2 EIS Requirements

The ToR for the Proposal were issued by the NT EPA in September 2016 under the EA Act (Northern Territory Environmental Protection Agency, September 2016). The matters raised in the ToR (where relevant to biodiversity) and references to where each matter is addressed in this Environmental Impact Statement (EIS) are provided in Table 1-1.

Table 1-1: Terms of Reference and the section of the report in which they are addressed

EIS Requirement	Section
3. Existing Environment	
3.1.4 Biodiversity	
The EIS should describe fauna, flora and vegetation communities of the Project area and local region.	Sections 3.9, Section 3.8 and Section 3.5 respectively.
The EIS should include details of the scope, survey/program timing (survey season/s), locations and methodology, to demonstrate appropriate and sufficient survey designs. At a minimum, surveys should be in accordance with the Northern Territory and Australian Government Guidelines. Include details of: • how the Australian Government best practice survey guidelines are applied • how they are consistent with (or a justification for divergence from) published Australian Government guidelines and policy statements.	Introduction to Section 2.
The EIS should describe and map, where relevant: • significant or sensitive vegetation types and/or ecosystems, including any areas already cleared or disturbed (if any) • the presence or likely presence of listed threatened and/or migratory species under the EPBC Act and/or the Territory Parks and Wildlife Conservation Act within the Project area and in any areas that may be impacted by the proposed action • aquatic ecosystems or groundwater dependent ecosystems likely to be affected by the Project • suitable habitat for listed threatened species, including the locations of historic records and consideration of habitat suitable for breeding, foraging, aggregation or roosting	• Section 3.5. • Section 3.5.1 (flora) and Section 3.6.1 (fauna). • Section 3.3. • Section 3.1.2 and Section 3.6.5.

EIS Requirement	Section
• the presence, or likely occurrence, of introduced and invasive species (both flora and fauna) within and adjacent to the Project area, and regionally, including weed species declared under the Weeds Management Act.	• The presence of introduced flora is provided in section 3.5.4. The presence or likely occurrence of introduced fauna is provided in section 3.1.5.
Explain the basis for statements made in response to the above, that is, whether the Proponent: • is identifying and relying upon existing literature or previous surveys. • has conducted its own surveys specifically for this purpose.	Section 3.
4.4 Biodiversity	
4.4.2 Assessment of risk	
The EIS should include a detailed risk assessment outlining the risks to biodiversity as a result of the Project, including consideration of the following construction and operational aspects of the Project: • clearance and disturbance activities in the mine area, waste storage and transfer areas, rail siding and haul/access roads • transportation of personnel, machinery and materials • modification of surface water hydrology • groundwater extraction, where there may be interaction with surface water • contamination of soils and/or water • dust, airborne salt and noise	Section 5

EIS Requirement	Section
The risk assessment should specifically consider, where relevant: • significant or sensitive vegetation types and/or ecosystems • suitable habitat for listed threatened species • the presence or likely presence of species listed under the EPBC Act and/or the TPWC Act, including but not limited to: ○ Crest-tailed Mulgara (*Dasycercus cristicauda*) ○ Brush-tailed Mulgara (*Dasycercus blythi*) ○ Southern Marsupial Mole (*Notoryctes typhlops*) ○ Greater Bilby (*Macrotis lagotis*) ○ Thick-billed Grasswren (eastern) (*Amytornis modestus*) ○ Night Parrot (Pezoporus occidentalis) ○ Princess Parrot (Polytelis alexandrae) ○ Great Desert Skink (*Liopholis kintorei*) ○ Slater's Skink (Liopholis slateri slateri). • the presence, or likely occurrence, of introduced and invasive species.	Section 3.5. Introduced flora: Section3.8.3, Introduced fauna: Section 3.9.4.
The EIS should specifically include the following for threatened species listed under the EPBC Act: • a description of the relevant direct, indirect and consequential impacts of the proposed action on listed threatened species, including the total clearance amount of suitable habitat for each relevant listed threatened species • details of the impacts on listed threatened species specific to each of the construction and operation aspects of the Project outlined above • a detailed assessment of the nature and extent of the likely direct, indirect and consequential impacts, including likely short-term and long-term impacts • a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible • an analysis of the significance of the relevant impacts • any technical data and other information used or needed to make a detailed assessment of the relevant impacts.	Section 4 and Section 5.

<table>
<tr><th>EIS Requirement</th><th>Section</th></tr>
<tr><td>Reference should be made to the EPBC Act Policy Statement 1.1 Significant Impact Guidelines - Matters of National Environmental Significance (2013).</td><td></td></tr>
<tr><td>Where a risk has been identified, the EIS should include an analysis of the risks to individuals and populations.
In addition to the above risk assessment, the EIS should include an analysis of the potential risks to sensitive vegetation communities at a local and regional scale. Consideration should be given to the potential for ongoing indirect impacts resulting from edge effects, increased dispersal of invasive plants/animals, fragmentation of habitat, etc.</td><td>Section 4

There are no significant vegetation communities in the Proposal area as stated in Section 3.5.</td></tr>
<tr><td colspan="2">4.4.3 Mitigation and monitoring</td></tr>
<tr><td>The EIS should contain mitigation and monitoring measures should be substantiated in accordance with best practice advice from relevant Northern Territory Biodiversity Management Plan (BMP) that outlines clear and concise methods to mitigate likely impacts to biodiversity. All and Australian Government advisory agencies focusing on:
• potentially significant impacts to the biodiversity as a whole mitigating the impacts to vegetation
• rare or threatened species at risk of being adversely impacted</td><td>• Mitigation and monitoring measures are provided in Section 6 and a Biodiversity Management Plan is provided in Appendix 6.</td></tr>
<tr><td>All mitigation and monitoring measures proposed to be undertaken to prevent, minimise or compensate for the relevant impacts of the proposed action on TPWC Act/EPBC Act-listed threatened species must include:
• a description of proposed mitigation measures to deal with relevant impacts of the proposed action, including mitigation measures proposed to be taken by State/Territory governments, local governments or the Proponent
• assessment of the expected or predicted effectiveness of the mitigation measures, including the scale and intensity of the impacts of the proposed action and the on-ground benefits to be gained from each of these measures
• a description of the outcomes the mitigation and monitoring measures will achieve
• any statutory or policy basis for the mitigation measures, including:
    ○ taking into account relevant approved conservation advice
    ○ how the measures are not inconsistent with any relevant threat abatement plans and recovery plans</td><td>• Section 6</td></tr>
</table>

EIS Requirement	Section
• the cost of the mitigation and monitoring measures • the name of the agency responsible for endorsing or approving each mitigation measure or monitoring program. The goals of the measures should be to avoid, mitigate/manage and monitor impacts to biodiversity. Management measures should be prepared by a suitably qualified expert that has demonstrated experience in the mitigation and monitoring of adverse impacts to biodiversity and threatened species. Present a proposed monitoring program for identified threatened species present in the local area, to monitor the effectiveness of the mitigation measures proposed for all stages of the development. The monitoring program should identify the methodology for monitoring the impacts to biodiversity and identify clear thresholds and contingency measures that will be implemented in the event that the mitigation measures appear ineffective. Proposed mitigation and monitoring measures must be incorporated in relevant sections of the Environmental Management Plan (EMP).	• A Flora and Fauna Monitoring Plan is provided in Section 4 of the Biodiversity Management Plan (Appendix 6))
4.10.2 Fire	
The Proponent should be aware of sections of the Bushfires Act and Regulations that apply to the Project and address risk and management of bushfires. The development of a Fire Management Plan should be in consultation with Traditional Owners, pastoralists and their representative organisations, including relevant Land Councils that have specialist knowledge in fire management. The EIS should outline proposed management to mitigate any identified risks from the Project with regard to fires that may affect waste storage facilities, including: • segregation of incompatible materials • ventilation • exclusion of ignition sources • fire protection • emergency planning	A Bushfire Management Plan is provided in Appendix 4.
4.10.6 Biting insects	
The proponent should assess the risk of exposure to high numbers of biting insects, both as a result of potential increases in breeding areas as a result of Project activities/infrastructure and	A Biting insect Management Plan is provided in Appendix 5.

EIS Requirement	Section
from existing nearby potential/known breeding areas (e.g. wetlands, mangroves). Where there is a significant risk identified, the Proponent should prepare a Biting Insect Management Plan (BIMP) detailing: • consultations with the Department of Health (Medical Entomology) regarding existing management programs and ongoing biting insect management through construction and occupation phases • a program for the rectification of known mosquito breeding sites in consultation with the Department of Health (Medical Entomology) • how the development meets the NT Department of Health Guidelines for preventing mosquito breeding sites associated with mining sites (available at: http://www.health.nt.gov.au/Medical_Entomology/Publications/Development_Guidelines/index.aspx)	
5. Environmental offsets	
The Australian Government Environmental Offsets Policy requires residual (after avoidance and mitigation measures have been implemented) significant impacts to be offset, with a focus on direct offsets. The Offsets Assessment Guide, which accompanies this policy, has been developed to give effect to the policy's requirements, utilising a balance sheet approach to quantify impacts and offsets. It applies where the impacted protected matter is a threatened species or ecological community. The EIS should provide information on: • any identified impacts or detriments that cannot be avoided or mitigated at reasonable costs and whether these impacts could be considered as 'significant' under the EPBC Act • risks of failure of management actions (such as rehabilitation, weed control, etc.) and uncertainties of management efficacy • proposed offsets for residual significant impacts to protected matters and an explanation as to how these proposed offsets are consistent with the requirements of the Environmental Offsets Policy and Offsets Assessment Guide, where relevant • how the proposed offsets meet the Environmental Offsets Policy requirement of a minimum of 90% 'direct offsets' (direct offsets are actions which provide a measurable conservation gain for the impacted protected matter).	Section 7.

1.3 Proposal description

The Proposal includes the Chandler Facility, the Apirnta Facility and haul and access roads (the Chandler Haul Road and the Henbury Access Road). A location map is provided in Figure 1-1. A description of the facilities and roads is provided below.

The Chandler Facility

Tellus propose to develop a new underground rock salt mine and complementary storage business with supporting aboveground infrastructure that would export up to 750,000 tonnes of salt product per annum. The facility would also provide for the safe and secure storage and permanent isolation of up to 400,000 tonnes of waste per annum. The rock salt mine and complementary storage facility is referred to as the Chandler Facility.

Mining activities at the Chandler Facility would involve:

- Deep mining of rock salt using a 'room and pillar' system of mining;
- Transport of salt via shaft hoisting to the surface;
- Stockpiling of rock salt for processing and packaging; and
- Transport of rock salt to domestic and overseas market:
    - **Domestic market (via road and rail)** - road transport via truck on federal and state highways. Rail transport via a proposed new railway siding located at the Apirnta Facility.
    - **Overseas market (via rail)** - rail transport also via the proposed new railway siding located at the Apirnta Facility, predominantly south to a port facility in Adelaide. From there, rock salt would be shipped to overseas markets predominantly in Asia.

Storage at the Chandler Facility would involve:

- Transport of materials (equipment, archives, etc.) and waste, predominantly by rail, for receipt and temporary storage at the Apirnta Facility;
- Transfer of waste materials from the Apirnta Facility to the Chandler Facility via the proposed Chandler Haul Road;
- Transport of packaged materials via mine access decline or via hydraulic backfill into the voids left from the salt mining operation;
    - Waste would be permanently isolated in line with a strict waste acceptance criteria and in accordance with operational management plans;
    - Materials such as equipment and archives would be stored separately for future retrieval.
- Once full, sealing the underground voids permanently with an engineered barrier.

A map of the proposed facility is provided in Figure 1-2. The facility would be designed and managed to allow for future waste recovery opportunities – that is, wastes would be stored like-with-like and the final disposal locations of all waste would be tracked and logged for future reference.

The salt would be mined from the Chandler Salt Bed which is located approximately 850 metres below the surface. Materials stored within the voids left from the mining operation would, therefore, be situated within a salt bed approximately 200 to 300 metres thick allowing the waste to be permanently removed from the biosphere in a stable and dry environment.

The key underground infrastructure at the Chandler Facility would include:

- Underground mine.
- Mine access decline.
- Two ventilation shafts (one allowing for salt hoisting and personnel riding as well as downcast ventilation, and one for upcast ventilation).

The key aboveground infrastructure at the Chandler Facility would include:

- Salt processing facilities (salt processing and sales would be deferred for the first five years of salt mining);
- Waste unloading area;
- Waste storage warehouse;
- Surface hydraulic backfill plant and underground reticulation;
- Salt and overburden stockpiles;
- Maintenance buildings;
- Administration buildings;
- Worker accommodation;
- Solar/diesel hybrid power plant;
- Clean and raw water dams;
- Water and sewage treatment;
- Fuel storage facility;
- Utility reticulation: and
- Technology recovery park.

Apirnta Facility

The Chandler Facility would be supported by a proposed new rail siding and a laydown area that would support the temporary storage of wastes (the Apirnta Facility). The purpose of the storage and transfer facility would be to provide a licensed facility that safely allows for the temporary storage of waste products prior to being transported by road for storage and permanent isolation at the Chandler Facility.

Waste would be brought to the storage and transfer facility via rail and offloaded at the new rail siding. They would be transported into the Apirnta Facility for temporary storage prior to being transported, via the proposed Chandler Haul Road, for storage and/or permanent isolation at the proposed Chandler Facility.

The proponent is seeking approval for the Apirnta Facility to temporarily store a maximum of 400,000 tonnes of waste, although average volumes are expected to be less than this amount. The waste would be stored either in a warehouse, within an open storage yard or within a liquid storage tank.

The Apirnta Facility would receive waste materials transported via road and rail from reputable companies licenced to transport dangerous goods. Waste arriving would be inspected, sampled, unloaded and appropriately stored in line with strict waste acceptance criteria and in accordance with operational management plans.

Waste materials to be stored in the warehouse would be sealed in storage containers and wrapped in plastic on wooden pallets then stacked in high-bays. The storage yard would be used for the temporary storage of waste materials that would be sealed in shipping containers. The liquid storage tank would be used to store a variety of liquid wastes.

The Chandler Haul Road and Henbury Access Road

Haul and access roads would be constructed as part of the Proposal. The Chandler Haul Road would be approximately 30 kilometres long and would connect the Chandler Facility to the Apirnta Facility. It would provide for the movement of salt from the Chandler Facility to the rail siding at the Apirnta Facility. It would also provide for the movement of waste temporarily stored at the Apirnta Facility to the Chandler Facility

The Henbury Access Road would be approximately 60 km long and would connect the Apirnta Facility to the Stuart Highway. The main purpose of the access road is to provide for the movement of workers and delivery vehicles to and from the Stuart Highway to the Apirnta Facility and through to the Chandler Facility. The Henbury Access Road would be constructed once mining operations have begun. During construction, all workers, equipment and delivery vehicles would access the Chandler Facility via the existing Maryvale Road (a public road).

Both roads would be unsealed and would be designed appropriate to their proposed end use. The Henbury Access Road is proposed to be single lane with passing places and the Chandler Haul Road is proposed to be dual lane. Both roads would be designed and constructed to appropriate industry standards.

1.4 Purpose of this report

The purpose of this assessment is to address the ToR with regards to biodiversity. The specific requirements and the section in which each item is addressed in the report are listed in Section 1.2. The assessment combines data from desktop surveys and six intensive field surveys undertaken by LES in the Proposal area for a time period of over four years.

The scope of the assessment is to:

- Identify and describe the existing environment in the Proposal area including:
    - the climate, bioregion and hydrology in the Proposal area;
    - soils, land systems, vegetation types, Sites of Conservation Significance (SoCS) and Sites of Botanical Significance (SoBS), and the fire history in the Proposal area;
    - the presence or likelihood of threatened flora species or vegetation communities and weeds in the Proposal area;
    - the presence or likelihood of threatened fauna species and migratory species in the Proposal area; and
    - fauna habitat in the Proposal area.
- Conduct a risk assessment of the potential risks to biodiversity as a result of the Proposal; and
- Describe and evaluate mitigation and monitoring techniques to avoid or minimise potential risks to biodiversity (including the preparation of a Biodiversity Management Plan, Biting Insects Management Plan and Bushfire Management Plan).

1.5 Legislative context

1.5.1 Commonwealth legislation

EPBC Act

The EPBC Act is the Australian Government's key piece of environmental legislation which came into force on July 16, 2000. The objective of the EPBC Act is to provide for the protection of matters of national environmental significance (MNES) and to promote the conservation of biodiversity. The EPBC Act focuses Australian Government interests on the protection of MNES, with the states and territories having responsibility for matters of state and local significance. The EPBC Act identifies MNES as:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mining); and
- A water resource, in relation to coal seam gas development and large coal mining development.

The Proposal was referred to the DoEE (the then Australian Government Department of Sustainability, Environment, Water, Population and Communities) and on 21 February 2013 and was determined to be a Controlled Action under the EPBC Act as the proposed action has the potential to result in significant impacts to listed threatened species and communities (sections 18 & 18A) which is a matter protected under Part 3 of the EPBC Act.

The Proposal will be assessed at the level of EIS under the NT EA Act. This will be done under the NT/Commonwealth bilateral environmental assessment process.

1.5.2 State legislation

Northern Territory Parks and Wildlife Conservation Act 2000

The NT *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) is “an Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves, and the study, protection, conservation and sustainable utilisation of wildlife”. Under the TPWC Act, all threatened species are classed as protected wildlife. The Act includes ‘Principles of Management’, which require that a threatened species be managed in a manner that “maintains or increases their population or the extent of their distribution at or to a sustainable level.

This report assesses the likelihood that flora and fauna listed under the TPWC Act occur within the Proposal area, the potential of the Proposal impacting the flora and fauna and management techniques to mitigate the potential for disturbance.

Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures 1984

The EA Act and the *Environmental Assessment Administrative Procedures 1984* is administered by the NT EPA. The Act provides a framework for the assessment of potential environmental impacts as a result of developments. The objective of the Act is to ensure that matters affecting the environment to a significant extent are fully examined and taken into account in decisions by the NT Government. The assessment process also evaluates the effectiveness of the proposed safeguards to mitigate these impacts during construction and operational phases of the development.

The Proposal was referred on November 23, 2012 to the NT EPA for assessment under the EA Act. On 7 March 2013, the NT EPA determined that the Proposal required formal assessment under the EA Act at the level of an EIS.

Mining Management Act 2001

The *Mining Management Act 2001* (MM Act) is administered by the NT Department of Primary Industries and Resources (DPIR). The objectives of the MM Act are to ensure that mining in the NT is conducted in accordance with best practice standards for health, safety and the environment. Under the MM Act, an application for authorisation to carry out mining activities must include a Mining Management Plan (MMP). If the Proposal is approved by the NT EPA, Tellus would submit a MMP.

Weeds Management Act 2001

The *Weeds Management Act 2001* is administered by the NT Department of Environment and Natural Resources (DENR). The objective of the Act is to prevent the spread of weeds in to and out of the NT and to ensure that the management of weeds is an integral component of land management in accordance with the Alice Springs Regional Weed Management Plan 2013 – 2018 (Department of Land and Resource Management Weed Management Branch, 2013) or any other strategy adopted to control weeds in the NT.

If a weed species is 'declared' under Section 7 of the Act, the mining operator is required to comply with the following action;

- Class A: To be eradicated;
- Class B: Growth spread to be controlled; and
- Class C: Introduction to the NT is to be prevented.

Other legislation

Other legislation that may be applicable to the Proposal includes:

General:

- *Mineral Titles Act 2016*; and
- *Northern Territory Environmental Protection Authority Act 2012.*

Land Use:

- *Planning Act 2016*;
- *Aboriginal Land Act 2013*;
- *Crown Lands Act 2014.*
- *Soil Conservation and Land Utilization Act 2016*;

- *Bushfires Act 2014*; and
- *Pastoral Land Act 2016.*

Cultural and Heritage:

- *Northern Territory Aboriginal Sacred Sites Act 2013*; *and*
- *Heritage Act 2016.*

Water Quality and Biodiversity Conservation:

- *Water Act 2016*;
- *Biological Control Act 2016*;
- *Public and Environmental Health Act 2016*; and

Air Quality, Noise and Waste Management:

- *Waste Management and Pollution Control Act 2016*; and
- *Public and Environmental Health Act 2016*.

Safety and Environmental Compliance:

- *Work Health and Safety (National Uniform Legislation) Act 2016*;
- *Environmental Offences and Penalties Act 2011*;
- *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2016*; and
- *Dangerous Goods Act 2012.*

2 METHODOLOGY

For the purpose of this EIS, LES, as commissioned by Tellus, has combined existing information from desktop studies including database and literature reviews and conducted on-ground surveys in order to gain the most comprehensive baseline data practicable.

2.1 Desktop review

Literature and database searches were undertaken to gain an understanding of the ecological context of the Proposal area and, over the four year study, to update assessments. Data collated from database searches records of the fauna and flora species known to occur in the region, particularly those of conservation significance. GIS mapping and a search of Australian Bureau of Meteorology (BoM) climate data were undertaken to provide an overview of the climate, soils, vegetation and habitats of the Proposal area and surrounds. A literature review was performed to obtain an understanding of data available and validity thereof, and information about the ecology of the threatened species identified by the database searches within and surrounding the Proposal area.

2.1.1 Database review

A database review including GIS mapping was undertaken using several data sources to provide an ecological context of the landscape, vegetation, habitats and climate of the Proposal area. The sources include:

- Climate data online (BoM, 2016);
- Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway & Cresswell, 1995);
- Land Systems of the Alice Springs area, Northern Territory, Australia (Perry, et al., 1960);
- Maryvale Station Land Units - Draft (Department of Land and Resource Management, 2015) ;
- Digital Atlas of Australian Soils (Northcote, K. H., et al, 1968);
- NTVIS - NT Data Compilation for the National Vegetation Information System to determine vegetation communities present in the Proposal area;
- Vegetation Survey of the Northern Territory Australia: Notes to accompany 1: 100, 000 Map Sheets (Wilson, et al., 1990); and
- Aerial photographs and satellite imagery.

Database searches provide lists of species of conservation significance that occur or are likely to occur within the vicinity of the Proposal area. Species of conservation significance are those that are listed as such under the EPBC Act and/or TPWC Act.

The DoEE Protected Matters Search Tool (PMST) identifies MNES that may occur in a given area. The PMST is based on predicted distributions of EPBC listed flora and fauna species and communities and/or their habitat, rather than known records and therefore may predict the occurrence of a species or community in an area when there are no documented records from the area. A PMST search was conducted for the Chandler Facility, centred on a polygon of EL29018 with a 20 km buffer. A PMST search was conducted for the Chandler Haul Road (outside EL29018), the Apirnta Facility and the Henbury Access Road, centred on a line incorporating the road and infrastructure with a 20 km buffer. A PMST was conducted in 2012 and updated at each stage including 2015

(Department of Environment, 2015a) and May 2016 to ensure accuracy and account for any update information (Department of Environment, 2016a).

The same areas were searched on the NT Species Atlas (maintained by DENR) and include the NT Fauna Atlas, NT Flora Atlas, Sites of Conservation Significance (SoCS) and Sites of Botanical Significance (SoBS) The NT Fauna and Flora Atlas search provided list of records of threatened, non-threatened and introduced fauna and flora species. A search of SoCS and SoBS was also undertaken to find the closest SoCS and SoBS to the Proposal.

Vegetation, soil type, and land system mapping were integrated to identify habitats within the proposed development footprint. This was then cross-referenced with information on threatened species habitat requirements obtained from the published literature and habitats in which mapped records occur. This was used to determine if threatened species habitat is present or likely to be present. Each species listed as threatened was then given a likelihood of occurrence in the Proposal area of either low, moderate or high.

2.1.2 Literature review

A literature review provided information on the ecology of the species occurring or potentially occurring within the Proposal area and surrounds. This informed the assessment of the likelihood that proposed operations would impact on these species of conservation significance. Sources of literature reviewed include:

- Chandler Salt Mine Project, Northern Territory, Australia. Environmental Desktop Study (Aurora Environmental , 2012);
- Species Profile and Threats Database (DoE, 2015b) for information about species listed in the EPBC Act – Information sheets, survey guidelines, recovery plans, and threat abatement plans (TAP) for key threatening processes (KTP);
- Northern Territory Threatened Species fact sheets published by the Department of Land Resource Management (DLRM); and
- Scientific literature (various referenced sources).

2.2 Field surveys

Six field surveys of the mine lease area and proposed access roads and haul road were undertaken between October 2012 and May 2016 (Table 2-1). Secondary sign, bird, landscape and vegetation surveys were carried out at 69 sites in total; with trapping undertaken at 32 of these sites. Site locations were recorded using a Garmin Map 60cX Map unit using the WGS 84 datum. Surveys were undertaken over several seasons to increase the chance of recording seasonal or ephemeral species. Survey sites were selected to provide a representative sample of the different habitats in the mine lease, proposed access road and haul road. Sites surveyed during the October 2012 survey were chosen to represent the major land systems occurring within the mine lease. Sites surveyed during the September 2013 survey focused on the land units where the proposed disturbance would occur and targeted surveys on potential species of conservation significance habitat. Sites surveyed in the four surveys in 2015 and 2016 were chosen to represent the land systems present along the road alignment and to target threatened species. Site locations are shown in Figure 2-1, Figure 2-2 and Figure 2-3, and GPS locations and land systems for each site are provided in Appendix 1.

Table 2-1: Surveys of the Tellus Chandlers lease to date.
Secondary sign, landscape and vegetation surveys were undertaken at all survey sites. Sites where trapping was undertaken are indicated in bold font. *sites where mole trenches were dug; #sites where SM2+BAT bat detectors were deployed.

The Proposal area	Survey date	Focus	Scope	Survey type	Sites	Approximate field person hours (hrs)
Chandler Facility and Chandler Haul Road.	Oct 2012.	Spring biodiversity survey.	To obtain a broad understanding of the mine lease area.	Trapping, area search bird survey, secondary sign search, vegetation transect and landscape description.	**S01a, S02a, S03a, S04a,** S05a, S06a, S07a.	360.
Chandler Facility and Chandler Haul Road.	Sept 2013.	Spring biodiversity survey and soil survey.	Environmental Impact Assessment for stage 1 drilling operations including soil survey.	Trapping, area search bird survey, secondary sign search, vegetation transect, landscape description, mole trenches, SM2+BAT, and soil survey.	**S04b*, S08*, S10, S11#,** CNP01, CNP03, CMP, SL1-5.	264.
Chandler Facility, Chandler Haul Road and Apirnta Facility.	June 2015.	Winter biodiversity survey.	Seasonal landscape, flora and fauna survey.	Trapping, area search bird survey, secondary sign search, vegetation transect, landscape description, mole trenches and SM2+BAT.	**S01b*, S03b*, S05b*, S07b, S**09, S12, **S13***, S14, S16, S18, S20, S22, S24, S26, S27.	276.
Chandler Facility, Chandler Haul Road and Apirnta Facility.	Oct 2015.	Spring biodiversity survey.	Seasonal landscape, flora and fauna survey.	Trapping, area search bird survey, secondary sign search, vegetation transect and landscape description.	**S02c*, S06b*, S13***, S15, S17, S19, S21, **S23, S29, S30.**	382.
Henbury Access Road and Apirnta Facility.	Nov 2015.	Spring biodiversity survey.	Seasonal landscape, flora and fauna survey.	Trapping, area search bird survey, secondary sign search, vegetation transect and landscape description.	**sd1*, re1, sn1*, csw1#, ch1, r1*#**, sd2#, an1, an2, ch2, r2, mdg1, mdg2, mdg3.	280.
Henbury Access Road and Apirnta. Facility	May 2016.	Autumn biodiversity survey.	Seasonal landscape, flora and fauna survey.	Trapping, area search bird survey, secondary sign search, vegetation transect and landscape description.	**Si-a*, An-a*#, Ch-a, Sn-a*, Re-a, Fi-a***, CSW-a#, Sd-a, Ch-a2, Sn-a2, Sn-a-cp, An-ar-a, Bu-ar-a, Ch-ar-a, Sn-ar-a, Ch-ar-sc.	280.

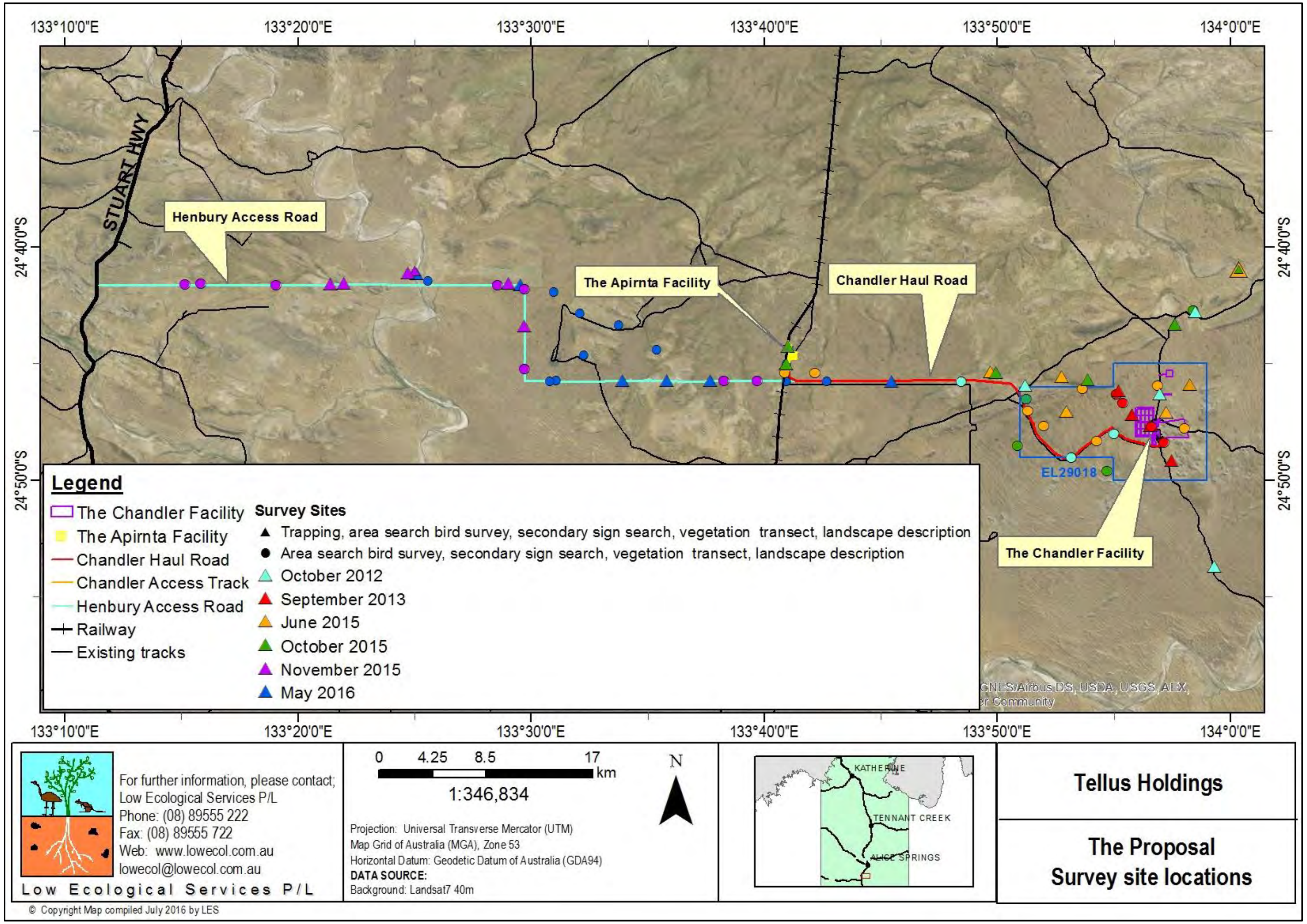


Figure 2-1: Location of flora and fauna survey sites for surveys undertaken by LES between 2012 to 2016

(See Figure 2-2 for sites surveyed for the Chandler Facility and Figure 2-3 for sites surveyed for the Apirnta Facility and Henbury Access Road)

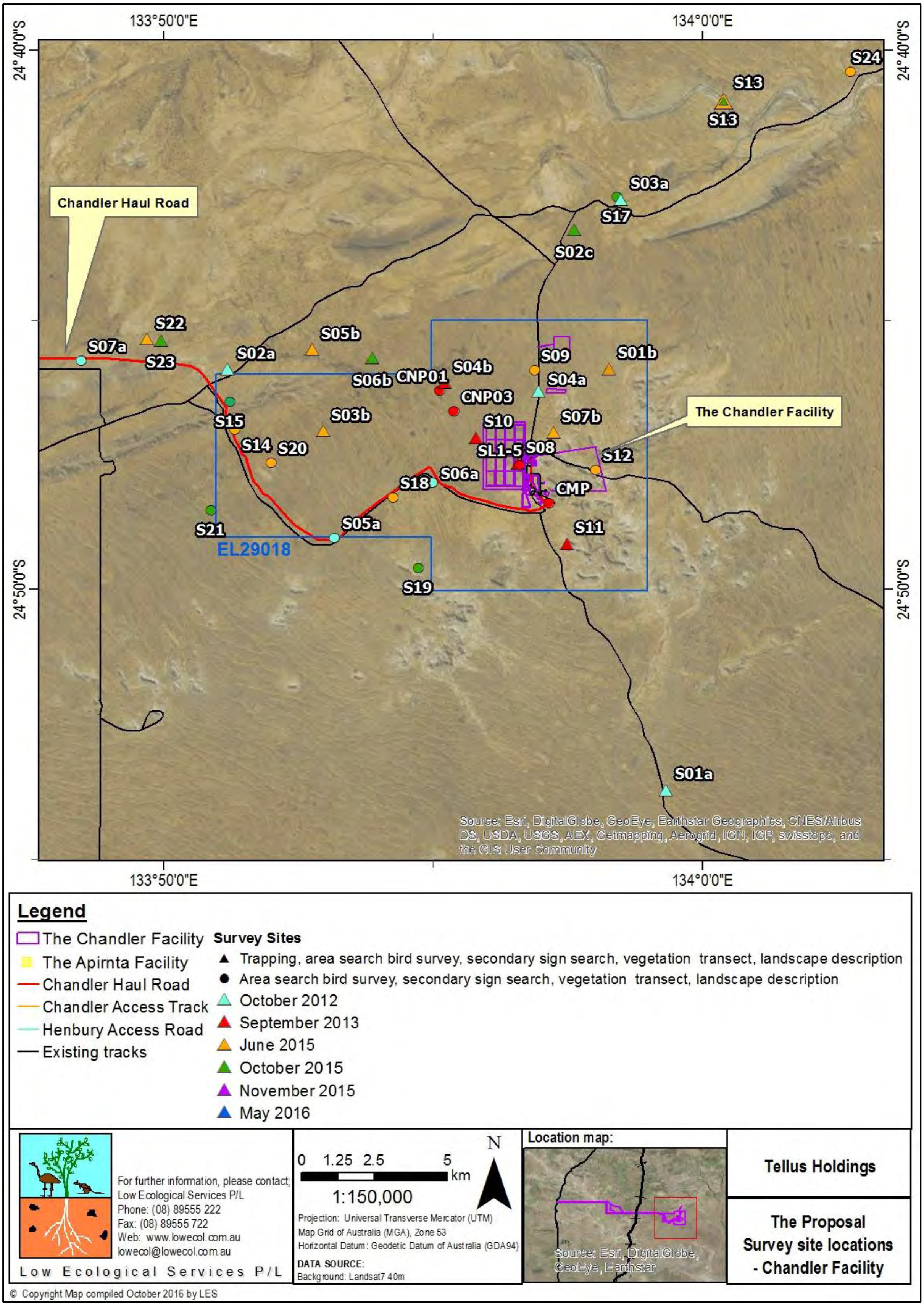


Figure 2-2: Survey sites relating to the Chandler Facility

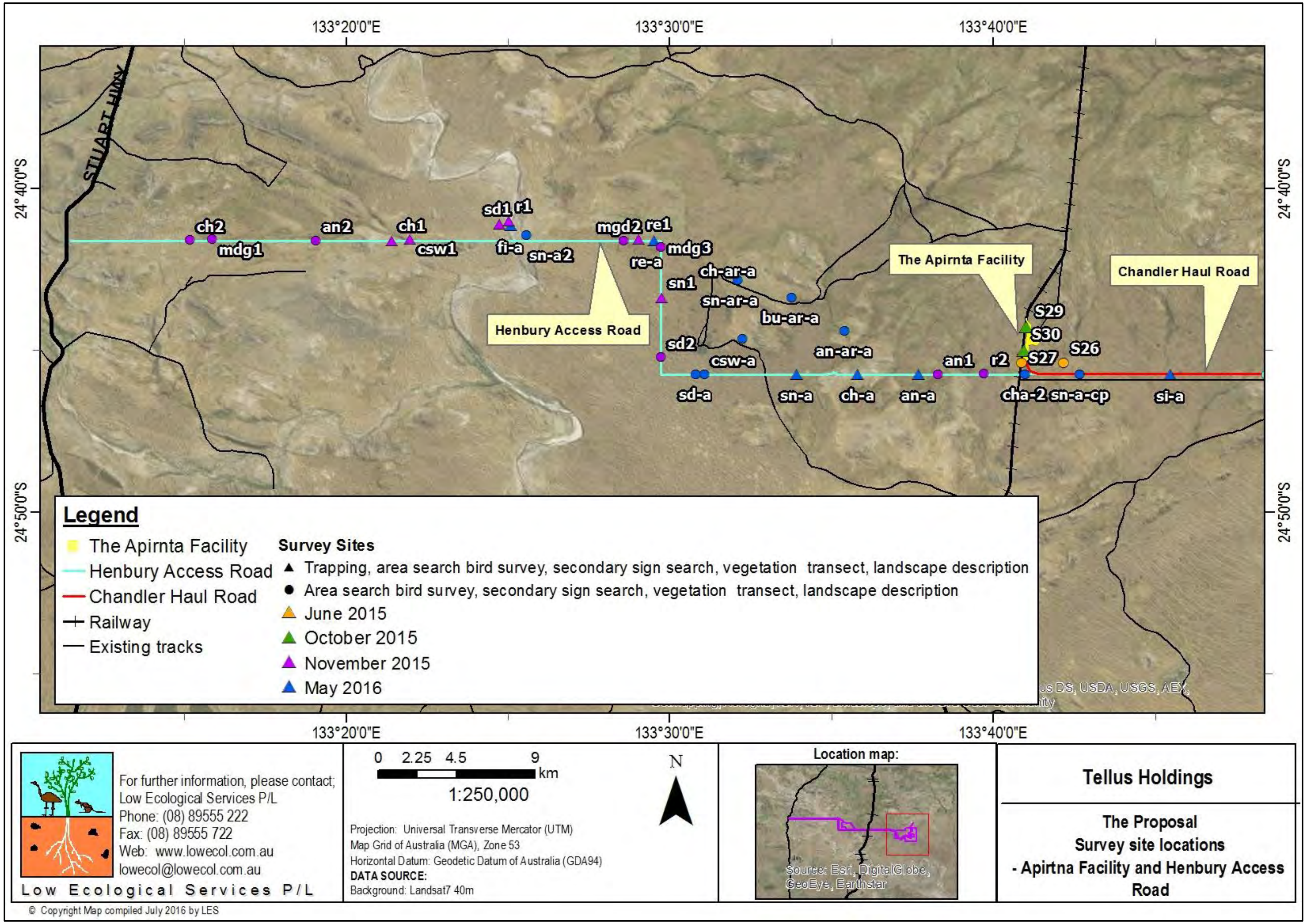


Figure 2-3: Survey sites relating to the Apirnta Facility and Henbury Access Road

2.2.1 Fauna surveys

General survey methodology follows the *Standard terrestrial vertebrate survey methods used by the DLRM* (in NT Environmental Protection Agency, 2013) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, et al., 2004). Trapping for fauna was undertaken at sites in each land system within the development footprint, with a particular focus on sites that are expected to be subject to direct disturbance by construction and operations of the Proposal and have suitable habitat for threatened species.

Habitat search

Searches were undertaken for potentially suitable habitat for threatened species while traversing the Proposal area.

Trapping

Trapping for small mammals and reptiles was undertaken at sites within each land system present within the proposed development footprint. Each site was trapped for three to four nights. At each site there was a transect of 25 Elliott traps spaced 10 - 20 m apart, two pitfall traps and four funnel traps. Pitfall traps were placed adjacent to Elliott trap transects and had a 10 m drift fence centred on top of each pit to guide animals into the trap. One funnel trap was placed at either end of each 10 m drift fence. All traps were checked just after sunrise each morning. Elliott traps were closed if the day was going to be warm and left open in cool weather, and were re-opened late in the afternoon if necessary. Pitfall and funnel traps were also checked while Elliott traps were being opened and re-baited in the late afternoon. Elliot traps were baited with a mixture of peanut butter and oats. Cage trapping as recommended by the *Standard terrestrial vertebrate survey methods used by the DLRM* (in EPA, 2013) was not conducted, as there are no species likely to be present in the appropriate size range for cage trapping. Medium to large sized mammal (cats, foxes, dingoes and rabbit) presence and abundance was determined though secondry sign surveys.

Secondary sign surveys

Searches for secondary sign of fauna species (e.g. tracks and scats) were undertaken within a 250 m x 200 m quadrat at each trap site. Additional sites were searched within systems not expected to be subject to direct disturbance or did not have habitat suitable for targeted threatened species identified by the EPBC PMST. Where the substrate was suitable, small track beds were created around pit traps, fences and Elliott traps to detect small animals that did not enter traps. Quadrats were searched for approximately one hour each.

Area search bird surveys

Area searches for birds were undertaken in the morning and afternoon within a 250 m x 200 m quadrat at each site for a minimum of 15 minutes. The quadrat area was searched and species were identified by sight and call. Incidental observations of all birds were also recorded throughout the day during general surveys. Two targeted bird surveys were undertaken in September 2013 and May 2016 in habitat identified as potentially suitable by land system mapping for thick-billed grasswrens (*Amytornis modestus*). For these surveys, calls of *A. modestus* were broadcast. Area searches were also used to survey for *Croitana aestiva.*

Spotlighting

Spotlighting transects were undertaken opportunistically along established tracks in the evening, directly after last light. The location of fauna species observed during spotlighting was recorded using a GPS unit, and where introduced/pest species were encountered the number of animals was recorded.

Motion-sensing camera surveys

Motion-sensing cameras were deployed at sites to record shy or nocturnal species or verify species presence. Cameras were set to take pictures when triggered by movement. Camera traps were baited with peanut butter and oats.

Microchiropteran bat surveys

A Song Meter 2 Bat+ (SM2Bat+) ultrasonic recorder was used to collect the high frequency calls of echolocating bats during the September 2013, June 2015, October 2015, November 2015 and May 2016 surveys. During the September 2013 survey two SM2Bat+ units were placed at a site near a dam containing water and in an open area between the camp and rocky hills. During the June 2015, October 2015, November 2015 and May 2016 surveys the detector was placed at a different trapping site each night in an open area, identified as a likely fly-way. Recordings were downloaded and referred to a bat specialist, Dennis Mathews for analysis. The calls were manually scanned in AnalookW and compared with known reference calls for the region.

Mole trench surveys

Mole trenches were excavated at sites in suitable marsupial mole habitat (sandy or clayey sand) during the September 2013, June 2015, October 2015, November 2015 and May 2016 surveys. The methodology followed *Manual for Marsupial Mole Survey and Monitoring by Trenches, Version 1.0* (Benshemesh, 2005). Trenches were excavated on the northern or western side of a dune to maximise drying by sunlight. Trenches were approximately 120 cm long and 40 cm wide by 80 cm deep. The longest side of the trench faces north to maximise sunlight on the southern side. A step was dug into the northern wall to increase the sunlight reaching into the trench. The southern side of the trench was rubbed to make it smooth. Trenches were left for three days for the surface to dry. After this time the surface of the southern wall was inspected for any symmetrical, sand-filled circular shaped structures larger than 25 mm. Suspected mole tunnels were photographed and sent to Dr. Joe Benshemesh for confirmation.

Incidental observations

Incidental observations of fauna species were recorded at all times and in all habitats during the field surveys.

Survey methods for threatened species identified in PMST

Survey methods used to determine the presence of threatened species follow those suggested in the *Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, Environment, Water, Population and Communities, 2011a), *Survey Guidelines for Australia's Threatened Reptiles* (DESEWPC, 2011b) and *Survey Guidelines for Australia's Threatened Birds* (Department of Environment, Water, Heritage and the Arts, 2010). Survey methods employed for targeted searches of each threatened species are shown in Table 2-2. Targeted searches were conducted for threatened species that may occur within the Proposal area as identified by the PMST;

- Great desert skink (*Liopholis kintorei*) ;
- Slater's skink (*Liopholis slateri slateri*) ;
- Desert sandskipper (*Croitana aestiva*) ;
- Australian painted snipe (*Rostratula australis*) ;
- Night parrot (*Pezoporus occidentalis*) ;
- Princess parrot (*Polytelis alexandrae*) ;
- Thick-billed grasswren (*Amytornis modestus*) ;
- Black-footed rock-wallaby (*Petrogale lateralis,* MacDonnell Ranges race);
- Central rock-rat (*Zyzomys pendunculatus*) ;
- Greater bilby (*Macrotis lagotis*) ;
- Brush-tailed mulgara (*Dasycercus blythi)* ;
- Crest-tailed mulgara (*Dasycercus* cristicauda); and
- Southern marsupial mole (*Notoryctes typhlops*).

Table 2-2: **Targeted survey methods for threatened species identified by the EPBC PMST as potentially occurring in The Proposal area.**
HS: habitat search; Tr: trapping; SS: secondary sign; Sp: Spotlighting; MT: mole trench; Cam: motion-sensing camera; ASBS: area search bird survey; BC: broadcast bird call survey

Common name	Scientific name	HS	Tr	SS	Sp	MT	Cam	ASBS	BC
Australian painted snipe	*Rostratula australis*	X						X	
Night parrot	*Pezoporus occidentalis*	X			X			X	
Princess parrot	*Polytelis alexandrae*	X						X	
Thick-billed grasswren	*Amytornis modestus*	X						X	X
Black-footed rock-wallaby	*Petrogale lateralis* MacDonnell Ranges Race	X		X					
Central rock-rat	*Zyzomys pendunculatus*	X	X	X					
Greater bilby	*Macrotis lagotis*	X		X			X		
Mulgara	*Dasycercus cristicauda, D. blythi*	X	X	X	X		X		
Southern marsupial mole	*Notoryctes typhlops*	X		X		X			
Great desert skink	*Liopholis kintorei*	X	X	X			X		
Slater's skink	*Liopholis slateri slateri*	X	X	X			X		
Desert sandskipper	*Croitana aestiva*	X						X	

2.2.2 Landscape description

Survey methods for landscape description followed surveys and landscape description generally follows *Northern Territory Guidelines and Field Methodology for Vegetation Survey* and Mapping (Brocklehurst, et al., 2007) and *A resource assessment towards a conservation strategy for the Finke*

Bioregion (Neave, et al., 2004). A site description was carried out within a 50 m x 50 m quadrat at each survey site. If a survey site had more than one distinctly different landscape type, an additional site description was conducted within each distinct landscape. Site descriptions provided an overall snapshot of the landscape, geology, soil, dominant flora species, vegetation structure and vegetation density at each site. The presence of termite mounds, woody debris, impact from disturbance, weeds and current vegetation condition were also noted. Representative photographs of the landscape and vegetation community were taken at each site, facing north, south, east and west.

2.2.3 Vegetation survey

Methodology for vegetation surveys is based on *Northern Territory Guidelines and Field Methodology for Vegetation Survey* and Mapping (Brocklehurst, et al., 2007) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, et al., 2004). Rather than 20 x 20 m quadrats, 100 m point-line transects were undertaken as this is a more widely used method for rangeland vegetation surveys. 100 m point-line transects are effective and time efficient and a more useful method to measure vegetation cover for rangeland vegetation which is characterised by sparse vegetation cover (Floyd & Anderson, 1987). A 100 m point-line transect was undertaken at each site to obtain a list of flora species at the site and their percentage cover, as well as the percentage of other ground cover types (e.g. rocks, bare ground). If survey sites had more than one vegetation community, an additional transect was undertaken within each distinct vegetation community. Flora species lists were completed by doing an area search in the vicinity of the transect to record additional species. Voucher specimens were taken where plants could not be identified in the field. Voucher specimens were identified by experienced botanist Des Nelson.

Survey methods for threatened species identified in PMST

Survey method for threatened plant species Latz's wattle (*Acacia latzii*) included conducting a habitat search to determine whether suitable habitat was present in the area.

2.2.4 Other

GPS locations and extent of weed infestations were recorded. Where possible, GPS locations of large mature trees of cultural significance were taken. These were mostly *Allocasuarina decaisneana* (desert oak), Corymbia *opaca* (bloodwood) and *Acacia estrophiolata* (ironwood), particularly in the vicinity of the proposed camp site and on the proposed footprint of the Henbury Access Road.

2.2.5 Limitations of the surveys

Records obtained from the NT Fauna and Flora Atlases display records from areas which have previously been surveyed. The lack of records at a locality commonly represents a lack of survey effort as opposed to the absence of various species in the area.

While invertebrates captured in traps were recorded, there are limited existing data and identification tools available for terrestrial invertebrates in the Australian arid zone. Therefore, only a casual attempt was made to identify any trapped invertebrates to genus or species level. No targeted survey for invertebrates was undertaken during a survey of the mine lease and proposed access road and haul road, as this was not a part of the scope of works.

Fauna capture rates in the Australian arid zone are characteristically low, and spatially and temporally variable. Capture rates can be very high after prolonged periods of rainfall, and very low (often 0%) during very dry periods. Many fauna species in the arid zone are also nomadic, for example *Polytelis alexandrae*, and will only be present in an area for a short time and may not return to the same location for decades. LES has attempted to carry out surveys across a number of years and seasons, and at an appropriate spatial scale for the proposed development. While this will increase the chances of obtaining sufficient data required to detect the presence of threatened species, it cannot be guaranteed that the species lists are complete.

Surveys were aimed at detecting appropriate landscapes and assessing the potential presence of threatened species within the Proposal area. Population surveys for abundance and density were not conducted within the Proposal area and surrounds.

2.3 Calculation of habitat loss

The layout of the Proposal was overlayed on habitat, vegetation and soil mapping of the Proposal area. The area of each habitat associated with each proposed infrastructure was then calculated in ArcGIS.

2.4 Assessment of significant impacts

The potential for significant impacts on MNES were assessed using the *Significant Impact Guidelines 1.1 - Matters of National Environmental Significance* (DoE, 2013) criteria. The potential for significant impacts were assessed for EPBC Act and TPWC Act listed threatened species (species listed as vulnerable, endangered or critically endangered) with a moderate to high likelihood of occurring in the Proposal area.

Following DoE (2013), an action is likely to have a significant impact on a **critically endangered** or **endangered** species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of a population;
- Reduce the area of occupancy of the species;
- Fragment an existing population into two or more populations;
- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of a population;
- Modify, destroy, remove , isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere with the recovery of the species.

Following DoE (2013), an action is likely to have a significant impact on a **vulnerable** species if there is a real chance or possibility that it will:

- Lead to a long-term decrease in the size of an important population of a species;
- Reduce the area of occupancy of an important population;
- Fragment an existing important population into two or more populations;

- Adversely affect habitat critical to the survival of a species;
- Disrupt the breeding cycle of an important population;
- Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;
- Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;
- Introduce disease that may cause the species to decline; or
- Interfere substantially with the recovery of the species.

Following DoE (2013), an action is likely to have a significant impact on a **migratory** species if there is a real chance or possibility that it will:

- Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species;
- Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species; or
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.

3 EXISTING ENVIRONMENT

3.1 Climate

The climate of the Proposal area is characterised by distinct hot summers and cold winters with a wide range in diurnal temperature. The Australian Bureau of Meteorology (BoM) maintains the closest weather station at Alice Springs Airport. Rainfall in the area is highly variable with a mean annual rainfall of 282.8 mm (over the period of 1941 – 2016), varying from 76.8 mm to 782.5 mm (Bureau of Meteorology, 2016a). Rainfall is generally higher in the summer months, November to March. The hottest months are October to March, with mean maximum temperatures over 30˚C (Bureau of Meteorology, 2016a). The maximum monthly average temperature was 40.0 ^{o}C in January (Bureau of Meteorology, 2016a). The coolest months are May to August with mean minimum temperatures under 10˚C. The minimum monthly average temperature was -0.1 ^{o}C occurring in June and July (Bureau of Meteorology, 2016a) (

Figure 1-1). Relative humidity averages at 33.5% in the summer months and 40% during the winter months (Bureau of Meteorology, 2016a). The predominant wind direction is south east and east (Bureau of Meteorology, 2016a) (Figure 3-1).

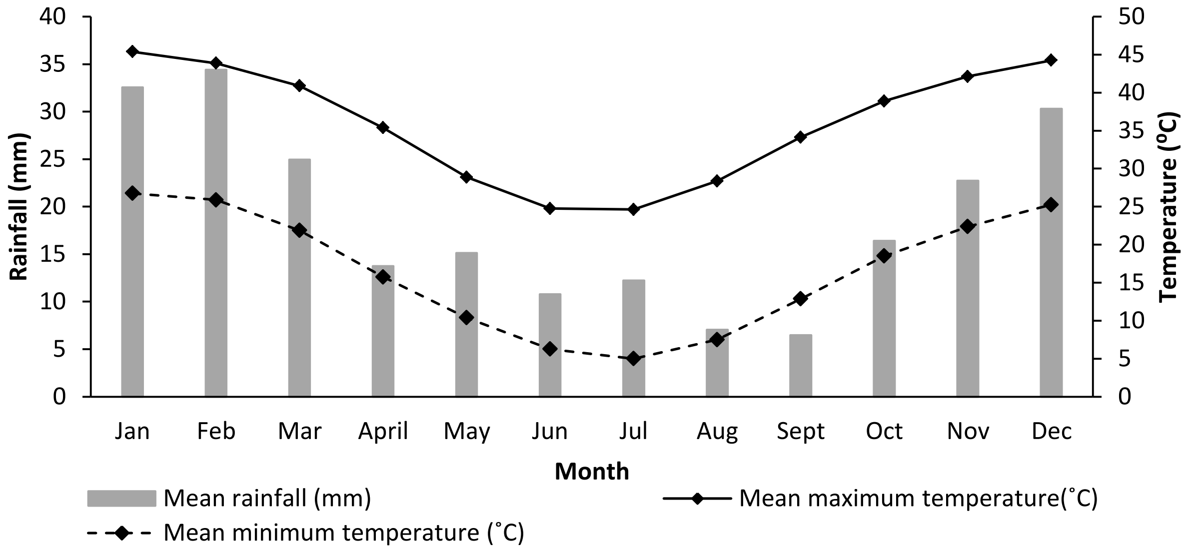


Figure 3-1: Climate statistics of the Proposal area based on data from the Bureau of Meteorology's Alice Springs Airport collection sites (Bureau of Meteorology, 2016a)

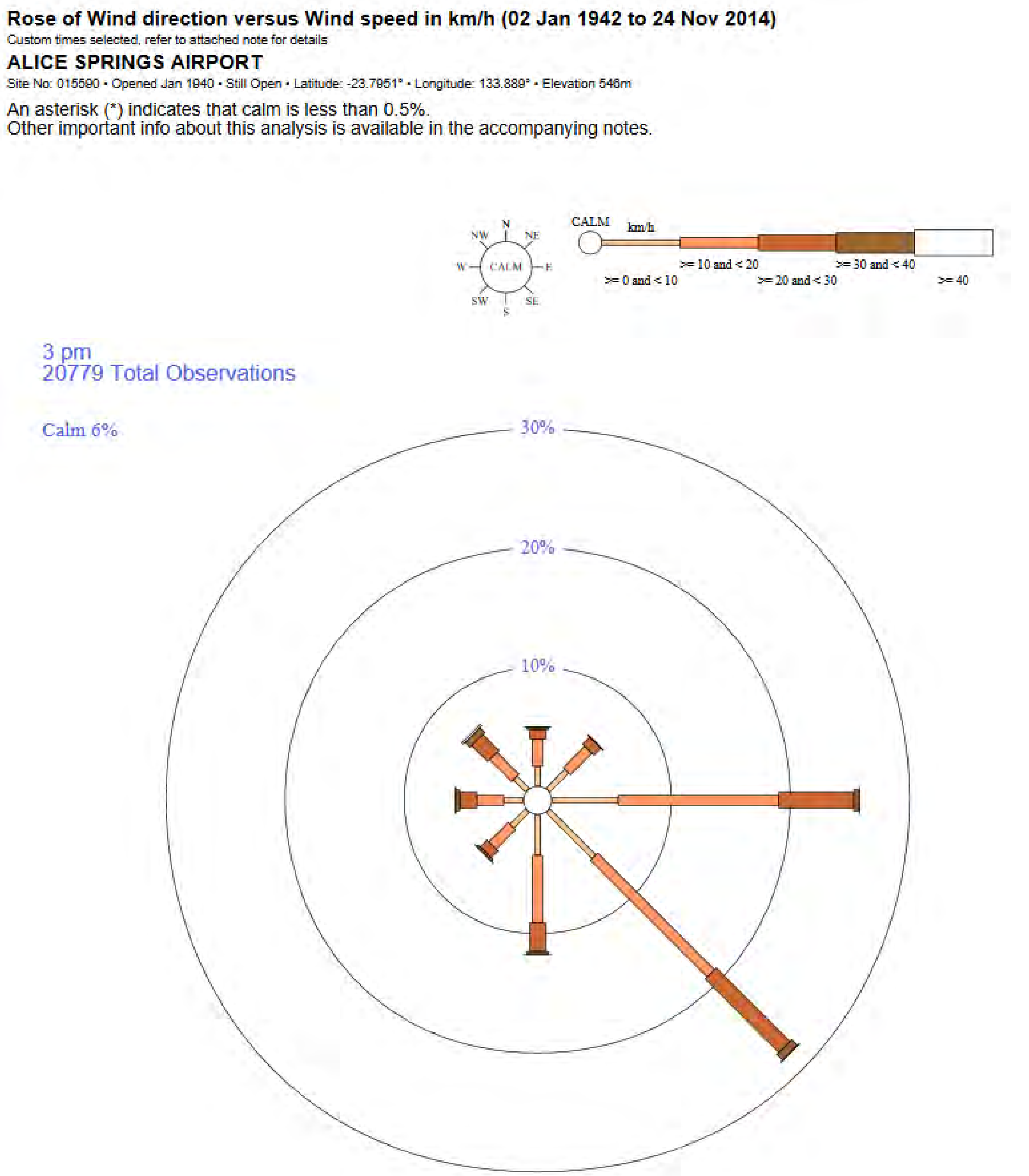


Figure 3-2: Wind rose for Alice Springs Airport BoM site (Bureau of Meteorology, 2016a)

3.2 Bioregion

The Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into geographically distinct bioregions based on common climate, geology, landform, native vegetation and species information (DESEWPC, 2012a). The Proposal area lies within the Northern Territory section of the Finke IBRA bioregion (Figure 3-3).

The Finke Bioregion covers an area of 54,292 km^2 in the Northern Territory, and a further 19,505 km^2 in northern South Australia. The Finke Bioregion is a geomorphologically complex and varied area of low sandstone ranges, weathered tablelands and rounded metamorphic hills, laterite-capped mesas, saline depressions and sandplains. Dominant vegetation includes hummock grasslands, acacia shrublands and saltbush/bluebush open shrublands.

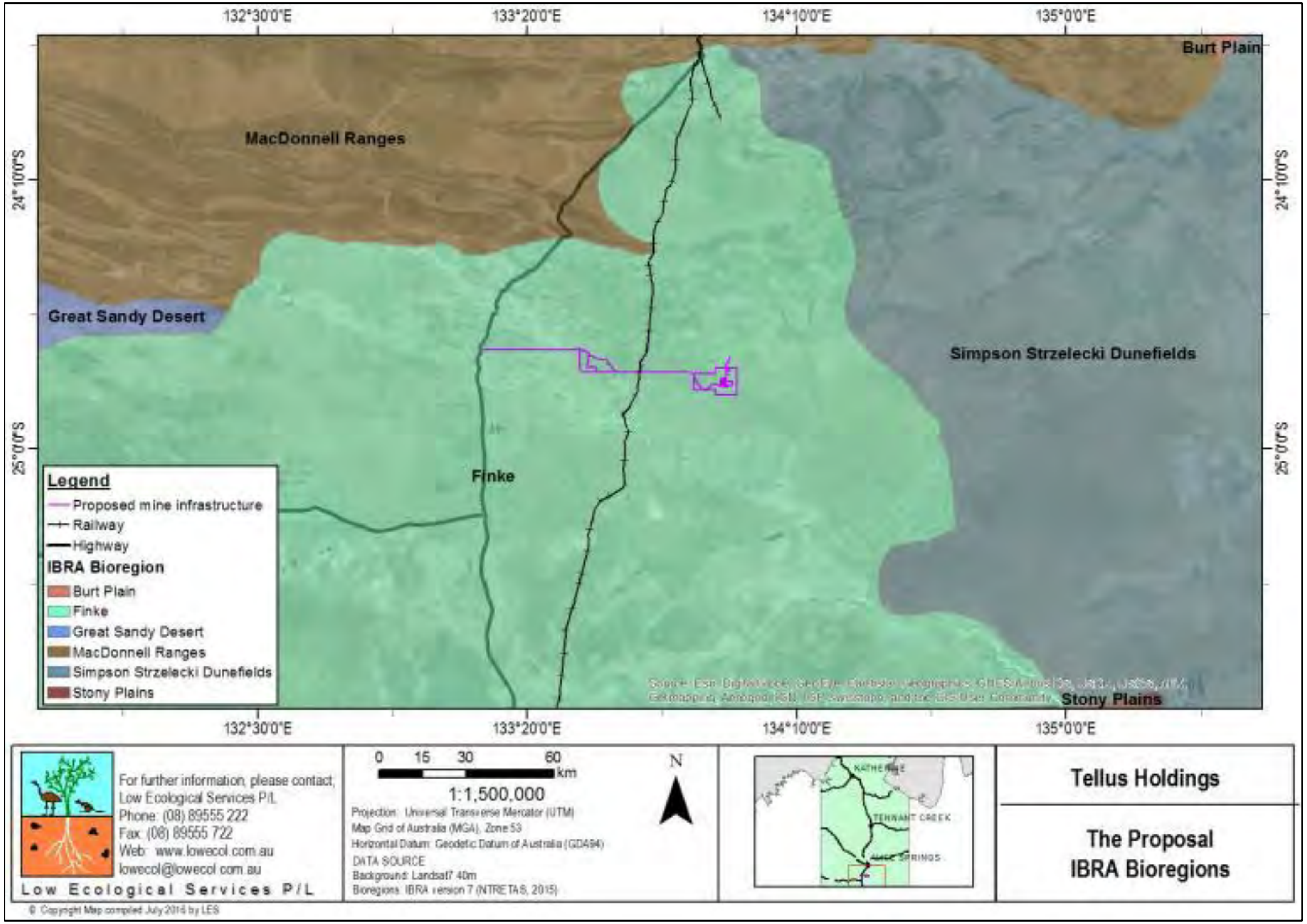


Figure 3-3: Interim Biogeographic Regionalisation for Australia (IBRA) bioregions in relation to EL29018 (Department of Sustainability, Environment, Water, Population and Communities, 2012a).

3.3 Hydrology

The surface hydrology of the Proposal area consists of ephemeral watercourses, claypans and swamps. There are two major water courses in the area, the Hugh River and Finke River. Both are ephemeral and can result in large scale flows and associated flooding onto surrounding flood outs during high rainfalls. The head of these rivers are located in the West MacDonnell Ranges, 250 km north of the Chandler Facility, and as such heavy rains in head water catchment can result in significant down stream flows affecting the Proposal area.

These two river systems are fed from smaller stream order watercourses in the Proposal area. Figure 3-4 below shows the surface hydrology for the Proposal. Smaller creeklines, drainage depressions and claypans provide important water sources for biodiversity during wet periods.

Duck Swamp and associated coolabah swamps and claypans are considered environmentally and culturally important ephemeral wetlands. Duck Swamp is located approximately 1 km north east of the Henbury Access Road. The associated Coolabah swamp extends downstream across the Henbury Access Road.

There are no aquatic ecosystems within the Proposal area. According to the BoM's *Atlas of Groundwater Dependent Ecosystems* (GDE) (2016), there are no groundwater dependent ecosystems and there is a 'low potential for groundwater interaction in the area of interest' (BoM, 2016b). The nearest GDE is located approximately 250 km west of the Proposal area.

There are no Nationally Important Wetlands within the Proposal area. The nearest Nationally Important Wetland is the Karinga Creek Paleodrainage system 130 km south-west. There are no Ramsar Wetlands or Wetlands of National Significance located within the Proposal area. The nearest Ramsar Wetland is Lake Pinaroo, 860 km south east.

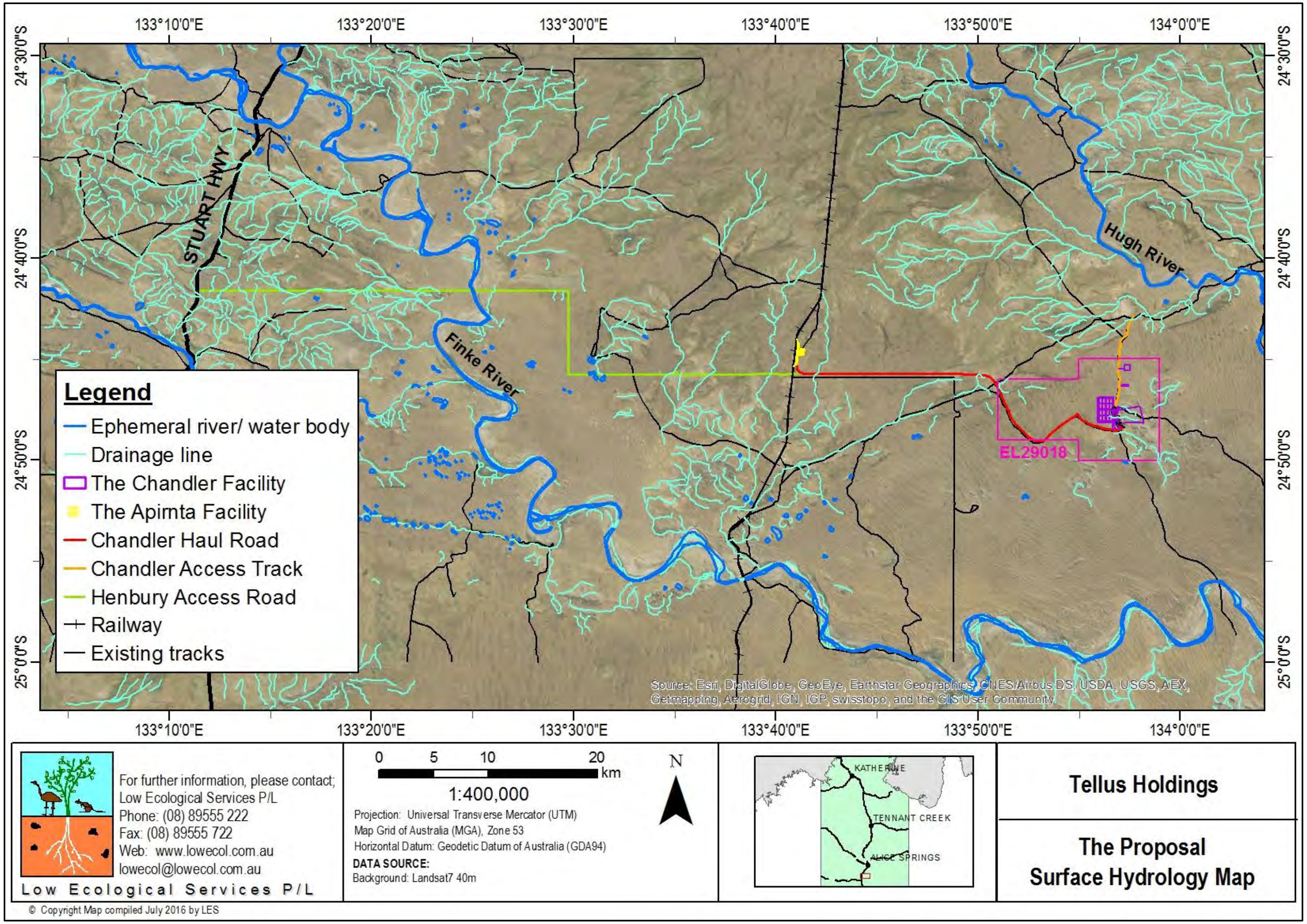


Figure 3-4: Surface hydrology map including ephemeral rivers and watercourse and drainage lines

3.4 Soils

Soil types in the Proposal area have been mapped using the Atlas of Australian Soils (Northcote, K. H., et al, 1968). However, because the currently accepted classification system is the Australian Soil Classification (ASC) (Isbell & National Committee on Soil and Terrain, 2016) a conversion from the Atlas of Australian Soils to Australian Soil Classification was developed by Ashton & McKenzie (2001). The Chandler Facility is situated on rudosol (B43) and sodosol (Nb19). The Apirnta Facility is situated on tenosol (Ab59) and sodosol (Nb25) and the Chandler Haul Road and Henbury Access Road traverse over a variety of soil including rudosol (Nb25), tenosol (Ab59 abd Ab78), calcerosol (Ld1), and sodosol (Nc3). Table 3-1 provides a map of the Australian Soil Atlas over the Proposal area and the map units are described along with the ASC conversion in Figure 3-5.

Table 3-1 Atlas of Australian Soils description (Northcote, K. H., et al, 1968) and ASC conversion (Isbell & National Committee on Soil and Terrain, 2016) for soils present in the Proposal area, and the limiting properties of each soil type

Map unit	Atlas of Australian Soils	ASC Conversion	Limiting properties
Ab59	Sandy plains with some dunes: chief soils are red earthy sands and red siliceous sands on the plains. Other soils include and massive earths and crusty red duplex soils on the plains.	Tenosol: Tenosols have a weakly developed soil profile which is typically very sandy and without obvious horizons. Tenosols form from highly salicious parent material and where rainfall is from 0 to 1400 mm. Generally tenosols have a very low agricultural potential with very low chemical fertility, poor structure and low water-holding capacity. Ground-water contamination can be a potential problem due to the high permeability of these soils.	• Susceptible to windsheet and watersheet erosion, when vegetation cover is reduced. • Interdunal swales and drainage depressions experience short periods (up to several days) of inundation after high rain events. • Claypans experience periods of inundation as a result of high rainfall events.
Ab78	Sandy plains with some dunes and claypans: chief soils are red earthy sands and deep red siliceous sands on the plains. Associated are loose siliceous sands on the dunes and clays in claypans.		
B43	Dune fields with dunes generally trending NW to SE; dune crests are inclined to drift readily; narrow inter-dune swales and corridor plains: chief soils are red siliceous sands but yellow and white siliceous sands and also some powdery calcareous loam) sands occur too. In general there is a grading from red to yellow and white sands from north to south; white sands are more common also in proximity to drainage-ways,	Rudosol: Soil with negligible (rudimentary) pedologic organisation apart from (a) minimal development of an A1 horizon or (b) the presence of less than 10% of B horizon material (including pedogenic carbonate) in fissures in the parent rock or	• Susceptible to windsheet and watersheet erosion, when vegetation cover is reduced. • Interdunal swales experience short periods (up to several days) of inundation after high rain events.

Map unit	Atlas of Australian Soils	ASC Conversion	Limiting properties
	pans, and lakes and grade through yellow to red sands away from these situations. Soils of the interdune areas are variable, and include sands such as deep red sands and earths such as non-calcareous alkaline earths. Also brown clays and other soils including yellow and yellow-grey duplex soils. There are also small inclusions of sandstone hills, mesas, claypans and clay flats.	saprolite. The soils are apedal or only weakly structured in the A1 horizon and show no pedological colour changes apart from the darkening of an A1 horizon. There is little or no texture or colour change with depth unless stratified or buried soils are present.	
Ld1	Undulating to hilly limestone country: chief soils are calcareous earths. Associated are firm calcareous sands and shallow loam soils on steep sites. Areas of alkaline duplex soils and red sand soils and also alkaline soils may occur locally.	Calcerosol: Soils that are calcareous throughout the solum - or calcareous at least directly below the A1 or Ap horizon, or a depth of 0.2 m (whichever is shallower). Carbonate accumulations must be judged to be pedogenic (either current or relict), and the soils do not have clear or abrupt textural B horizons. Hydrosols, Organosols and Vertosols are excluded.	• Moderately susceptible to erosion – scalding, rilling and and gullying can occur adjacent to natural drainage lines
Nb25	Flat-topped hills, mesas, and cuestas on shales, limestones, and sandstones and stony lowlands all covered by dense silcrete stone and gravel pavements: chief soils are crusty loamy soils (both neutral and alkaline). Associated are shallow sandy soils and with rock outcrop on areas of strong relief. Small areas of red sands and crusty red duplex soils occur in the narrow valleys, and calcareous earths may occur locally.	Sodosol: Soils with a clear or abrupt textural B horizon and in which the major part of the upper 0.2 m of the B2 horizon (or the major part of the entire B2 horizon if it is less than 0.2 m thick) is sodic and not strongly acid. Hydrosols and soils with strongly subplastic upper B2 horizons are excluded.	Nb25: • Soils tend to be dispersive • Soils may be shallow in areas. • Soils may be susceptible to erosion - rilling and and gullying, as a result of reduced vegetation. Nb19: • Soils may be shallow in areas. • Soils may be dispersive and susceptible to erosion - rilling and and gullying, as a result of reduced vegetation. • Gilgai depressions and soils with a high clay content experience inundation after
Nb19	Dissected stony plateaux with silcrete cappings on shale, claystone, and sandstone; surfaces are mantled by siliceous gravels and stones: chief soils are crusty loamy soils that occur on plateau summits and pediment slopes. Associated are brown clays in gilgai		

Map unit	Atlas of Australian Soils	ASC Conversion	Limiting properties
	depressions on plateau summits; various shallow stony soils such as -firm calcareous sands and firm shallow calcareous loams on areas of strong relief; and grey self-mulching cracking clays on fringing plains.		high rainfall events for a periods of days to weeks. Nc3: • Floodplains succeptible to scalding and rilling erosion, when vegetation cover is reduced. • River and floodplains succeptible to flooding after high rain events, although soils are well drained.
Nc3	Riverine plains: chief soils are crusty loamy soils. Associated are a variety of deep sandy soils.		

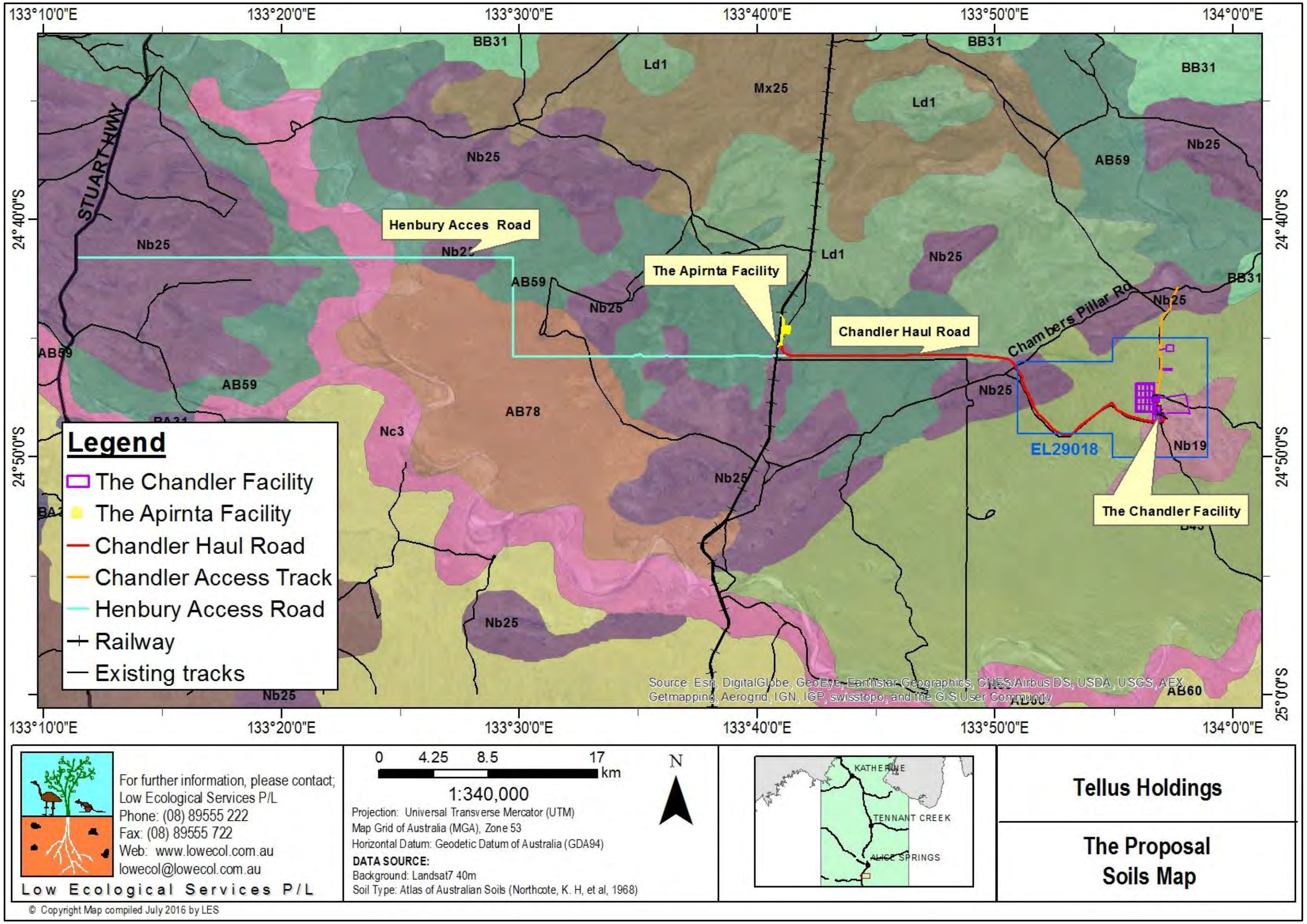


Figure 3-5: Soil types mapped over the Proposal area (Northcote, K. H., et al, 1968)
Refer to Table 3-1 for soil type descriptions

1.1 Land systems

Land system mapping of the Alice Springs area by Perry *et al.* (1960) is available at a scale of 1:100,000. A total of nine broad land systems have been mapped over the Proposal area. The dominant land systems over the Chandler Facility are Singleton and Rumbalara. The Apirnta Facility is mapped on Singleton and the dominant land systems on the Chandler Haul Road and Henbury Access Road are Chandlers, Simpson, Angas and Singleton. Table 3-2 summarises the land systems in the Proposal area which are shown in Figure 3-6.

Table 3-2: Description of land systems in the Proposal area (Perry, et al., 1960)

Code	Land system	Landform	Soil description	Vegetation	Limiting properties	Photograph
An	Angas	Undulating sandy plains with sandstone and limestone ridges.	Reddish brown sandy loams and calcareous earths.	Open to scattered mulga and witchetty bush over emubush, cassia and bluebush. Understory consists of copperburrs, sida and forbs.	Slightly succeptible to windseet and watersheet erosion if vegetation removed.	
Au	Amulda	Sandy foothill fans with broad drainage depressions and creeks.	Red clayey sands and sandy clay loams.	Over storey of Mulga, blue mallee and ironwood over witchetty bush and emu bush. Understory of spinifex, woollybutt grass and kerosene grass.	• Moderately succeptible to erosion – scalding, rilling and and gullying can occur adjacent to creeks drainage lines. • Drainage depressions experience short periods (up to several days) of inundation after high rain events.	

Code	Land system	Landform	Soil description	Vegetation	Limiting properties	Photograph
Cn	Chandlers	Mesas, low ranges and stony plains with clayey stony slopes and silcrete or shale outcrop	Stony clayey soils, and shallow calcareous soils	Generally treeless, scattered bluebush, emubush and cassia over copperburrs and sida	• Skeletal soils, clayey stony slopes are highly susceptible to watersheeting, rill erosion and gullying if rock cover is removed. • Open woodlands moderately susceptible to water sheeting	
Fi	Finke	Sandy alluvial plains adjacent to major rivers including active floodplain dunes	Sand bed. Levees with loamy sands and fine sands. Dunes with reddish sands.	Tall open woodland of river red gum over colony wattle and sticky hopbush with an understory of buffel grass, couch and sand hill cane grass.	• Floodplains susceptible to scouring floodwater erosion, particularly when vegetation cover is reduced. • Ephemeral river and floodplains susceptible to flooding after high rain events, although soils are well drained.	
Gi-1	Gillen	Rugged quartzite and sandstone ranges.	Rock and shallow stony soils.	Absent or scattered mulga and witchetty bush over low shrubs, spinifex and forbs.	• Very shallow soils • Succeptible to rill and gully erosion, when rock and vegetation cover is reduced.	

Code	Land system	Landform	Soil description	Vegetation	Limiting properties	Photograph
Gi-2	Gillen	Colluvial and alluvial fans and plains.	Red brown sandy clay loams and deep red loamy sands.	Ironwood, mulga, corkwood and witchetty over kerosene grass, mulga grass and other perennial grasses.	• Shallow soils • Succeptible sheet and rill erosion when rock and vegetation cover is reduced.	
Rn	Renners	Undulating limestone slopes and rises.	Calcareous earths and shallow gravelly soils.	Sparsely vegetated. Mulga and witchetty bush with a shrub layer of dead finish, emu bush and bluebush over copperburrs, sidas and forbs.	• Shallow soils. • Moderately susceptible to erosion – scalding, rilling and gullying can occur on broad slopes adjacent to natural drainage lines, particularly if rocky mantle is removed.	
Ru	Rumbulara	Plateaux, mesas and stony slopes.	Rocky and stony surfaces, stony sandy clay loams, shallow calcareous earths.	Scattered mulga on the plateaux. Low shrubs - cassia, emu bush, bluebush over perennial grasses and forbs.	• Succeptible to rill and gully erosion, when vegetation or rocky cover is reduced.	

Code	Land system	Landform	Soil description	Vegetation	Limiting properties	Photograph
Si	Simpson	Sand dunes and swales.	Red sands on dunes, red clayey sands, sandy loams and calcareous earths in swales.	Desert oak over cassia and emubush. Understory consists of spinifex and seasonal forbs.	• Succeptible to windsheet, watersheet and pedicel erosion, when vegetation cover is reduced. • Roads constructed parallel to wind direction through dunes will wind erode. • Interdunal swales experience short periods (up to several days) of inundation after high rain events.	
Sn	Singleton	Level to slightly undulating plain. Occasional low rises and very broad swales including broad drainage depressions.	Red clayey sands and red earths.	Sparse trees (mulga, mallee, desert oak, and beefwood) and shrub layer over spinifex. Small areas with mulga over woolybutt and kerosene grass.	• Moderately susceptible to erosion- scalding, rilling and gullying- adjacent to natural drainage lines or on gentle slopes • Drainage depressions experience short periods (up to several days) of inundation after high rain events.	

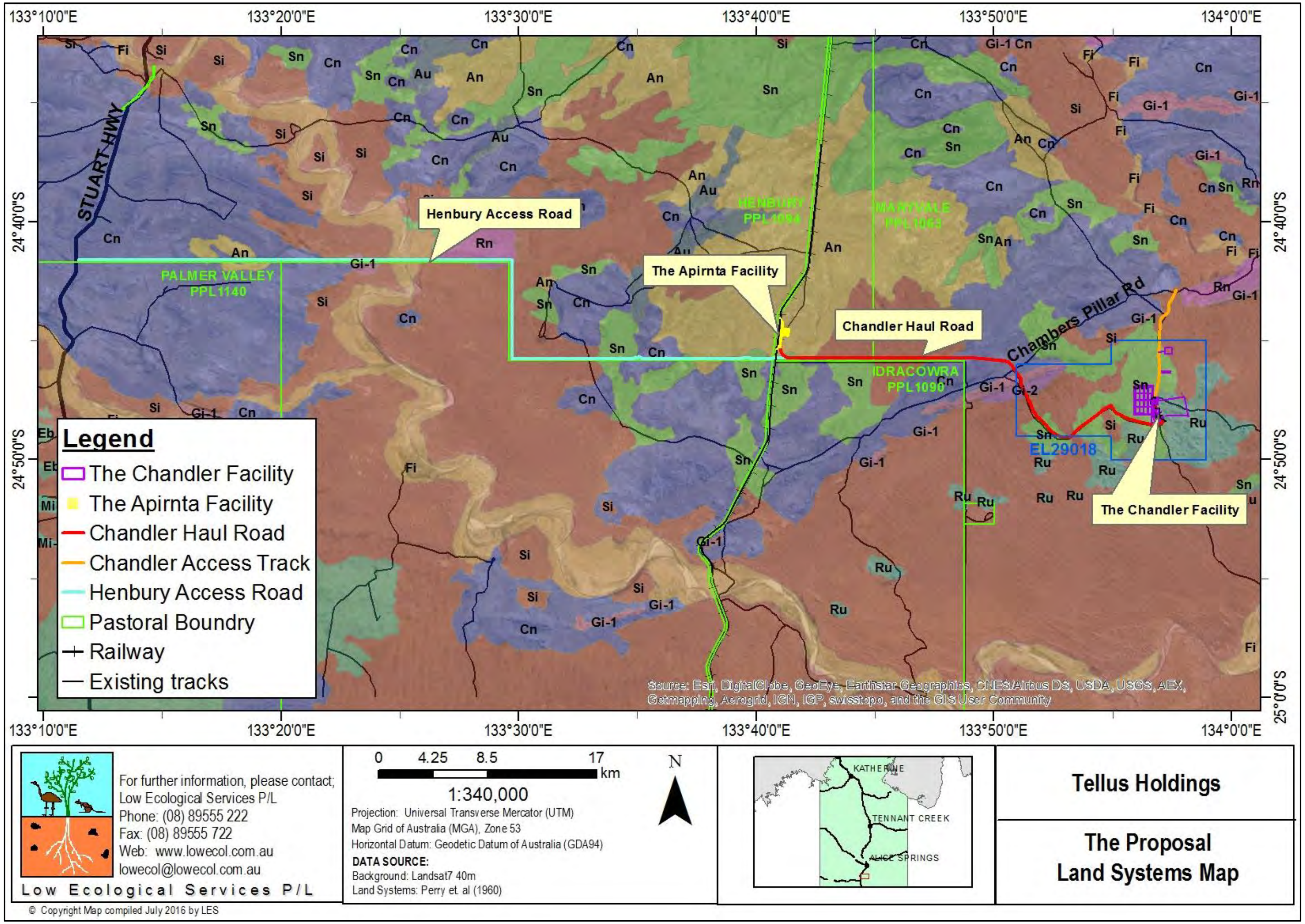


Figure 3-6: Land systems mapped over the Proposal area (Perry, et al., 1960)
Refer to Table for Land system descriptions

3.5 Vegetation types

Vegetation in the Proposal area has been mapped at a scale of 1: 1, 000 000 in the Vegetation Survey of the Northern Territory (Wilson, et al., 1990). The Proposal area includes six vegetation communities typical of arid central Australia (Table 3-3; Figure 3-7). There are no sensitive or significant vegetation communities in the Proposal area. The Chandler Facility is located on vegetation type 83 (*Triodia* low hummock grassland) and 110 (*Maireana* low open chenopod shrubland). The Apirnta Facility is located on vegetation type 83 (*Triodia* low hummock grassland). The Chandler Haul Road and Henbury Access Road are located on predominantly vegetation unit 83 (*Triodia* low hummock grassland) and vegetation type 108 (*Maireana* low open chenopod shrubland) with smaller areas of 66 (*Acacia* tall open shrubland) and vegetation type 73 (*Acacia* tall sparse shrubland).

3.5.1 Vegetation condition

As a result of good rains over the past four years, vegetation across the Proposal area is generally in a moderate to good condition and active seedling recruitment was observed. There is a localised high level of disturbance as a result of cattle (grazing, trampling and weed invasion), that is confined to watering points, ephemeral watercourses and tracks. Land has been previously cleared for tracks and a small amount of land has been cleared previously for mining exploration by Central Petroleum (seismic lines, drill holes and a camp).

3.5.2 Threatened ecological communities

There are no threatened ecological communities in the Proposal area.

Table 3-3: Description of vegetation types in the Proposal area as mapped by Wilson, *et. al*., (1990)

Vegetation	Broad Vegetation Classification	Structural Formation	Fine vegetation Classification	Fine Vegetation Description	Photographs
66	Open Shrubland.	Acacia tall open Shrubland.	Acacia tall open shrubland\ Eriachne low sparse tussock grassland.	Acacia aneura, Acacia kempeana+/ Corymbia opaca over Enneapogon avenaceus, tussock grass, forbs, fern.	
70	Sparse shrubland	Acacia tall sparse shrubland	Acacia tall sparse shrubland/eriachne low open tussock grassland	*Acacia aneura* +/- *Corymbia opaca* +- *Senna artemisioides helmsii* over *Fimbristylis dichotoma, Eriachne aristidea, Ptilotus obovatus,* tussock grass, sedges and forbs.	

Vegetation	Broad Vegetation Classification	Structural Formation	Fine vegetation Classification	Fine Vegetation Description	Photographs
73	Sparse Shrubland.	Acacia sparse Shrubland.	Acacia mid sparse shrubland\Salsola low forbland.	*Acacia tetragonophylla, Acacia kempeana* +/- *Atalaya hemiglauca* over senna, tussock grass.	
82	Hummock grassland.	Triodia low hummock grassland.	Acacia tall sparse shrubland\ Triodia low hummock grassland.	*Acacia aneura, Acacia kempeana*, cassia, over *Triodia pungens, Eragrostis eriopoda, Aristida holathera*, hummock grass, tussock grass.	

Vegetation	Broad Vegetation Classification	Structural Formation	Fine vegetation Classification	Fine Vegetation Description	Photographs
83	Hummock grassland	Triodia low hummock grassland	Acacia mid open mallee woodland\ Acacia mid sparse shrubland\ Triodia low hummock grassland	*Allolcasurina decasneana, Eucalyptus gamophylla, Acacia aneura, Acacia kempeana, Acacia ligulata, Senna artemisioides filifolia* over *Triodia basedowii, Triodia pungens, Eragrostis eriopoda* hummock grass tussock grass. Includes stands of *Allocasurina decasneana.*	 

Vegetation	Broad Vegetation Classification	Structural Formation	Fine vegetation Classification	Fine Vegetation Description	Photographs
108	Open shrubland.	Maireana low open chenopod Shrubland.	Maireana mid open chenopod shrubland\ Sclerolaena low forbland.	*Maireana astrotricha, Atriplex vesicaria*, *Acacia* spp. over chenopod shrubs, *Sclerolaena cornishiana, Enneapogon cylindricus*, forb, tussock grass.	
110	Sparse shrubland.	Atriplex low sparse chenopod shrubland.	Atriplex mid sparse chenopod shrubland\ mid open tussock grassland.	*Saltbush* +/- *Acacia aneura* +/- *cassia*, chenopod shrubs over *sida, Portulaca oleracea*, forbs, tussock grass.	

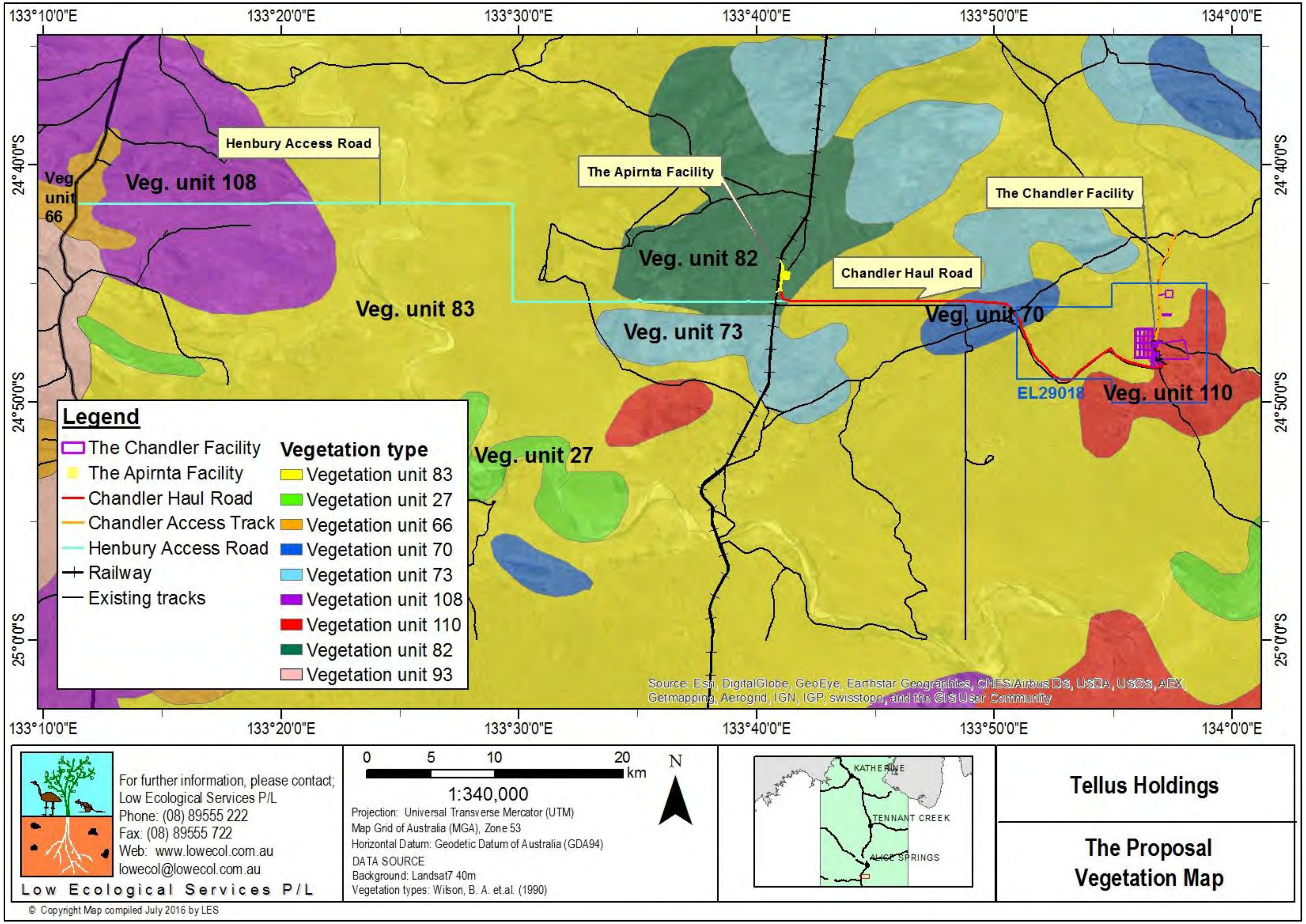


Figure 3-7: Vegetation types in the Proposal area as mapped by Wilson et al. (1990)

3.6 Sites of Conservation Significance

There are no SoCS or SoBS as defined under the TPWC Act located within 15 km of the Proposal. The nearest SoCS are Greater MacDonnell Ranges (located 30 km north of the Henbury Access Road), the Rodinga Range and Adjacent Ranges, (located 35 km east of the Chandler Facility) and the Karinga Creek Paleodrainage system (located 39 km south of the Henbury Access road) (Figure 3-8). The nearest SoBS are the Bacon Ranges (located approximately 15 km from the western end of the Henbury Access Road), Camel Creek (located approximately 24 km north east of the Chandler Facility) and Fox Salt Lakes, located 25 km south of the western end of the Henbury Access Road (Figure 3-8).

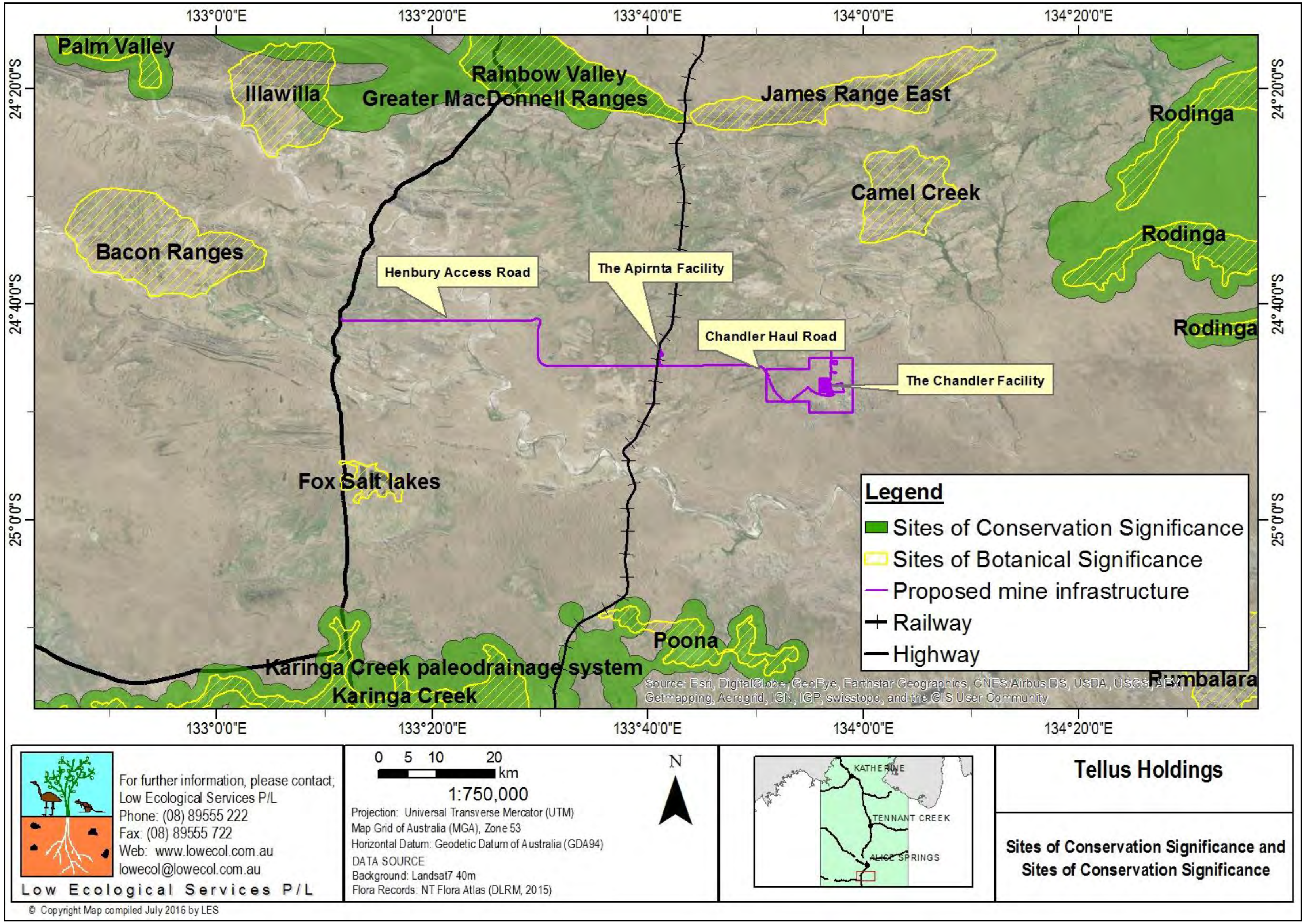


Figure 3-8: SoCS and SoBS located nearest to the Proposal.

3.7 Fire history

Mapping obtained from the North Australia and Rangelands Information website (North Australia and Rangelands Fire Information, 2016) shows fire scarring in some areas of the Proposal area in 2011 from late dry season fires (Figure 3-9).

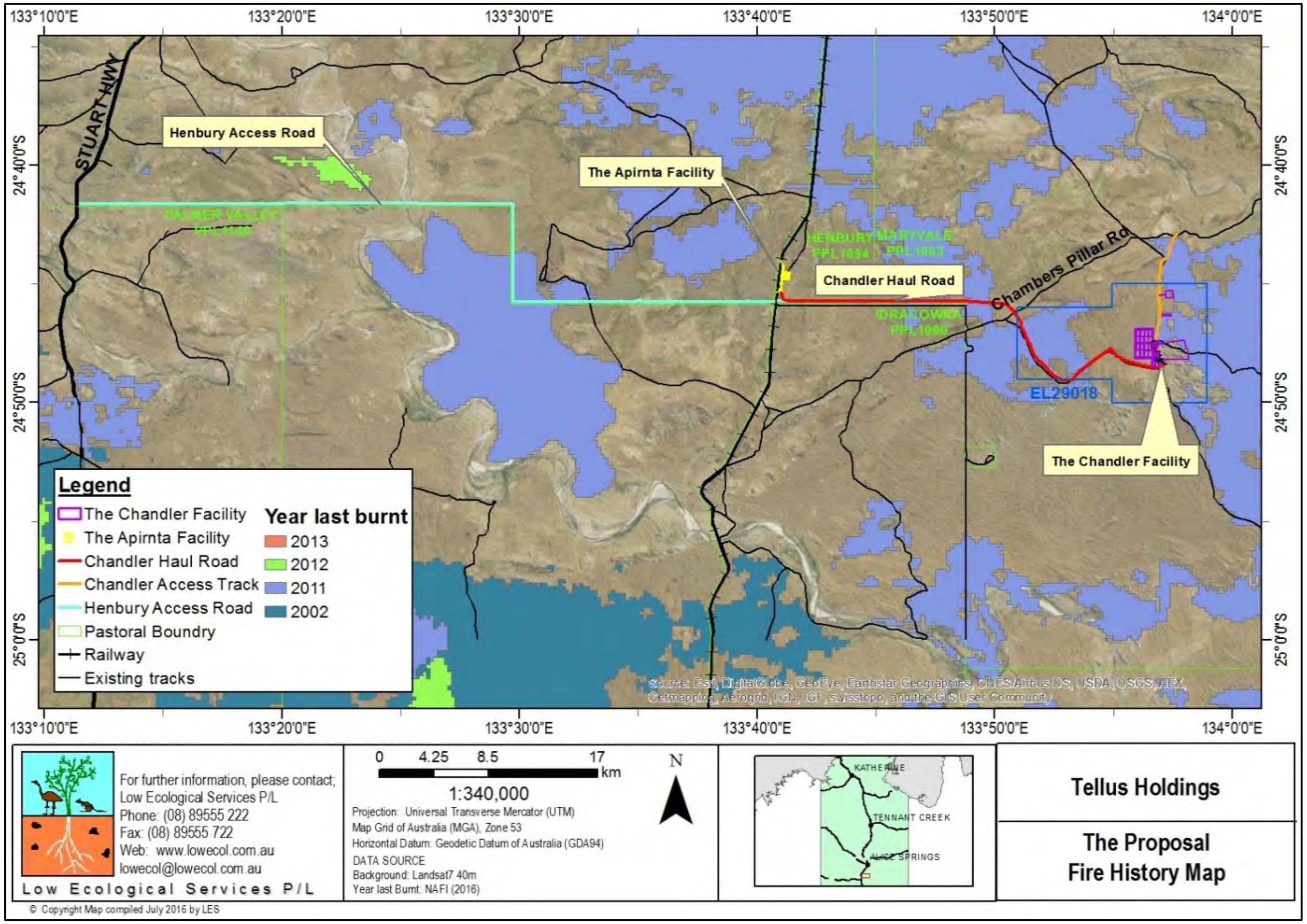


Figure 3-9: Fire history in the Proposal area (North Australia and Rangelands Fire Information, 2016)

3.8 Flora

3.8.1 Flora records

An interrogation of the NT Flora Atlas identified 1,386 records of 296 species or subspecies in the area of interest. A total of 192 species from 37 families, comprising of 185 native and seven introduced species were recorded during the field surveys. The most diverse families recorded were Poaceae (34 native species, 2 introduced), Fabaceae (30 native species) and Chenopodiaceae (22 native species). Appendix 2 provides a list of all species recorded during the surveys and the land systems they were recorded in.

3.8.2 Flora species of conservation significance

Nine flora species of conservation significance were identified by the PMST or NT Flora Atlas as occurring or potentially occurring within the area of interest (Table 3-4). One EPBC listed species was identified by the PMST as potentially occurring within the area of interest, *Acacia latzii* (Latz's wattle). The NT Flora Atlas identified eight TPWC listed species as occurring within the area of interest, three near threatened species and five data deficient species. One TPWC listed species, *Calandrinia remota*, was not recorded in the NT Flora Atlas but was recorded during an on-ground survey. Three species of conservation significance were recorded in the Proposal area:

- *Maireana carnosa* (cottony bluebush), listed as Nt under the TPWC Act;
- *Crotalaria eremaea* (bluebush pea), listed as DD under TPWC Act; and
- *Calandrinia remota* (listed as DD under the TPWC Act).

An additional five species listed as Nt or DD under the TPWC Act have a moderate to high likelihood of occurring within the Proposal area. All of the following Nt and DD listed species are not considered to have conservation significance in the Proposal area. Figure 3-10 shows NT Flora Atlas records of threatened species with in the area of interest.

Table 3-4: **Flora species of conservation significance identified by the desktop study as potentially occurring within the area of interest and/or recorded on surveys, with status under the TPWC Act (TPWC) and EPBC Act (EPBC), if the species was recorded in the PMST, NT Flora Atlas or during on-ground surveys (on-ground), and the likelihood (likelihood) of occurrence in the Proposal area.**
DD: data deficient, Nt: near threatened, Vu: vulnerable

Scientific Name	Common name	TPWC	EPBC	PMST	NT Flora Atlas	On-ground	Likelihood
Ixiochlamys nana	Small fuzzweed	DD	-	-	X	-	Moderate
Brachyscome ciliaris	Variable daisy	DD	-	-	X	-	High
Maireana carnosa	Cottony bluebush	Nt	-	-	X	X	High
Sclerolaena longicuspis	Long-spined poverty bush	Nt	-	-	X	-	Moderate
Crotalaria eremaea	Bluebush pea	DD	-	-	X	X	High
Acacia oswaldii	Umbrella wattle	DD	-	-	X	-	High
Acacia latzii	Latz's wattle	Vu	Vu	X	X	-	Low

Scientific Name	Common name	TPWC	EPBC	PMST	NT Flora Atlas	On-ground	Likelihood
Potamogeton crispus	Curly pondweed	Nt	-	-	X	-	Low
Calandrinia remota	-	DD	-	-	-	X	High
Synaptantha tillaeacea	-	DD	-	-	X	-	Moderate

***Acacia latzii* Latz's wattle**

Acacia latzii has a disjunct distribution within the Finke bioregion of the southern NT and is located in two areas, the Bacon Range west of Henbury Craters south west of Alice Springs and the Beddome Range east of the Stuart Highway on the NT-South Australian (SA) border (Nano, et al., 2012). The populations are separated by 200 km (Nano, et al., 2012). *Acacia latzii* has a high level of habitat specificity, being found on silcrete-capped mesas and stony denuded hills derived from mainly shale and siltstone in the north and south of its range and limestone, sandstone and dolomite in the north (Nano, et al., 2008). This species is often sparsely concentrated along minor creek lines and on hills and slopes (Nano, et al., 2008). Soil types are sandy clay-loams and are often highly alkaline and calcareous at depth (Nano, et al., 2008). The gnarled and twisted spiky appearance of *A. latzii* is distinctive and readily recognized when it is present. Threats to *A. latzii* include increase fire exposure associated with invasion of buffel grass, seedling loss during a recruitment phase due to animal browsing and trampling, and impacts from stochastic events due to its small population size and fragmented distribution (Nano, et al., 2012).

The closest records of *A. latzii* to the Proposal area are approximately 20 km north west from the western end of the proposed Henbury Access Road. These records are within Chandlers land system and vegetation type 108 (Table 3-2; Table 3-3). The Chandlers land system occurs in the Proposal area in the western and central portions of the proposed Henbury Access Road. Vegetation type 108 is present within the Chandlers land system in a small area within the Proposal area, for a 10 km stretch at the western end of the Henbury Access Road. A habitat search was conducted in this area and it was concluded that no suitable habitat for *A. latzii* was present due to the lack of geomorphological features described above. Therefore *A. latzii* has a low likelihood of occurrence within the Proposal area.

***Maireana carnosa* Cottony bluebush**

Maireana carnosa is a widespread chenopod occurring in all the arid zone states and in the NT. It is a spreading to prostrate perennial herb with a woody base. *Maireana carnosa* occurs on flat, shallow clayey soils near salt lakes (Moore, 2005). There is one previous recording within the area of interest, approximately 20 km south of the Apirnta Facility. *Maireana carnosa* was recorded in the western part of the development footprint, on sandplain 500 m south of the Apirnta Facility (site S27) and in the vicinity of the Henbury Access Road at sites R2, CH-a, RE-a, Am-ar-a and Ch-ar-a. Therefore there is a high likelihood for the species to occur within the Proposal area. As the species is not uncommon and is widespread in the area and therefore there is low risk of The Proposal having a significant impact on the species.

***Sclerolaena longicuspis* Long-spined poverty bush**

Sclerolaena longicuspis is a moderately tall fleshy herb with distinctive long spines. This chenopod species is widespread but rare in saline stony breakaways and plains with heavy soils. There is one recording of *S. longicuspis* within the area of interest, approximately 15 km north west of the Henbury Access Road in the Bacon Ranges. While *Sclerolaena longicuspis* was not recorded during the on-ground surveys, there is a moderate likelihood for the species to occur within the Proposal area.

***Potamogeton crispus* Curly pondweed**

Potamogeton crispus is a rhizomatous, submerged aquatic perennial herb. The species occurs in long lasting waterholes or dams. There is one recording of *P. crispus* approximately 15 km north west of the Henbury Access Road in the Bacon Ranges. *Potamogeton crispus* was not recorded during the on-ground surveys. Due to the absence of appropriate habitat, long lasting waterholes or dams in the Proposal area, there is a low likelihood for the species to occur within the Proposal area.

***Ixiochlamys nana* Small fuzzweed**

Ixiochlamys nana is a widespread annual daisy occurring on fine clay loam alluvial soils. There is one recording of *I. nana* within the area of interest, approximately 15 km north west of the Henbury Access Road in the Bacon Ranges. This species was not recorded during the on-ground surveys however there is suitable habitat within the Proposal area and a moderate likelihood for the species to occur within the Proposal area. As the species is widespread and not uncommon, *I. nanna* is not considered to have conservation significance in the Proposal area.

***Brachyscome ciliaris* Variable daisy**

Brachyscome ciliaris is a widespread and common annual to perennial daisy, occurring in a variety of habitats including sandplains, gibber plains and disturbed areas. Records of the species were widespread within the area of interest, with 21 recordings in the NT Flora Atlas. The species occurs on a variety of soils including red-brown medium textured soils, sand and gibber plains and in rock crevices (Moore, 2005). While *B. ciliaris* was not recorded during the on-ground surveys, there is a high likelihood of the species occurring within the Proposal area. As *B. ciliaris* is very common and widespread in a variety of habitats in central Australia, the Proposal area will not have a significant impact on the species .

***Crotalaria eremaea* Bluebush pea**

Crotalaria eremaea is a shrub common on sand dunes in southern NT and in the Proposal area. *Crotalaria eremaea* is common in southern NT and is found on red-brown sandy soils, on sand dunes (Moore, 2005). There are four recordings of *C. eremaea* from within the area of interest, three 20 km north and one eight kilometres east of the Chandler Facility. *Crotalaria eremaea* was recorded during the on-ground surveys on a sand dune Site S06, (approximately 1.5 km west of the Chandler Facility, on the Chandler Haul Road) and sighted occasionally in sand dunes while traversing the Proposal area. Therefore there is a high likelihood for the species to occur in the Proposal area. As *C. eremaea* is not uncommon in sand dunes in Central Australia, the species is not considered to have conservation significance in the Proposal area.

Acacia oswaldii **Umbrella wattle**

Acacia oswaldii is a shrub or tree two to eight metres high. The species is widespread and scattered in arid, semi-arid and subtropical areas in all Australian mainland states. *Acacia oswaldii* is usually a solitary plant and is grows in a variety of soil and vegetation types in southern NT (Moore, 2005). There is one recording of *A. oswaldii* in the NT Flora Atlas within the area of interest, located approximately 15 km north east of the Chandler Facility. *Acacia sessiliceps* is often synonymised with *A. oswaldii,* but is treated by the NT Herbarium as a distinct taxon, distinguished by phyllode nervation and pale, globular, usually sessile flower heads (Northern Territory Herbarium , 2013). *Acacia sessiliceps* was recorded at three sites on the Henbury Access Road during the November 2015 survey. *Acacia sessiliceps* is classified as least concern under the TPWC Act and is generally more common that *A. oswaldii* in the area of interest. While *A. oswaldii* was not recorded during the on-ground survey there is suitable habitat on the site and therefore a high likelihood for the species to occur in the area.

Synaptantha tillaeacea

Synaptantha tillaeacea is a small widespread prostrate succulent herb growing with stems to 15 cm long. *Synaptantha tillaeacea* has narrow-elliptic to narrow-oblanceolate leaves 3-17 mm long and 1-3 mm wide (PlantNET). The flowers are axillary, whitish with petals 1-2 mm long (PlantNET). The species is found in creek beds throughout central Australia (PlantNET). There are two records of *S. tillaeacea* within the area of interest, located 10 km north of the access road and 21 km north east of the Chandler Facility. While not found during surveys of the Proposal area, there is a moderate likelihood of its occurrence in the area.

Calandrinia remota **Round-leaf parakeelya**

Calandrinia remota is a small parakeelya herb with a basal rosette of leaves and erect flowering stems to 30 cm long (PlantNET). The leaves are linear to lanceolate to oblong, 3.5-11 cm long and 4-10 mm wide (PlantNET). The flowers are dark pink to purple with petals 8-18 mm long (PlantNET). There were no records of *C. remota* within the area of interest in the NT Flora Atlas. *Calandrinia remota* was recorded during the September 2013 survey on site S04, a sandplain four kilometres north east of the Chandler Facility. It is a widespread species of the sand dune and sand plains in northern South Australia and southern NT and any impact on the species in the Proposal area is not considered to have conservation significance.

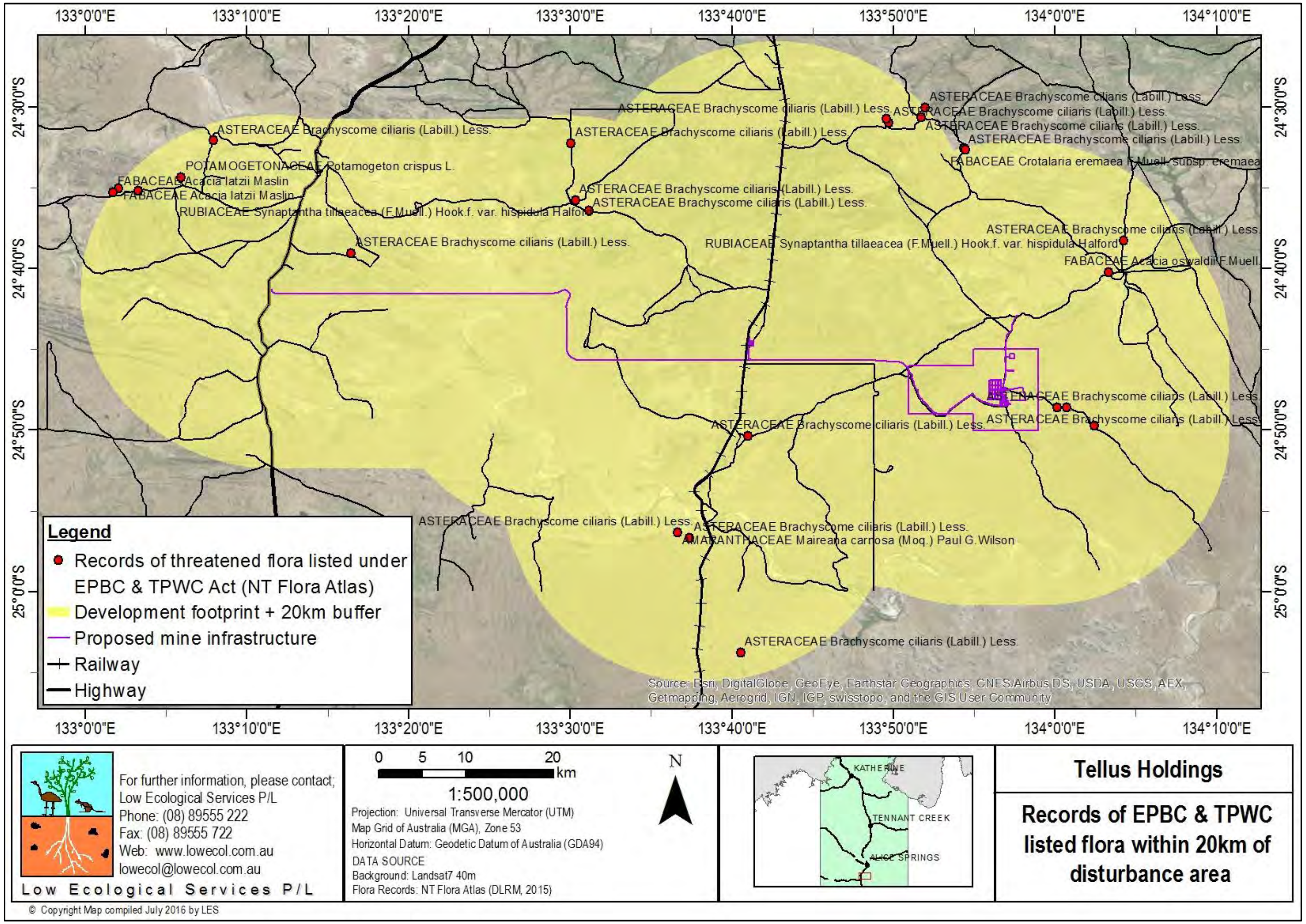


Figure 3-10: Location of records of flora species of conservation significance identified by the NT Fauna Atlas in the Proposal area

3.8.3 Introduced and weed species

An interrogation of the NT Flora Atlas identified 66 records of 13 introduced flora species in the area of interest. A total of seven introduced species were recorded in the Proposal area during on-ground surveys (Table 3-5). With the exception of buffel grass, all weed species recorded during on-ground surveys occurred in very low densities. One of these species is a Weed of National Significance (WoNS), and three species are declared weeds under the *Weeds Management Act* 2013.

WoNS are declared based on invasiveness, potential for spread and environmental, social and economic impacts. Strategic plans for WoNS are developed as a result of their declaration, which defines responsibilities and identifies strategies and actions to control the species. Landholders and managers are ultimately responsible for managing WoNS, and the state/territory government is responsible for overall legislation and administration (Department of Sustainability, Environment, Water, Population and Communities, 2012b). One WoNs, *Tamarix aphylla* (athel pine) was recorded in the Finke River within the Proposal area (24°41'0.18"S, 133°25'0.55"E) during the November 2015 survey.

In the NT, a plant is declared a weed if it has been identified for control, eradication or prevention of entry into NT (Department of Land and Resource Management, 2014). All landholders, land managers and land users must comply with the declaration classification. Based on the risk of harm they could cause and how difficult they are to control weeds are placed into the following classes:

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

Weeds declared in the NT and recorded in the Proposal area during on-ground surveys include *Datura leichhardtii* (native thorn apple), *Tribulus terrestris* (caltrop) *and T. aphylla* (discussed above). *Datura leichhardtii* was recorded at site R1, on the bank the Finke River during the November 2015 survey. *Tribulus terrestris* was recorded on the proposed Henbury Access Road at sites CH2, MDG3 and SD2 and during the November 2015 survey on the proposed Henbury Access Road at sites SD-A and SN-AR-A during the May 2016 survey.

Other introduced, although not declared, species recorded during on-ground surveys include *Cenchrus ciliaris* (buffel grass), *Cynadon dactylon* (couch grass), *Citrullus lanatus* (paddy melon) and *Solanum nigrum* (black berry nightshade). *Cenchrus ciliaris* was recorded at most sites throughout the survey area, being mostly concentrated in disturbed areas and along ephemeral water courses. *Cynadon dactylon* was recorded in the Finke River and in a small creek bed 2 km west of the railway line, where it dominated ground cover on the banks of the watercourses. *Solanum nigrum* was recorded as an incidental observation during the October 2012 and June 2015 survey near the Halfway Dam and the temporary camp (24°48'24.13"S, 133°57'7.38"E).

Table 3-5: Introduced flora species recorded in the proposal area during on-ground surveys, including if the species is a WoNS, the class it is declared under in the NT, and control requirements (Weeds Management Act, 2001).

Scientific Name	Common Name	WoNS	Declared weed in NT	Control requirements
Cenchrus ciliaris	Buffel grass	-	-	-
Citrullus coloynthis	Paddy melon	-	-	-
Cynodon dactylon	Couch grass	-	-	-
Datura leichhardtii	Native thorn apple	-	Class C under *Datura* spp.	Not to be introduced into the NT.
Solanum nigrum	Blackberry nightshade	-	-	-
Tamarix aphylla	Athel pine	X	Class B and Class C.	Growth and spread to be controlled. Not to be introduced into the NT.
Tribulus terrestris	Caltrop	-	Class B.	Growth and spread to be controlled.

3.9 Fauna

3.9.1 Fauna records

Interrogation of the NT Fauna Atlas identified 5,023 records of 244 fauna species within the Proposal area. Eighty-nine native bird species, 19 mammal species (12 native and seven introduced), ten native bat species, and 25 native reptile species were recorded during on-ground surveys. A full list of fauna recorded during the on-ground surveys is provided in Appendix 3.

3.9.2 Fauna species of conservation significance

Thirty-one fauna species of conservation significance were identified by the PMST and NT Fauna Atlas as occurring or potentially occurring within the area of interest. Eleven threatened fauna species were identified by the EPBC PMST as potentially occurring or having suitable habitat within the Proposal area. Seven of these species are listed under the EPBC Act as vulnerable and six as endangered. Rostratula benghalensis (sensu lato) is listed as endangered, migratory and marine under the EPBC Act. However, as discussed below this species is no longer considered to occur in Australia. An additional 20 species listed as threatened, near threatened or data deficient under the TPWC Act have been recorded in the NT Fauna Atlas within the area of interest (Table 3-6, Figure 3-1).Two of these species are regionally extinct, one is critically endangered, three are vulnerable, 12 are near threatened and two are data deficient.

Nine fauna species of conservation significance were recorded in the Proposal area during on-ground surveys

- *Notoryctes typhlops* (southern marsupial mole), listed as vulnerable under the TPWC Act;
- *Dasycercus* sp. (mulgara). *Dasycercus cristicauda* (crest-tailed mulgara), listed as vulnerable under the both the EPBC Act and TPWC Act/ *Dasycercus blythi* (brush-tailed mulgara), listed as vulnerable under the TPWC Act. Mulgara tracks were recorded, although it was not possible to identify these to the species level as there is suitable habitat for both *D. blythi* and *D. cristicauda* in the Proposal area.
- *Ardeotis australis* (Australian bustard), listed as near threatened under the TPWC Act;
- *Burhinus grallarius* (bush-stone curlew) , listed as near threatened under the TPWC Act;
- *Calyptorhynchus banksii samueli* (red-tailed black cockatoo), listed as near threatened under the TPWC Act;
- *Dromaius novaehollandiae* (emu), listed as near threatened under the TPWC Act;
- *Neophema splendida* (scarlet chested parrot) , listed as near threatened under the TPWC Act; and
- *Pyrrholaemus brunneus* (redthroat) , listed as near threatened under the TPWC Act.

A number of old *Bettongia lesueur* (burrowing bettong) burrows were recorded during the June 2015, October 2015, November 2015 and May 2016 surveys and *Leporilis apicalus* (lesser stick-nest rat) nests were recorded during the June 2015 survey. However, these were inactive and both of these species are extinct in the region.

Table 3-6: Fauna species of conservation significance recorded in the proposal area or identified by the EPBC PMST and NT Fauna Atlas as potentially occurring within the area of interest

Nt: near threatened, Vu: vulnerable, En: endangered, Cr: critically endangered, ER: extinct regionally Mi: migratory, Ma: marine, *likelihood of occurring after high rainfall, #Tracks of *Dasycercus* sp. recorded.

Group	Species name	Common name	Status		PMST	NT Fauna Atlas	On-ground	Likelihood of occurrence
			TPWC	EPBC				
Bird	*Acanthiza iredalei*	Slender-billed thornbill	ER	Vu	-	X		Low
	Amytornis modestus indulkana	Thick-billed grasswren (north western subspecies)	Cr	Vu	X	-		Low -moderate
	Amytornis striatus	Striated grasswren	Nt	-	-	X		Moderate
	Ardeotis australis	Australian bustard	Nt	-	-	X	X	High
	Burhinus grallarius	Bush stone-curlew	Nt	-	-	X	X	High
	Calyptorhynchus banksii samueli	Red-tailed black cockatoo	Nt	-	-	X	X	High
	Conopophila whitei	Grey honeyeater	DD	-	-	X		High
	Cinclosoma castanotum	Chestnut quail-thrush	Nt	-	-	X		High
	Dromaius novaehollandiae	Emu	Nt	-	-	X	X	High
	Elanus scriptus	Letter-winged kite	Nt	-	-	X		High*
	Leipoa ocellata	Malleefowl	Cr	Vu	-	X (1930)		Low
	Lophoictinia isura	Square-tailed kite	Nt	-	-	X		High
	Neophema splendida	Scarlet-chested parrot	Nt	-	-	X	X	High*
	Pezoporus occidentalis	Night parrot	Cr	En	X	-		Low
	Polytelis alexandrae	Princess parrot	Vu	Vu	X	-		Moderate*
	Pyrrholaemus brunneus	Redthroat	Nt	-	-	X	X	High
	Rostratula australis	Australian painted snipe	Vu	En	X	-		Moderate*
Invertebrate	*Croitana aestiva*	Desert sand-skipper	En	En	X	-		Low
Mammal	*Antechinomys laniger*	Kultarr	Nt	-	-	X		High

Group	Species name	Common name	Status		PMST	NT Fauna Atlas	On-ground	Likelihood of occurrence
			TPWC	EPBC				
	Dasycercus blythi	Brush-tailed mulgara	Vu	-	-	-	X#	High
	Dasycercus cristicauda	Crest-tailed mulgara	Vu	Vu	X	-	X#	High
	Isoodon auratus	Golden bandicoot	Vu	En	-	X		Low
	Macrotis lagotis	Greater bilby	Vu	Vu	X	-		Low
	Notomys cervinus	Fawn hopping-mouse	ER	-	-	X		Low
	Notoryctes typhlops	Southern marsupial mole	Vu	-	-	X	X	High
	Petrogale lateralis MacDonnell Ranges race	Black-footed rock-wallaby	Nt	Vu	X	-		Low
	Rattus tunneyi	Pale field-rat	Vu	-	-	X		Low
	Zyzomys pedunculatus	Central rock-rat	En	En	X	-		Low
Reptile	*Delma demosa*	Desert delma	DD	-	-	X		High
	Liopholis kintorei	Great desert skink	Vu	Vu	X	-		Low- Moderate
	Liopholis slateri slateri	Slater's skink	Vu	En	X	-		Low-Moderate
	Pseudechis australis	King brown snake	Nt	-	-	X		High

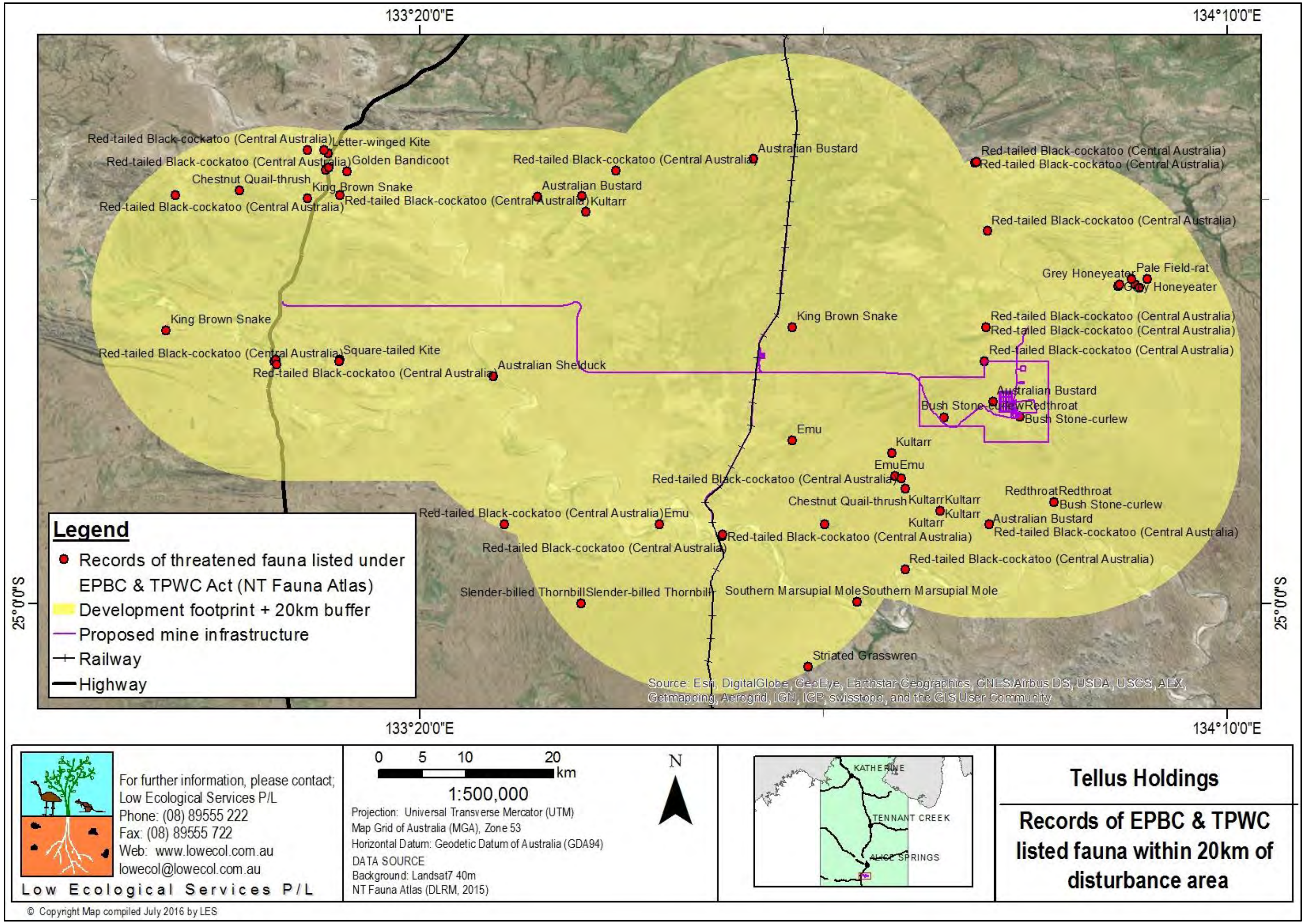


Figure 3-11: Threatened fauna listed under EBPC Act and TPWC Act Atlas recorded in the NT Fauna Atlas within a 20 km radius of the disturbance area.

***Acanthiza iredalei* (slender-billed thornbill)**

Acanthiza iredalei is listed as extinct regionally under the TPWC Act and Vu under the EPBC Act. There are three subspecies of *Acanthiza iredalei* of which one, *A. i. iredalei,* has been recorded in the NT. This subspecies is known from just one specimen on nearby Idracowra Station in 1913 (Pavey & Ward, 2012a). *Acanthiza iredalei iredalei* typically inhabits areas of saltmarsh dominated by samphire, bluebush or saltbush around salt lakes or low heath on sandplain. The diet consists of invertebrates, mostly insects and spiders, that it forages for amongst the foliage of shrubs (Pavey & Ward, 2012a). *Acanthiza iredalei iredalei* breeds from July to November and nests in low shrubs (Pavey & Ward, 2012a). Habitat degradation as a result of grazing by sheep and rabbits potentially threatens the species in parts of its range (Pavey & Ward, 2012a).

The closest record of *A. i. iredalei* to the proposed disturbance area is approximately 17 km. This is the only record from the NT and is dated 1913. The record of *A. i. iredalei* is located within the Simpson land system and vegetation type 83 – *Triodia basedowii* (hard spinifex) or *T. pungens* (soft spinifex) hummock grassland with *Eucalytpus gamophylla* (blue mallee), *Acacia* tall sparse-shrubland overstorey. These two units form the predominant land system and vegetation types in the proposed disturbance area. Subsequent surveys of the area have not recorded *A. i. iredalei*, and it has been classified as regionally extinct (Pavey & Ward, 2012a). *Acanthiza iredalei iredalei* was not recorded during any on-ground survey of the Proposal area. Therefore there is a low likelihood that this species occurs within Proposal area and this species will not be further assessed in this report.

***Amytornis modestus indulkana* (thick-billed grasswren)**

Amytornis modestus indulkana (listed as vulnerable at the species level under the EPBC Act and critically endangered at the subspecies level under the TPWC Act) was identified by the EPBC PMST as potentially occurring within the Proposal area, but there are no NT Fauna Atlas records of the species within a 20 km radius of the Proposal area. Potentially suitable habitat was identified in the Proposal area based on vegetation, land system and land unit mapping. Taxonomy of the subspecies within *A. modestus* is somewhat unclear. Black (2011) identified four subspecies based on tail and bill morphology and mitochondrial DNA (MtDNA) analysis. Records from the southern NT, around Charlotte Waters were considered to be *A. m. indulkana*, and those of the extinct MacDonnell Ranges subspecies were considered to be *A. m. modestus*. The NT listing of this species follows this taxonomy, with *A. m. indulkana* being listed as critically endangered and *A. m. modestus* as extinct. However, subsequent to the taxonomic revision by Black (2011), Christidis *et al*. (2013) suggested that currently available morphological and genetic data provides robust evidence for just two subspecies and consider *A. m. indulkana* and *A. m. modestus* the same subspecies; *A. m. modestus.*

In the NT the populations of *A. modestus indulkana* identified by Black (2011) are known only from records close to the NT-SA border south of Charlotte Waters along a drainage line (Pavey & Ward, 2012b). Throughout their range south to Andamooka and Bon Bon Stations in SA, *A. m. indulkana* occupies low shrublands 0.5-2 m tall with approximately 15% cover of predominantly Oodnadatta saltbush and cottonbush vegetation on bare and rocky ground (Black, et al., 2011). The population near Charlotte Waters occurs on areas dominated by the saltbush *Atriplex nummularia* (Pavey & Ward, 2012b). *Amytornis modestus indulkana* is a ground forager, feeding on seeds and invertebrates (Pavey & Ward, 2012b). The species is sedentary, with pairs occupying a home range of approximately 20-40 ha (Pavey & Ward, 2012b). *Amytornis modestus* has been recorded breeding during all months of the year except December, and predominantly from August to October and nest within the foliage of a shrub (Black, et al., 2011; Pavey & Ward, 2012b). Stock grazing and severe drought have been cited as potential causes of the the extinction of small isolated populations of *A. modestus,* however this cannot be confirmed (Garnett & Crowley, 2000). Predation by foxes, feral cats and grazing by introduced grazing herbivores and wildfires are also potential threats to *A. modestus* populations (Garnett, et al., 2011).

The closest records of *A. m. indulkana* to the proposed disturbance area are approximately 167 km south east. There are records in the McDills and Endinda landsystems. McDills landsystem is lower flood-plains and flood-out basins of the Finke with layered silty and sandy soils and mainly open cassia, saltbush or bluebush vegetation. Endinda landsystem consists of broadly undulating stony plains, relief up to 30 ft with stone-mantled texture contrast soils and open of sparse shrubland vegetation. McDills landsystem does not occur within the Proposal area, and only a small area of Endinda landsystem is present in the south. The records occur within vegetation types 109 – chenopod open-herbland with ephemeral open-herb/grassland, and 110 – *Atriplex vesicaria* (bladder saltbush) low sparse-shrubland with ephemeral open-herb/grassland. Vegetation type 110 occurs within the proposed disturbance area at the eastern edge. A desktop survey identified the habitat at sites S11, ch-a and ch-a-2 to be potentially suitable for *A. m. indulkana*. Ground-truthing found S11 was not to be suitable habitat as *A. modestus indulkana* inhabits areas with relatively high covers of Oodnadatta saltbush and cottonbush shrubs. Shrub species present at all three sites did not provide the same cover at ground level as Oodnadatta saltbush and cottonbush. Habitat searches at sites ch-a and ch-a-2 on the Henbury Access Road found potentially suitable *A. m. indulkana* habitat; however the species was not recorded during the bird surveys. Due to the cryptic nature of the species, and the difficulty associated with recording the species, there is still a low-moderate likelihood that this species occurs within the Proposal area.

***Amytornis striatus (*striated grasswren)**

Amytornis striatus (listed as near threatened under the TPWC Act) occurs in central and south west Qld, south west NSW, north west Victoria, and from southern SA into the western NT and throughout the Pilbara to the coast of WA (Pizzey & Knight, 2012). *Amytornis striatus* occurs in spinifex habitats with mallee and acacia vegetation, other inland scrublands and coastal scrublands in WA (Pizzey & Knight, 2012). More specifically this species occurs in areas with mature spinifex (Garnett, et al., 2011). The breeding season of *A. striatus* is February to April in the north west and inland areas of the species distribution (Pizzey & Knight, 2012). *Amytornis striatus* nests in spinifex clumps (Pizzey & Knight, 2012). The primary threat to this species is large scale fires, which can eliminate suitable habitat (Garnett, et al., 2011). Declines of *A. striatus* are evident in central Australia, with a notable disappearance of the species from 9/10 sites at Uluru as a result of periods of large fires in 1990s and early 2000s (Garnett, et al., 2011).

The closest record of *A. striatus* to the Proposal area is 20 km south. This record was taken in 1897. A more recent record of the species is approximately 40 km south of the Proposal area from 1987. Both of these records are from spinifex hummock grasslands. There is a low-moderate likelihood that *A. striatus* is present in the Proposal area in areas of undisturbed old spinifex. Potentially suitable habitat for *Amytornis striatus* is relatively limited in the area of interest, but widespread in the region. . Therefore the low likelihood of occurrence and low risk of impact on the species is considered to be very low in the Proposal area and therefore will not be assessed further in this report.

***Ardeotis australis* (Australian bustard)**

Ardeotis australis is listed as near threatened under the TPWC Act. *Ardeotis australis* is widely distributed across inland Australia, where it is still common away from settlement in parts of inland and northern Australia and WA (Pizzey & Knight, 2012). *Ardeotis australis* inhabits grasslands, spinifex, open scrublands, grassy woodlands, sandhills, pastoral lands, burned ground, and occasionally crops and airfields (Pizzey & Knight, 2012). The species is irruptive and dispersive in response to rainfall (Pizzey & Knight, 2012). The breeding season of *A. australis* is from August to November in southern Australia and can occur during all months of the year in northern Australia in response to wet seasons (Pizzey & Knight, 2012). *Ardeotis australis* nests on open bare ground by bush, stones and tussock grasses (Pizzey & Knight, 2012).

Ardeotis australis was recorded incidentally during the October 2012 survey within the mine lease and at site r2, near a creek line west of the railway line in spinifex hummock grassland habitat during the November 2015 survey. *Ardeotis australis* has a widespread distribution and is expected to be relatively common across the Proposal area. Therefore, the species is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Burhinus grallarius* (bush stone-curlew)**

Burhinus grallarius, listed as near threatened under the TPWC Act. *Burhinus grallarius* is distributed across mainland Australia with the exception of the southern inland and Nullarbor regions (Pizzey & Knight, 2012). *Burhinus grallarius* is mainly nocturnal and inhabits open woodland, dry watercourses with fallen branches, leaf litter and sparse grasses, sandplain with spinifex and mallee, coastal scrub, mangrove fringes, golf courses, rail reserves, timber remnants on roadsides, orchards, plantations and urban areas (Pizzey & Knight, 2012). The breeding season of *B. grallarius* is generally from August to January, but can be earlier in northern Australia, and the species nests on bare ground (Pizzey & Knight, 2012).

Burhinus grallarius was recorded incidentally during the October 2012 survey within the mine lease in spinifex hummock grassland and low sparse shrubland habitats. Therefore the species has a high likelihood of occurrence in the Proposal area. *Burhinus grallarius* is a common and widespread specie and there is no critical habitat for the species in the Proposal are. Therefore, the species is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Calyptorhynchus banksii samueli* (red-tailed black-cockatoo)**

The subspecies *Calyptorynchus banksii samueli* occurs in inland NSW, southern Qld, southern NT, northern SA and western WA (Pizzey & Knight, 2012). The species is listed as near threatened under the TPWC Act. *Calyptorhynchus banksii samueli* inhabits tall open forests, woodlands, grasslands, scrublands, floodplains, river margins, *E. camaldulensis* along watercourses and wetlands (Pizzey & Knight, 2012). *Calyptorhynchus banksii samueli* breeds between April and July in tree hollows (Pizzey & Knight, 2012).

The NT Fauna Atlas identified records of *C. b. samueli* on the edge of the mine lease and within the Proposal area in spinifex hummock grassland, and low sparse-shrubland habitat. *Calyptorhynchus* *banksii samueli* was recorded at the Finke River in the area for the proposed Henbury Access Road, during the May 2015 survey. There is a high likelihood that *C. b. samueli* will occur within the Proposal area. The Proposal area does not include critical habitat for the species. Therefore, *C. b. samueli* is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Conopophila whitei* (grey honeyeater)**

Conopophila whitei is sparsely distributed across inland Australia from north east SA west through the Pilbara in WA and north to Frewena and Wave Hill, NT (Pizzey & Knight, 2012). *Conopophila whitei* inhabits mature mulga woodland, open mulga with spinifex, tall open acacia scrubland and sandhills with red mulga, canegrass, beefwood and desert bloodwood (Pizzey & Knight, 2012). The breeding season of *C. whitei* is generally between August and September (Pizzey & Knight, 2012). The species nests in the outer foliage of shrubs approximately 2 m above the ground (Pizzey & Knight, 2012).

The closest record of *C. whitei* to the Proposal area is approximately 11 km north east in spinifex hummock grassland habitat. There is a high likelihood that *C. whitei* is present within the Proposal area. *Conopophila whitei*, listed as Nt under the TPWC Act has a widespread distribution, although it is nomadic and elusive. There is no critical habitat for the species in the Proposal area. Therefore species is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Cinclosoma castanotum* (chestnut quail-thrush)**

Cinclosoma castanotum is distributed across southern Australia from western NSW and north western Victoria through southern SA to south western WA, and north into the south western NT. *Cinclosoma castanotum* inhabits mallee-spinifex vegetation, mulga and cypress pine vegetation with a shrub layer, desert eucalypt woodlands, saltbush vegetation, desert heath and coastal tea-tree (Pizzey & Knight, 2012). *Cinclosoma castanotum* breeds between August and November or after rain and nests by mallee trunks, fallen branches, low shrubs and grass tufts (Pizzey & Knight, 2012).

The closest record of *C. castanotum* to the Proposal is approximately 7 km south in spinifex hummock grassland habitat. There is also a record approximately 13 km north west of the western end of the access road in low open-shrubland habitat. There is a high likelihood that *C. castanotum* is present within the open shrublands in the Proposal area. *Cinclosoma castanotum*, listed as Nt under the TPWC Act, has a large but patchy range and there is no critical habitat for the species in the Proposal area. Therefore *C. castanotum* is not considered to have conservation significance in the Proposal area and therefore will not be assessed further in this report.

***Dromaius novaehollandiae* (emu)**

Dromaius novaehollandiae was widely distributed across the Australian mainland, but is now mostly absent from closely settled areas (Pizzey & Knight, 2012). *Dromaius novaehollandiae* inhabits plains, scrublands, open woodlands, coastal heaths, alpine pastures, semi-deserts, margins of lakes, and pastoral and cereal growing areas (Pizzey & Knight, 2012). *Dromaius novaehollandiae* breeds between April and October, and nests on the ground (Pizzey & Knight, 2012).

Dromaius novaehollandiae was recorded incidentally during the October 2012 and September 2013 survey within the Chandler Facility Area, at site S20 (approximately 8 km east of the Chandler Facility site within the mine lease) and site S27 (the Apirnta Facility site) during the June 2015 survey, at sites r2 and mdg3 on the Henbury Access Road route during the November 2015 survey and at site si-a on the Henbury Access Road route during the May 2016 survey. These sites were in spinifex hummock grassland habitats. *Dromaius novaehollandiae*, listed as Nt under the TPWC Act, is widespread across most of Australia and are not uncommon in the area of interest. Secondary signs of *D. novaehollandiae* were widespread across the site. There is no critical habitat for *D. novaehollandiae* in the Proposal area. The species is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Elanus scriptus* (letter-winged kite)**

Elanus scriptus is distributed throughout the arid inland of western Qld, northern SA and southern NT (Birdlife Australia, 2016). It inhabits open country and grasslands with trees for roosting and nesting (Pizzey & Knight, 2012). *Elanus scriptus* is unique among raptors, being the only truly nocturnal raptor (Pavey, et al., 2008). *Elanus scriptus* feeds predominantly on small mammals, especially rodents, and breeds intensively during rodent irruptions (del Hoyo, et al., 1994). This species is thought to be nomadic in response to the availability of prey (del Hoyo, et al., 1994).

The closest record of *Elanus scriptus* to the Proposal area is approximately 17 km north of the western end of the access road in spinifex hummock grassland habitat. There is a high likelihood that *E. scriptus* will be present in the Proposal area during times of high resource availability (often linked to high rainfall). However as *E. scriptus*, listed as Nt under the TPWC Act, is a widespread species and there is no critical habitat in the Proposal area, it does not have conservation significance in the Proposal area and will not be assessed further in this report.

***Leipoa ocellata* (malleefowl)**

Leipoa ocellata has a patchy distribution throughout the semi-arid regions of southern Australia (Pavey, 2006a). In the NT it has mainly been recorded south of the Tanami Desert and west of the Stuart Highway, but not since the early 1960s (Pavey, 2006a). *Leipoa ocellata* is diurnal and ground-dwelling with large home ranges (Pavey, 2006a). The male builds a mound up to 3 m wide and 60 cm above the ground made of organic material and soil where the female lays eggs (Pavey, 2006a). *Leipoa ocellata* inhabits woodland, shrubland and scrubs, favours areas with a shrubby understorey, and is strongly associated with mallee in most parts of its range (Pavey, 2006a). *Leipoa ocellata* forages on the ground for mostly seeds and also other plant material and invertebrates, and roosts in the foliage of shrubs and trees (Pavey, 2006a). Predation by introduced carnivores, hunting by humans, environmental stress from drought and altered fire regimes are threatening processes impacting *L. ocellata*, with predation likely being the major threat faced by remaining populations (Pavey, 2006a).

Leipoa ocellata is considered to be locally extinct in the Proposal area. The closest record of *L. ocellata* to the proposed disturbance area is approximately 18 km from 1930. *Leipoa ocellata* was not recorded during any on-ground surveys and there is a low likelihood that this species still persists in the Proposal area and therefore *L. ocellata* will not be assessed further in this report.

***Lophoictinia isura* (square-tailed kite)**

Lophoictinia isura inhabits heathlands, woodlands, forests, tropical and subtropical rainforests, timbered watercourses, and hills and gorges across much of Australia except the central and inland south (Pizzey & Knight, 2012). *Lophoictinia isura* is rare, sparse and partly migratory (Pizzey & Knight, 2012). *Lophoictinia isura* breeds between July and November and nests high in trees (Pizzey & Knight, 2012).

The closest record of *L. isura* to the Proposal area is approximately 4.5 km south in low open-shrubland habitat. There is a high likelihood that *L. isura* will be present in the Proposal area when resource availability is suitable. However the species (listed as Nt under the TPWC Act) is widespread and there is no critical habitat for *L. isura* within the Proposal area. Therefore, the species does not have conservation significance within the Proposal area and will not be assessed further in this report.

***Neophema splendida* (scarlet-chested parrot)**

Neophema splendida is distributed across southern inland Australia and inhabits mallee and other eucalypt woodlands, and habitats with mulga and other acacias, belah and other she-oaks, spinifex, saltbush and succulents (Pizzey & Knight, 2012). *Neophema splendida* is highly nomadic and irruptive and has a core range in the Great Victoria Desert in SA/WA, and extends its range in good seasons as far as SW Qld, western NSW and north western Victoria and north to near Alice Springs (Pizzey & Knight, 2012). Breeding occurs from August to December and the species nests in hollows of eucalypts and mulga (Pizzey & Knight, 2012).

Neophema splendida was recorded within the mine lease during the October 2012 survey in spinifex hummock grassland habitat. The species is listed as Nt under the TPWC Act but has a large core populations SA and WA and would occur in the Proposal area only during population irruptions. Therefore, the species does not have conservation significance in the Proposal area and will not be assessed further in this report.

***Pezoporus occidentalis* (night parrot)**

Pezoporus occidentalis is restricted to arid and semi-arid Australia. The distribution of *P. occidentalis* has not been well documented but records are known from northern WA, SA, NSW and western QLD (Pavey, 2006b). The species was widely considered to be extinct before a specimen was discovered in near Boulia and Cloncurry in Qld in 1990 (Pavey, 2006b). More recently, a small population of *P. occidentalis* was detected in western QLD, confirming its persistence (Pyke & Ehrlich, 2014). The species was apparently relatively common in central Australia prior to the 1920's; however there are only unconfirmed records post-1950 (Pavey, 2006b).

Records of *P. occidentalis* are primarily from spinifex (*Triodia* sp.) hummock grasslands in stony or sandy areas and chenopod shrublands on floodplains, salt lakes and claypans, likely being more common in the former (Pavey, 2006b; Pyke & Ehrlich, 2014). *Pezoporus occidentalis* roosts and nests within clumps of these plants and feeds on their seeds (Pyke & Ehrlich, 2014). *Pezoporus occidentalis* is nocturnal and Pyke & Ehrlich (2014) suggest that they are sendentary, but may occasionally fly to and from the areas where they spend most of their time to water sources. Pavey (2006), however, states that *P. occidentalis* appears to be highly nomadic in response to food and water availability, highlighting the lack of consistent information about the ecology of the species. *Pezoporus occidentalis* becomes active during dusk, and generally flies to water before foraging (Pavey, 2006b). The species is said to breed after abundant rainfall, but this is not confirmed. *Pezoporus occidentalis* appears to have suffered widespread decline and local extinction throughout its range beginning prior to the end of the 19th century (Pyke & Ehrlich, 2014). Suggested causes of this decline include overgrazing of vegetation by rabbits, predation by introduced cats and foxes, stock grazing and altered fire regimes (Pyke & Ehrlich, 2014).

The closest NT Fauna Atlas record of *P. occidentalis* to the proposed disturbance area is approximately 52 km south-east and dated 1930. This record is within the Simpson landsystem, which is described as parallell, reticulate and irregular sand dunes with stable flanks with red dune sands and red clayey sands, minor areas of mobile sand and spinifex vegetation. This record is located within vegetation type 83 – *Triodia basedowii* (hard spinifex) or *T. pungens* (soft spinifex) hummock grassland with *Eucalytpus gamophylla* (blue mallee), *Acacia* tall sparse-shrubland overstorey. This land system and vegetation type occur together over much of the proposed disturbance area and broader Proposal area. Therefore, there is potentially suitable habitat for *P. occidentalis* within the Proposal area, but the species is unlikely to be present as it is generally accepted to be extinct in the region due to the presence of the threatening processes discussed above. This species was not recorded during on-ground surveys. There is a low likelihood that *P. occidentalis* is present in the Proposal area, and will not be assessed further in this report.

***Polytelis alexandrae* (princess parrot)**

Polytelis alexandrae has a patchy and irregular distribution in the arid zone of WA, NT and SA (Pavey, 2006c; Pavey, et al., 2014). Within the NT, *P. alexandrae* has been recorded from the southern Tanami in the north, south of Yulara and Angas Downs and east to Alice Springs (Pavey, 2006c). The exact distribution within the NT range is unclear as records are irregular and patchy, and there may be long intervals (up to 20 years) between them (Pavey, 2006c). Originally referred to as nomadic or migratory, it is now generally accepted that *P. alexandrae* is irruptive, with a core range that is possibly centred on the Great Sandy Desert and the eastern Gibson Desert and western Great Victoria Desert (Pavey, et al., 2014). *Polytelis alexandrae* has been recorded from sandplain environments with vegetation characterised by *Eremophila, Grevillea* and *Hakea* shrubs with scattered trees and less frequently in riverine forest, woodland and shrubland habitats (Pavey, 2006c). *Polytelis alexandrae* forages on the ground and in the foliage of shrubs and trees (Pavey, 2006c; Pavey, et al., 2014). The diet consists of flowers, seeds and other material from a wide range of plants (Pavey, 2006c; Pavey, et al., 2014). *Polytelis alexandrae* breeds in the hollows of *Eucalyptus* trees, predominantly river red gum (*E. camaldulensis*), but also marble gum (*E. gongylocarpa*) and other hollow bearing Eucalypts (Pavey, 2006c; Pavey, et al., 2014). Breeding has been observed between August and November and in January in response to a high continuous rainfall event (Pavey, et al., 2014). Possible causes of decline in this species are environmental degradation and habitat homogenisation post-European settlement in the arid zone, which may have been exacerbated by grazing of rabbits and other introduced herbivores and altered fire regimes (Pavey, 2006c). Local impacts to breeding colonies can also occur through the collection of eggs and fledglings from nests for the overseas bird trade (Pavey, 2006c).

The closest record of *P. alexandrae* to the proposed disturbance area is approximately 57 km. It is located within the Amadeus land system, which is described as saline pans with waterlogged clays that are unvegetated or fringed with samphire and fringing dunes of red sand with spinifex. The record is within vegetation type 82 – *T. basedowii* hummock grassland with *E. gamophylla* (blue mallee) tall sparse-shrubland overstorey between dunes. This vegetation type occurs along a portion of the proposed access road. However, it occurs within the Angas and Singleton landsystems here. As this species is likely to be inhabiting areas based on breeding habitat (i.e. breeding hollows in trees), vegetation type, rather than land system, could be more important for identifying potentially suitable habitat. Areas within the Proposal area, such as sandplain, hills and low ranges and creekline and riverine areas with hollow bearing trees may be suitable habitat for *P. alexandrae*. *Polytelis alexandrae* was not recorded during any on-ground surveys. This species is known to occur irregularly in different areas and is thought to be irruptive and, therefore, there is a moderate that the species will inhabitat the Proposal area when resources are suitable.

***Pyrrholaemus brunneus* (redthroat)**

Pyrrholaemus brunneus is distributed across much of inland Australia, inhabiting inland scrubs with mulga and other acacias, mallee associations with spinifex, eucalypt regrowth, tea-tree, saltbush and bluebush (Pizzey & Knight, 2012). It breeds between August and November and nests in low shrubs, spinifex and occasionally tree hollows (Pizzey & Knight, 2012).

Pyrrholaemus brunneus was recorded within the exploration lease during the October 2012 survey in low sparse-shrubland habitat. There are also records of *P. brunneus* from the NT Fauna Atlas in the area of interest in tall sparse-shrubland, spinifex hummock grassland and low open-shrubland. There is a high likelihood the species will occur within the Proposal area. The species is listed as Nt under the TPWC Act, but is widespread and not uncommon, and there is no critical habitat for *P. brunneus* in the Proposal area. The fore the species is not considered to have conservation significance in the Proposal area and will not be assessed further in this report.

***Rostratula australis* (Australian painted snipe)**

The taxonomy of *R. australis* has been unclear in the past. It was originally described as a species distinct from *R. benghalensis* (painted snipe), but the two were synonomised by Peters (1934) (Baker, et al., 2007). Although the reason for this was uncertain, this classification was followed until recently when Lane & Rogers (2000) proposed species level separation (Baker, et al., 2007). *Rostratula australis* is considered a full species under the EPBC Act and TPWC Act. It is thought that *R. benghalensis* and *R. australia* are geographically separated and that *R. australis* does not migrate outside of Australia (Lane & Rogers, 2000; Baker, et al., 2007). Therefore, the identification of *R. benghalensis* by the EPBC PMST in the Proposal area is thought to be erroneous and this species will not be discussed any further.

The majority of *R. australis* records are from south eastern Australia, particularly in the Murray-Darling Basin region (Taylor, et al., 2013). In the NT, *R. australis* has been recorded on the Barkly Tablelands, at Lake Woods and Sturt Plateau, but may occur in the northern NT or on any shallow ephemeral wetlands in central or southern NT (Taylor, et al., 2013). Most records of *R. australis* are from shallow inland wetlands, either fresh or brackish, which may be temporarily or ephemerally filled (Lane & Rogers, 2000). There are no sites where *R. australis* is known to be resident or even regular in occurrence, suggesting the species may be nomadic (Lane & Rogers, 2000). *Rostratula australis* feeds mainly at night on a diet of seed and invertebrates at the waters edge and on mudflats, and nests on the ground (Taylor, et al., 2013). There appears to have been a consistent and dramatic decline of this species since the 1970's particularly in the south eastern inland parts of its range, thought to be driven by the drainage of wetlands for irrigated agriculture (Lane & Rogers, 2000). The decline of *R. australis* in the Kimberley has been attributed to degradation of habitat by cattle (Johnstone & Storr, 1998 as cited in Taylor *et a*., 2013). As most habitat suitable for this species in the NT is located on pastoral land, degradation by cattle may also be an issue, but there is not data with which to assess this (Taylor, et al., 2013). The replacement of native wetland vegetation by weeds may also reduce habitat suitability for *R. australis* (Garnett, et al., 2011). Though there is no evidence that predation by feral mammals has caused decline in *R. australis,* it is a potential threat (Garnett, *et al*., 2011; DoE, 2016g).

The closest record of *R. australis* to the proposed disturbance area is approximately 85 km north west of the western end of the proposed access road. This species inhabits shallow inland wetlands, which are ephemeral within the Proposal area. This species was not recorded during any on-ground surveys, and is only likely to be present during high rainfall periods. There is a moderate likelihood that this species may be present within the Proposal area during times of high rainfall.

***Croitana aestiva* (desert sand-skipper)**

Croitana aestiva is endemic to the southern NT, known only from a 1,400 km^2 area in the West MacDonnel Ranges as far west as Mt Liebig, 260 km west of Alice Springs (Palmer, et al., 2012). The distribution of *C. aestiva* is driven by the presence of the larval food plant, *Neurachne tenuifolia*, which occupies sheltered slopes and gorges within the Chewings and Heavitree Ranges (Palmer, et al., 2012). Adult emergence and abundance are dependent on rainfall (Palmer, et al., 2012). As the larval food plant *N. tenuifolia* is likely to be intolerant to fire the combination of exotic grass invasion (particularly buffel grass) and altered fire regimes is likely to be a threat to this species (Palmer, et al., 2012).

It is unknown how far the nearest record of *C. aestiva* is to the proposed disturbance area, as records of this species are not included in the NT Fauna Atlas. However, the closest record of *N. tenuifolia* is approximately 100 km north of the proposed disturbance area in the West MacDonnell Ranges. Neither *C. aestiva* nor *N. tenuifolia* were recorded during on-ground surveys of the Proposal area. As both these species appear to be confined to the West MacDonnel Ranges, there is a low likelihood that *C. aestiva* is present in the Proposal area or area of interest and therefore the species will not be discussed further in this report.

***Antechinomys laniger* (kultarr)**

Antechinomys laniger is irruptive and patchily distributed across arid Australia from south western Qld and western NSW, through SA and southern NT to central and south WA (Menkhorst & Knight, 2011). *Antechinomys laniger* inhabits desert plains, stony and sandy land where grasses and small shrubs constitute the main vegetation and *Acacia* scrubland (Valente, 2008). It shelters in logs or stumps, beneath saltbush and spinifex, in deep cracks at the base of *Acacia* and *Eremophila* trees and the burrows of other animals, but it is not known if the species digs its own burrows (Valente, 2008). Pouch young have been recorded between August and November, and populations fluctuate seasonally (Valente, 2008).

Antechinomys laniger has been recorded within the Proposal area approximately 4.5 km south east of the mine lease in spinifex hummock grassland habitat. There is potentially suitable habitat throughout the Proposal area, and there is a high likelihood that the species is present. Listed as Nt under the TPWC Act, the species is sporadically common in the region, particularly during population irruptions. If *A. laniger* does irrupt in the Proposal area there is a low risk of impact of the Proposal on the species.

***Dasycercus blythi* (brush-tailed mulgara)**

Dasycercus blythi is listed as vulnerable under the TPWC Act. Woolley *et a*. (2013) have provided updated distribution maps of the two *Dasycercus* species based on their interrogation of museum specimens, and show that *D. blythi* has a wide distribution across the Australian arid zone from the Simpson Desert Region of south west NT, south west QLD and north east SA, west to central north WA (Woolley, et al., 2013). *Dasycercus blythi* inhabits sandplain, gibber plain and cracking clay habitats supporting tussock or hummock grasslands (Dickman, *et al*., 2001; Pavey, *et al*., 2011; L. Young, unpublished data). *Dasycercus blythi* feeds on rodents, other dasyurid marsupials, reptiles, small birds and invertebrates (Pavey, et al., 2009). Reproduction can occur in June to September/October, and potentially later in the year (Pavey, et al., 2011). Potential threatening processes include altered fire regimes, grazing by introduced herbivores and predation by introduced predators (Pavey, et al., 2006a).

The closest record of *D. blythi* to the proposed disturbance area is approximately 78 km south east. This record is located in the Rumbulara land system, which is described as stony plateaux with relief up to 300 ft, little soil with sparse shrubs and sparse grass. Spur and lowland areas also occur with stone-mantled texture-contrast soils with *Sclerolaena* sp. or saltbush vegetation. The record is also located in vegetation type 110 – *Atriplex vesicaria* (bladder saltbush) low sparse-shrubland with ephemeral open-herb/grassland, which is located in the east of the proposed disturbance area. However *D. blythi*, as described above, inhabits a wide range of habitats. Some of these habitats (e.g. sandplain) are present in the proposed disturbance area. *Dasycercus* sp. tracks were observed at site S22, located outside the mine lease, approximately 0.5 km north of the proposed Chandler Haul Road route, during the June 2015 survey, though it is not possible to identify these tracks to the species level and a motion sensing camera trap was not successful in capturing an image of the mulgara. *Dasycercus blythi* undergoes population peaks and troughs and can shift its local range, and although it was not directly recorded during any on-ground surveys, there is a high likelihood that this species is present in the Proposal area.

***Dasycercus cristicauda* (crest-tailed mulgara)**

As discussed above, until relatively recently, the taxonomic distinction between *Dasycercus cristicauda* and its congeneric *D. blythi* was ambiguous, but has been clarified by Woolley (2005). This lack of taxonomic clarity has led to a lack of clarity in the distribution of the two species, as it is difficult to relate the current taxonomy to records prior to the acceptance of this taxonomic revision. The distribution maps produced by Woolley *et al.* (2013) show that the distribution of *D. cristicauda* is driven largely by the distribution of dunefields and appears to be confined largely to the Simpson Desert area of southern NT, north eastern SA and south west QLD.

In the southern NT, a population of *D. cristicauda* inhabits the slopes and crests of sandridges with a high cover of *Triodia basedowii* and a relatively high abundance of ephemeral plant species with large seed crops (Pavey, et al., 2011). More recently *D. cristicauda* has been recorded on a dune slope with sandhill canegrass (*Zygochloa paradoxa*) (L. Young, unpublished data), which conforms to the description of habitat by Masters (2008). *Dasycercus cristicauda* is a nocturnal species, which constructs burrows at the base of *Triodia* and *Z. paradoxa* hummocks (Pavey, et al., 2006b; Pavey, et al., 2011). Breeding has been observed during June and September (Pavey, et al., 2011). *Dasycercus cristicauda* is carnivorous and its diet includes invertebrates, reptiles and small mammals (Pavey, et al., 2006b). Threats to *D. cristicauda* may include predation by introduced predators, altered fire regimes and grazing by introduced herbivores (Pavey, et al., 2006b; Pavey, et al., 2011).

The closest record of *D. cristicauda* to the Proposal area is approximately 140 km south east. These records are from sand ridges on the western edge of the Simpson Desert, which support *Z. paradoxa* or *T. basedowii* hummock grasslands. *Triodia* sp. sand dunes are present within the Proposal area, and although this species was not directly recorded during on-ground surveys (see comment on *Dasycercus* sp. tracks above) there is a high likelihood that it is present in the Proposal area.

***Isoodon auratus* (golden bandicoot)**

Isoodon auratus historically occurred over most of northern, central and western Australia across a variety of habitats (Palmer, et al., 2012). However, the last specimen from the deserts of NT was in 1952 from The Granites (Palmer, et al., 2012). Given this information, it is unlikely that *I. auratus* persists in central Australia. The only study of the ecology of *I. auratus* was from Marchinbar Island north of Nhulunbuy, NT where it occurs in heathland and shrubland on sandstone or sandsheets, and avoids vegetation with greater tree cover (Palmer, et al., 2012). Threats to the persistence of *I. auratus* include feral dog and cat predation and inappropriate fire regimes (Palmer, et al., 2012).

The closest record of *I. auratus* to the proposed disturbance area is approximately 15 km north. This is a record from before 1971 (Palmer, et al., 2012). As discussed above, *I. auratus* has not been recorded in central Australia since 1952 and is considered locally extinct. Therefore there is a low likelihood that *I. auratus* is present within the Proposal area and the species will not be discussed further in this report.

***Macrotis lagotis* (greater bilby)**

Macrotis lagotis is a nocturnal medium-size marsupial, originally distributed across 70% of the Australian mainland but now restricted to 20% of its former range in south west QLD and an area extending from the western deserts of the NT and WA north to the Pilbara and Kimberley regions (Pavey, 2006d). *Macrotis lagotis* occurs in a wide variety of habitats that can be classified into three major groups; sparse grassland/forbland on uplands and hills with a low fire frequency, mulga scrub/ woodlands on ridges and rises with an infrequent (20-50 year) fire interval and hummock grassland/ mixed shrub or woodland steppe on plains and alluvial areas with a high (4-10 year) fire frequency (Southgate, 1990b). In the sandy deserts, *M. lagotis* appears to exhibit low site fidelity and high mobility and it is thought that movement of groups is in response to spatial and temporal variability in resource availability (Southgate, et al., 2007). *Macrotis lagotis* is an opportunistic omnivore with a diet consisting of termites, ants, beetles, larvae, grasshoppers, spiders, *Cyperus bulbosus* bulbs, seeds, fruit and fungi (Gibson, 2001; Southgate & Carthew, 2006). It appears that *M. lagotis* can breed at any time of the year in response to resource availability (McCracken, 1990; Southgate, et al., 2000). Threats to *M. lagotis* include predation by introduced predators, habitat degradation by introduced herbivores, altered fire regimes, drought, road mortality and habitat destruction and degradation resulting from mining and other development (Pavey, 2006d).

The closest records of *M. lagotis* to the Proposal area is approximately 80 km north east and 80 km south west. Habitat available in the Proposal area is consistent with those described by (Southgate, 1990b) and, therefore, potentially suitable for *M. lagotis.* However, the most recent of these records was from 1969. *Macrotis lagotis* was not recorded during any of the on-ground surveys. It is generally accepted that *M. lagotis* no longer occurs within this region. Therefore, there is a low likelihood that this species is present in the Proposal area and the species will not be discussed further in this report.

***Notomys cervinus* (fawn hopping-mouse)**

Notomys cervinus are found on gibber plains and claypans of the Lake Eyre Basin in north east SA and south west QLD (Pavey & Ward, 2012c). There are records from the Charlotte Waters area in NT from 1895 and more recent, but disputed, records from Uluru-KataTjuta National Park and Curtin Springs (Pavey & Ward, 2012c). *Notomys cervinus* is a burrowing rodent that feeds primarily on seeds but also green plant material and insects (Pavey & Ward, 2012c). Breeding occurs opportunistically when conditions are favourable (Pavey & Ward, 2012c). Possible threatening processes impacting *N. cervinus* are habitat degradation, predation by cats and foxes and competition with introduced herbivores (Pavey & Ward, 2012c).

Given that *N. cervinus* is considered extinct in the NT, and there is no potential contemporary habitat for the species within the Proposal area, there is a low likelihood that it will be present and the species will not be discussed further in this report.

***Notoryctes typhlops* (southern marsupial mole)**

Notoryctes typhlops occurs in the sandy deserts of central WA, northern SA and the NT (Pavey, 2015). In these areas, *N. typhlops* occupies dunes, sandy plains and river flats (Pavey, 2015). Aboriginal people have indicated that *N. typhlops* needs soft sandy substrates and cannot tunnel through hard or loamy substrates that occur in swales between widely spaced dunes (Pavey, 2015). The diet of *N. typhlops* includes invertebrates and geckoes (Winkel & Humphrey-Smith, 1988). *Notoryctes typhlops* tunnels through the sand, back-filling as they move along (Pavey, 2015). *Notoryctes typhlops* rarely comes to the surface and seems more inclined to do so in the summer (January to March) after rain in areas with mid-aged or long-unburnt vegeatation (Bennison, et al., 2014). Threats to *N. typhlops* are hard to determine, but may include predation by introduced predators and dingos when above ground, soil compaction by stock movement or vehicles and a change in the abundance of prey items due to altered fire regimes and grazing (Pavey, 2015).

The closest record of *N. typhlops* to the proposed disturbance area is approximately 12 km north west. This record is from 1966. Due to the cryptic nature of *N. typhlops* it is difficult to survey appropriately and a lack of records may reflect this and not the true distribution of the species. Trenches were dug to survey for *N. typhlops* during on-ground surveys and sign of the species was recorded at Site r1 on the western bank of the Finke River and fi-a on the eastern bank on the Finke River, therefore there is a high likelihood of occurrence.

***Petrogale lateralis* (black-footed rock-wallaby [MacDonnell Ranges Race])**

The distribution of *Petrogale lateralis* spans from the Davenport and Murchison Ranges in the north, east to the Jervois Range, west to the WA border and south to the SA border (Pavey, 2006e). *Petrogale lateralis* is also present in the Gibson Desert of WA and in the Anangu-Pitjatjantjara land of northern SA (Pavey, 2006e). Geomorphological features favoured by *P. lateralis* are steep slopes, cuestas, deep gorges and boulder scree slopes, which are common in quartzite ranges where the majority of *P. lateralis* records are from (Gibson, 2000). Individuals emerge late in the afternoon or early evening to feed mainly on grass (Eldridge & Close, 1995). Breeding may be influenced by seasonal factors and is potentially continuous (Pavey, 2006e). Threats to *P. lateralis* include predation by introduced and native predators and competition for food and shelter by introduced herbivores, altered fire regimes, habitat destruction from clearing, mining and quarrying, habitat degradation by invasive weeds, small population sizes and fragmentation, disease, disturbance by tourists, drought and climate change (Pearson, 2013).

The closest record of *P. lateralis* to the proposed disturbance area is approximately 30 km north in the Sonder land system. The Sonder land system is described as bold quartzite and sandstone ridges with rocky cliffs, steep slopes and very little soil supporting spinifex vegetation. This species was not recorded during on-ground surveys. Rocky hills investigated during on-ground surveys did not appear to provide suitable habitat for *P. lateralis* within the Proposal area due to lack of geomorphological features described above. There have also been no historical records of *P. lateralis* from the Proposal area. Therefore, there is a low likelihood that *P. lateralis* occurs within the Proposal area and the species will not be discussed further in this report.

***Rattus tunneyi* (pale field rat)**

Historically *Rattus tunneyi* was widespread in dense vegetation along creeks throughout much of continental Australia (Braithwaite & Griffiths, 1996; Young & Hill, 2012). However, it suffered an 85% decline in distribution over less than 100 years and is currently distributed throughout higher rainfall areas of the Kimberley through northern NT to south eastern QLD (Braithwaite & Griffiths, 1996; Young & Hill, 2012). In these areas, *R. tunneyi* is reliant on riparian vegetation in the savanna of tropical Australia (Braithwaite & Griffiths, 1996). *Rattus tunneyi* is nocturnal and shelters in burrows during the day and feeds on seed, fruit, other plant material and insects (Braithwaite & Griffiths, 1996; Young & Hill, 2012).

The closest record of *R. tunneyi* to the proposed disturbance area is 12 km north east. This record is from 1975 and as discussed above, it is not thought to currently persist in central Australia. No suitable habitat was identified during on-ground surveys. This species was not recorded during on-ground surveys. Therefore, the is a low likelihood that *R. tunneyi* is present in the Proposal area and the species will not be discussed further in this report.

***Zyzomys pedunculatus* (central rock-rat)**

Zyzomys pedunculatus was considered extinct in 1990 after not being recorded for 30 years (Wurst, 1990 as cited in Nano, *et a*. 2003). The species was subsequently rediscovered in a remote area of the West MacDonnell Ranges in 1996 (Nano, et al., 2003). *Zyzomys pedunculatus* is confined to high elevation (>1,000 m) quartzite ridges and mountain peaks in the West MacDonnell Ranges, west of Alice Springs (McDonald, et al., 2013). The species is irruptive, with reproduction and subsequent population peaks driven by dramatic increases in primary productivity (Edwards, 2013). During these times, it may become locally abundant in a wider variety of rocky habitats (Edwards, 2013). The diet of *Z. pedunculatus* includes predominantly seed and leaf, with a small proportion of stem and invertebrates (Nano, et al., 2003). Potential threatening processes impacting *Z. pedunculatus* include predation by dingos and cats and inappropriate fire regimes (McDonald, 2012a).

The closest record of *Z. pedunculatus* to the proposed disturbance area is approximately 30 km north. This record is from prior to 1971 (McDonald, 2012a). *Zyzomys pedunculatus* is currently restricted to rugged quartzite ridges >1,000 m high in the West MacDonnell Ranges. There is no habitat matching this description in the Proposal area and there is a low likelihood that *Z.*

pedunculatus will be present in the Proposal area and the species will not be assessed further in this report.

***Delma demosa* (desert delma)**

Delma desmosa is distributed across the arid regions of WA through the Great Sandy, Gibson and northern Great Victoria Deserts to the Tanami Desert, NT and the north west corner of SA (Cogger, 2014). *Delma desmosa* is a terrestrial species found in a variety of rocky and sandy habitats, under rocks or litter and often in association with open spinifex grassland or spinifex under *Acacia* or eucalypt scrub (Cogger, 2014).

The closest record of *D. desmosa* to the Proposal area is approximately 13 km north in spinifex hummock grassland habitat. There is a high likelihood that *D. desmosa* is present within the Proposal area. *Delma demosa*, listed as data deficient, occurs in habitat which is present throughout the region as well as occuring in the Proposal area, thus any impact of the Proposal on the species will have little significance and therefore the species will not be assessed further in this report.

***Liopholis kintorei* (great desert skink)**

Liopholis kintorei is an endemic arid zone skink, occurring from Uluru-Kata Tjuta National Park north to Rabbit Flat in the Tanami Desert (Pavey, 2006f). *Liopholis kintorei* also occurs in north western SA and in the Gibson Desert and sections of the Great Sandy Desert in WA (Pavey, 2006f). *Liopholis kintorei* is predominantly found in sandplains and adjacent swales containing *Triodia* grassland vegetation and scattered shrubs, but can occupy a range of vegetation types such as lateritic palaeodrainage lines within *Melaleuca* shrubs in the Tanami Desert (McAlpin, 2001). *Liopholis kintorei* is omnivorous, with a diet including plant matter, invertebrates and small vertebrates (McAlpin, 2001). The species' burrows are identifiable by at least one large external latrine (McAlpin, 2001). Breeding occurs between December and February (Pavey, 2006f). Fire, particularly that which takes out all ground cover, has been found to adversely effect *L. kintorei* in spinifex grasslands, and large scale intense fires resulting from a cessation of traditional patch burning may threaten the species (McAlpin, 2001; Moore, et al., 2015). Other potential threatening processes impacting *L. kintorei* include predation by introduced and native predators and increasing tourism pressure, particularly at Yulara (McAlpin, 2001; Pavey, 2006f).

The closest record of *L. kintorei* to the proposed disturbance area is approximately 100 km south west of the western end of the proposed access road. There is potentially suitable habitat for this species within the Proposal area, as much of it consists of sandplain habitat with *Triodia* grassland vegetation. This species was not recorded during on-ground surveys. However, due to potential suitability of habitat there is a low-moderate likelihood that *L. kintorei* could be present in the Proposal area.

***Liopholis slateri slateri* (Slater's skink)**

Liopholis slateri includes two subspecies, *L. slateri slateri* in southern NT and *L. slateri virgata* in northern SA (McDonald, 2012b). *Liopholis slateri slateri* has been recorded from the Finke and MacDonnell Ranges bioregions where it occurs on plains in the valleys of major drainages (Pavey, 2004). At most sites, *L. slateri slateri* inhabits shrubland and open shrubland on alluvial soils close to drainage lines (McDonald, 2012b). The species has also been recorded in an isolated dune supporting shrubland, low rolling calcareous rises with 60% spinifex cover, and on an elevated, narrow, rocky creek-line (Pavey, 2004). *Liopholis slateri slateri* digs complex burrows in the low pedestal of soil that builds up under small shrubs, and occassionally burrows under tussock or hummock grasses or fallen timber (McDonald, 2012b). It is a diurnal and crepuscular skink, and has an insectivorous diet (McDonald, 2012b). Buffel grass invasion and the associated changes in fire regimes are a likely threat to the persistence of *L. s. slateri* in central Australia (Pavey, 2004; McDonald, 2012b).

The closest record of *L. s. slateri* to the proposed disturbance area is approximately 67 km north east of the western end of the proposed access road. While there are shrublands and open-shrublands on alluvial soils close to drainage lines within the Proposal area, *L. s. slateri* was not recorded during on-ground surveys. There is a low-moderate likelihood that *L. s. slateri* is present within the Proposal area.

***Pseudechis australis* (king brown snake)**

Pseudechis australis is widely distributed across mainland Australia, except in the humid eastern and southern areas, and inhabits a wide variety of habitats from tropical woodlands and monsoon forests to deserts (Wilson & Swan, 2013). *Pseudechis australis* shelters in any terrestrial sites available, including abandoned burrows, soil cracks and hollow logs, and is nocturnal or diurnal according to temperature (Wilson & Swan, 2013). The species is listed as Nt under the TPWC Act, but has a widespread distribution and is not uncommon. The fore *P. australis* is not considered to have conservation significance in the Proposal area.

The closest record of *P. australis* to the Proposal area is approximately 2 km east in spinifex hummock grassland habitat. There is a high likelihood that *P. australis* is present within the Proposal area. The species is not in decline in southern NT and does not have conservation significance in the proposal area. Therefore *P. australis* will not be discussed further in this report.

3.9.3 Migratory species

Eight migratory species were also identified by the PMST, all of which are also listed marine species (Table 3-7). An additional two migratory species, *Calidris acuminata* and *Tringa nebularia* were identified by the NT Fauna Atlas in the area of interest. Three migratory species, including one not identified by the PMST or NT Fauna Atlas, were recorded during on-ground surveys. There is no important habitat for any of these migratory species within the Proposal area.

Table 3-7: Fauna species listed as migratory under the EPBC Act as identified by the PMST and the NT Fauna Atlas as occurring or having potentially suitable habitat within the Area of Interest, their occurrence during on-ground surveys, relevant international agreements and likelihood of occurrence in the Proposal area.
Mi: Migratory; Ma: Marine J: Japan-Australia Migratory Bird Agreement; C: China-Australia Migratory Bird Agreement; R: Republic of Korea-Australia Migratory Bird Agreement; B: Bonn Convention (Convention on the Conservation of Migratory Species of Wild Animals)

Scientific name	Common name	PMST	NT Fauna Atlas	On-ground	International Agreements	Likelihood
Apus pacificus	Fork-tailed swift	X	-	-	J, C, R	Mod
Ardea modesta	Eastern great egret	X	-	-		Mod
Calidris acuminata	Sharp-tailed sandpiper	-	X	X	B, J, C, R	High
Charadrius veredus	Oriental plover	X	-	-	B, J, C, R	Mod
Glareola maldivarum	Oriental pratincole	X	-	-	J, C, R	Mod
Merops ornatus	Rainbow bee-eater	X	X	X		High
Motacilla cinerea	Grey wagtail	X	-	-	J, C, R	Low
Motacilla flava	Yellow wagtail	X	-	-	J, C, R	Low
Pandion haliaetus	Osprey	X	-	-	B	Low
Tringa nebularia	Common greenshank	-	X	-	B, J, C, R	High
Tringa stagnatilis	Marsh sandpiper	-	-	X	B, J, C, R	High

Fork-tailed swift *Apus pacificus*

Apus pacificus occurs mostly over inland plains, but sometimes above foothills, in dry or open habitats, including riparian woodland, tea-tree swamps, low scrub, heathland or saltmarsh (DoE, 2016a). *Apus pacificus* does not breed in Australia, but in Siberia in August-September (Department of Environment, 2016b). The species arrives in Australia around October each year and stays in the Northern Territory until late-April (Department of Environment, 2016b). Potential threats impacting *A. pacificus* include habitat destruction and predation by feral animals (Department of Environment, 2016b). The closest record of *A. pacificus* to the Proposal area is approximately 65 km north. There is potentially suitable habitat for *A. pacificus* within the Proposal area, particularly after high rainfall. There is a moderate likelihood that this species will occur in the Proposal area after high rainfall. *Apus pacificus* does not breed in Australia and is not likely to be in the Proposal area in high numbers.

Eastern great egret *Ardea modesta* (Great Egret *A. alba*)

Ardea modesta was originally treated as a subspecies of *Ardea alba,* but was recently elevated to full species status (Christidis & Boles, 2008). *Ardea modesta* is widespread in Australia, occurring in all states and territories (Department of Environment, 2016c). *Ardea modesta* occurs in a wide range of usually shallow wetland habitats including swamps and marshes, margins of rivers and lakes, damp or flooded grasslands, agricultural land, sewage ponds, drainage channels, salt pans, salt lakes, salt marshes, estuarine mudflats, tidal streams, mangrove swamps, coastal lagoons and offshore reefs (Department of Environment, 2016c). Threats impacting *A. alba* are loss and/or degradation of foraging and breeding habitat through alteration of water flows, drainage and/or clearing of wetlands for development, frequent burning of wetland vegetation, salinization and invasion by exotic plants (Department of Environment, 2016c).

The closest record of *A. modesta* to the Proposal area is approximately 22 km south. This species inhabits shallow wetlands. Therefore there is the potential for suitable habitat to be present in the Proposal area after high rainfall. There is a moderate chance that *A. modesta* may occur in the Proposal area after high rainfall in low numbers.

Sharp-tailed sandpiper *Calidris acuminata*

Most of the global population of *C. acuminata* occurs in Australia during the non-breeding season (Department of Environment, 2016d). *Calidris acuminata* begins arriving in Australia in mid-August, and temporarily occur in the inland wetlands of arid and east Australia between August and December (Department of Environment, 2016d). The species departs by April, with records from the arid inland between February to April (Department of Environment, 2016d). *Calidris acuminata* occupies shallow fresh or brackish wetlands, including sewage ponds, dams, waterholes, soaks, bore drains and bore swamps, saltpans and salt lakes in inland areas (Department of Environment, 2016d). Threats impacting *C. acuminata* in Australia include habitat loss and degradation (Department of Environment, 2016d).

There are two records of *C. acuminata* within the Proposal area, one 2.9 km west of the access track into the mine lease, and one 7 km south of the mine lease. This species was observed incidentally within the mine lease during the October 2012 survey. *Calidris acuminata* has a high likelihood of occurring in the Proposal area during the non-breeding season.

Oriental plover *Charadrius veredus*

The global population of *C. veredus* occurs in coastal and inland areas of Australia during the non-breeding season (Department of Environment, 2016e). *Charadrius veredus* arrives in Australia in early-mid September and temporarily occupies coastal habitats before dispersing inland (Department of Environment, 2016e). The species generally leaves Australia between February and April (Department of Environment, 2016e). In inland Australia, *C. veredus* occupies flat, open, semi-arid or arid grasslands interspersed with hard bare ground such as claypans, or open areas that have been recently burnt (Department of Environment, 2016e). There are no known specific threats to *C. veredus* in Australia (Department of Environment, 2016e).

The closest record of *C. veredus* to the Proposal area is 100 km south east. *Charadrius veredus* does not breed in Australia. There is a moderate likelihood that this species could occur within the Proposal area following high rainfall in low numbers.

Oriental pratincole *Glareola maldivarum*

Most of the global migratory population of *G. maldivarum* is thought to spend the non-breeding season in Australia (Department of Environment, 2016f). *Glareola maldivarum* arrives in Australia between late October and early November and departs between mid-March and the first week of April (Department of Environment, 2016f). In Australia, *G. maldivarum* usually occupies open plains, floodplains or short grassland near terrestrial wetlands and artificial wetlands such as reservoirs and sewage ponds (Department of Environment, 2016f). There are no immediate threats known to impact *G. maldivarum* (Department of Environment, 2016f).

The closest record of *G. maldivarum* to the Proposal area is approximately 95 km north. *Glareola maldivarum* does not breed in Australia. There is a moderate likelihood that *G. maldivarum* may occur in the Proposal area after high rainfall.

Rainbow bee-eater *Merops ornatus*

Merops ornatus is found across most of mainland Australia, where the majority of the global population breeds (Department of Environment, 2016g). The movements of *M. ornatus* are complex and not well understood. The southern populations migrate northwards after breeding to northern Australia, Papua New Guinea and eastern Indonesia between February and June and remain there for the austral winter (Department of Environment, 2016g). Populations that migrate to other countries return to Australia between August and October, and return to breeding sites in southern Australia by November (Department of Environment, 2016g). *Merops ornatus* inhabits open forests and woodlands, shrublands, grasslands and riparian, floodplain or wetland vegetation assemblages in arid or semi-arid areas (Department of Environment, 2016g). The only threat identified to be impacting *M. ornatus* is the introduced cane toad (*Bufo marinus*) (Department of Environment, 2016g). Predation by introduced predators may also impact *M. ornatus* populations (Department of Environment, 2016g).

There are four records of *M. ornatus* within the mine lease and numerous others in the surrounding area. *Merops ornatus* was recorded regularly during the surveys in summer months in a range of habitats across the Proposal area, at three sites and incidentally between sites during the October 2012 survey, at four sites and incidentally while traversing between sites during the October 2015 survey and incidentally while traversing the Henbury Access Road during the November 2015 survey. *Merops ornatus* generally breeds at sites in southern Australia, and there is a low likelihood of the species breeding within the Proposal area. There is a high likelihood that *M. ornatus* will occur in the Proposal area each year during migration between the northern and southern parts of its range.

Grey wagtail *Motacilla cinerea*

Motacilla cinerea is a non-breeding summer visitor to Australia between November and April (Pizzey & Knight, 2012). In Australia *M. cinerea* has been recorded near running water in disused quarries, along sandy, rocky streams in escarpments and rainforests, and at sewage ponds, ploughed fields and airfields (Pizzey & Knight, 2012). Deterioration of water and soil quality threatens *M. cinerea* (Department of Environment, 2016h).

The closest record of *M. cinerea* to the Proposal area is approximately 85 km south. There is a low likelihood of occurrence in the Proposal area.

Yellow wagtail *Motacilla flava*

Motacilla flava was split into *M. flava* and *M. tschutschensus* by Christidis & Boles (2008). This taxonomy is not recognised under the EPBC Act. However the species is listed as *M. tschutschensus* (eastern yellow wagtail) in the NT. *Motacilla flava* is a non-breeding summer migrant to Australia, occurring in mainly coastal areas between November and April (Pizzey & Knight, 2012). In Australia, *M. flava* has been recorded in habitats with short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns (Pizzey & Knight, 2012).

The closest record of *M. flava* (listed as *M. tschutschensus* in the NT Fauna Atlas) to the Proposal area is approximately 100 km north. There is a low likelihood of occurrence in the Proposal area.

Eastern osprey *Pandion cristatus (*Osprey *P. haliaetus*)

Pandion haliaetus cristatus was recently elevated to full species status as *P. cristatus* (Christidis & Boles, 2008). The EPBC listing follows this taxonomy (Department of Environment, 2016i). The breeding range of *P. cristatus* in Australia extends around the northern coast of Australia, with an isolated breeding population on the coast of South Australia (Department of Environment, 2016i). *Pandion cristatus* has been recorded from mainly coastal habitats, but may occasionally travel inland along major rivers (Department of Environment, 2016i). They occupy a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes (Department of Environment, 2016i). There have been records of single birds in central Australia between May and December during years of average or above-average rainfall when fish are abundant in inland waterways (Department of Environment, 2016i). The main threat impacting *P. cristatus* in Australia is loss, degradation or alteration of habitat for urban or tourism development (Department of Environment, 2016i).

The closest record of *P. cristatus* is approximately 70 km north west of the western end of the proposed Henbury access road. Records of *P. cristatus* in central Australia are generally single birds, and it is not likely that *P. cristatus* will be found breeding in the Proposal area. There is a low likelihood of *P. cristatus* occurring in the study area.

Common greenshank *Tringa nebularia*

Tringa nebularia is a non-breeding migrant to Australia, but occurs in all types of wetlands and has the widest distribution of any shorebird in Australia (Department of Environment, 2016j). *Tringa nebularia* is widely but sparsely distributed throughout the Northern Territory (Department of Environment, 2016j). The species uses permanent and ephemeral terrestrial wetlands including swamps, lakes, dams, rivers, creeks, billabongs, waterholes, inundated floodplains, claypans and saltflats, sewage farms, saltworks dams, inundated rice crops and bores (Department of Environment, 2016j). *Tringa nebularia* forages on molluscs, crustaceans, insects, fish and frogs at the edges of wetlands and roosts in shallow pools and puddles and slightly elevated on rocks, sandbanks and small muddy islets (Department of Environment, 2016j). The species nests in a shallow scrape lined with some plant material on open ground, usually next to a piece of dead wood or beside rocks, trees, fences or sticks (Department of Environment, 2016j). *Tringa nebularia* arrives in Australia from August and leaves again from March (Department of Environment, 2016j). Threats to *T. nebularia* in Australia include loss or modification of habitat, increased silt, pollution, weeds or pest invasion, disturbance from human recreational activity, and the effects of introduced plant species on habitat suitability (Department of Environment, 2016j).

Tringa nebularia was identified by the NT Fauna Atlas approximately 20 km south of the Proposal area and approximately 20 km north of the western end of the access road. There is a high likelihood that this species will occur in the Proposal area during the non-breeding season.

Marsh sandpiper *Tringa stagnatilis*

Tringa stagnatilis occurs throughout Australia during the non-breeding season in permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, pools on inundated floodplains, intertidal mudflats and at sewage farms and saltworks (Department of Environment, 2016k). They are also less frequently recorded at reservoirs, waterholes, soaks, bore-drain swamps and flooded inland lakes (Department of Environment, 2016k). *Tringa stagnatilis* forages for insects and molluscs in shallow water at the edge of wetlands and roosts on tidal mudflats, near low saltmarsh and around inland swamps (Department of Environment, 2016k). *Tringa stagnatilis* arrive in Australia in September, move south between September and December and then start migrating north again in March-April (Department of Environment, 2016k). Some non-breeding birds stay in Australia during the breeding season (austral winter), with those who do mainly occurring in northern Australia (Department of Environment, 2016k). In Australia *T. stagnatilis* is threatened by habitat loss and degradation, disturbance from residential and recreational activities and direct mortality from activities such as wind farms in migration or movement pathways, aircraft strike, hunting and chemical and oil spills (Department of Environment, 2016k).

The NT Fauna Atlas identified a record of *T. stagnatilis* approximately 70 km north-west of the western end of the access road. There are also further records within a 100 km radius indicating that this species occurs in the area during the non-breeding season. *Tringa stagnatilis* was also recorded at incidentally in a small ephemeral waterhole in the Finke River during the November 2015 survey. *Tringa stagnatilis* has a high likelihood of occurring in the Proposal area during the non-breeding season.

3.9.4 Introduced fauna species

Seven introduced species were identified as potentially occurring within the area of interest by the EPBC PMST (Table 3-8). 124 records of eight introduced species were identified by the NT Fauna Atlas within the area of interest (Table 3-8). Seven of these species were recorded during on-ground surveys of the Proposal area (Table 3-8).

Table 3-8: **Introduced species identified as potentially occurring within the Proposal area, and recorded in the NT Fauna Atlas and during on-ground surveys**

Scientific name	Common name	EPBC PMST	NT Fauna Atlas	On-ground
Bos taurus	Domestic cattle	X	X	X
Camelus dromedarius	Camel	X	X	X
Canis lupis familiaris	Domestic dog	X		
Equus asinus	Donkey		X	X
Equus caballus	Horse		X	
Felis catus	Cat	X	X	X
Mus musculus	House mouse	X	X	X
Oryctolaugs cuniculus	Rabbit	X	X	X
Vulpes vulpes	Red fox	X	X	X

3.9.5 Fauna habitat in the Proposal area

Eleven broad habitat types have been identified in the Proposal area. There are seven habitats within EL29018, where the Chandler Facility is located (Figure 3-22) and one habitat type at the location of the Apirnta Facility. The Chandler access track passes through three habitat types (Figure 3-22), the Chandler haul road passes through seven habitat types (Figure 3-22, Figure 3-23), and the Henbury access road passes through nine habitat types (Figure 3-24).

Dunefield

The dunefields in the Proposal area are both parallel and reticulate with deep red-brown sandy loam soils and a moderate cover of clear and black crust (Figure 3-12). Despite the difference in dune articulation, vegetation assemblages at both were comparable. Dunefields in the Proposal area supported *Acacia aneura* (mulga) open to low open-woodland with a mixed *Acacia* midstorey and a grassy understorey. The overstorey at some sites included *Acacia decaisneana* (desert oak), *Acacia estrophiolata* (ironwood) and *Atalaya hemiglauca* (whitewood). The midstorey consisted of *Acacia* spp. and *Dodonaea viscosa angustissima* (narrow-leaved hop bush). The grassy understorey included *Eragrostis eriopoda* (woollybutt grass), *Triodia pungens* (soft spinifex), *Zygochloa paradoxa* (sandhill canegrass) and *Aristida holathera* (erect kerosene grass). Termite mounds were not observed at survey sites, and there was little cover of fallen logs.

Allocasuarina decaisneana provides important habitat for birds, reptiles and bats. *Pseudomys hermannsburgensis* (sandy inland mouse), *Ctenophorus nuchalis* (central netted dragon), *Diporiphora winneckei* (canegrass dragon), *Varanus giganteus* (perentie), *V. gouldii* (sand goanna), and *V. brevicauda* (short-tailed pygmy monitor) were recorded in the dunefield habitat within the Proposal area. Bat species recorded in this habitat include *Chalinolobus gouldii* (Gould's wattled bat) and *C. morio* (chocolate wattled bat), *Nyctophilus geoffroyi* (lesser long-eared bat) and *Scotorepens balstoni* (western broad-nosed bat). All bat species recorded are tree hollow dwelling and roosting in this habitat is likely (Churchill, 2008). Nineteen species of bird were recorded in this habitat type, including *Taeniopygia guttata* (zebra finch), *Corvus orru* (torresian crow), *Artamus cinereus* (black-faced woodswallow) and *Ocyphaps lophotes* (crested pigeon).

Secondary sign of macropod, rodent, dasyurid, bird and reptile were common during all seasons in this habitat type. Secondary sign of introduced species was also commonly recorded and species identified were donkey, cattle, house mouse, camel and red fox.

Although not detected, the dunefield habitat has the potential to support threatened species including *D. blythi, D. cristicauda* and *N. typhlops.* Other non-threatened species potentially occurring within the dunefield habitat are *Notomys alexis* (spinifex hopping-mouse), *Sminthopsis hirtipes* (hairy-footed dunnart), *S. youngsoni* (lesser hairy-footed dunnart) and frog species such as *Neobatrachus* spp.

Figure 3-12: Dunefield habitat

Sandplain

Sandplains are widespread within the Proposal area, including the lease area and along the proposed haul road. Sandplain habitat consisted of flat or gradually sloping plains of deep red-brown sandy loams with a small area containing ephemeral watercourses (Figure 3-13). The proposed rail siding along the Darwin to Adelaide railway line is located in this habitat type. Flora species diversity was low on the sandplains relative to the dunefields.

Vegetation in the sandplain habitat consisted of and *Acacia aneura* tall to tall-open shrubland or low open woodland with a midstorey of *Eremophila* spp. (emu bush) and *Senna artemisioides* subspp. (cassia) and a grassy understorey. *Acacia kempeana* (witchetty bush), *Corymbia opaca* (desert bloodwood) and *A. decaisneana* were present at some but not all sandplain sites. Grasses in the understorey included *Eragrostis eriopoda, Triodia pungens, Aristida* spp. and *Monachather paradoxus* (bandicoot grass). Vegetation cover was relatively low (~35%), with the remaining cover being mainly represented by bare ground. *Cenchrus ciliaris* (buffel grass) was common along the railway, which was expected due to disturbance by trains, railway maintenance crews and the presence of an optic fibre line maintenance shed in close proximity.

Mammals recorded during on-ground surveys in the sandplain habitat were *Psuedomys hermannsburgensis* and *Mus musculus* (house mouse). Reptiles were common during summer and included *Ctenotus schomburgkii* (wedge-snouted ctenotus), *C. pantherinus* (leopard ctenotus), *C. leonardhii* (common desert ctenotus, *C. isolepis* (central military dragon), *Nephrurus levis* (knob-tailed gecko) and *Varanus brevicauda.* Trap disturbance in sandplain habitat by *Corvus* spp. was common and may have influenced trap success. Twenty species of bird were recorded in the sandplain habitat, with common species including *T. guttata, Aphelocephala leucopsis* (southern whiteface), *Rhipidura leucophrys* (willie wagtail) and *Pomatostamus temporalis* (grey-crowned babbler).

There were no threatened species or secondary sign of threatened species recorded at the study sites within sandplain habitat. The presence of particularly *D. blythi* and to a lesser extent *N. typhlops* are a possibility within the sandplain habitat. *Dasycercus cristicauda* is predominantly found on sand dunes, therefore it is less likely that this species will occur within the sandplain habitat. The sandplain habitat may also provide habitat for non-threatened species including *P. desertor* (desert mouse), *Lucasium stenodactylum* (sandplain gecko) and *Antechinomys laniger* (kultarr).

Figure 3-13: Sandplain habitat (left) and sandplain with watercourses (right)

Mesa Terrain

There were two types of mesa terrain considered in the Proposal area; low and high mesa terrain (Figure 3-14). This habitat type consists of a rocky substrate made up of mostly pebbles <0.6 cm, but also rocks up to 20 cm. Soils were mostly absent on the low and high mesas, but some pockets of skeletal red sand occurred where crusting was extensive. Soils on the plains were moderately deep red sands. Vegetation in the plains between mesas consists of mixed *Acacia* tall open-shrubland with a mixed species shrubby midstorey and a grassy understorey. Overstorey species include *Acacia aneura, A. estrophiolata* (ironwood) and *A. tetragonophylla* (dead finish). The midstorey contains several subspecies of *Senna artemisioides*, *Eremophila freelingii* (rock fuschia) and *Dodonaea viscosa*. *Fimbristylis dichotomoa* (common fringe-rush) was the predominant understorey species. Vegetation on the slope and top of the high mesas consisted of *A. aneura* open-scrub over *Eremophila freelingii* and *A. tetragonophylla* midstorey and a forb and low shrub understorey. Species in the understorey included *Solanum quadriloculatum* (wild tomato), *Maireana georgeii* (golden bluebush), *Sclerolaena bicornis* (goathead burr) and *Ptilotus obovatus* (silver mulla mulla).

Areas previously mapped as low mesas were found to be more consistent with sandplain with large calcrete extrusions forming broad mounds. Tall shrubs were absent at the survey sites in the low mesa habitat. Vegetation consisted of a mixed species low-shrubland with a grass/forb understorey. Shrub species included *Senna artemisioides sturtii* and *D. viscosa.* Species recorded in the understorey were *Ptilotus obovatus, F. dichotoma, Sporobolus actinocladus* (fairy grass), *Enneapogon avenaceus* (bottlewashers) and *Enneapogon polyphyllus* (woolly oat-grass).

Sminthopsis crassicaudata (fat-tailed dunnart) was trapped on the lower slopes of a mesa on the Henbury Access road. Secondary sign of macropods and *Tachyglossus aculeatus* (echidna) were common on high mesas. Small caves were common in the high mesa habitat, and may provide shelter for a range of bird and mammal species, including bats. A motion-sensing camera in one of these caves captured *Pseudantechinus macdonnellensis* and an unknown rodent. The calls of *Vespadelus finlaysoni* (Finlayson's cave bat) were recorded in the high mesa habitat where they likely roost in the caves. Secondary sign of dragons and macropods was recorded in the low mesa habitat.

Four bird species were recorded in the mesa habitat of which *Acanthiza uropygialis* (chestnut-rumped thornbill) was the most common. Vegetation associated with mesa habitat was originally identified by desktop surveys to be potentially suitable for *Amytornis modestus indulkana*. Secondary sign of the introduced herbivores cattle and camel were observed in the high mesa habitat, and there was secondary sign of cattle, camels, donkeys and rabbits in the low mesa habitat.

Figure 3-14: High mesa habitat (left) and low mesa habitat (right)

Riverine Dunes/River

This habitat includes the sand banks associated with the Hugh River and the Finke River. The river channel is loose sand and unvegetated. The river banks and dunes associated with the Hugh River are deep yellow sands dominated by a *Eucalyptus camaldulensis* (river red gum) and *Melaleuca glomerata* (desert honey myrtle) open-woodland over a mixed *Acacia* midstorey and shrub and grass understorey. Midstorey species included *A. victoriae* (prickly wattle), *A. ligulata* (umbrella wattle), *A. murrayana* (sandplain wattle), *Dodonaea viscosa* and *Vachellia farnesiana* (needle bush). The understorey included *Euphorbia wheeleri*, *Euphorbia australis*, *Rhagodia eremaea* (tall saltbush) and *Scaevola spinescens* (currant bush), and stands of *Zygochloa paradoxa. Cenchrus ciliaris* and *Cynadon dactylon* (couch grass) were the dominant ground cover along the banks of the Hugh River and Finke River (Figure 3-15).

Pseudomys hermannsburgensis (sandy inland mouse) was the only mammal species trapped during on-ground surveys in this habitat. Secondary sign of *Tachyglossus aculeatus* was recorded on the river bank and back filled tunnels indicating *N. typhlops* (marsupial mole) were present in pits dug in the flood plain adjacent to the river. Reptiles recorded included *Lerista bipes* (two-toed lerista), *Demansia psammophis* (yellow-face whip-snake), *Gehyra variegata* (tree dtella) and *Varanus gouldii* (sand goanna). Eight bird species were recorded in this habitat, including *Lichenostomus penicillatus* (white-plumed honeyeater), *Taeniopygia Guttata* (zebra finch). River channels are often used as flyways and foraging sites by bats and a number of species likely occur here. The back filled tunnels of marsupial moles indicates at least periodic use of the flood plains along the river and these were the only record or secondary sign of threatened species in the riverine dune/river habitat. Princess Parrots have been recorded elsewhere as using riverine forests. Introduced species recorded in the riverine dune/river habitat were cat, red fox, cattle and donkey. A cat was captured on a motion-sensing camera positioned on the bank in this habitat.

Figure 3-15: Riverine dune/river habitat

Prominent Hills and Low Ranges

The slopes of the prominent hills and low ranges habitat were between 5% and 8%. Soil was grey-brown loam or red stony sands with sandstone, granite and quartzite rocks from 0.6 cm to 20 cm diameter over approximately 30% of the ground surface. Vegetation consisted of *Corymbia opaca* and *Acacia aneura* low open-woodland over a mixed species shrub midstorey and grass understorey. *Acacia tetragonophylla* was present in the overstorey at some sites. Midstorey species included *Senna artemisioides* subspp., *Eremophila* spp., *Ptilotus* spp. and saltbush. *Aristida contorta* (bunched kerosene grass), *Eragrostis eriopoda* and *Enneapogon* spp. were common in the understorey (Figure 3-16).

Searching for tracks in the prominent hills and low ranges habitat was difficult due to high rock cover. However, there were secondary signs or direct observation of *Macropus rufus* (red kangaroo), *Varanus* sp., *Macropus robustus* (euro) and *Canis lupus dingo* (dingo) in this habitat. Introduced species recorded in this habitat included donkey and cattle.

There were no threatened species recorded in the prominent hills and low ranges habitat, and it was assessed as not being suitable for any of the threatened species identified by the desktop study.

Figure 3-16: Prominent hill and low range habitat

Alluvial Plains

Alluvial plain habitat in the Proposal area is located at the base of low mesas and have deep red sandy loam soils (Figure 3-17). Vegetation consists of *Atalaya hemiglauca* low open-woodlands over a mixed shrub midstorey and grass understorey. Midstorey species include *Dodonaea viscosa*, *Acacia* *murrayana* and *Acacia aneura*. Understorey species include *T. pungens, Enneapogon avenaceus* and the introduced *Cenchrus ciliaris.*

Secondary sign of *Macropus rufus* (red kangaroo), skinks and *Varanus* sp. including *Varanus giganteus* (Perentie) were common within the alluvial plain habitat. Nine species of bird, including *Falco berigora* (brown falcon) were recorded in the alluvial plain habitat. Introduced species recorded in the alluvial plain habitat were cattle, red fox, donkey and camel. The deep sands and hummock grasses associated with the alluvial plain habitat may provide suitable habitat for threatened fauna including *Liopholis kintorei* and *L. slateri slateri*. These species were not recorded during on-ground surveys.

Figure 3-17: Alluvial plain habitat

Claypans

There is claypan habitat dispersed throughout the Proposal area however it is more prevalent on the western side. Claypans are devoid of vegetation and have deep red-brown clay soils with a low covering of small stones ≤2 cm diameter. Black and clear crusts are present (Figure 3-18). Vegetation surrounding the claypans consists of *A. aneura, A. kempeana* and *A. tetragonophylla* tall open-shrubland over a mixed shrub midstorey and *Aristida holathera* understorey. Midstorey species included *Eremophila duttoni* (emu bush), *Sclerolaena* sp. and *Solanum quadriloculatum.*

Claypans hold water after rain, and can provide important watering points for fauna. Secondary sign of *Macropus rufus* (red kangaroo), *Dromaius novaehollandiae, Canis lupus dingo* and *Varanus* sp. were recorded in the claypan habitat. *Dromaius novaehollandiae* is listed as near threatened under the TPWC Act. Three bird species were observed in the vegetation surrounding the claypan habitat; *Artamus cinereus* (black-faced woodswallow), *Lichenostomus virescens* (singing honeyeater) and *T. guttata.* Introduced species recorded in this habitat include cattle, camels and donkeys.

This land unit does not provide permanent suitable habitat for any species identified by the PMST and NT Fauna Atlas. It may, however, provide ephemeral habitat for migratory birds, or threatened species such as *R. australis*, following rainfall and, as discussed above, provide water for a range of other species.

Figure 3-18: Claypan habitat

Plains

Flat or gently undulating plains with deep red-brown clay loam soils and isolated small areas of gibber plain and calcareous grey-brown clay loam are located north of Chambers Pillar Road (Figure 3-18). Vegetation consists of *A. aneura* open to tall open-shrubland over a midstorey of *A. tetragonophylla* and *A. kempeana* and an understorey of shrubs, grasses and forbs. *Atalaya hemiglauca* (whitewood) is present in the overstorey in some areas. An overstorey is occasionally not present. Midstorey species may also include *Eremophila sturtii* (turpentine bush), *S. a. artemisioides* and *Rhagodia spinescens.* Understorey species include *S. quadriloculatum, Sclerolaena* spp., *Ptilotus sessfolius, C. ciliaris, Enneapogon cylindricus, Eragrostis setifolia, E. eriopoda* and *Aristida* spp.

Pseudomys hermannsburgensis, Pogona vitticeps (bearded dragon), and *C. leonardii* were trapped at survey sites in the plains habitat. Recent *Dasycercus* sp. tracks were recorded at site S22, located outside the mine lease, approximately 0.5 km north of the proposed Chandler Haul Road route. The description of plains habitat is consistent with habitat known to be occupied by *D. blythi*. Therefore, it is more likely that the tracks were from this species however without trapping this cannot be confirmed. *Varanus gouldii* was observed in this habitat. Secondary signs of dragons, rodents, *M. rufus*, *Macropus robustus* (Euro) and *C. l. dingo* were also recorded in the plains habitat. Eleven species of bird, including *Dromaius novaehollandiae, Oreioca guttarlis* (crested bellbird), *Rhipidura leucophrys* (willie wagtail), *T. guttata, Psephotus varius* (mulga parrot) and *Artamus cinereus* (black-faced woodswallow), were recorded in the plains habitat. Introduced species recorded in the plains habitat were house mouse, rabbit, cat, cattle and camel.

Figure 3-19: Plains habitat

Tall Rocky Outcrops and Valleys

This habitat consisted of two distinct habitats; tall rocky outcrops and valleys. The soils are deep red-brown sandy loams and small drainage lines run through the valleys.

Vegetation consists of *Eucalyptus intertexta* (coolibah) low open-woodland over a mixed shrub midstorey and an understorey dominated by *Tecticornia* spp. Midstorey species include *Senna artemisioides filifolia* (desert cassia), *A. tetragonophylla, Hakea leucoptera* (needlewood) *and Eremophila duttonii* (hareliquin fuchsia). Additional understorey species include *Enneapogon avenaceus* (bottlewashers), *Sporobolus actinocladus* (fairy grass) and introduced *C. ciliaris*.

Five bird species, including *T. guttata* and *Smicrornis brevirostris* (weebill), were recorded.

Creekline/Drainage Depression

The creekline/drainage depression habitat has deep red-brown sandy loam soils within creeklines and associated floodplains. Vegetation consists of woodland to open-woodland over a mixed species shrub midstorey and a grass/forb understorey. The overstorey was dominated by *A. aneura* or *Eucalyptus intertexta* (coolabah) or *E. camaldulensis* with *A. hemiglauca* also present. Midstorey species include *A. kempeana*, *A. tetragonophylla*, *S. a. filifolia, Eremophila latrobei* (crimson turkey bush), *E. duttonii* and *Eremophila sturtii* (turpentine bush). Understorey species include *A. holathera, Abutilon otocarpum* (desert Chinese lantern), *C. ciliaris*, *Fimbristylis dichotoma, E. eriopoda*, *Maireana astrotricha* and *S. quadriloculatum* (Figure 3-20).

Reptiles were the dominant group trapped in the creekline/drainage depression habitat, with species including *Ctenophorus nuchalis* (central netted dragon), *Morethia ruficauda* (lined firetail skink) and*). Mus musculus* was also trapped in this habitat. Secondary sign of dragons and skinks was abundant. Sixteen bird species, including *Pomatostomus superciliosus* (white-browed babblers) and *Psephotus varius* (mulga parrot)*,* were recorded in the creekline/drainage depression habitat.

Figure 3-20 Drainage/ creekline habitat dominated by *Acacia Aneura*

Coolabah and lignum swamp

Coolabah and lignum swamp habitat is found in Duck swamp and associated claypans, which experience irregular ephemeral inundation. Soils are clays to sandy or loamy clays with black and clear crusts present (Figure 3-21). The vegetation community is a low-open woodland *Eucalyptus coolabah arida* (coolabah) over a midstory of mixed species including *Muehlenbeckia cunninghamii* (lignum), *Euphorbia biconvexa* and *R. spinescens.* Understorey species include short grasses and forbs such as *Frankenia cordata* (salty heath)*, Scleroleana patenticuspis* (spear-fruit copper burr)*, S.*

convexula (tall copper burr), *Sida platycalyx* (lifesaver burr), *Tribulus eichlerianus* (bindieye), *Eragrostis setifolia* (narrow-leaf neverfail) *and E. eriopoda.* Introduced C*. ciliaris* was recorded around the fringes of the swamp above the flood line. Vegetation is dependent on ephemeral and infrequent inundation.

Four bird species were recorded in this habitat including *P. varius*, *L. penicillatus*, *Oreoica gutturalis* (crested bellbird) and *R. leucophrys*. Reptile species recorded include *C. nuchalis*, *Diplodactylus conspicillatus* (fat-tailed gecko) and *Gehyra variegata* (tree dtella). Mammal species recorded include *M. rufus* and *C. l. dingo*. Secondary sign of introduced donkey and cattle were recorded. All bat species recorded are tree hollow dwelling and roosting in this habitat is likely (Churchill, 2008). While there were no threatened species recorded in this habitat, coolabah and lignum swamps are potentially suitable habitat for *C. b. samueli, Neophema splendida*, *Polytelis alexandrae* (Princess Highway). After periods of high rainfall, this habitat may support EPBC listed migratory and marine bird species.

Figure 3-21: Coolabah lignum swamp habitat

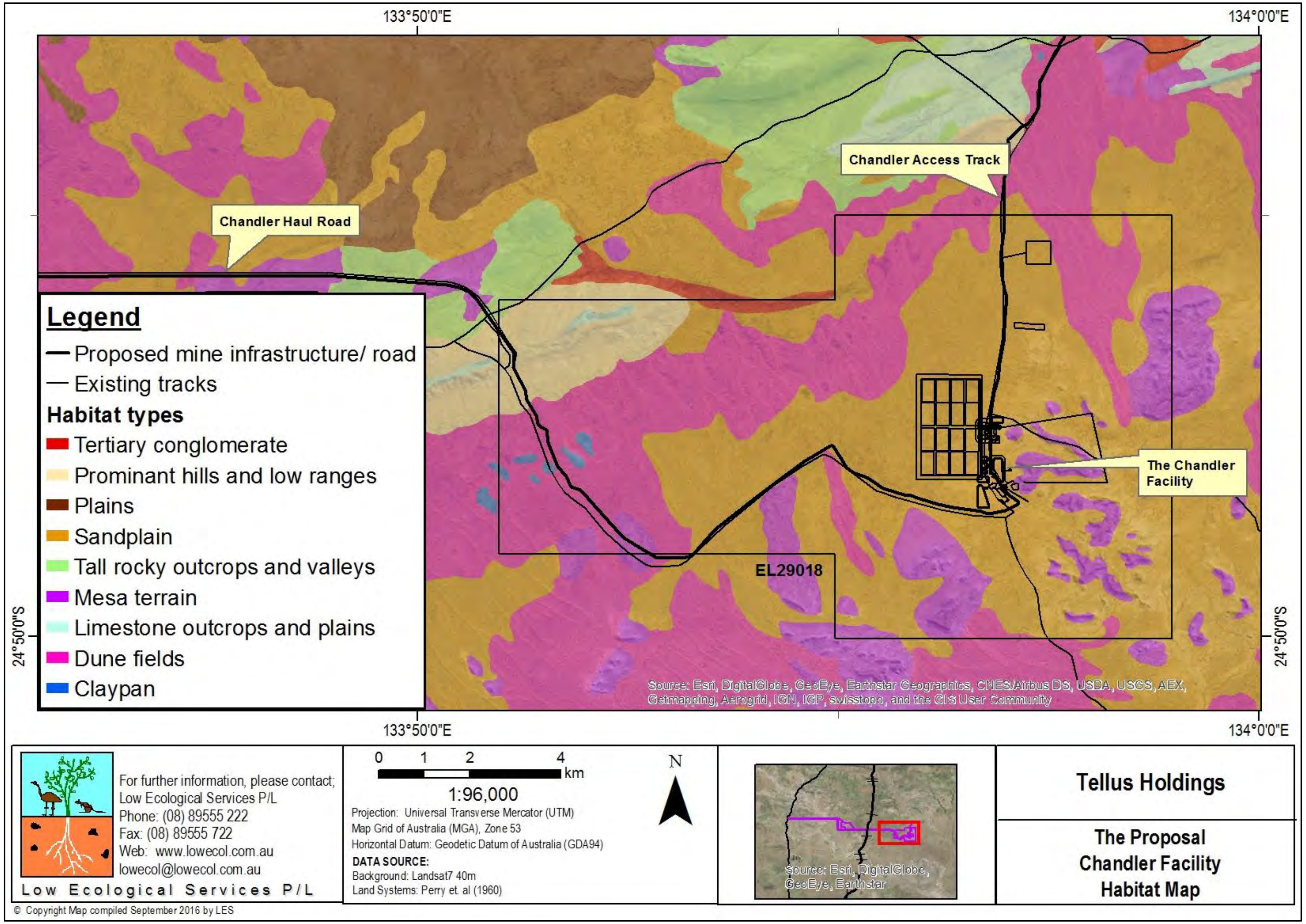


Figure 3-22 Chandler Facility habitat map

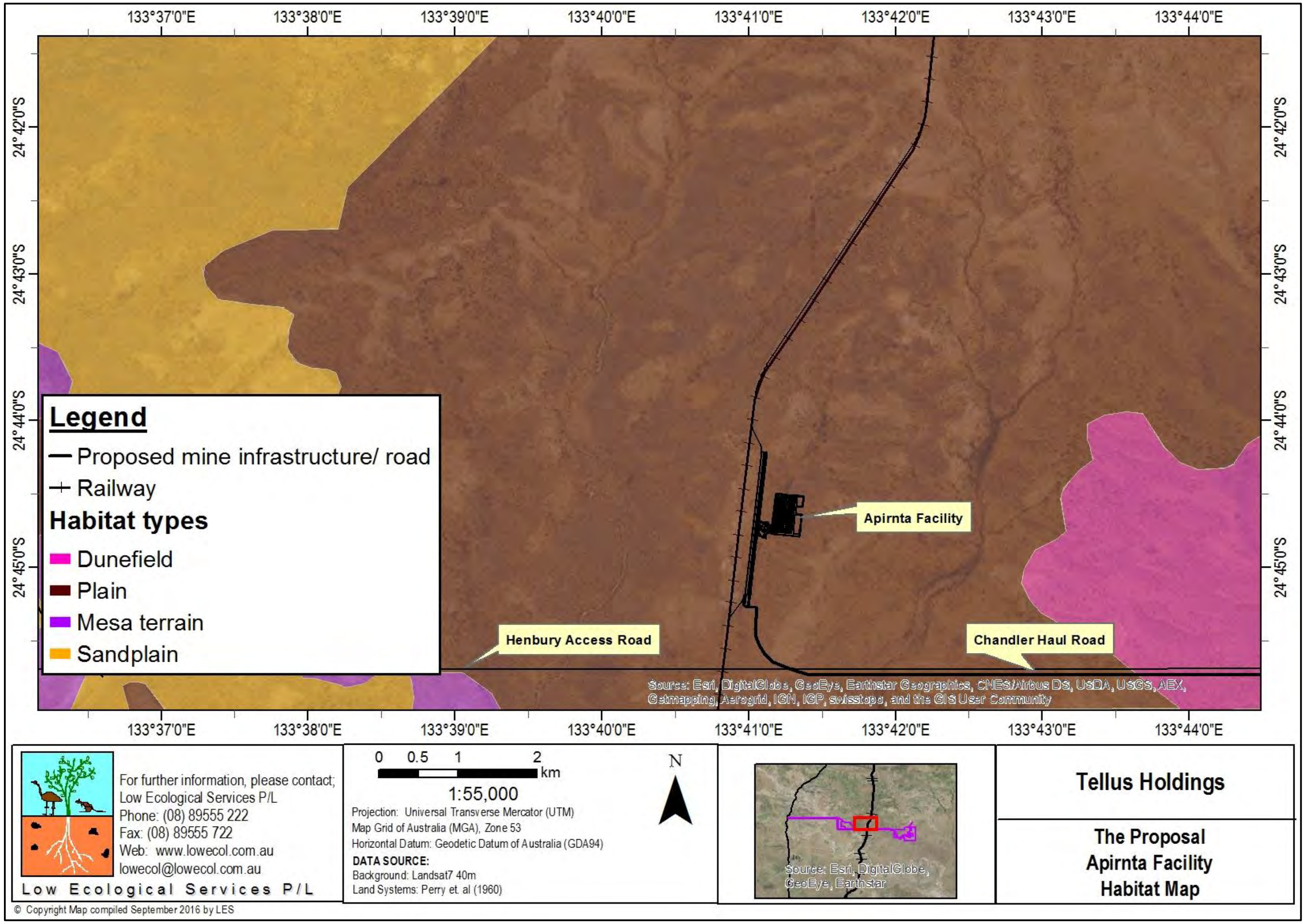


Figure 3-23 Apirnta Facility habitat map

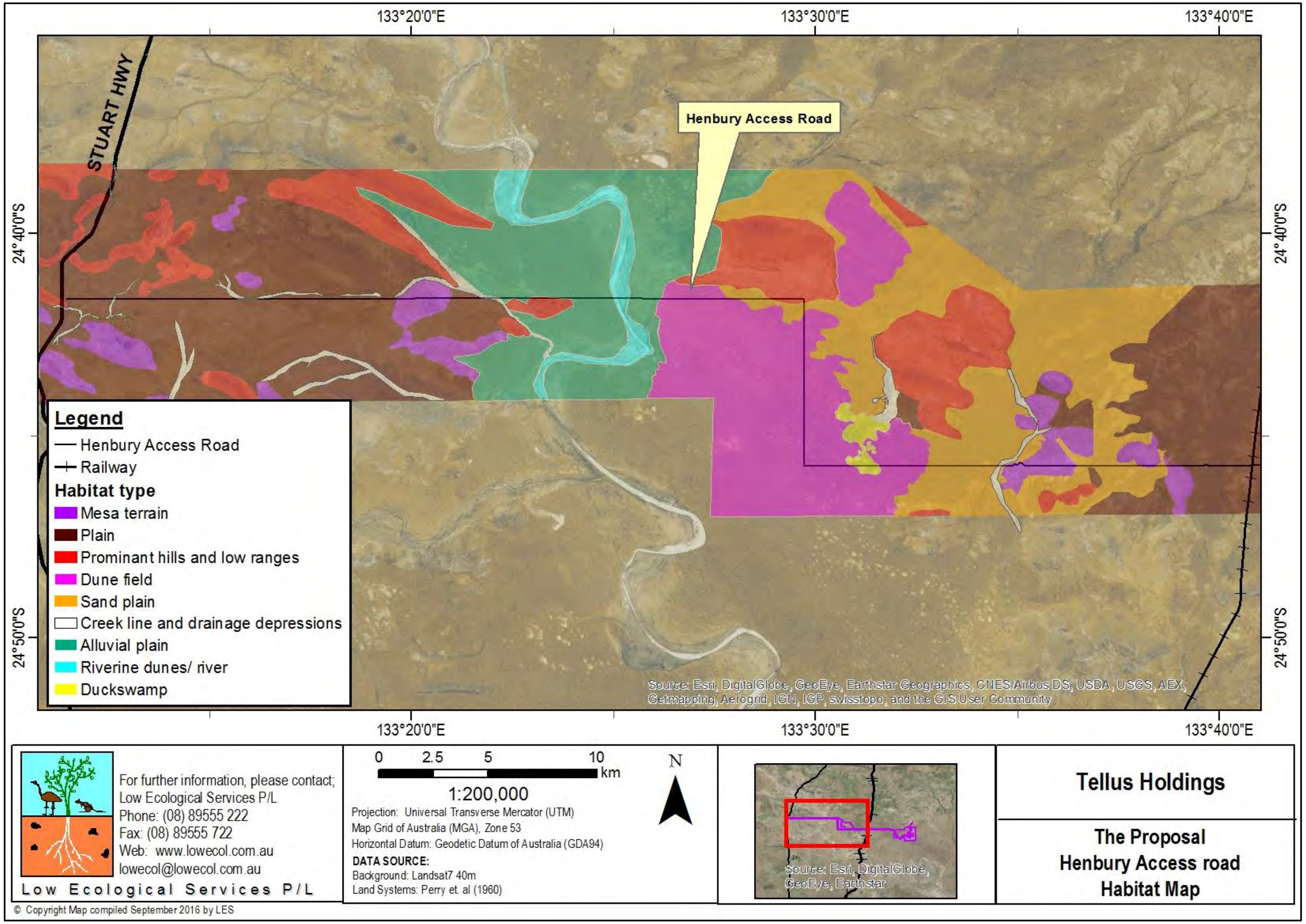


Figure 3-24 Henbury Access Road habitat map

3.10 Additional Matters of National Environmental Significance

There are no additional MNES relating to the Proposal. The closest MNES to the Proposal is Witjira-Dalhousie Springs National Heritage Place, located approximately 230 km south east of the Chandler Facility.

3.11 State and Territory Reserves

A Territory Reserve, Chambers Pillar Historical Reserve, is located approximately 6.8 km from the Chandler Facility. Chambers Pillar Historical Reserve is visited by between 3,600 to 6,700 visitors per year (NT Parks and Wildlife, 2016). State and Territory Reserves are not a MNES.

4 ASSESSMENTS OF SIGNIFICANCE

4.1 Key Threatening Processes

Key threatening processes (KTP) under the EPBC Act are identified processes that threaten or may threaten the survival, abundance or evolutionary development of a native species or ecological community (Department of Environment and Energy, 2016a). Processes listed as a KTP could:

- Cause a native species or ecological community to become eligible for inclusion in a threatened list (other than the conservation dependent category); or
- Cause an already listed threatened species or threatened ecological community to become more endangered; or
- Adversely affect two or more listed threatened species or threatened ecological communities.

Threat abatement plans (TAPs) establish a national framework to guide and coordinate research, management and other actions necessary to reduce the impact of KTPs registered under the EPBC Act (Department of Environment and Energy, 2016b). KTPs of relevance to the proposal are discussed in Table 4-1. Where TAPs have been published for the KTPs, these are also noted.

Table 4-1: Key Threatening Processes (KTP) and associated Threat Abatement Plans (TAP) of relevance to the Proposal

KTP	TAP	Comment
Clearing of native vegetation	-	The proposal would involve the clearing approximately 400 ha of native vegetation. Vegetation is relatively sparse over much of the Proposal area and is in a moderate to good condition with localised disturbances as a result of cattle. There are no threatened flora species, threatened ecological communities or sensitive vegetation types in the Proposal area. All vegetation types present in the Proposal area are well represented in the Finke Bioregion or surrounding bioregions. Mitigation measures would be implemented to minimise the clearing of vegetation and retain fauna habitat where possible (Section 6.2 Mitigation and monitoring – *Vegetation clearing, habitat loss and fauna displacement*).
Predation by feral cats	Predation by feral cats	Feral cats were recorded in low numbers during on-ground surveys of the Proposal area. The construction of new roads, access tracks, firebreaks and large cleared spaces has been shown to increase predator species access. Predation by feral cats could potentially impact on the threatened species assessed below, particularly crest-tailed mulgara, brush-tailed mulgara, Slater's skink, great desert skink and thick-billed grasswren. The construction and operation of the Proposal is not likely to exacerbate the KTP as a pest fauna will be carefully managed and monitored, and the population will be controlled as necessary (see Section 6.2 Mitigation and monitoring - *Increased pest fauna species* and *Increased predator species access*).
Predation by the European red fox	Predation by the European red fox (*Vulpes vulpes*).	The European red fox was recorded in low numbers during on-ground surveys of the Proposal area. The construction of new roads, access tracks, firebreaks and large cleared spaces has been shown to increase predator species access. Predation by the European red fox could potentially impact on the threatened species assessed below, particularly crest-tailed mulgara, brush-tailed mulgara, Slater's skink, great desert skink and thick-billed grasswren. The construction and operation of the Proposal is not likely to exacerbate the KTP as a pest fauna will be carefully managed and monitored, and the population will be controlled as necessary (see Section 6.2 *Increased pest fauna species* and *Increased predator species access*).
Competition and land degradation by rabbits	Competition and land degradation by rabbits	Rabbits were recorded during on-ground surveys of the Proposal area. The proposal may cause a localised increase in the rabbit population due to the increase in water (effluent disposal from septic system, etc.) leading to an increase in fresh green vegetation in the Proposal area. If the rabbit population is high, associated land degradation may impact on threatened species in the Proposal area. The removal of vegetation may reduce cover and expose threatened species to predation, particularly crest-tailed mulgara, brush-tailed mulgara, Slater's skink, great desert skink and thick-billed grasswren.

KTP	TAP	Comment
		The construction and operation of the Proposal is not likely to exacerbate the KTP as a pest fauna will be carefully managed and rabbit populations will be controlled as necessary (see Section 6.2 *Increased pest fauna species* and *Increased predator species access*).
Human-caused climate change	-	Land clearing associated with construction of the Proposal and combustion of fuels associated with construction and operation will contribute to human-caused climate change. Direct emissions during construction would be 710.7 t CO_2-e per year with over half of emissions due to land clearance activities. During operation, direct emissions would be 388.0 t CO_2-e per year. Indirect emissions are calculated to be minor during both the construction (15.4 t CO_2-e per year) and operation (12.2 t CO_2-e per year) phases of the Proposal. The fore, the Proposal would exacerbate this this KTP. Mitigation measures would be implemented to minimise the clearing of vegetation and retain fauna habitat where possible (Section 6.2 Mitigation and monitoring – *Vegetation clearing, habitat loss and fauna displacement*).

4.2 Impacts on listed threatened species and migratory species

This section assesses impacts on MNES and on state-listed threatened species from the construction, operation, and decommissioning and rehabilitation of the Proposal in accordance with the *Significant Impact Guidelines 1.1- Matters of National Environmental Significance* (Department of Environment, 2013).

4.2.1 Endangered fauna

Fauna listed as endangered under the EPBC Act to be assessed against the guidelines are *R. australis* and *L. s. slateri.* As assessed by the guidelines below, the Proposal would not have a significant impact on *R. australis*. However, if *L. s. slateri* (which has a low-moderate likleihood of occurance in the Proposal area) is present in the Proposal area, it is possible that the species will be impacted by the destruction of habitat as this species occurs in small isolated populations, and by the potential encroachment of *C. ciliaris* into suitable habitat following clearing.

Australian painted snipe *(Rostularia australis)*

Rostratula australis is listed as endangered under the EPBC Act and vulnerable under the TPWC Act. It inhabits shallow inland wetlands, which are ephemeral within the Proposal area. This species was not recorded during any on-ground surveys, and has a low-moderate likelihood to occur in low numbers after high rainfall periods in the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of a population
Rostratula australis is considered to occur as a single, contiguous breeding population throughout Australia (Garnett & Crowley, 2000). *Rostratula australis* is only likely to occur in the Proposal area after rainfall when ephemeral wetlands hold standing water, and disperse as these wetlands dry out. Considering that this species is only likely to occur in the Proposal area in low numbers, not constituting a population, and the Proposal would not impact ephemeral wetlands, the Proposal would not lead to a long-term decrease in the size of a population of *R. australis.*
Reduce the area of occupancy of the species
Rostratula australis is only likely to occur in the Proposal area after high rainfall and in low numbers. Considering this, the high mobility of the species, and that the Proposal is not likely to significantly impact ephemeral wetlands in the Proposal area, the Proposal would not reduce the area of occupany of *R. australis.*
Fragment an existing population into two or more populations
Rostratula australis is only likely to occur in the Proposal area when ephemeral wetlands, which would not be impacted by the Proposal, hold standing water. *Rostratula australis* is considered to occur as a contiguous breeding population across its distribution (Garnett & Crowley, 2000). Therefore, the localised impacts of the Proposal would not fragment the existing population into two or more populations.

Adversely affect habitat critical to the survival of the species

Wetland habitat suitable for breeding is critical for the survival of *R. australis* (Threatened Species Scientific Committee, 2013). These habitat requirements may be specific; shallow wetlands with areas of bare wet mud and both upper and canopy cover nearby (Department of Environment, 2016m). Habitat in the Proposal area will only be suitable after high rainfall when ephemeral wetlands, which would not be significantly impacted by the Proposal, hold standing water. Therefore, the Proposal would not adversely affect habitat critical to the survival of *R. asutralis.*

Disrupt the breeding cycle of a population

Rostratula australis is only likely to be present in the Proposal area after high rainfall, and in low numbers. Breeding habitat for the species, as described above, is also only likely to be present in the Proposal area after high rainfall and would not be significantly impacted by the Proposal. If breeding occurs in the Proposal area, it is only likely to be a low number of individuals, and not the entire population. Therefore the Proposal would not disrupt the breeding cycle of a population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

Ephemeral wetlands are common in the Proposal area, and *R. australis* is highly mobile (i.e. able to disperse to other suitable habitat if disturbance were to occur). *Rostratula australis* is only like to be present in the Proposal area after high rainfall, and not in numbers that would consitute a significant proportion of the population. Therefore the Proposal is unlikely to modify, destroy, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. The Proposal would not destroy, isolate or decrease the availability or quality of ephemeral wetland habitat in the Proposal area.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

The replacement of native vegetation by invasive plants and predation by feral predators are potential threats to *R. australis.* Clearing of vegetation may lead to weed species such as *C. ciliaris* establishing around wetland areas and the clearing of roads and uncovered food wastes providing resource supplementation may lead to an increase in feral predators in the Proposal area. Grazing and associated trampling by stock is a threat to *R. australis* particularly in arid regions where grazing can be concentrated around wetlands (Department of Environment, 2016m). The presence of stock would not be increased by the Proposal; therefore the impact on ephemeral wetlands by stock would not be promoted by the Proposal. If not mitigated, the Proposal may increase the impacts of weed invasion and feral predators on the low numbers of *R. australis* that may occur in the Proposal area after high rainfall. However, this would not impact the species as a whole and Tellus would implement a Weed Management Plan and Pest Fauna Management Plan to reduce these risks.

Introduce disease that may cause the species to decline

There are no known diseases affecting *R. australis* that are relevant to the Proposal. The Proposal is unlikely to increase the potential for significant disease vectors to affect this species.

Interfere with the recovery of the species*.*

The Proposal is unlikely to interfere with the recovery of *R. australis*, as the Proposal area is not an important breeding site and the species is only likely to occur in the Proposal area

irregularly after high rainfall.
Conclusion
Considering that *R. australis* is only likely to occur within the proposed development footprint and vicinity in low numbers (not constituting a population) and ephemeral wetlands would not be impacted, there would be no long-term decrease in the size of a population of Australian painted snipe resulting from the construction, operation, or decommissioning and rehabilitaiton of the Proposal. There would be no reduction in the area of occupancy of the species, no fragmentation of a population into two or more populations, and no impact on habitat critical to the survivial of the Australian painted snipe. There are no important breeding sites within the proposed development footprint or vicinity for the species. Activities associated with construction, operation, and decommisioning and rehabilitation would not to interfere with the recovery of the *R. australis*. Therefore, there would be no significant impact on the *R. australis* during construction, operation, or decommissioning and rehabilitation of the Proposal.

Slater's Skink (*Liopholis slateri slateri*)

Liopholis slateri slateri is listed as endangered under the EPBC Act and the TPWC Act. *Liopholis slateri slateri* occurs in shrublands and open-shrublands on alluvial soils close to drainage lines, and minor drainages among stony hills in the central ranges (McDonald, 2012b). There is a low-moderate possibility that *L. s. slateri* is present within the Proposal area as marginally suitable habitat occurs on the proposed Henbury Access Road at the crossing of the Finke River and possibly the drainage lines adjacent to the Hugh River. *Liopholis slateri slateri* was not recorded during on-ground surveys despite considerable survey effort. A pre-construction survey would be conducted, plus on-going six monthly to annual surveys to determine the species presence within the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of a population
Marginally suitable habitat occurs on the proposed Henbury Access Road at the crossing of the Finke River. *Liopholis slateri slateri* occurs in small, highly fragmented populations (TSSC, 2016). The presence of an access road through suitable habitat may also lead to mortality by vehicle strike. There is the potential for the Proposal to lead to a long-term decline in the size of a population of this species if a significant amount of suitable and occupied habitat, i.e. suitable burrowing habitat, were to be cleared. It is not currently known if the species is capable of longer-distance movement and would be able to disperse away from areas of disturbance.
Reduce the area of occupancy of the species
There is suitable habitat for *L. s. slateri* in the Proposal area on the Finke River floodplain, which makes up approximately 10 ha of the disturbance area on the Henbury Access Road. *Liopholis slateri slateri* occurs in small, fragmented populations. Small populations are more likely to be detrimentally impacted by disturbance. A population of *L. s. slateri* occurring in the Proposal area is likely to be small and isolated from other populations. Therefore, clearing of habitat where this species occurs, alluvial shrublands and minor drainage lines on stony hills, may reduce the area of occupancy of the species.
Fragment an existing population into two or more populations
The proposed Henbury Access Road passes through marginally suitable habitat for *L. s. slateri*. This

may lead to the fragmentation of a population. If it exists or establishes, into two or more populations by creating a barrier to dispersal (the road) across suitable habitat. It is not known how mobile *L. s. slateri* is, and therefore if the species has the capacity to move away from disturbance. Therefore, the Proposal may fragment an existing population of *L. s. slateri* into two or more populations. A pre-construction survey would be conducted to determine the presence of the species. If present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. Alternatively, a program of trapping and relocating would be implemented to avoid significant impacts to the species. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE.

Adversely affect habitat critical to the survival of the species

There is no critical habitat listed for *L. s. slateri* in a recovery plan or on the Register of Critical Habitat. Habitat suitable for *L. s. slateri,* including sediment mounds under shrubs in which they burrow and forage from, occurs within the Proposal area.

Disrupt the breeding cycle of a population

If habitat in which *L. s. slateri* occurs is destroyed due to the Proposal, the breeding cycle of the population would be disrupted, either by making the habitat unsuitable for persistence or by reducing mating opportunities for the species by fragmenting a population. Therefore, if *L. s. slateri* is present within the Proposal area, the Proposal may disrupt the breeding cycle of a population.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The Proposal area includes approximately 10 ha of habitat marginally suitable for *L. s. slateri*. Therefore, the Proposal may modify, destroy, remove, isolate or decrease the availability or quality of habitat for *L. s. slateri* populations, if the species is present. *Liopholis slateri slateri* populations are small and individuals are active over a small area (Pavey, et al., 2010). Considering this, and that the species persists in just small, isolated populations, If there is a population of *L. s. slateri* in the Proposal area, the Proposal has the potential to modify, destroy, remove, isolate or decrease the availability of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

Cenchrus ciliaris invasion has been suggested as a potential threat and a driver of decline in *L. s. slateri* populations. *Cenchrus ciliaris* is the dominant ground cover in many alluvial habitats, suitable habitat for *L. s. slateri*, across central Australia in high density (McDonald, 2012b). The invasion of *C. ciliaris* into an area can result from the clearing of vegetation, which provides bare areas in which the grass can establish. Once established *C. ciliaris* alters the vegetation structure and species composition of the systems that it invades. Therefore, a population of *L. s. slateri* may be impacted if *C. ciliaris* were to become more abundant in the area as a result of vegetation clearing. Tellus would implement a Weed Management Plan and esure no further spread of *C. ciliaris* in the Proposal area.

Introduce disease that may cause the species to decline

There are no known diseases affecting *L. s. slateri* that are relevant to the Propoal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.

Interfere with the recovery of the species.

Due to the localised impact associated with the Proposal it is unlikely that the Proposal would interfere with the recovery of *L. s. slateri.*

Conclusion
If the species is present within the Proposal area, it is possible that an isolated population of the species would be significantly impacted through habitat loss and by the potential encroachment of buffel grass into suitable habitat following the removal of vegetation. Surveys would be undertaken of the proposed access road alignment prior to construction to determine the presence/absence of this species. If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. Alternatively, a program of trapping and relocating would be implemented to avoid significant impacts to the species. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE.

4.2.2 Endangered flora

There were no endangered flora identified by the EPBC PMST, the NT Flora Atlas and on- ground surveys as occurring or potentially occurring within the area of interest.

4.2.3 Vulnerable fauna

The following fauna listed as vulnerable under the EPBC Act that were recorded or have a low-moderate, moderate or high likelihood of occurring within the Proposal area:

- *Amytornis modestus indulkana* (thick-billed grasswren);
- *Polytelis alexandrae* (princess parrot);
- *Dasycercus cristicauda* (crest-tailed mulgara); and
- *Liopholis kintorei* (great desert skink).

As assessed by the guidelines below, the Proposal is not likely to have a significant impact on these species.

Thick-billed grasswren *(Amytornis modestus indulkana)*

Amytornis modestus is listed as vulnerable under the EPBC Act. Under the TPWC Act it is listed as critically endangered as the subspecies *A. m. indulkana*. Although the closest records of *A. m. indulkana* are approximately 167 km south east, potentially suitable habitat for *A. m. indulkana* occurs in a number of areas on the Henbury Access Road. Despite considerable survey effort, the species was not recorded during on-ground surveys. However due to the cryptic nature of the species and the difficulty associated with recording the species and the presence of suitable habitat, there is a low-moderate likelihood that *A. m. indulkana* could occur in the proposal area. If a population were present, it would meet the definition of being an important population as it would be at the northern extent of the range. A pre-construction survey would be conducted, plus on-going six monthly to annual surveys to determine the species presence within the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
In the NT, there is only one known population of *A m. indulkana* close to the NT-SA border south of Charlotte Waters (Pavey & Ward, 2012b). A population of *A. m. indulkana* in the area of interest

would be at the limit of the species range, and therefore meet the criteria for being an important population under the *Significant Impoact Guidelines 1.1*. If *A. m. idulkana* is present within the Proposal area, the clearing of habitat and potential increase in feral predator abundance may lead to a long-term decrease in the size of an important population of the species.

Reduce the area of occupancy of an important population

A population of *A. m. indulkana* in the Proposal area would be at the northern limit of the species range, and therefore meet the criteria for being an important population under the *Significant Impoact Guidelines 1.1*. Throughout their range south to Andamooka and Bon Bon Stations in SA, *A. m. indulkana* occupies low shrublands 0.5-2 m tall with approximately 15% cover of predominantly Oodnadatta saltbush and cottonbush vegetation on bare and rocky ground (Black, et al., 2011). The population near Charlotte Waters occurs on areas dominated by the saltbush *Atriplex nummularia* (Pavey & Ward, 2012b). Appropriate habitat for *A. m. indulkana* may occur in areas of habitat fairly consistent with these descriptions on the Henbury Access Road. Due to the localised nature of the impact of the Henbury Access Road and the availability of appropriate habitat in adjacent and surrounding areas, if *A. m. indulkana* is present within the Proposal area, the clearing of habitat may only slightly reduce the area of occupancy of an important population. A pre-construction survey would be conducted to determine the presence or absence of the species. If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road.

Fragment an existing important population into two or more populations

If *A. m. indulkana* is present in the Proposal area, it would constitute an important population under the *Significant Impoact Guidelines 1.1*. The clearing of approximately 60 m of suitable habitat for the Henbury Access Road may fragment an existing important population into two or more populations, if clearing were to isolate areas of habitat that were originally contiguous.

Adversely affect habitat critical to the survival of the species

As *A. m. indulkana* and has a range extending through South Australia and the impacts from the Proposal are relatively localised, the Proposal is not likely to adversely affect habitat critical to the survival of the species a a whole.

Disrupt the breeding cycle of an important population

If *A. m. indulkana* is present in the Proposal area, habitat fragmentation from vegetation clearance and increased abundance of feral predators may disrupt the breeding cycle of and important population of the species.

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The range of *A. m. indulkana* extends through to South Australia. Considering this and that the impact of the Proposal is relatively localised, it is unlikely that the Proposal would modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

Predation by introduced predators is listed as a potential threat to *A. m. indulkana*, and if this species is present in the Proposal area it may be impacted by an increase abundance of feral predators. Tellus would implement a Pest Fauna Management Plan to ensure feral predator numbers to not increase as a result of the Proposal.

Introduce disease that may cause the species to decline
There are no known diseases affecting *A. modestus* that are relevant to the Propoal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.
Interfere with the recovery of the species*.*
As the range of this *A. m. indulkana* extends into South Australia where it is more widespread and the impact of the Proposal is localised, it is not likely that the Proposal would interfere with the recovery of the species.
Conclusion
If the species is present within the proposed development footprint, it is possible that the species would be significantly impacted because a population within the proposed development footprint or vicinity would be at the northern limit of it's range. This population would, therefore, meet the criteria of an important population under the *Significant Impoact Guidelines 1.1*. Given this, there is the potential for a long-term decrease in the size of an important population of this species. There is also a possibilitiy of a slight reduction in the occupancy of an important population. If the species is present within the proposed development footprint, there is the potential to fragment an existing population into two or more populations or to disrupt the breeding cycle of an important population. There is also a possibility that invasive species harmul to the thick-billed grasswren become established in it's habitat. Surveys would be undertaken prior to construction to confirm the presence/absense of this species. If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. Alternatively, a program of trapping and relocating would be implemented to avoid significant impacts to the species. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE.

Princess Parrot *(Polytelis alexandrae)*

Polytelis alexandrae is listed as vulnerable under the EPBC Act and TPWC Act. This irruptive species is known to occur irregularly in the central arid zone of WA, NT and SA in areas outside it's core range in the Great Sandy Desert, or the eastern Gibson Desert and western Great Victoria Desert (Pavey *et al.* 2014). It has been recorded in sandplain environments with vegetation characterised by *Eremophila, Grevillea* and *Hakea* shrubs with scattered trees, and less often in riverine forest, woodland and shubland habitats (Pavey *et al.* 2006c). *Polytelis alexandrae* was not recorded during any on-ground surveys although historic records occur within 75 km of the Proposal. *As P. alexandrae* is irruptive, there is a moderate likelihood that the species would inhabitat the Proposal area when resources are suitable. Habitat types within the Proposal area, such as the sandplain, hill/low ranges areas and creekline/drainage depressions with hollow bearing trees and *Eremophila*/*Grevillea*/*Hakea* shrubs, and to a lesser extent the alluvial areas around the Finke River, are potential breeding habitat for *P. alexandrae* during irruptions.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
Polytelis alexandrae is only likely to inhabit the Proposal area when resources are suitable during irruptions from its core range, which is probably centred on the Great Sandy Desert or the eastern

Gibson Desert and western Great Victoria Desert. Populations occuring in the area of interest will likely not be resident or constitute an important population (i.e. will not be key populations for breeding and dispersal). Therefore, the Proposal would not lead to a long-term decrease in the size of an important population of *P. alexandrae.*

Reduce the area of occupancy of an important population

As *P. alexandrae* is only likely to inhabit the Proposal area when resources are suitable during irruptions from its core range, which is probably centred on the Great Sandy Desert or the eastern Gibson Desert and western Great Victoria Desert, the Proposal would not reduce the area of occupancy of an important population of *P. alexandrae.*

Fragment an existing important population into two or more populations

For the reasons stated above, the Proposal would not fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of the species

Habitat within the core range of *P. alexandrae*, as described above, is likely to be critical to the survival of the species as it ensures their persistence during the non-irruptive low population phase. *Polytelis alexandrae* will not inhabit the area of interest on a regular or long-term basis. As the core range is not within the area of interest and *P. alexandrae* is only likely to be present irregularly, the Proposal would not adversely affect habitat critical to the survival of the species.

Disrupt the breeding cycle of an important population

For the reasons stated above Proposal would not disrupt the breeding cycle of an important population of *P. alexandrae.*

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

For the reasons stated above the Proposal would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

Invasive species that are potentially harmful to *P. alexandrae* are introduced herbivores, via grazing impacts and the reduction or alteration of favoured food resources. The Proposal would not lead to an increase introduced herbivores. Land clearing can lead to the spread of *C. ciliaris. Cenchrus ciliaris* is associated with more frequent and intense fire events, and can lead to increased tree mortality. Altered fire regimes may have also contributed to the decline of *P. alexandrae*, and may negatively impact the availability of food plants and breeding trees.

Introduce disease that may cause the species to decline

Pssitacine Beak and Feather Disease affects *P. alexandrae*, but it is unlikely that this would be introduced to a population of the species as a result of the Proposal. The Proposal is unlikely to introduce any other disease that may cause *P. alexandrae* to decline and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.

Interfere with the recovery of the species.

As *P. alexandrae* is only likely to be in the area of interest when resources are suitable during irruptions, and any populations in the Proposal area are not likely to be important populations, the Proposal would not interfere with the recovery of the species.

Conclusion
As a population of *P. alexandrae* within the proposed devleopment footprint or vicinity would not meet the criteria for being an important population, activities associated with construction, operation, and decommissioning and rehabiliation would not impact an important population of this species. For the same reasons, it is highly unlikely that there would be a reduction in the area of occupancy of the species, no fragmentation of a population into two or more populations, and no impact on habitat critical to the surivial of the princess parrot. Activities associated with construction, operation, and decommisioning and rehabilitation are highly unlikely to interfere with the recovery of the princess parrot. Activities associated with construction, operation, and decommisioning and rehabilitation are highly unlikely to disrupt the breeding cycle of the species, impact the availabiliy or quality of habitat for the species, or interfere with the recovery of the princess parrot. There is a potential for encroachment of buffel grass into disturbed areas where it is not currently established, which may negatively impact food plants and breeding trees for the princess parrot. Though as this species is highly mobile and there is suitable habitat outside the proposed development footprint, it is unlikely that this would significantly impact princess parrot. For the reasons listed above, there would be no significant impact on the princess parrot during construction, operation, or decommissioning and rehabilitation of the Proposal.

Crest-tailed Mulgara *(Dasycercus cristicauda)*

Dasycercus cristicauda is listed as vulnerable under the EPBC Act and TPWC Act. This species occurs in sand dune habitats, and is found predominantly on the slopes and crests of dunes with *Zygochloa paradoxa* and *Triodia* spp. vegetation. *Triodia* sp. sand dunes are present and widespread within the Proposal area. *Dasycercus* sp. tracks were observed during on-ground surveys, though it was not possible to identify these to species. There is a high likelihood that *D. cristicauda* is present in the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
A population of *D. cristicauda* in the area of interest would be at the limit of its known range, thereby meeting the criteria for an important population. However, the Proposal would not lead to a long-term decrease in the size of an important population of *D. cristicauda* given that impacts from the Proposal are localised and the availability of suitable habitat in the surrounding area is widespread.
Reduce the area of occupancy of an important population
The impacts of the Proposal are localised and the availability of suitable habitat in the surrounding area is widespread. Therefore the Proposal is not likely to reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations
As the potentially suitable habitat for *D. cristicauda* in the area of interest is widespread, and the impacts of the Proposal are localised, any disturbance to potentially suitable habitat in the Proposal area would not fragment an existing important population into two or more populations.

Adversely affect habitat critical to the survival of the species

Due to the widespread availability of potentially suitable habitat within the area of interest and the impacts of the Proposal will be localised, the Proposal would not adversely affect habitat critical to the survival of *D. cristicauda*.

Disrupt the breeding cycle of an important population

The impacts of the Proposal will be localised and suitable habitat for *D. cristicauda* is widespread in the area of interest and the Proposal is not likely to hinder access to mates or access to resources needed for reproduction. Therefore, the Proposal would not disrupt the breeding cycle of an important population of *D. cristicauda.*

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

The impacts of the Proposal will be localised and suitable habitat for *D. cristicauda* is widespread in the area of interest. Therefore the Proposal is not likely to modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *D. cristicauda* is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

Threats to *D. cristicauda* associated with invasive species include predation by feral predators, altered fire regimes and grazing by introduced herbivores. The Proposal is not likely to influence grazing pressure by introduced herbivores. Predation pressure may be increased through the clearing of vegetation for the proposed haul and access roads providing an easy path through the landcape for feral predators. Fire regimes may be altered, as discussed for *P. alexandrae*, through the introduction, and establishment of *C. ciliaris.*

Introduce disease that may cause the species to decline

There are no known diseases affecting *D. cristicauda* that are relevant to the Proposal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.

Interfere with the recovery of the species.

Due to the localised impact associated with the Proposal and the widespread availability of suitable habitat in the area of interest, it is not likely that the Proposal would interfere with the recovery of *D. cristicauda*.

Conclusion

As potentially suitable habitat for *D. cristicauda* is widespread within the proposed development footprint and vicinity (and in the region) and the construction, operation, and rehabilitation and decommissioning activities would be localised, it is highly unlikely that there would be a long term decrease in the size of an important population of the species. For the same reasons, it is highly unlikely that there would be a reduction in the area of occupancy of the species, fragmentation of a population into two or more populations, and impact on habitat critical to the surivial of the species. Activities associated with construction, operation, and decommisioning and rehabilitation are highly unlikely to disrupt the breeding cycle of the species, impact the availabiliy or quality of habitat for the species, or interfere with the recovery of the *D. cristicauda*.

For the reasons listed above, there would be no significant impact on *D. cristicauda* during construction, operation, or decommissioning and rehabilitation of the Proposal.

Great Desert Skink *(Liopholis kintorei)*

Liophlis kintorei is listed as vunerable under the EPBC Act and TPWC Act. *Liopholis kintorei* is predominantly found in sandplains and adjacent swales containing *Triodia* grassland vegetation and scattered shrubs, but can occupy a range of vegetation types such as lateritic palaeodrainage lines within *Melaleuca* shrubs in the Tanami Desert (McAlpin, 2001). Potentially suitable habitat for *L. kintorei* is widespread within the Proposal area, consisting of sandplain habitat with *Tridodia* grassland vegetation. This species was not recorded during on-ground surveys. However, due to potential suitability of habitat there is a low-moderate likelihood that *L. kintorei* could be present in the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
If *L. kintorei* is present in the area of interest it would constitute an important population as it would be on the edge of the known range of the species. As potentially suitable habitat for this species is widespread in the Proposal area and impacts from the Proposal are likely to be localised, the Proposal would not lead to a long-term decrease in the size of an important population of the species.
Reduce the area of occupancy of an important population
As potentially suitable habitat for this species is widespread in the Proposal area and impacts from the Proposal are likely to be localised, the Proposal is not likely not reduce the area of occupancy of an important population of *L. kintorei.*
Fragment an existing important population into two or more populations
As potentially suitable habitat for this species is widespread in the Proposal area and impacts from the Proposal are likely to be localised, the Proposal would not fragment an existing important population of *L. kintorei* into two or more populations.
Adversely affect habitat critical to the survival of the species
The habitat most widely used by *L. kintorei* is sandplain vegetated by *Triodia* spp. and scattered shrubs, though the presence of *L. kintorei* in different areas may be driven by fire regime (McAlpin, 2001). Due to the localised impact of the Proposal and the widespread availability of this habitat type in the area of interest, the Proposal would not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population
As potentially suitable habitat for this species is widespread in the Proposal area and impacts from the Proposal are likely to be localised, the Proposal is not likely to disrupt the breeding cycle of an important population of *L. kintorei,* as access to mates and resources required for reproduction would not be interfered with.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
Due to the localised impact of the Proposal and the widespread distribution of the habitat in the area of interest, the Proposal would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *L. kintorei* is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.
Altered fire regimes and predation by feral predators are threats impacting *L. kintorei.* As described above, there is the potential for increased predator abundance and activity in the area of interest from activities associated with the Proposal, and encroachment of *C. ciliaris* leading to altered fire regimes.
Introduce disease that may cause the species to decline
There are no known diseases affecting *L. kintorei* that are relevant to the Propoal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.
Interfere with the recovery of the species.
Due to the localised impact associated with the Proposal, the Proposal is not likely to interfere with the recovery of *L. kintorei.*
Conclusion
Potentially suitable habitat for *L. kintorei* is widespread regionally as well as within the proposed development footprint and vicinity (and in the locality) and no populations are known within the region. Consequently if the species is present in the Proposal area, the localised construction, operation, and rehabilitation and decommissioning activities are unlikely to cause a long term decrease in the size of an important population of the species. For the same reasons, it is unlikely that there would be a reduction in the area of occupancy of the species, fragmentation of a population into two or more populations, or impact on habitat critical to the surivial of the *L. kintorei*. Activities associated with construction, operation, and decommisioning and rehabilitation are highly unlikely to disrupt the breeding cycle of the species, impact the availabiliy or quality of habitat for the species, or interfere with the recovery status of *L. kintorei*. For the reasons listed above, there would be no significant impact on *L. kintorei* during construction, operation, or decommissioning and rehabilitation of the Proposal.

4.2.4 Vulnerable flora

There were no vulnerable flora identified but the EPBC PMST, the NT Flora Atlas and on-ground surveys as occurring or potentially occurring within the area of interest.

4.2.5 Migratory and marine species

The assessment of significant impacts on species listed as Mi and Ma under the EPBC Act recorded or with a moderate to high likelihood of occurring in the Proposal area are presented as one assessment below. This is due to the commonalities between assessments of the species. Species assessed include:

- *Apus pacificus* (fork-tailed swift);
- *Ardea modesta* (eastern great egret);
- *Caladris acuminata* (sharp-tailed sandpiper);
- *Charadrius veredus* (oriental plover);
- *Glareola maldivarum* (oriental pratincole);
- *Merops ornatus* (Rainbow bee-eater);

- *Tringa nebularia* (Common greenshank); and
- *Tringa stagnatilis* (Marsh sandpiper).

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an migratory species if there is a real chance or possibility that it will:
Substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species
Habitat within the Proposal area is not in a region that supports an ecologically significant proportion of any migratory species potentially occurring in the Proposal area; is not of critical importance to any of these species at particular life-cycle stages; is not at the limit of the range of any of these species; and is not within an area where any of these species is declining (DoE, 2016a). Therefore, the habitat within the Proposal area does not meet the criteria for being classified as important habitat for any of the migratory species potentially occurring in the Proposal area. For this reason, the Proposal would not substantially modify, destroy or isolate an area of important habitat for the migratory species potentially occurring within the Proposal area.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
For the reasons stated above, habitat within the Proposal area does not meet the criteria for being classificed as important habitat. Therefore the Proposal would not result in an invasive species that is harmful to any migratory species potentially occurring within the Proposal area becoming established in an area of important habitat for these migratory species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species
It is unlikely that any of the migratory species potentially occuring within the Proposal area will be present in high enough numbers to constitute an ecologically significant proportion of their Australian population. Therefore, it is unlikely that the Proposal would seriously disrupt the lifecycle of an ecologically significant proportion of the population of any of the migratory species potentially occurring within the Proposal area.
Conclusion
As habitat within the Proposal area is not in a region that supports an ecologically significant proportion of any migratory species potentially occurring in the Proposal area; is not of critical importance to any of these species at particular life-cycle stages; is not at the limit of the range of any of these species; and is not within an area where any of these species is declining, it is not likely that the Proposal will significantly impact any migratory species.

4.2.6 Species listed under the TPWC Act

Threatened Fauna

The following threatened fauna listed as vulnerable under the TPWC Act were recorded or have a high likelihood of occurring within the Project area:

- *Dasycercus blythi* (crest-tailed mulgara); and
- *Notoryctes typhlops* (southern marsupial mole).

As assessed by the guidelines below, the Proposal is not likely to have a significant impact on these species.

There are thirteen species listed as data deficient or near threatened under the TPWC Act with a moderate to high likelihood of occurring in the Proposal area; however these species are not assessed as they are not of conservation concern in the Proposal area.

Brush-tailed Mulgara *(Dasycercus blythi)*

Dasycerus blythi is listed as vulnerable under the TPWC Act. This species inhabits sandplain, gibber plain and cracking clay habitats supporting tussock or hummock grasslands, or sparse chenopod shrubland (Dickman, *et a*., 2001; Pavey, *et a*., 2011; L. Young, unpublished data). Habitat suitable for *D. blythi* is widespread throughout the Proposal area. *Dasycercus* sp. tracks were observed during on-ground surveys, though it was not possible to identify these to species. *Dasycercus blythi* undergoes population peaks and troughs and can shift its local range, and although it was not directly recorded during any on-ground surveys, there is a high likelihood that this species is present in the Proposal area.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
A population of *D. blythi* in the Proposal area is not likely to be a key source population for breeding or dispersal, a population necessary for maintaining genetic diversity or a population near the limit of the species range, as it does not occur in an isolated area of suitbale habitat, suitable habitat is widespread in the Proposal area, and it is not at the edge of the species range. Therefore, it would not meet the criteria under the guidelines for being an important population.
Reduce the area of occupancy of an important population
As a population of *D. blythi* in the Proposal area would not fit the criteria for being an important population, the Proposal would not reduce the area of occupancy of an important population of *D. blythi.*
Fragment an existing important population into two or more populations
As potentially suitable habitat for *D. blythi* in the Proposal area is widespread and a population would not meet the criteria for being an important population, any disturbance to potentially suitable habitat in the Proposal area would not fragment an existing important population into two or more populations.
Adversely affect habitat critical to the survival of the species
Due to the widespread availability of potentially suitable habitat within the Proposal area and throughout the range of the species, the Proposal would not adversely affect habitat critical to the

survival of *D. blythi.*

Disrupt the breeding cycle of an important population

As a population of *D. blythi* in the Proposal area would not meet the criteria for being an important population, the Proposal would not disrupt the breeding cycle of an important population of *D. blythi.*

Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline

As suitable habitat for *D. blythi* is widespread in the area of interest, and impacts from the Proposal will be localised, the Proposal would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that *D. blythi* is likely to decline.

Result in invasive species that are harmful to the species becoming established in the species' habitat.

Threats to *D. blythi* associated with invasive species include predation by feral predators, altered fire regimes and grazing by introduced herbivores (Pavey, et al., 2006a). The Proposal is not likely to influence grazing pressure by introduced herbivores. Predation pressure may be increased through the clearing of the proposed access and haul roads providing an easy path through the landcape for feral predators. Fire regimes may be altered, as discussed for *P. alexandrae*, through the introduction and establishment of *C. ciliaris.*

Introduce disease that may cause the species to decline

There are no known diseases affecting *D. blythi* that are relevant to the Proposal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.

Interfere with the recovery of the species.

Due to the localised impact associated with the Proposal and the widespread availability of suitable habitat in the Proposal area, the Proposal would not interfere with the recovery of *D. blythi*.

Conclusion

As potentially suitable habitat for the *D. blythi* is widespread within the proposed development footprint and vicinity (and in the locality) and the construction, operation, rehabilitation and decommissioning activities would be localised, it is highly unlikely that there would be a long term decrease in the size of an important population of the species. For the same reasons, it is highly unlikely that there would be a reduction in the area of occupancy of the species, no fragmentation of a population into two or more populations, and no impact on habitat critical to the survival of the brush-tailed mulgara. Activities associated with construction, operation, and decommisioning and rehabilitation are highly unlikely to disrupt the breeding cycle of the species, impact the availabiliy or quality of habitat for the species, or interfere with the recovery of *D. blythi*.

For the reasons listed above, there would be no significant impact on the *D. blythi* during construction, operation, or decommissioning and rehabilitation of the Proposal.

Southern Marsupial Mole *(Notoryctes typhlops)*

Notoryctes typhlops is listed as vulnerable under the TPWC Act. *Notoryctes typhlops* occupies dunes, sandy plains and river flats (Pavey, 2015). This habitat is widespread in the Proposal area. *Notoryctes typhlops* was recorded during on-ground surveys and sign of the species was recorded at two sites in the banks of the Finke River, approximately 850 m north of the proposed Henbury Access Road, on the eastern and western site of the river bank.

According to the significant impact criteria for an endangered species, an action is likely to have a significant impact on an vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of the species
There are no important populations identified in the recovery plan for *N. typhlops* (Benshemesh, 2004). Potentially suitable habitat for *N. typhlops* is widespread throughout the area of interest and the species range, and impacts from the Proposal are likely to be localised. A population of *N. typhlops* within the Proposal area is unlikely to be a key source population for breeding or dispersal, a population that is necessary for maintaining genetic diversity or a population at the extent of the species range. Therefore, it does not meet the criteria for being classified as an important population. For this reason the Proposal would not lead to a long-term decrease in the size of an important population of *N. typhlops.*
Reduce the area of occupancy of an important population
As suitable habitat for *N. typhlops* is widespread in the area of interest and a population in the area of intersest does not meet the criteria for being an important population, the Proposal would not reduce the area of an important population of *N. typhlops.*
Fragment an existing important population into two or more populations
As suitable habitat for *N. typhlops* is widespread in the area of interest and a population in the area of intersest does not meet the criteria for being an important population, the Proposal would not fragment an existing important population of *N. typhlops* into two or more populations.
Adversely affect habitat critical to the survival of the species
Notoryctes typhlops is most often recorded in sandy dunes with shrubs, and often but not always in association with spinifex (Benshemesh, 2004). This habitat is widespread and typical within the Proposal area and throughout the species range, and impacts associated with the Proposal are likely to be localised. Therefore, the Proposal would not adversely affect habitat critical to the survival of *N. typhlops.*
Disrupt the breeding cycle of an important population
As suitable habitat for *N. typhlops* is widespread in the area of interest, and a population in the area of intersest does not meet the criteria for being an important population, the Proposal would not disrupt the breeding cycle of an important population of *N. typhlops.*
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
Given that potentially suitable habitat for *N. typhlops* is widespread throughout the Proposal area and the species range and impacts associated with the Proposal are likely to be localised, the Proposal would not modify, destroy, remove, isolate or decrease that availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to the species becoming established in the species' habitat.
Notoryctes typhlops is known to be preyed upon by *V. vulpes.* Therefore, predation by feral predators is a threat to *N. typhlops.* The Proposal has the potential to increase the abundance and activity of feral predators in the Proposal area through clearing creating pathways through the landscape.

Introduce disease that may cause the species to decline
There are no known diseases affecting *N. typhlops* that are relevant to the Propoal and the Proposal is unlikely to increase the potential for significant disease vector to affect this species.
Interfere with the recovery of the species.
Given that impacts associated with the Proposal are likely to be localised, and potentially suitable habitat for *N. typhlops* is widespread throughout the Proposal area and the species range, the Proposal would not interfere with the recovery of the species.
Conclusion
As potentially suitable habitat for *N. typhlops* is widespread within the proposed development footprint and vicinity (and in the locality) and the construction, operation, rehabilitation and decommissioning activities would be localised, it is highly unlikely that there would be a long term decrease in the size of an important population of the species. For the same reasons, it is unlikely that there would be a reduction in the area of occupancy of the species, fragmentation of a population into two or more populations, or impact on habitat critical to the surivial of the *N. typhlops*. Activities associated with construction, operation, decommisioning and rehabilitation are unlikely to disrupt the breeding cycle of the species, impact the availabiliy or quality of habitat for the species, or interfere with the recovery of *N. typhlops*. For the reasons listed above, there would be no significant impact on *N. typhlops* during construction, operation, or decommissioning and rehabilitation of the Proposal.

Threatened flora

There are no threatened flora species listed under the TPWC Act with a moderate to high likelihood of occurring in the Proposal area. Eight near threatened or data deficient flora species were assessed as having a moderate to high likelihood of occurring within the Proposal area, however these species are not of conservation concern in the area of interest and therefore have not been assessed.

5 RISKS TO BIODIVERSITY

This section assesses the potential impacts and environmental risks associated with each phase of the Proposal; including construction, operation, decommissioning and rehabilitation.

In each phase, the impacts and risks are assessed based on the following classifications:

- Direct Impacts – where the loss or modification of an environmental aspect is the direct result of activities at the Proposal area;
- Indirect Impacts – a secondary impact as a result of a direct impact or an impact from a disturbance outside of the Proposal area, resulting in the loss or modification of an environmental aspect ;
- Consequential Impacts – where the loss or modification of an environmental aspect results from the development of the Proposal, i.e. increased third party access from road and track development; and
- Cumulative Impacts – combined effects on the environment from the Proposal in conjunction with impacts from surrounding activities or developments. Due to the remote location and lack of other developments in the area, cumulative impacts have not been addressed here; see Section 8 for details on cumulative impacts for the Proposal.

Table 5-1 is the risk matrix used to provide a numerical assessment of the risk that may result from the Proposal (Table 5-2). The risk rating is based on the assessment of potential likelihood of an event occurring and the associated consequences. Industry best practise, experience from similar operations in the region, stakeholder engagement and LES's extensive arid lands ecology experience in central Australian mining operations has been used to quantify these risks. Mitigation measures, described in Section 6, have been developed to reduce this risk to as low as reasonably practical (ALARP). The assessment of the effectiveness of these mitigation measures on reducing the identified risk has also been provided in mitigation and monitoring measures for threatened species.

The development of this risk assessment has been based on LES's extensive experience in mining, petroleum and other land clearing and rehabilitation projects in arid central Australia, including but not limited to work with:

- Rehabilitation monitoring of old Uluru to Kata Tjuta road after decommissioning: (Low, et al., 2012);
- Newmont Gold Mine;
- ABM Resources Tanami Gold Mine;
- Central Petroleum seismic line, drilling, exploration and field developments; and
- MacArthur River Mine.

Further industry best practise and government guidelines have been adapted to site specific issues to assess the risk.

Relevant statutory threat abatement plans, threatened species recovery plans and the scientific literature have been drawn onto assess risks and potential impacts from the Proposal on identified threatened flora and fauna species. Section 4 assesses the significance of the potential impacts that may result from the Proposal on identified threated species in more detail. Threatened species that were recorded during surveys or have a moderate to high likelihood of occurring in the Proposal area were specifically addressed in the risk assessment process. *Liopholis slateri slateri* and *A. m. indulkana* were assessed as being potentially significantly impacted by the Proposal if they were found to be present in the Proposal area.

Table 5-1: Risk assessment matrix outlining consequence and likelihood assessment categories using current NT EPA terminology

		Low Risk / Moderate Risk / High Risk	LIKELIHOOD – Probability of Harm / Loss					
			1	**2**	**3**	**4**	**5**	**6**
		Environmental Impact	**Unlikely/ Unknown; Not expected to occur**	**Remote potential; May occur only on exceptional circumstances**	**Possible; Could occur at some time**	**Probable; Expected to occur at some time**	**Frequent; Likely to occur regularly**	**Highly Likely, ever present; occurs in most circumstances**
CONSEQUNCES – Severity of Harm / Loss	**1**	Alteration/disturbance within the limits of natural variability; effects not transmitted or accumulating; resources not impaired. Minimal pollution effect, contained locally.	1	2	3	4	5	6
	2	Temporary alteration/disturbance beyond natural variability; effects confined to site and not accumulating; resources temporarily affected. Minor pollution, slight or negligible impact, negligible remedial or recovery work. Short term, localised and insignificant impacts to habitat or populations. Rapid recovery – measured in hours.	2	4	6	8	10	12
	3	Alteration/disturbance of a component of an ecosystem; effects not transmitted or accumulating. Pollution with some onsite impact and recovery work; possible outside assistance to contain. Incidental changes to abundance/biomass of biota in affected area; insignificant changes to overall ecological function. Recovery period measured in days – months.	3	6	9	12	15	18
	4	Alterations to one or more ecosystems or component levels, but which are recoverable; effects can be transmitted/accumulating. Significant pollution with offsite impact and recovery work. Impact that will cause a detectable effect in local ecosystem factors. Recovery period measured in months.	4	8	12	16	20	24
	5	Irreversible alteration to one or more ecosystems or several component levels; effects can be transmitted, accumulating; lost sustainability of most resources. Massive site impact and recovery work. Detrimental effect that will cause a significant effect on local ecosystem factors. Recovery period measured in years.	5	10	15	20	25	30
	6	Irreversible alteration to one or more ecosystems or several component levels; effects can be transmitted, accumulating; lost sustainability of most resources. Massive pollution with significant recovery work. Large scale detrimental effect that is likely to cause a highly significant effect on local ecosystem factors such as water quality, nutrient flow, community structure and food webs, biodiversity, habitat availability and population structure. Long term recovery period measured in decades	6	12	18	24	30	36

Table 5-2: Assessment of risks to the environment that may result from the Proposal

C1: consequences, L2: likelihood

Hazard Identification			**Risk Analysis**			**Mitigation and Monitoring Measures**	**Residual Risk Analysis**		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Vegetation clearing	Removal of large trees. Removal of ground cover. Fragmentation of land types. No erosion or sediment .control devices Insufficient dust control.	Fragmentation of habitat and edge effect.	3	2	6	Use water trucks for dust mitigation. Only clear the minimum amount of land required for safe operation of the Proposal. All areas to be surveyed for flora and fauna by qualified consultants before clearing. Leave mature trees where possible, especially desert oaks and bloodwoods. Stockpile vegetation, top soil and spoil separately in low profile mounds, less than 1.5 m in height. Avoid clearing during period of expected higher rainfall, December – March, if practicable. Land clearing guideline checklist to include all relevant government approvals required and environmental best practise methods. Ensure best practise erosion and sedimentation control devices and measures are utilised during clearing works in accordance with DLRM and International Erosion Control Association (IECA) guidelines.	2	1	2
		Loss of conservation significant flora species.	3	2	8		2	2	4
		Loss of conservation significant fauna habitat.	5	3	15		3	1	3
		Erosion and sedimentation.	4	3	12		2	2	4
		Increased dust and top soil loss.	4	4	16		2	2	4
		Altered hydrology.	4	3	12		2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Habitat Loss	Removal of small shrubs, grasses and tree hollows; Removal of fallen logs greater than 10cm in diameter. Soil compaction; Altered surface hydrology. Removal of rocks and rocky outcrops	Loss of conservation significant fauna habitat.	4	2	8	Induct all staff into the BDMP (Biodiversity Management Plan) and identification of fauna habitat. Implement mitigation and monitoring measures for vegetation clearing. Leave fallen logs >15 cm diameter or relocate to surrounding environment. Relocate any bird nest found in trees or shrubs to be cleared, into surrounding environment.	2	1	2
		Loss of fauna habitat.	3	4	12		1	3	3
Fauna Strike or Injury	Access undisturbed areas. Increased traffic. Heavy vehicle access.	Conservation significant fauna.	4	2	8	Induct all staff and contractors into the requirements of the BDMP and other associated management plan's. Minimal use of vehicles required for safe operation of plant site No off-road driving. Develop and maintain a fauna strike register. Minimise driving at night. Limit access of third parties to Proposal area. Traffic to adhere to speed limits and local road rules. Speed limit and potential fauna crossing signs clearly displayed on Chandler Haul Road and Henbury Access Road and other access tracks within the Proposal area. Avoid driving at dusk, dawn and at night, as	3	1	3
		Other fauna.	4	4	16		3	2	6

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						practicable.			
Edge Effects	Clearing of vegetation. Reducing capacity to resist weeds and other invasive species. Reducing capacity to resist erosion and sedimentation.	Increased weed species.	4	3	12	Routine inspection for weeds and invasive species around cleared areas. Routine inspection for weeds and invasive species around cleared areas. Implement introduced fauna mitigation measures as listed. Ensure remnant vegetation has a larger area to perimeter ratio, to increase buffer against edge effects	2	2	4
		Erosion and sedimentation.	4	3	12		2	2	4
		Increased pest and predator species.	4	3	12		2	2	4
Habitat Fragmentation	Clearing of habitat types.	Discontinuous habitat available for conservation significant fauna for foraging and shelter.	4	2	8	Mitigation measures for as for edge effects above.	3	1	3
Fauna Displacement	Land clearing Construction .works Road development Lighting, noise and vibration.	Distress to conservation significant fauna.	3	3	9	Induct all staff into the BDMP and identification of fauna habitat. All of the mitigation measures for vegetation clearing apply. Third party qualified consultants to ensure all	3	1	3

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						fauna is removed from areas intended to be cleared.			
Hazardous Material	Stores of hydrocarbons on site. Spill, leak or accidental release of hydrocarbons.	Contamination of soil.	4	3	12	All hazardous waste to be contained within a bunded area sufficient to hold 110% of all material. Only store the minimum amount of hazardous materials required for construction, operation, decommissioning and rehabilitation. Any incident or spill involving hazardous material recorded in incident log for review and remediation actions. Use of suitably qualified consultants for remediation and contaminated site assessments. Hazardous material to be stored away from watercourses, large trees or significant vegetation. Develop and maintain a hazardous material storage log. Bund integrity to be routinely monitored Any break in bund integrity to be immediately remediated and actions recorded in incident log.	2	2	4
		Contamination of water.	5	2	10		2	1	2
		Contamination of groundwater .	5	2	10		5	1	5
		Contamination of vegetation.	4	3	12		2	1	2
		Direct dermal contact with fauna.	4	3	12		3	2	6

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
		Direct ingestion by fauna.	4	3	12	All contaminated waste, from spills or accidental loss, to be classified and either remediated on site or transported to nearest licensed waste disposal facility. National Environmental Protection Measure (NEPM) guidelines Volume B, 2013 to be used in remediation and contamination assessments. No open flames or heat sources near flammable material, appropriate signage used. MSDS, spill kits and appropriate firefighting equipment (water, chemical or foam, etc.) stored next to hazardous material storage and use areas. Eye and body wash stations located around the Chandler and Apirnta facilities at locations of use, handling and storage of hazardous material. Site inductions to cover storage, handling and use procedures for all hazardous materials used at the Chandler and Apirnta facilities.	3	1	3
Windblown Salt	Salt stockpiles. Salt transport. Salt mining activities.	Conservation significant flora.	3	2	6	Cover all salt during transport. Monitor dust and airborne particles. Store salt in open stockpile for minimum time required. Survey/monitor flora in dominant down wind direction from salt mine for impacts.	2	1	2
		General vegetation.	2	2	4		2	1	2
		Water courses.	2	2	4		2	1	2
		Soil.	2	2	4		2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Lighting Noise and Vibration	Construction noise, Blasting and vibrations. Increased traffic.	Disturbance to local fauna.	2	3	6	Construction, operations, decommissioning and rehabilitation activities confined from 7am to 5pm, where possible. Turn off machinery when not in use. Establish and maintain a noise complaints register. Ensure blasting works restricted between 7am to 5pm. Maintain and regularly service all generators, engines and vehicles on site. Ensure vehicles carry full loads were possible to limit the number of vehicles on the Chandler Haul Road and Henbury Access Road. Direct lights towards the ground, where possible; or use shield to direct lights to only area it is required. Only have minimal lights on needed for safe operation of facilities. Have lights positioned as low as possible. Turn lights off when not in use. Use of lower intensity lights, e.g. yellow or red lighting, where possible. This would reduce impacts on nocturnal species and limit insect attraction. Restrict work to daylight hours, where possible	2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Dust	Blasting and underground works. Windblown salt Construction works. Increased vehicle traffic.	Disturbance to local fauna and conservation significant fauna.	3	4	12	Use water trucks during construction, operation, decommissioning and rehabilitation to control dust. Avoid clearing during dry windy conditions. Clear with blade up, where possible. Leave vegetation 10 cm in height on firebreaks and non-crucial tracks. Stage clearing operations to reduce total exposed cleared surface at any one time. Inspect flora for signs of stress along edges of roads and cleared areas.	2	2	4
		Impacts to vegetation	3	4	12		2	2	4
		Water courses.	2	1	2		2	1	2
		Conservation significant flora.	2	1	2		2	1	2
Fire	Increased ignition sources. Natural events/climatic conditions. Inadequate bushfire management. Vegetation stockpiles. Traffic accidents.	Conservation significant flora.	4	2	8	Develop and implement a Bushfire Management Plan, refer to Appendix 4. Keep up to date with bushfire website and state services. Construct and maintain firebreaks around all infrastructure and significant habitats. No open flames outside of designated areas unless hot works permit is approved. Flammable material clearly labelled Adequate firefighting equipment stored on site and staff trained in use. Provide designated smoking area. Organise and implement strategic back burning with CLC (Central Lands Council). Limit unauthorised third party access.	3	2	5
		Conservation significant fauna.	5	4	20		3	2	5
		Site personnel safety.	5	3	15		3	1	3
		Site infrastructure.	5	3	15		3	1	3
		General ecology.	5	4	20		2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						Implement and carry out annual fuel load surveys in September, before high risk fire season.			
Waste	Poor domestic waste management. Storage locations not fauna proof or adequately contained. Increased predators and introduced species.	Soil and water contamination.	5	4	20	Develop and implement a Waste Management Plan. Ensure all domestic waste stored in fauna proof bins. All waste stored in appropriate labelled containers. Bund liquid waste where required. Implement waste hierarchy triangle – avoid/minimise, reuse, recycle, recovery, and then disposal. Reduce, re-use, recycle and if not then waste. All waste disposed off-site by licensed contractor. All hazardous waste and hydrocarbons stored separately in bunding, with appropriate signage.	3	1	3
		Impacts to fauna and conservation significant fauna.	4	4	16		3	1	3
		Visual amenity loss.	2	3	6		2	1	2
Altered Hydrology	Altered surface hydrology. Groundwater drawdown. Artificial surface	Conservation significant flora.	3	1	3	Allow natural surface drainage to continue without interruption Avoid clearing or disturbance to watercourses or drainage depressions, as practicable. Avoid infrastructure developments in	2	1	2

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
	water sources. Contamination due to spill or uncontrolled. release of hazardous. materials Clearing of large vegetation.	Conservation significant fauna.	2	1	2	watercourses or drainage depressions, as practicable. Ensure no impedance to natural creek flow. Develop and implement a Surface Water Management Plan. Develop creek crossing to natural contours of creek bed. Remove any concentration points that would impede natural sheet flow. Remove all windrows from access and haul roads.	2	1	2
		Downstream receptor impacts.	3	3	9	Minimal disturbance within water course buffer zones (as a guide reference would be made to DLRM land clearing guidelines for buffer distance until site specific buffers have be detailed by a suitably qualified consultant). Leave large mature trees and shrubs, where possible. Use flat bottom drains. Install erosion and sediment control devices in accordance with the ESCP with reference to DLRM and IECA best practise guidelines. Routine inspection and maintenance of drains and water courses. Monitor riverine vegetation for signs of stress. Control weed species as per the weed and	2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						invasive species mitigation measures listed above.			
Groundwater Abstraction	Drawdown of aquifer for construction. Road maintenance. Dust suppression. Poor well hygiene.	Surrounding stakeholders utilising the aquifer.	4	3	12	Annual sampling of water quality from all extraction bores. Monitor water drawn down Static Water Level (SWL) in all extraction and monitoring bores. Baseline standard physical chemical and metals analysis of water quality and SWL (Standing Water Level) measurements of all production and monitoring wells. Followed by second sample event one month after initial heavy use to ascertain if any changes have occurred. If significant changes occurred sample again in 6 months' time to determine rate of change, if not sample annually as mentioned above. Monitor well surface hygiene to ensure no foreign material enters wells. Install well caps on monitoring wells. Fence off bore field to avoid damage from fauna and large herbivores. Ensure no spill or contamination enters wells. Record extraction rate and amount.	2	1	2
		Contamination of aquifer.	5	2	10		5	1	5

Hazard Identification			**Risk Analysis**			**Mitigation and Monitoring Measures**	**Residual Risk Analysis**		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Erosion and Sedimentation	Concentration points. Land clearing Inadequate drainage. Inadequate erosion and sediment control devices.	Watercourse direction and sediment load.	3	2	6	Develop and implement an Erosion and Sediment Control Plan (ESCP). Leave 5-10 cm of surface vegetation during clearing, where possible. Avoid clearing in water courses, drainage depressions or slopes greater than 2%, as practicable. Avoid high risk erosion soils; Ld1, Nb25 and Nb19 (see Section 3.4). Consider final alignment of roads and tracks to minimise risks to the environment based on vegetation type, land systems and soils present; this would avoid the use of some mitigation required. Construct erosion control devices in line with DLRM and IECA best practise guidelines. Ensure all water crossings are developed to base of natural water course or adequate culverts are established to reduce flow constriction of watercourses. Ensure cleared areas are rehabilitated as soon as no longer required for safe operation of the Proposal. Remove all windrows and any concentration points to overland sheet flow, where possible	2	2	4
		Drainage line diversion and scour.	3	3	9		3	1	3
		Vegetation loss.	3	3	9		2	1	2

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
		Top soil loss.	4	3	12	along roads, tracks and cleared surfaces. Install flat bottom off-let drains along roads and access tracks. Maintain roads and drains. Use whoa-boys or diversion bunds on cleared slopes to dissipate and direct water flow into the surrounding environment; reducing erosion potential. IECA guidelines and DLRM best practise guidelines would be utilised in the development of these control devices. Ensure waste rock and other stockpiles are sloped at 18-20% to reduce run-off velocities. Develop roads and tracks along the contour where possible to limit the velocity of surface water flow directly down gradient. Routine site inspection for any signs of erosion Construct sediment control devices in line with DLRM and IECA best practise guidelines. Monitor erosion control devices to ensure integrity. Install sediment catch fences during construction, if required. Check watercourse and drainage depression crossings for signs of sediment accumulation.	2	2	4

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Introduction and Spread of Weeds and Invasive Species	Lack of weed hygiene measures Construction equipment moving from weed infested area to clean area Newly disturbed areas	Infestation of weed or invasive species.	4	4	16	Induct all staff into the requirements of the weed management plan see Appendix 6. Vehicle/machinery wash-down prior to leaving Alice Springs or entering an area uncontaminated by weeds. Avoid contact with any weed or invasive species seed, plant matter or soil potentially contaminated with weed seeds. Avoid clearing or removal of any weed or invasive species during seeding Remove seed and mud from vehicle tyres and front grill daily. Ensure weed identification and reporting procedures are included in inductions Annual weed mapping of the Proposal area Removal of any weeds identified following specialist advice from third party qualified consultant or Weeds Branch, NT Government. Removal of weed or invasive species outside of seeding times. Avoid driving in wet and muddy conditions, where possible.	3	1	3
		Loss of conservation significant fauna food and habitat.	4	2	8		3	1	3
		Outcompeting native flora.	4	3	12		3	1	3
		Blocking watercourses.	4	3	12		2	2	4
Increase Introduced Fauna	Increased predators Increased	Outcompeting or preying on native fauna.	4	4	16	Prevent access to artificial water and heat sources through construction of fences.	3	1	3

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
	herbivores	Watercourses destruction and depletion from large herbivores.	4	3	12	Dispose of all waste in predator proof bins. Develop and implement a no tolerance policy to the introduction of pest species by contractors, suppliers and personnel. Place brush or vegetation stockpiles across linear developments no longer required (seismic lines, access tracks etc.) to inhibit movement of predators and introduced herbivores. Annual flora and fauna survey to record numbers of introduced fauna species Develop, implement and maintain fauna sighting register. Develop and implement an introduced fauna control program Carry out feral animal control as required in consultation with stakeholders.	3	1	3
		Overgrazing.	3	3	9		2	2	4
		Soil degradation.	4	3	12		2	1	2
Increased Predator Species	Cleared areas. Long linear developments. Wastes and artificial food sources. Artificial water sources. Access into new areas.	Conservation significant fauna.	4	3	12	Reduce artificial standing water. Install fauna proof fence around all infrastructure. Close off and rehabilitate any cleared areas no longer required for safe operation. Ensure waste receptacles are fauna proof Do not feed fauna. Remove any dead fauna or insects from the Proposal and either dispose off-site or bury > 50 cm deep to avoid predators uncovering.	3	1	3
		Other fauna.	4	4	16		2	1	2

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						Trap and relocate predator species if they are noticed to have increased in numbers and habituate around facilities. Appropriate third party advice would be sought before any action taken.			
Soil Compaction and Top Soil Loss	Increased run-off and water flow in watercourses Surface difficult for vegetation to establish	Inhibited regrowth potential.	4	3	12	Locate roads, access tracks and required operational areas on solid surfaces, where possible. Limit compacted areas to minimum required. Ensure reduced infiltration rate of compacted surfaces accounted for in ESCP.	3	1	3
		Loss of seed bank and nutrient rich soil matter.	4	3	12		3	1	3
Unauthorised Third Party Access	New roads	Increased chance fauna strike or injury.	3	2	6	Routine inspection of site for signs of unauthorised entry. All access to site to be recorded in a site register. All visitors must complete induction or be accompanied by Tellus employee whilst on site Dog leg smaller access tracks when joining larger roads to limit third party access by reducing access tracks visibility from the main road. Clearly mark access tracks and roads as private property. Clear signage indicating prohibition of unauthorised entry.	2	2	4
		Increased wastes.	2	2	4		2	1	2
		Weed spread potential.	3	2	6		3	1	3

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
Rehabilitation	Sites not rehabilitated. Improper rehabilitation techniques employed. Inadequate post rehabilitation monitoring.	Conservation significant flora.	2	2	4	Leave any infrastructure, plant or cleared area as so detailed in a land use agreement with the land manager. Ensure any remaining actions - contaminated sites from spills, damage from unauthorised clearing, off-road driving, any erosion or sedimentation issues, weed or invasive species infestations, etc. still requiring work to be finished. Remove all infrastructure, plant, machinery and operational and construction wastes. Re-contour all cleared surfaces to match surrounding topography, as close as possible. Rip any compacted area. Ensure final surface is rough to increase infiltration. Block all access points to roads and tracks, unless agreed with land manager. Fill in sumps or turkey nest, unless agreed otherwise with land manager. Close off and seal all groundwater wells. Leave underground salt mine in condition as stipulated with rehabilitation plan. Develop and implement a decommissioning and rehabilitation management plan. Re-spread top soil. Install erosion and sediment control	2	1	2
		Conservation significant fauna.	4	2	8		2	1	2
		Altered hydrology.	2	3	6		3	1	3
		Top soil loss and compaction.	3	2	6		2	1	2
		Erosion and sedimentation.	4	2	8		2	1	2
		Contamination.	4	2	8		2	1	2

Hazard Identification			Risk Analysis			Mitigation and Monitoring Measures	Residual Risk Analysis		
Hazard	**Causes**	**Impacts**	**C1**	**L2**	**Risk Rating**	**ALARP**	**C1**	**L2**	**Risk Rating**
						temporary structures to assist with rehabilitation. Respread spoil first, then top soil and last cleared vegetation over surfaces.			

5.1 Assessment of risk during construction

This section addresses the environmental risks associated with the construction phase of the Proposal.

5.1.1 Direct impacts

Vegetation clearing

The construction of the Proposal would involve clearing of approximately 397.5 ha. This is made up of approximately:

- 85.5 ha for the Chandler Facility;
- 180 ha for the Henbury Access Road;
- 39 ha for the Apirnta Facility; and
- 93 ha for the Chandler Haul Road.

Vegetation is relatively sparse over much of the Proposal area and is in moderate to good condition with localised disturbances as a result of stock grazing (refer to Section 3.5.1). There are no threatened flora species, threatened ecological communities or sensitive vegetation types in the Proposal area. Therefore, none are likely to be directly impacted by vegetation clearing undertaken during the Proposal. There was one species listed as near threatened and two species listed as data deficient under the TPWC Act recorded during the on-ground surveys, and an additional five near threatened or data deficient species with a moderate or high likelihood of occurring within the Proposal area. However these species are not considered to have conservation significance within the Proposal area (refer to Section 3.8.2).

Broad scale soil types, land systems and vegetation types determined from desktop and on-ground survey work (Section 3) have been used to assess the impacts of vegetation clearing on environmental aspects with the area of interest. The prevalence of un-impacted representations of these soil types, land systems and vegetation types surrounding the Proposal have been taken into consideration when assessing the regional risks. Table 5-3, Table 5-4, Table 5-5 and Table 5-6 show approximate area of soil types, land systems, vegetation types and habitat types to be cleared during construction.

Table 5-3: Area (ha) of mapped broad soil types impacted at each component of the Proposal during the construction phase.
- indicates soil type not present at component of the Proposal

Soil Types	Chandler Facility	Apirnta Facility	Henbury Access Road	Chandler Haul Road	Total
AB59	-	39.0	66.24	34.6	139.84
AB78	-	-	34.16	-	34.16
B43	42.75	-	-	29.06	71.81
Ld1	-	-	-	8.30	8.30
Nb19	-	-	-	6.09	6.09
Nb25	42.75	-	69.39	14.95	127.09
Nc3	-	-	10.21	-	10.21
Total	85.5	39.0	180.0	93	397.5

Table 5-4: Area (ha) of land systems cleared for each component of the Proposal during the construction phase.
- indicates land system not present at component of the Proposal

Land Systems	Chandler Facility	Apirnta Facility	Henbury Access Road	Chandler Haul Road	Total
Angas	-	39	22.5	2.28	63.78
Amulda	-	-	-	-	-
Chandler	-	-	63.9	19.94	83.84
Finke	-	-	7.92	-	7.92
Gillen (1)	-	-	6.3	1.88	8.18
Gillen (2)	-	-	-	2.90	2.90
Renners	-	-	15.61	1.61	17.22
Rumbulara	34.2	-	-	1.71	35.91
Simpson	-	-	47.34	33.86	81.2
Singleton	51.3	-	14.84	30.41	96.55
Total	85.5	39.0	180.0	93	397.5

Table 5-5: Area (ha) of mapped vegetation types impacted at each component of the Proposal during the construction phase.
- indicates vegetation type not present at component of the Proposal

Vegetation Types	Chandler Facility	Apirnta Facility	Henbury Access Road	Chandler Haul Road	Total
Maireana low open chenopod shrubland (type 110)	43.5	39	-	3.42	85.92
Triodia low hummock grassland (type 83)	42	-	95.68	69.10	206.78
Triodia low hummock grassland (type 82)	-	-	32.06	3.08	35.14
Maireana low open chenopod shrubland (type 108)	-	-	47.72	-	47.72
Mulga tall sparse shrubland with low sparse shrubland understorey (Type 70)	-	-	-	17.40	17.40
Acacia tall open shrubland (type 66)	-	-	4.54	-	4.54
Total	85.5	39.0	180.0	93	397.5

Figure 3-5 shows the footprint of the Proposal overlayed on soil types in the area of interest and the relative representation of these soil types in the surrounding area in the Finke Bioregion. Soil types are an important driver of potential indirect impacts such as:

- Altered hydrology;
- Erosion;
- Dust;
- Vegetation type re-growth;
- Sedimentation; and
- Compaction.

Only one soil type, Nb19, is poorly represented in the surrounding area. This soil type is located on the surface above the underground storage facility and as such the Proposal would have minimal impact. This soil type is relatively common in the greater region around central Australia.

Figure 3-6 shows the footprint of the Proposal overlayed on land systems from the area of interest and the relative representation of these land systems in the surrounding area in the Finke Bioregion. There are three land systems that are not well represented in the surrounding area:

- Rn – Renners;
- Gi-1 – Gillen; and
- Gi-2 – Gillen.

These three land systems are typical of the MacDonnell Ranges Bioregion and cover a larger area to the north of the Proposal. Their existence as outliers in the area of interest makes them of uncertain value to biota dependent on these landscapes, thus impact on these landscapes should be minimised.

Figure 3-7 shows the footprint of the Proposal overlayed on vegetation types from the area of interest and the relative representation of these vegetation types in the surrounding area in the Finke Bioregion. The two vegetation types that are not well represented in the immediately surrounding environment are:

- Type 66 (Tall open Mulga Shrubland); and
- Type 70 (Sparse Tall Mulga Shrubland).

Both of these vegetation types are common further north in central Australia and would have the least area impacted from the Proposal; associated with clearing works for the Chandler Haul Road and Henbury Access Road. The final road alignment would be selected to cause the least impact to the established vegetation within these types. That is, avoiding mature *Acacia aneura*, dense *Acacia kempeana* stands and large patches of tussock grasses.

Habitat Loss

Loss of potential and actual fauna habitat would be highest during the construction phase of the Proposal. Fauna habitat is lost through:

- Removal of small shrubs, grasses, large trees and tree hollows;
- Removal of fallen logs greater than 10cm in diameter;
- Soil compaction;
- Altered surface hydrology; and
- Removal of rocks and rocky outcrops.

Tree hollows provide important habitat to birds, reptiles and provide refuge from predators for small fauna (Bennet, et al., 1994).

Vegetation cover can provide predator protection, a source of food and shelter from extreme climatic conditions. It also aids in slowing the flow of surface water during flood events, allowing sediments to settle (Costantini, et al., 1999).

Potential fauna habitat in the area of interest has been derived from desktop and on-ground surveys. Vegetation type and land system mapping have been used to calculate area of potential fauna habitat lost or modified by the Proposal. Eleven habitat types have been identified in Section 3.6.5 for the area of interest. Table 5-6 shows a summary of overall habitat types potentially impacted by the Proposal and threatened species with a low- moderate, moderate or high likelihood of occurring in the Proposal area that may rely on these habitats. Figure 3-22, Figure 3-23, Figure 3-24 show the area of direct impact on habitat types from the Proposal and the relative representation of these habitat types in the undeveloped surrounding area.

Table 5-6: Area (ha) of habitat types identified in the Proposal Area to be impacted by the Proposal in the Proposal area and potential loss of habitat for threatened and migratory species that were recorded or have a moderate (or low-moderate) to high likelihood of occurring within the Proposal area.

Habitat type	Dependant on groundwater	Dependant on surface water	Area impacted (ha)					Potentially supports threatened or migratory species
			Henbury access road	Chandler facility	Apirnta facility	Chandler haul road	Total	
Dune Fields.	No	No	42.78	0.36	-	27.98	68.12	*D. blythi, D. cristicauda, N. typhlops, P. alexandrae* and *M. ornatus.*
Sand Plains.	No	No	39.51	59.74	-	23.25	91.31	*D. blythi, D. cristicauda (D. cristicauda is predominantly found on sand dunes),* and *N. typhlops, P. alexandrae* and *M. ornatus.*
Mesa Terrain.	No	No	19.9	0.76	-	15.06	31.63	*Amytonris modestys indulkana* and *Merops ornatus.*
Riverine dunes/River.	No	Yes – ephemeral river flows	2.09	-	-	-	2.09	*N. typhlops, P. alexandrae* and *M. ornatus.*
Prominent Hills and Low Ranges.	No	No	14.77	24.64	-	6.4	45.81	*P. alexandrae* and *M. ornatus.*
Alluvial Plains.	No	No	15	-	-	-	75.11	*L. kintorei, L. s. slateri, P. alexandrae* and *M. ornatus.*
Clay plans.	No	Yes	-	-	-	-	-	*M. ornatus* and may support migratory birds after high rainfall – *R. australis, A. pacificus, A. modesta*, *C. acuminata*, *C. veredus, G. maldivarum, T. nebularia* and *T. stagnatilis.*
Plains.	No	No	37.63	-	39	10.71	70.01	*D. blythi* and *M. ornatus.*
Tall Rocky Out Crops and Valleys	No	No	-	-	-	9.6	9.6	*M. ornatus.*

Habitat type	Dependant on groundwater	Dependant on surface water	Area impacted (ha)					Potentially supports threatened or migratory species
			Henbury access road	Chandler facility	Apirnta facility	Chandler haul road	Total	
Creek lines and Drainage Depressions	No	Yes - ephemeral	4.5	-	-	-	-	*P. alexandrae* and *M. ornatus.*
Coolabah and Lignum Swamps	No	Yes – infrequent flooding	3.8	-	-	-	3.82	*P. alexandrae* and *M. ornatus.*
Total			180	85.5	39	93	397.5	

Fauna strike or injury

During the construction phase of the Proposal there is the potential for an increase the risk of fauna strike, injury and/or displacement in the Proposal area (Donaldson & Bennet, 2004). Direct strike to fauna with low mobility is likely from construction vehicles during the initial clearing works. There is also the potential for fauna strike due to increased access and use of roads after the clearing and construction of roads. Initially, access would be via the Stuart Highway and Maryvale Road. Both these roads are already regularly trafficked and well established; hence the risk of increased fauna strike due to increased traffic along these roads would be minimal.

Construction of the Henbury Access Road and Chandler Haul Roads will be undertaken early in the construction phase to improve site access. The highest likelihood of fauna strike would occur during the hours of dusk and dawn which coincides with high activity for crepuscular species, accompanied with low visibility (Rowden, et al., 2008). There are several locations along the Henbury Access Road and Chandler Haul Road that have a higher likelihood of fauna strike or injury due to the habitat type present or where the view of fauna may be obstructed by vegetation (see Table 5-6 above).

5.1.2 Indirect impacts

Habitat fragmentation

Habitat fragmentation is the process of habitat loss whereby large continuous habitat is broken down into smaller more isolated sections (Fahrig, 2003). Negative effects associated with habitat fragmentation are one of the leading causes of biodiversity loss in highly fragmented areas worldwide. However negative effects associated with habitat loss can be wrongly associated with habitat fragmentation; there can be both negative and positive impacts from habitat fragmentation (Fahrig, 2003). A positive impact of habitat fragmentation is development of new habitat, increasing biodiversity (Fahrig, 2003), which may be through invasive species. Habitat fragmentation is concerned with assessing risks due to fragmenting continuous habitat, independent of the amount of habitat lost (Fahrig, 2003).

Most habitat types directly impacted during the construction phase are well represented and interconnected in the surrounding environment. Three land systems (Rn - Renners, Gi-1 - Gillen & Gi-2 - Gillen) are poorly represented and/or interconnected. However, there is low likelihood of threatened species occurring in these land systems and the land systems are regionally well represented in the MacDonnell Ranges Bioregion to the north. Therefore, there may be small, localised fragmentation of habitat as a result of the Proposal; however, the risk is moderate due to the relatively small area of the Proposal compared to surrounding un-impacted habitat.

Fauna displacement

There will be local displacement of more mobile fauna species during the construction of the Proposal (Buehler & Percy, 2012). The impact of displacement will affect individual animals or plants and not impact on the species unless the species is already at a threatened level.

Actions likely to impact on fauna displacement during construction are:

- Heavy vehicle and machinery use;
- Noise and vibration (Donaldson & Bennet, 2004);
- Loss of suitable habitat (Fahrig, 2003);

- Increased access for predator species (Claridge, 1998);
- Increased use of the cleared areas;
- Soil compaction (Donaldson & Bennet, 2004); and
- Lighting (Donaldson & Bennet, 2004).

Edge effects

Edge effects are the result of a disturbance or development that results in two contrasting habitats meeting without any gradient or gradual change between them. Edge effects can occur due to clearing, decreasing an ecosystem's resilience to external pressures such as weeds, erosion, and invasive pests (May & Norton, 1996). Generally, it is more prevalent where the remnant vegetation has a larger perimeter to area ratio, e.g. a long narrow rectangular block. The level of risk is dependent on clearing type (bare soil or top vegetation only), location and cumulative impacts from surrounding developments. The biggest risk due to edge effects is the increased probability of weed invasion (Parendes & Jones, 2000) and increased access for introduced fauna (May & Norton, 1996).

Due to the remote location, lack of development in the surrounding area and the majority of land system and vegetation types being well represented locally, if appropriate management plans for invasive species are in place, there is unlikely to be a long term impact on biodiversity in the Proposal area as a result of edge effects.

Altered hydrology

Altered hydrology is an indirect impact of land clearing during the construction phase. The surface hydrology can change due to:

- Altered surface water drainage patterns;
- Blocking or diverting watercourses;
- Change in topography;
- Increased sediment;
- Increased runoff;
- Increased scour or erosion; and
- Soil compaction.

These changes in turn can have impacts on flora and fauna downstream through:

- Reduced flows (Reid, et al., 2016);
- Increased sediment in water refuges (Reid, et al., 2016);
- Dispersal of weeds species; and
- Creation of artificial water sources, which can attract predators and other pest fauna species (DeStafano, et al., 2000).

Impacts to flora and fauna downstream during construction would be localised and short term. As the surface hydrology is ephemeral and the construction of the Proposal is not impacting on any important wetlands or dry season water refuges, the changes and modifications impacting downstream flora and fauna would be low. Sediment laden surface run-off is expected during the construction period, however with effective mitigation techniques outlined in Section 6.2, the impacts would be reduced.

Groundwater abstraction

There would be no drawdown impacts on vegetation as the target horizon for water supply is between 140 m below ground level (bgl) and 170 mbgl. The effects of drawdown are considered to be minor owing to the relatively small volumes of water required during construction and operation. Furthermore, there is no continuous water table at shallow depths. It is assessed that there exists a series of water lenses that are relic pockets of ancient water. The “water lenses” are not thought to be vertically recharged by surface water/rainfall events. Therefore, there is a low risk of impact to vegetation from groundwater abstraction. The impacts on other users of groundwater in the area are expected to be minimal based on the above information. There are only two bores within 10 km of the proposed road construction bores for the Proposal. The patchy aquifer system suggests no interconnection between the wells. Monitoring and mitigation prescribed in Section 6.2 would reduce this uncertainty.

Erosion and sedimentation

Erosion and sedimentation can have long lasting negative impacts on the environment and biodiversity. Land clearing can exacerbate and/or cause erosion leading to sedimentation of downstream receptors (IECA, 2013). The presence of established vegetation and crust stabilises the soil surface which resists erosion and sediment transport (Barger, et al., 2006). Other factors that affect the rate and presence of erosion are changed surface topography and soil infiltration (IECA, 2013). Erosion and sedimentation is generally caused by water flow but can also result from wind (refer to following section on dust) and rain splash (IECA, 2013). Unchecked erosion and sedimentation can also impact safety of staff through damage to infrastructure and road integrity (IECA, 2013).

The risk of erosion and sedimentation is the highest during the land clearing component of the construction phase before any control devices are installed. Initial minimisation of risk is to undertake construction when rainfall and erosion potential is minimal and control devices would be established early in construction, greatly reducing this risk of erosion. The area is dominated by surface flow and ephemeral water courses, with the majority flowing to the major rivers, the Hugh River east of the Proposal area or the Finke River in the west of the Proposal area.

The areas with the highest risk of erosion are on hills slopes, calcareous soils and river banks. The majority of the Proposal is located in dune fields and sand plains, with good infiltration rate and lower risk of erosion. Works would be undertaken in the probable dry season during non-summer months and would be suspended during periods of heavy rains.

Dust

Dust impacts would be highest during the construction phase of the Proposal. Impacts on the surrounding flora and fauna due to the temporary increase in dust would be minimal. The heterogeneous nature of dust and difference in plant response means that dust issues for local flora and fauna is site specific (Turner, 2013) and long term monitoring would determine if further mitigation techniques are required.

The arid environment is adapted to periods of ‘boom and bust’, where it is possible to experience several years of drought and high amounts of dust. This natural occurrence of dust in the arid environment has increased species resilience to impacts related to dust deposition on leaves, bark, flowers etc.

Light, noise and vibration

Light, noise and vibration during construction can cause temporary impacts to surrounding fauna. However, due to the remote location and lack of surrounding developments; affected fauna would likely relocate without stress into area unaffected. Any blasting activities would be of a short period and high intensity, which would only temporarily impact surrounding fauna. Lighting in the area may attract and increase the number of insects locally. The increase of lighting is one of several factors that can attract more predator species, increasing pressure on native prey. Insects provide a valuable food source to many native and introduced fauna species. Lights can also impact on the movement of nocturnal animals; however, light concentration impacts would be localised, with only ambient light transferred further.

Waste

If waste products are not adequately stored and separated they can cause contamination, loss of visual amenity, impact on fauna and attract predator and pest species. Waste hydrocarbons can contaminate soil or leach into watercourses, impacting vegetation and soil biota. Uncovered food and domestic waste can attract predator species and introduced fauna increasing pressure on small mammal and other prey; either direct through predation or indirect by outcompeting for limited resources.

Introduction and spread of weeds and invasive species

Desktop survey work identified 13 invasive flora species as occurring or potentially occurring within the Proposal area, with seven species recorded during site visits. One species recorded during on-ground surveys, *Tamarix aphylla* (athel pine), is a WoNs and a declared weed in the NT. An additional two species are declared weeds in the NT and the remaining four are introduced but not declared weeds. With the exception of *C. ciliaris*, all introduced flora species recorded during on-ground surveys occurred in low densities (see Section 3.8.3 for more information on introduced flora).

During construction there is risk of weed incursion at the Proposal area due to vehicle movements, imported material and disturbed area. Introduced flora can readily establish in disturbed areas after rain, quickly out competing native vegetation and colonising. Although introduced flora populations are currently confined to small localised areas within the Proposal area, there is a risk that a spread of the current populations could be expanded during the construction phase. *Tamarix aphylla* was recorded in the Finke River. It is a highly invasive and easily transported species, having severe impacts on the local environment. Mitigation measures would be implemented to manage this risk, see Section 6.2 and the Weed Management Plan in the Biodiversity Management Plan (Appendix 6)

Fire

Fire risk during construction would increase due to the following hazards:

- Increased ignition sources;
- Large stockpiles of vegetation;
- Open flames;
- Access to new areas; and
- Hot works.

These hazards would be managed by implementing a Bushfire Management Plan (BFMP). This plan is provided in Appendix 4.

Risks to the environment from increased fire activity include:

- Loss of habitat;
- Loss of vegetation;
- Fauna death or injury;
- Fauna relocation; and
- Decrease in soil stability due to vegetation loss.

5.1.3 Consequential Impacts

Consequential impacts are those made possible by activities in the construction phase. The potential consequential impacts from the construction phase include:

- Unauthorised third party access;
- Increased spread and occurrence of declared weeds and other introduced flora species;
- Increased predator fauna species; and
- Increased herbivore and introduced species.

Unauthorised third party access

Creation of new roads and site access could potentially lead to unauthorised third party access. Associated risks to biodiversity may include:

- Higher traffic;
- Increased rubbish;
- Increased water usage through access to groundwater bores or above ground water storage;
- Increased weed spread potential;
- Fauna strike; and
- Vehicle accident with potential to cause fire, destroy vegetation and habitat, and increase fauna strike.

Due to the remote location, remoteness from surrounding human populated places and use of managed access from public roads the increase in unauthorised third party access to site would, however, be minimal.

Increased predator species

Opening up new roads, access tracks and large cleared spaces has been shown to increase predator species access through the environment and hence predation success (Claridge, 1998). Studies in eucalypt forest in NSW have shown this to be particularly important for the distribution of red foxes into new habitat (Catling & Burt, 1995). This can increase predator numbers and spread which in turn will increase stress on native species.

Creation of artificial water sources increases the occurrence of predator species locally (DeStafano, et al., 2000) and potential food sources (e.g. waste bins) and sources of heat and shade can cause predators to habituate an area; increasing stress on local prey.

High risk areas include camps around food production, washing, grey water disposal, lighting and warmth from generators and kitchens. Lighting over the whole site during construction can attract insects and in turn small mammals and reptiles, which are prey to attract larger predators. Sources of heat and shade would be created by earthmoving equipment, laydown areas, generators and newly constructed infrastructure. Artificial water sources will be developed for road construction whether in an open turkey nest or, of lower risk, inside a water tank.

Increased introduced fauna activity

Introduced fauna species may increase in the Proposal area as a result of the Proposal due to increased access through the landscape from clearing activities or access to artificial water sources (Claridge, 1998; DeStafano, et al., 2000). Issues that may arise from increased pest fauna activity include:

- Surrounding stakeholders access to livestock;
- Destruction of property (DSEWPC, 2010);
- Increased fauna activity and potential strike (Donaldson & Bennet, 2004);
- Increased pressure on native fauna (Donaldson & Bennet, 2004);
- Destruction of native flora;
- Potential spread of weed and pathogens (Wilson, et al., 2000);
- Conflicting use of the Proposal area (stakeholders); and
- Impacts on surface water topography and surrounding water courses (Costantini, et al., 1999).

By opening up new access through the landscape introduced species are able to more easily hunt prey and access new habitat, or in the case of camels, just ‘go for a walk’. Introduced herbivores can also more easily access new pastures, increasing grazing pressure on previously undisturbed environments. On-ground survey work identified the highest disturbance from introduced herbivores are around watering points. Mitigation measures in Section 6.2 have been developed to reduce this risk.

5.2 Assessment of Risk during Operation

This section addresses the environmental risks associated with the operation phase of the Proposal.

5.2.1 Direct impacts

Fauna strike or injury

The risk of fauna strike or injury would be similar to that during the construction phase. Vehicle used will be restricted to half an hour after sunrise to half an hour before sunset and increased to an hour if driving into the rising or setting sun, where possible.

Seasonal and climatic conditions may increase the risk of fauna strike. For example, during drought conditions fauna may move closer to areas of higher water and food availability, such as those adjacent to the road that receive water run-off. (Donaldson & Bennet, 2004) Reptiles will be more active during warmer months, increasing the abundance of fauna on roads during this time.

Hazardous material

Accidental spills or leaks of hazardous materials may occur during the handling, use, storage or transportation of such materials. This may result in contamination of soil, vegetation or watercourses. Contamination of soil or watercourses can then impact vegetation or downstream receptors through direct or indirect pathways (Donaldson & Bennet, 2004). Direct impacts to fauna include inhalation, dermal contact or ingestion, and indirect impacts may occur through root uptake by food plants or contamination of drinking water.

All hazardous wastes brought to site for underground storage will be individually bunded and stored in shipping containers. The risk of these breaking and causing contamination is low. There will be minimal hazardous substance and fuel stored on site, as required for general operations.

5.2.2 Indirect impacts

Windblown salt

Mined salt would be temporarily stored on site before being packaged and transported off site for sale. The risk of spill of salt during transport may occur during the handling, use, storage or transportation of salt. The salt stockpile would form an impenetrable crust during wet weather restricting off-site migration into the surrounding environment and watercourses. A study undertaken on the impacts of windblown salt from an underground waste storage facility in an excavated salt cavity in New Mexico, United States (Cockman, 1988) is relevant. Vegetation study plots were established, near-the facility at a distance of 150 m and control sites at a distance at least 2 km from the salt stockpiles. The results of the three year study indicated an increase in the soil salinity levels at the near-field plots, but no discernible difference in vegetation cover (Cockman, 1988).

Direct impact with fauna by windblown salt should be minimal, except during high wind periods where respiratory and dermal impacts may occur due to there being a higher concentration of particles in the air. During low intensity rainfall events, water would interact with the salt forming an impervious layer to impede off site migration of salt. There is a risk that during higher intensity rainfall, there may still be a proportion of salt dissolved in run-off waters. There is the risk that salt may be released to the environment during transportation through accident. However, as the area is semi-arid with only ephemeral watercourses, off-site migration of spilled or uncontrolled release of salt would be minimal.

Dust

The impacts on vegetation of dust from mining activities can include chemical toxicity or physical interference with gas exchange and thermal regulation (Turner, 2013). Although the mine is underground there is risk of this contamination occurring as the material is brought to surface. The highest risk is from windblown salt, and this is dealt with in the section preceding.

Light, noise and vibration

The environmental risks due to light, noise and vibration are similar to those during construction. Operational noise would be more consistent with less variation in source, location and timing. Blasting works would have minimal impact due to the infrequent short duration of each blast. Most of the operations would occur during the hours of 7 am to 5 pm and site lighting outside of these hours would be the minimal needed for security purposes.

Fire

As with the construction phase, fire risk during the operation phase would be higher due to increased ignition sources, large stockpiles of vegetation, open flames, access to new areas and hot works. These hazards are dealt with comprehensively in the BFMP (Appendix 4). Additional to those measures undertaken during the construction phase, during operation firebreaks will be established and a comprehensive back burning plan will be implemented to manage fuel loads. Risks to the environment from increased fire activity include loss of habitat, loss of vegetation, fauna death or injury, fauna relocation and a decrease in soil stability due to vegetation loss. The likelihood of fire from natural events remains the same in all phases of the Proposal.

Altered hydrology

Alterations to surface hydrology from the construction phase of the Proposal will persist into the operation phase of the Proposal. Off-let drains established on the Chandler Haul Road and Maryvale Access Road, and diversion bunding around infrastructure have the potential to develop new drainage patterns or alter existing ones. Off-let drains have the potential to concentrate natural surface flow into the receiving environment, causing erosion (Costantini, et al., 1999). Water pooling due to blocked off-let drains or poorly designed drainage channels can attract fauna and potentially breed mosquitos.

These risks would be mitigated through appropriate road construction design and monitoring which is described in detail in Section 6.2. River crossings will need to be continually monitored due to large sediment movement and channel geometry changes during flood events. This is to ensure that river crossings are trafficable and that the installation of the river crossing is not causing follow-on erosion or sediment issues on the banks or surrounding watercourses. In higher intensity rainfall events the underground mine cavity may require dewatering, potentially carrying contaminants to the surface.

Presence of established dams and surface water sources can cause predator species to habituate (DeStafano, et al., 2000); this will in turn place more stress on fauna species. If a temporary dam or turkey nest is required for ongoing road maintenance during the operation phase, this risk will be mitigated as described in Section 6.2.

Waste

If waste products are not adequately stored and separated they can cause contamination, loss of visual amenity, impact on fauna and attract predator and pest species. Waste hydrocarbons can contaminate soil or leach into watercourses, impacting vegetation and soil biota. Uncovered food and domestic waste can attract predator species and pest fauna increasing pressure on small mammal and other prey; either directly through predation or indirectly by outcompeting for limited resources.

Introduction and spread of weeds and invasive species

There is a reduced risk of the introduction of weed or introduced species in the operation phase compared with the construction phase as all cleared and disturbed areas are established, roads and general operation areas require less water once established (minimal required for dust control) and fewer vehicles accessing the site. However there is still a risk of introduction of weeds and introduced species from vehicles, plant and wastes brought to site (Donaldson & Bennet, 2004). There is the risk for the introduction of weeds and introduced species not currently present in the Proposal area, and the spread of those with pre-existing populations in the Proposal area. Weed management procedures will minimise this risk by ensuring vehicles are weed-free before entering the Proposal area and when operating between weed contaminated areas and wee-free areas.

5.3 Assessment of Risk during Decommissioning and Rehabilitation

This section addresses the environmental risks associated with the decommissioning and rehabilitation phase of the Proposal.

5.3.1 Direct impacts

Fauna strike or injury

The same level of risk of fauna strike or injury applies as for the construction phase. There will be fewer vehicle movements than during the operation phase but higher use of earthmoving equipment. Fauna activity may be higher around roads and access tracks due to easier movement through the landscape, new habitat formation from changes in surface topography, vegetation distribution and composition, altered hydrology and infrastructure shading. There may be several areas of higher vegetation growth and favourable habitat due to altered hydrology (Donaldson & Bennet, 2004).

Hazardous materials

The final removal of hazardous materials involved in the general running and operation of the Proposal and associated plant and vehicles, e.g. fuels, would be the time of highest risk of impact from hazardous materials. Any residual contamination or waste hazardous material will be removed from site during this phase. There is a risk that contaminated material could spill or there could be an uncontrolled release of this material during transport and handling. The company policy will be to not leave any hazardous material on site following decommissioning and rehabilitation of the Proposal.

5.4 Indirect impacts

Erosion and sedimentation

Inadequate surface rehabilitation can lead to the development of erosion. This increases the loss of nutrient rich top soil, which impedes rehabilitation success. Sedimentation can block watercourses and drainage channels, leading to altered surface hydrology and impacts to species that rely on the ephemeral surface water (Reid, et al., 2016). See mitigation Section 6.2 for details on final surface rehabilitation.

Introduction and spread of weeds and invasive species

Weeds can establish after the site has been rehabilitated. Rehabilitation activities, such as ripping compacted soil, can create disturbed areas of soil that are suitable for the germination and establishment of weed or introduced species. If unmonitored, these species can quickly spread into other areas. Weeds may have a higher tolerance of more frequent fire or other disturbance, and can therefore thrive in disturbed sites, outcompeting native species. The main WoNS, athel pine, noted during the on-ground surveys along the Finke River, is a particularly aggressive coloniser of appropriate riverine habitat (CRC Weed Managment, 2003). See mitigation Section 6.2 for details on final rehabilitation controls. A Weed Management Plan is provided in the Biodiversity Management Plan (Appendix 6).

Soil compaction and top-soil loss

Soil left compacted, and not deep ripped, has a reduced ability to rehabilitate due to difficulties for native flora to re-establish. Compacted soil has a lower infiltration rate, which makes it more difficult for seedlings to germinate. Compacted soil also increases surface run-off and decreases staggered sediment loss, resulting in large sediment loads running downstream.

Nutrient rich top soil containing the seed bank required for rehabilitation can be lost post-rehabilitation through wind and water. Large cleared areas with top soil respread require control devices to ensure that surface water flows following rainfall events do not transport top soil away from rehabilitated surfaces. Loss of top soil would greatly reduce re-vegetation on the rehabilitated surfaces. It is also important to ensure sufficient surface roughness to capture wind borne dust and seed from the rehabilitated surface and surrounding vegetation. See mitigation Section 6 for details on final rehabilitation controls.

Altered hydrology

The final landforms would be returned as close as possible to the pre-existing landform. However, there would initially be some slight variations that would likely settle out to a natural pattern over time. There is a risk that this changed hydrology could impact downstream receptors and flow patterns in the area. This changed flow pattern may impact the vegetation composition and/or location of new vegetation growth or species distribution. Surface water may become trapped in rehabilitated surfaces which may encourage new growth of vegetation in these areas. However, this would also reduce surface water available to downslope ecosystems. This impact would be relatively short term as the rehabilitated surface settles out and vegetation re-growth returns to pre-development state.

6 MITIGATION AND MONITORING

6.1 Introduction

The mitigation and monitoring measures provided in this section would be implemented with the development of the following plans:

- Biodiversity Management Plan (BMP);
- Bushfire Management Plan;
- Weed Management Plan; and
- Pest Fauna Management Plan; and
- Biting Insect Management Plan.

The mitigation measures have been developed based on industry best practise, government guidelines and regulations, relevant conservation advice, LES' arid land ecology experience and other similar scale projects in central Australia.

All efforts have been made where possible to use mitigation and monitoring measures that have proven scientific evidence documenting the quantitative effectiveness of the measure. A level of effectiveness has been applied to each mitigation measure based on Table 6-1, which is based on proven best industry practices to mitigation measures that have not been tested in the industry. This level of uncertainty in unproven technology would be reduced by monitoring the effectiveness of the measures during the construction, operation and rehabilitation of the Proposal.

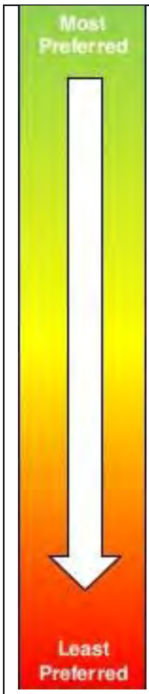
The effectiveness of mitigation and monitoring measures would be reviewed annually and steps taken to improve these measures, if required.

The risks and/or hazards requiring mitigation and monitoring measures have been identified in Section 5. The mitigation and monitoring measures are provided in two sections:

1. Section 6.2- Mitigation and monitoring measures for biodiversity and vegetation; and
2. Section 6.3- Mitigation and monitoring measure developed to specifically target threatened species identified in Section 4 as having a moderate (or low-moderate) to high likelihood of occurrence within the Proposal area.

A hierarchy of mitigation measures (Table 6-1) was used to assist in the assessment of the effectiveness of each measure prescribed in Table 6-3.

Table 6-1: Hierarchy of mitigation measure classification



Mitigation Measure	Classification
Elimination, Substitution or Avoidance.	Design Out.
Guards and Controls.	Engineering Controls.
Awareness Devices.	Administrative Controls.
Training and Procedure.	
Signage and Protective Equipment.	

6.2 Mitigation and monitoring measures for biodiversity and vegetation

The effectiveness or confidence in each mitigation measure proposed in Table 6-3 is based on the descriptions given in Table 6-2.

Table 6-2: Effectiveness descriptors for mitigation measures

Effectiveness descriptor	Examples
High	Proven Best Practice Measures (BPM) Best Available Technology (BAT) Environmentally Sound Management (ESM) Policy and guidance
Moderate	Effective mitigation strategy and considered standard practice. but is not recognised as Best Practice Measures, Best Available Technology, Environmentally Sound Management, or satisfying all requirements of policy and guidance.
Low	Technology has not been demonstrated in industry Not yet tried and/or tested

The mitigation and monitoring measures audit and improvement review would adopt an adaptive management approach. Avoidance or elimination measures have been identified to remove the need for mitigation and monitoring measures. Where it is not possible to eliminate the risk, mitigation and monitoring measures have been developed. These mitigation measures are shown in Table 6-3 for the hazards identified in the risk assessment process detailed in Section 4. Mitigation measures would be annually reviewed to improve their effectiveness and efficiency.

Table 6-3: Mitigation and monitoring measures for biodiversity, based on outcomes of risk assessment section, focusing on moderate to high risks to biodiversity.
Note: C – Construction phase; O – Operation phase; D – Decommissioning phase; & R – Rehabilitation phase.

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
Vegetation clearing, habitat loss and fauna displacement	Zero unapproved clearing. Adhere to buffers around boundaries and watercourses set by the NT Land Clearing Guidelines. Maintain vegetation buffers. No threatened flora/ fauna harmed as a result of clearing. Pre-clearance survey for every clearing event. All staff inducted into this BMP.	Pre-clearance survey checklist, based on the NT Land Clearing Guidelines (Department of Natural Resources, Environment, The Arts and Sport, 2010) detailing the following: -confirmed extent of clearing area has required approvals; -land to be cleared is clearly marked; -checked for signs of threatened species; -check for fauna, and re-locate if necessary; - number of mature trees (>5m high). Avoid clearing if possible; - number of large trees with hollows, avoid clearing if possible -number of fallen logs >15 cm in diameter, relocate to surrounding environment; -stockpiles within defined areas; -Topsoil stockpiles <1.5 m in height; -clearing is progressive for environmental benefits; -land clearing supervised; and -once clearing is completed, the supervisor would register the total cleared area in a cleared area register.	C.O.D.R	Moderate	Engineering control	• Pre-clearance survey checklist. • Staff induction records. • Check cleared area register is consistent with approved cleared area for the annual operations performance reporting.
		Delay clearing following exceptionally high rainfall events until the ground is sufficiently dry to hold machinery.	C.	Low	Administrative control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		Stockpile vegetation top soil and spoil separately in low mounds, less than 1.5 m in height.	C.	Moderate	Engineering control	
		All staff inducted into this BMP.	C.O.D.R	Low	Administrative control	
Introduction and Spread of Weeds	No additional weed species (not previously recorded on site) recorded on site. No increase to weed spread in the Proposal area. Manage declared weeds in accordance with the NT Weeds Management Act	Induct all staff into the requirements of the Weed Management Plan; see Biodiversity Management Plan (Appendix 6).	C.O.D.R	Moderate	Administrative control	• Annual weed mapping of the Proposal area, using GPS, during flora and fauna monitoring survey. • Vegetation health monitoring conducted annually (See Flora & Fauna Monitoring Plan in Appendix 6 – Biodiversity Management Plan). Data would be compared between surveys. • Vehicle wash
		Vehicle/machinery wash-down prior to leaving Alice Springs or entering an area uncontaminated by weeds.	C.O.D.R	Moderate to High	Engineering control	
		All personnel to avoid spreading any weed or invasive species seed, plant matter or soil potentially contaminated with weed seeds.	C.O.D.R	Low	Engineering control	
		Avoid clearing or removal of any weed or invasive species during seeding, or put plastic bag over seed heads before removing plant.	C.O.D.R	Low	Engineering control	
		Ensure weed identification and reporting procedures are included in inductions.	C.O.D.R	Low	Administrative control	
		Removal of any weeds identified following specialist advice from third party qualified consultant or Weeds Branch, NT Government.	C.O.D.R	Low	Engineering control	
		Removal of weed or invasive species before of seeding times.	C.O.D.R	Low	Engineering control	
		Avoid driving in wet and muddy conditions, where possible.	C.O.D.R	Low	Engineering control	
		Annual flora and fauna survey to record numbers and distribution of introduced flora and fauna species.	C.O.	Mod	Administrative control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
						down weed report.
Increased pest fauna	Minimal increase in number or frequency of introduced fauna at the Proposal	Develop and implement a pest fauna management plan and carry out pest fauna control as required in consultation with stakeholders	C.O.D.R	Moderate	Administrative and engineering control	• Track-based monitoring, fauna trapping and spotlighting conducted annually (See Flora & Fauna Monitoring Plan in Appendix 6 – Biodiversity Management Plan). Data can be compared with between surveys. • Fauna sighting register.
		Prevent access to artificial water and heat sources through construction of fences.	C.O.D.R	Moderate	Engineering control	
		Dispose of all waste in predator proof bins.	C.O.D.R	Low	Engineering control	
		Develop and implement a no tolerance to the introduction of pest species by contractors, suppliers and personnel.	C.O.D.R	Low	Design	
		Place brush or vegetation stockpiles across linear developments no longer required (seismic lines, access tracks etc.) to inhibit movement of predators and introduced herbivores.	C.O.D.R	Moderate	Engineering control	
		Annual flora and fauna survey to record numbers of introduced fauna species.	C.O.D.R	Moderate	Administrative control	
		Develop, implement and maintain fauna sighting register.	C.O.D.R	Low	Administrative control	
		Install fauna proof fence around all infrastructure.	C.O.D.R	Moderate to high	Engineering control	
		Develop and implement a no tolerance policy to the introduction of pest species by contractors, suppliers and personnel.	C.O.D.R	Low	Administrative control	
		Remove any dead fauna or insects from the Proposal area.	C.O.D.R	Low	Administrative control	
		Do not feed fauna.	C.O.D.R	Low	Administrative control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		Replace cleared brush or vegetation stockpiles on all cleared areas no longer required (to inhibit movement of predators and introduced herbivores	C.O.D.R	Low	Administrative control	
		Ensure waste receptacles are fauna proof	C.O.D.R	Low	Administrative control	
		Install fauna proof fence around all infrastructure.	C	Moderate to High	Engineering control	
Fauna Strike or Injury	Zero or minimal fauna strike	Induct all staff and contractors into the requirements of the BDMP and other associated management plan's.	C.O.D.R	Low	Administrative control	All fauna strike recorded in Fauna fatalities register.
		Minimal use of vehicles required for safe operation of plant site and avoid driving during high risk times; dawn, dusk and at night.	C.O.D.R	Low	Administrative control	
		No off-road driving.	C.O.D.R	Low	Engineering control	
		Develop and maintain a fauna strike register.	C.O.D.R	Low	Administrative control	
		Limit access of third parties to mining lease.	C.O.D.R	Moderate	Engineering control	
		Traffic to adhere to speed limits and local road rules.	C.O.D.R	Low	Engineering control	
		Speed limit and potential fauna crossing signs clearly displayed on roads and other access tracks within the Proposal area.	C	Moderate	Administrative control	
		Driving restricted at dusk, dawn and at night.	C.O.D.R	Low	Administrative control	
Airborne Salt	No notable impacts to surrounding	Cover all salt during transport.	C.O.D.R	Moderate to High	Engineering control	Vegetation health monitoring

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
	vegetation as a result of airborne salt.	Store salt in open stockpile for minimum time required.	C.O.D.R	Moderate	Engineering control	conducted annually (See Flora & Fauna Monitoring Plan Appendix 6 - Biodiversity Management Plan).
Noise and Vibrations	Reduce noise and vibration.	Turn off machinery when not in use	C.O.D.R	Low	Administrative control	• Noise complaints register. • Vehicle & generators and service logbooks.
		Establish and maintain a noise complaints register	C	Low	Administrative control	
		Ensure blasting works restricted between 7am to 5pm, as practicable.	C.O.D.R	Low	Engineering control	
		Maintain and regularly service all generators, engines and vehicles on site.	C.O.D.R	High	Engineering control	
		Ensure vehicles carry full loads were possible to limit the number of vehicles on the Chandler Haul Road and Henbury Access Road.	C.O.D.R	Low	Administrative and engineering Control	
Hazardous Material	Minimal spills or leak of hazardous material into surrounding environment.	All hazardous waste to be contained within a bunded area sufficient to hold 110% of all material	C.O.D.R	High	Engineering control	• Hazardous material storage log. • Incident log. • Bund integrity would be monitored weekly by the environment
		Only store the minimum amount of hazardous materials required for construction, operation, decommissioning and rehabilitation	C.O.D.R	Low	Engineering control	
		Any incident or spill involving hazardous material recorded in incident log for review and remediation actions.	C.O.D.R	Moderate	Administrative control	
		Use of suitably qualified consultants for	C.O.D.R	Moderate	Engineering	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		remediation and contaminated site assessments.			control	al manager or delegated staff.
		Hazardous material to be stored outside flood zones and away from watercourses, at the distances specified for clearing in the NT Land Clearing Guidelines.	C	Low	Engineering control	
		Hazardous material to be at least 4 m or outside the canopy of large trees (>10m) or significant vegetation.	C.O.D.R	Low	Administrative control	
		Develop and maintain a hazardous material storage log.	C.O.D.R	Low	Administrative control	
		Bund integrity to be routinely monitored.	C.O.D.R	Low	Engineering control	
		Any break in bund integrity to be immediately remediated and actions recorded in incident log.	C.O.D.R	Low	Engineering and administrative control	
		All contaminated waste, from spills or accidental loss, to be classified and either remediated on site or transported to nearest licensed waste disposal facility.	C.O.D.R	Moderate	Engineering control	
		National Environmental Protection Measure (NEPM) guidelines Volume B, 2013 to be used in remediation and contamination assessments.	C.O.D.R	Moderate	Administrative and engineering control	
		No open flames or heat sources near flammable material, appropriate signage used.	C.O.D.R	Low	Design	
		Material Safety Data Sheets (MSDS), spill kits and appropriate firefighting equipment (water, chemical or foam, etc.) stored next	C	High	Administrative control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		to hazardous material storage and use areas.				
		Site inductions to cover storage, handling and use procedures for all hazardous materials used at the Chandler and Apirnta facilities.	C.O.D.R	Low	Administrative control	
Waste	No construction or operational waste left uncontained on site	Develop and implement a Waste Management Plan.	C	Moderate	Administrative control	Weekly checks of bins by environmental manager to ensure they are secure and fauna proof.
		Ensure all domestic waste stored in fauna proof bins.	C.O.D.R	Low	Engineering control	
		All waste stored in appropriate labelled containers.	C.O.D.R	Low	Engineering control	
		Bund liquid waste where required.	C.O.D.R	Moderate to High	Engineering control	
		Implement waste hierarchy triangle – Avoid/minimise, reuse, recycle, recovery, and then disposal. Reduce, re-use, recycle and if not then waste.	C.	Moderate	Engineering control	
		All waste disposed off-site by licensed contractor.	C.O.D.R	High to Expensive	Engineering control	
		All waste stored in appropriate labelled containers.	C.O.D.R	Low	Engineering control	
		All hazardous waste and hydrocarbons stored separately in bunding, with appropriate signage.	C.O.D.R	Moderate	Administrative and engineering control	
Dust	No significant increase in dust in the Proposal area.	Avoid clearing during dry windy conditions.	C.	Low	Administrative control	• Dust monitoring results to be
		Clear with blade up, where possible, for	C.	Low	Administrative	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		plant and soil retention.			control	analysed every month during construction period and every 3 months during operation period. • Vegetation health monitoring conducted annually (See Flora & Fauna Monitoring Plan). Data would be compared between surveys.
		Use water trucks during construction, operation, decommissioning and rehabilitation to control dust.	C.O.D.R	High- expensive	Engineering control	
		Leave vegetation 10 cm in height on firebreaks and non-crucial tracks.	C.O.	Low	Administrative control	
		Stage clearing operations to reduce total exposed cleared surface at any one time.	C.	Low	Administrative control	
		Inspect flora for signs of stress along edges of roads and cleared areas.	C.O.	Low	Administrative control	
		Develop and implement a Soil Conservation Management Plan.	C.O.D.R	Low	Administrative control	
		Conduct dust monitoring	C.O.	Moderate	Administrative control	
Fire	No bushfires as a result of the Proposal	Implement a Bushfire Management Plan (Appendix 4).	C	Moderate	Administrative control	• Site manager/ Environmental Manager to keep up to data with bushfire warnings
		Keep up to date with bushfire website and state services.	C.O.D.R	Low	Administrative control	
		Construct and maintain firebreaks around all infrastructure and significant habitats.	C.O.D.R	High to Expensive	Engineering control	
		No open flames outside of designated areas unless hot works permit is approved.	C.O.D.R	Low	Engineering control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		Flammable material clearly labelled.	C.O.D.R	Low	Engineering control	• Routine checks to ensure all flammable material is labelled. • Weekly check of firefighting equipment during the season.
		Adequate firefighting equipment stored on site and staff trained in use.	C.O.D.R	Moderate	Engineering control	
		Provide designated smoking area.	C	Low	Engineering control	
		Organise and implement strategic controlled burning with CLC and TOs to reduce risk of wild fire spread.	C.O.	High	Engineering control	
Groundwater drawdown and contamination	No drawdown significant to impact on surrounding properties. No contamination of groundwater as a result of the Proposal.	Monthly sampling of water quality from all extraction bores.	C.O.D.R	Moderate	Engineering control	• Baseline standard physical chemical and metals analysis of water quality and SWL measuremen ts of all production and monitoring wells. • Monthly sampling of water quality and depth from all extraction bores.
		Monitor Static Water Level (SWL) in all extraction and monitoring bores.	C.O.D.R	Low to Moderate	Engineering control	
		Install well caps on monitoring wells.	C	Low to Moderate	Engineering control	
		Fence off bores to avoid damage from fauna and large herbivores.	C	Moderate to High	Engineering control	
		Ensure no spill or contamination enters wells.	C.O.D.R	Low	Engineering control	
		Record extraction rate and amount.	C.O.D.R	Low	Administrative control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
						• Bore water extraction rates. • Monthly monitoring of well surface hygiene to ensure no foreign material enters wells.
Erosion and Sedimentation	Minimise erosion and sedimentation	Leave 5-10 cm of surface vegetation during clearing where appropriate.	C	Low	Engineering control	• Environmental Manager would undertake Monthly site inspection for any signs of erosion including checking watercourse and drainage depression crossings for signs of sediment accumulation • Environmental Manager would routinely
		Avoid clearing in water courses, drainage depressions or slopes greater than 2%;	C	Low	Engineering control	
		Adhere to land clearing buffers in the NT Land Clearing Guidelines (Department of Natural Resources, Environment, The Arts and Sport, 2010)	C	Low	Administrative control	
		Construct erosion control devices in line with DLRM and IECA best practise guidelines.	C	Moderate	Engineering control	
		Ensure all road water crossings are developed to base of natural water course or adequate culverts are established to reduce flow constriction of watercourses.	C	Moderate to High	Engineering control	
		Ensure cleared areas are rehabilitated as soon as no longer required for safe operation of the Proposal.	C.	Moderate	Engineering control	
		Remove all windrows and any concentration points to overland sheet flow, where	C.	Moderate	Engineering control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		possible along roads, tracks and cleared surfaces.				monitor erosion control devices to ensure integrity.
		Install flat bottom off-let drains along roads and access tracks.	C.	Moderate to High	Engineering control	
		Maintain roads and drains.	C.O.D.R	Moderate to High	Engineering Control	
		Limit compacted area to minimum required.	C.	Low	Administrative control	
		Use whoa-boys or diversion bunds on roads and tracks to dissipate and direct water flow into the surrounding vegetated or stable environment; reducing erosion potential.	C.	High	Engineering control	
		Use Diversion drains to maintain flows to downstream vegetation communities.	C.	High	Engineering control	
		Ensure waste rock and other stockpiles are sloped at < 18-20% (preferably 12%) to reduce run-off velocities.	C.O.D.R	High to Expensive	Engineering control	
		Develop roads and tracks along the contour where possible to limit the velocity of surface water flow directly down gradient.	C.	Moderate to High	Engineering control	
		Install sediment catch fences during construction, if required.	C.	Moderate	Engineering control	
Altered Hydrology	No long term alterations to hydrology as a result of the Proposal.	Implement a Surface Water Management plan.	C.	Low	Administrative and engineering control	• Routine inspection and maintenance of drains and water courses, particularly following major run-off. • Vegetation health
		Allow natural surface drainage to continue without interruption.	C.	Moderate	Engineering control	
		No disturbance within watercourse buffer zones set in NT Land Clearing Guidelines.	C	Moderate	Engineering control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
		Develop any creek crossing to natural contours of creek bed.	C	Moderate to High	Engineering control	monitoring conducted annually (See Flora & Fauna Monitoring Plan in Appendix 6 - Biodiversity Management Plan). Data would be compared between surveys to monitor any change as a result of altered surface flows.
		Remove any concentrations points that would impede natural sheet flow.	C	Moderate to High	Engineering control	
		Remove all windrows from access and haul roads.	C	Moderate	Engineering control	
		Leave large mature trees and shrubs, where possible.	C	Low	Engineering control	
		Construct drains with flat bottoms.	C	Moderate	Engineering Control	
Rehabilitation	The Proposal area is rehabilitated in accordance to agreement with future land managers. Soil is be stable and in relatively uniform with surrounding topography. No new weeds or additional spread of existing weeds as a result of the Proposal. No waste left behind as a result of the Proposal. All infrastructure	Develop and implement a decommissioning and rehabilitation management plan.	C.O.D.R	Low	Administrative and engineering control	• Site manager/ Environmental Manager would ensure performance standards are met. • Third party rehabilitation audit.
		Install erosion and sediment control temporary structures to assist with rehabilitation.	D.R	Moderate to High	Engineering control	
		Respread spoil first, then top soil and last cleared vegetation over surfaces.	D.R	Low to Moderate	Engineering control	
		Leave any infrastructure, plant or cleared area as so detailed in a land use agreement with the land manager.	D.R	Low	Administrative control	
		Remove all infrastructure, plant, machinery and operational and construction wastes.	D.R	High to Expensive	Engineering control	
		Contour all cleared surfaces to match surrounding topography, as close as possible.	D.R	Moderate to High	Engineering control	

Hazard	Outcome	Mitigation Measure	Timing	Effectiveness	Classification	Monitoring
	removed.	Rip any compacted area ensuring final surface is rough to increase infiltration.	D.R	Moderate to High	Engineering control	
		Ensure final surface is rough to increase infiltration.	D.R	Low	Engineering control	
		Block all access points to roads and tracks, unless agreed with land manager.	D.R	Moderate	Engineering control	
		Fill in sumps or turkey nest, unless agreed otherwise with land manager.	D.R	Moderate to High	Engineering control	
		Close off and seal all groundwater wells.	D.R	High	Engineering control	

6.3 Mitigation and monitoring measures for threatened species

The potential significant impact on sixteen threatened and migratory species as listed under the EPBC Act and TPWC Act that were recorded or have a low-moderate, moderate to high likelihood of occurring within the Proposal have been assessed in Section 4. While only two species with a low-moderate likelihood of occurring in the Proposal area (*A. m. indulkana* and *L. s. slateri*) have the potential to be significantly impacted if the species is present; there still exists risks to individuals of the remaining 14 threatened species. Table 6-4 provides mitigation and monitoring measures for these species that align with State/Territory and Federal government threatened species recovery plans, EPBC Act conservation advice, TAPs or other relevant policy and legislation requirements. Mitigation and monitoring measures take into account threatening processes identified by these documents for each species and the presence or potential presence of these threats in the Proposal area. Relevant species of each species ecology were also taken into account when developing these measures; i.e. the small spatial area of occupancy of *L. s. slateri* populations in relation to land clearing, or the monitoring of this species during warmer months when it is active and detectable. As a result of this process, the mitigation and monitoring measures developed are in line with relevant threat abatement plans, recovery plans and other approved conservation advice.

Mitigation measures are provided for the following species:

- *A. m. indulkana* (thick-billed grasswren) (vulnerable EPBC Act, critically endangered TPWC Act);
- *D. cristicauda* (crest-tailed mulgara) (vulnerable EPBC Act, vulnerable TPWC Act);
- *L. kintorei* (great desert skink) (vulnerable EPBC Act, vulnerable TPWC Act);
- *L. s. slateri* (Slater's skink) (endangered EPBC Act, vulnerable TPWC Act);
- *P. alexandrae* (princess parrot) (vulnerable EPBC Act, vulnerable TPWC Act);
- *R. australis (*Australian painted snipe), (endangered EPBC Act, vulnerable TPWC Act);
- *D. blythi* (crest-tailed mulgara) (vulnerable TPWC Act);
- *N. typhlops* (southern marsupial mole) (vulnerable TPWC Act); and
- Migratory birds (EPBC Act): *A. pacificus* (fork-tailed swift)*, A. modesta* (eastern great egret), *C. acuminata* (sharp-tailed sandpiper), *C. veredus* (oriental plover), *G. maldivarum* (oriental pratincole), *M. ornatus* (rainbow bee-eater) and *T. nebularia* (common greenshank) and *T. stagnatilis* (marsh sandpiper).

Due to the limited significant impacts of the Proposal on threatened and migratory species, the below mitigation and monitoring measure are covered in Table 6-3 above. The main purpose of Table 6-4 is to link the mitigation and monitoring measures developed in Table 6-3 with relevant recovery plans, threat abatement advice, and other government plans and policies.

Table 6-4: Mitigation and monitoring measures for threatened species with a low- moderate, moderate or high likelihood of occurring in the Proposal area with the potential be impacted by the Proposal either as an individual, population or through habitat loss.

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
EPBC Act listed threatened species				
Thick-billed Grasswren (*A. m. indulkana)*	If the species is present within the Proposal area, it is possible that the species would be significantly impacted (See Section 4.2.3 Thick-billed grasswren). Potential impacts from the Proposal may include: • Spread of buffel grass; • Introduced predators; • Loss of understorey vegetation caused by grazing by domestic stock, rabbits and camels; and • Habitat fragmentation.	• Adapted recovery plan for *Thick-billed Grasswren (Eastern Subspecies)* (*Amytornis textilis modestus*) (New South Wales National Parks and Wildlife Service, 2002). • Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a) • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b). • Threat abatement plan for competition and land degradation by rabbits (Department of Environment, Water, Heritage and the Arts, 2008c). • National feral camel action plan (Department of Sustainability, Environment, Water, Population and Communities , 2010).	• Pre-construction survey targeting thick-billed grasswren to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE. • Weed management – Table 7-4 Introduction and spread of weeds. • Introduced predators – Table 7-4 Increased Pest Fauna. • Introduced herbivores – Table 7-4 Increased Pest Fauna. • Habitat Fragmentation – Table 7-4 Vegetation clearing, habitat loss and fauna displacement.	Flora and Fauna Monitoring Program would be conducted six month to annually (See Appendix 6 - Biodiversity Management Plan): • Area search bird surveys and call playback surveys (most effective during breeding season of June to September); and • Track based monitoring to monitor feral predator populations.

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
Crest-tailed Mulgara (*D. cristicauda)*	*Dasycercus cristicauda* would not be significantly impacted by the Proposal (see Section 4.2.3 crest-tailed mulgara) however individuals may be impacted by the Proposal. Potential impacts from the Proposal may include: • Vehicle strike; • Increased predator species; • Grazing by domestic stock, rabbits and camels; and • Bushfires.	• Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a); • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b); • Threat abatement plan for competition and land degradation by rabbits (Department of Environment, Water, Heritage and the Arts, 2008c); and • Commonwealth Conservation Advice *for* Dasycercus cristicauda *(Crest-tailed Mulgara)* (Threatened Species Scientific Committee, 2013).	• Fauna Strike –Table 7-4 Fauna Strike or Injury. • Introduced predators – Table 7-4 • Introduced herbivores – Table 7-4 • Bushfires – Table 7-4 Fires and Bushfire Management Plan Appendix 4.	• Fauna incident register; and • Fauna sightings register Flora and Fauna Monitoring Program would be conducted six month to annually (See Appendix 6 - Biodiversity Management Plan): • Fauna trapping; • Spotlighting; • Track-based monitoring; and • Vegetation health monitoring.
Great Desert Skink (*L. kintorei)*	If the great desert skink is present Proposal area, the species would not be significantly impacted by the Proposal (see Section 4.2.3 great desert skink) however individuals may be impacted by the Proposal. Potential impacts from the Proposal may include: • Vehicle strike; • Increased predator species; • Grazing by domestic stock, rabbits and camels; and • Spread of buffel grass.	• *A recovery plan for the Great Desert Skink* (Egernia kintorei) 2001 – 20011 (McAlpin, 2001); • Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a); and • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b).	• Pre-construction survey targeting great desert skink to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • If the species is found to be present, significant impacts could be avoided through re-positioning of conflicting sites. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE. • Fauna Strike –Table 7-4 Fauna Strike or Injury. • Introduced predators – Table 7-4 Increased Pest Fauna. • Introduced herbivores – Table 7-4	• Fauna incident register; and • Fauna sightings register Flora and Fauna Monitoring Program would be conducted annually (See Appendix 6 - Biodiversity Management Plan): • Fauna trapping and searches for burrows in the warmer seasons when the species is active and detectable; • Track-based monitoring to monitor feral predator species populations; and • Vegetation health monitoring to monitor

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
			Increased Pest Fauna. • Weed management – Table 7-4 Introduction and spread of weeds.	habitat.
Slater's Skink (*L. s. slateri*)	If Slater's skink is present in the Proposal area, it is possible that the species would be significantly impacted as this species occurs in small isolated populations (See section 4.2.1 Slater's Skink). Potential impacts from the Proposal may include: • Vehicle strike; • Increased predator species; • Grazing by domestic stock, rabbits and camels; and • Spread of buffel grass. • Habitat destruction and fragmentation	• Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a); • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b); and • Approved Conservation Advice for *Liopholis slateri slateri* (Slater's skink, floodplain skink) (Threatened Species Scientific Committee, 2016).	• Pre-construction survey targeting Slater's skink to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE • Fauna Strike –Table 7-4 Fauna Strike or Injury. • Introduced predators – Table 7-4 Increased Pest Fauna. • Introduced herbivores – Table 7-4 Increased Pest Fauna. • Weed management – Table 7-4 Introduction and spread of weeds. • Habitat Fragmentation – Table 7-4 Vegetation clearing, habitat loss and fauna displacement.	• Fauna incident register; and • Fauna sightings register Flora and Fauna Monitoring Program would be conducted six monthly to annually (See Appendix 6 - Biodiversity Management Plan): • Fauna trapping, area searches for active burrows including trying to record individuals at burrows; all undertaken during warmer months when the species is active. • Track-based monitoring to monitor feral predator species populations; and • Vegetation health monitoring to monitor habitat.
Princess parrot (*P. alexandrae*)	If the Princess parrott is present in the proposal area, the species would not be significantly impacted by the Proposal (see Section 4.2.3 princess parrot) however individuals may be impacted by the Proposal.	• *Commonwealth Conservation Advice on* Polytelis alexandrae *(Princess Parrot)* (Threatened Species Committee, 2008).	• Pre-construction survey targeting Slater's skink to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • Introduced herbivores – Table 7-4	• Fauna incident register; Flora and Fauna Monitoring Program would be conducted six monthly to annually (See BMP): • Area search bird surveys,

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
	Potential impacts from the Proposal may include: • grazing by domestic stock, rabbits and camels.		Increased Pest Fauna.	targeted searches and waterhole watches in late dry-season conducted annually; and • Vegetation health monitoring to monitor habitat.
Australian painted snipe (*R. australis*)	If the Australian painted snipe is present in the proposal area, the species would not be significantly impacted by the Proposal (see Section 4.2.3 princess parrot) however individuals may be impacted by the Proposal. Potential impacts from the Proposal may include: • Increased predator species.	• *Commonwealth Conservation Advice on* Rostratula australis *(Australian Painted Snipe)* (Threatened Species Scientific Committee, 2013); • Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a); • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b);	• Pre-construction survey targeting Australian painted snipe to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • Introduced predators – Table 7-4 Increased Pest Fauna.	Flora and Fauna Monitoring Program would be conducted six monthly to annually (See Appendix 6 - Biodiversity Management Plan): • Area search bird surveys and stationary observations during breeding season; • Track based monitoring to monitor feral predator populations; and • Vegetation health monitoring to monitor habitat.
EPBC listed migratory and marine species				
Migratory and Marine Species (*A. modesta, C. acuminata, C. veredus, G. maldivarum, M. ornatus, T. nebularia* and*, T. stagnatilis*)	As habitat within the Proposal area is not in a region that supports an ecologically significant proportion of any migratory species potentially occurring in the Proposal area; is not of critical importance to any of these species at particular life-cycle stages; is not at the limit of the range of any of these species; and is not within an area where any of these species is declining, Proposal would not significantly impact any migratory species (see Section 4.2.5). However individuals may be impacted by	• Threat abatement plans for predation by European red foxes (Department of Environment, Water, Heritage and the Arts, 2008a); and • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b).	• Pre-construction survey targeting Migratory and Marine Species to determine the presence or absence of the species. See Flora and Fauna Monitoring Program (within Biodiversity management plan – Appendix 6). • Introduced predators – Table 7-4 Increased Pest Fauna.	• Fauna incident register; and • Fauna sightings register Flora and Fauna Monitoring Program would be conducted six monthly to annually (See Appendix 6 - Biodiversity Management Plan): • Area search bird surveys, particularly near water bodies; and

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
	the Proposal. Potential impacts from the Proposal may include: • Increased predator species.			• Track-based monitoring to monitor feral predator populations.
TPWC Act listed threatened species				
Brush-tailed Mulgara (*Dasycercus blythi*)	*Dasycercus blythii* would not be significantly impacted by the Proposal (see Section 4.2.9 brush-tailed mulgara, however individuals may be impacted by the Proposal. Potential impacts from the Proposal may include: • Vehicle strike; • Increased predator species; • grazing by domestic stock, rabbits and camels; • Bushfires.	• Threat abatement plans for predation by European red fox (Department of Environment, Water, Heritage and the Arts, 2008a); • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b); and • Threat abatement plan for competition and land degradation by rabbits (Department of Environment, Water, Heritage and the Arts, 2008c).	• Fauna Strike –Table 7-4 Fauna Strike or Injury. • Introduced predators – Table 7-4 Increased Pest Fauna. • Introduced herbivores – Table 7-4 Increased Pest Fauna. • Bushfires – Table 7-4 Fires and Bushfire Management Plan Appendix 4.	• Fauna incident register; and • Fauna sightings register. Flora and Fauna Monitoring Program would be conducted six monthly to annually (See Appendix 6 - Biodiversity Management Plan): • Fauna trapping; • Spotlighting; • Track-based monitoring to monitor feral predator populations; and • Vegetation health monitoring to monitor habitat condition.
Southern Marsupial Mole (*Notoryctes typhlops*)	*Dasycercus blythii* would not be significantly impacted by the Proposal (see Section 4.2.9 southern marsupial mole, however individuals may be impacted by the Proposal. Potential impacts from the Proposal may include: • Increased predator species; and • Compaction for roads and	• *Commonwealth Listing Advice on* Notoryctes typhlops *(itjaritjari)* (Threatened Species Committee, 2015)*;* • Recovery Plan for Marsupial Moles *Notoryctes typhlops* (Benshemesh, 2004)*;* • Threat abatement plans for predation by European red foxes (Department of Environment,	• Introduced predators – Table 7-4 Increased Pest Fauna. • Soil Compaction – Table 7-4 Vegetation clearing, habitat loss and fauna displacement • Rehabilitation – Table 7-4 Rehabilitation	Flora and Fauna Monitoring Program would be conducted annually (See Appendix 6 - Biodiversity Management Plan): • Mole trenches; and • Track-based monitoring to monitor feral predator populations.

Species	Potential Impacts from the Proposal	Relevant Commonwealth TAP, Recovery Plans and Conservation Advice	Mitigation Measures	Monitoring
	infrastructure.	Water, Heritage and the Arts, 2008a); and • Threat abatement plans for predation by feral cats (Department of Environment, Water, Heritage and the Arts, 2008b).		

The effectiveness of each mitigation and monitoring measure has been assessed using the criteria outlined in Table 6-5. The effectiveness descriptors of each mitigation and monitoring measure are defined in Table 6-2.

Table 6-6 is an analysis of the costing of the effectiveness of mitigation and monitoring measures proposed for threatened species identified as being potentially impacted by the Proposal. An assessment of the effectiveness of mitigation and monitoring measures are provided in

Table 6-6 as each measure relates to more than one threatened species.

Table 6-5 Generic significance criteria used for assessment of impacts on threatened species by the Proposal

Significance	Criteria
Eliminated	Because of mitigation, the likelihood and/or the consequence has been removed.
Low	These impacts are recognisable, but acceptable within the decision-making process. They are still important in the determination of environmental management requirements. These impacts tend to be short term, or temporary and at the local scale.
Medium	These impacts are relevant to decision making, particularly for determination of environmental management requirements. These impacts tend to range from long to short term, and occur over medium scale areas or focused within a localised area. Environmental receptors are moderately sensitive, and/or the impacts are of regional or local significance.
High	These impacts are likely to be of importance in the decision-making process. They tend to be permanent, or otherwise long to medium term, and can occur over large or medium scale areas. Environmental receptors are high to moderately sensitive, and/or the impacts are of state significance.
Extreme	These impacts are considered critical to the decision-making process. They tend to be permanent, or irreversible, or otherwise long term, and can occur over large scale areas. These effects are generally but not exclusively associated with sites and features of and/or the impacts of national importance. Typically, mitigation measures are unlikely to remove such effects.

Table 6-6: Costing and effectiveness of threatened species mitigation and monitoring measures for the Proposal, with agency responsible for approving each measure.

	Issue	Scale	Impact Significance[6]	Measure	Agency Responsible	Cost[7]	Effectiveness[9]
Mitigation	Increase in pest fauna, particularly predators	Local	High	Pest fauna management plan[1]	PWC NT, DENR	$2,500	High
	Fauna strike	Local	Medium	Induction[2]	PWC NT, DENR	$1,500	Moderate
	Bushfire	Regional	Extreme	Implement bushfire management plan	NTFS, DENR	See note[3]	High
	Soil compaction	Local	Low	Correct rehabilitation	DENR	See note[4]	Moderate

	Issue	Scale	Impact Significance[6]	Measure	Agency Responsible	Cost[7]	Effectiveness[9]
	Increase in weeds	Local	High	Weed Management Plan	DENR, NT Weeds branch	Already developed	High
	Threatened species present within area of impact	Local	High	Pre-construction survey – in line with EPBC guidelines; see Table 6-4.	DENR	$12,000	High
	Herbivore increase	Local	Medium	Pest fauna management plan	DPIR	See note[5]	Moderate
	Loss of threatened species habitat	Local	High	Re-alignment of access road	DENR	$0 to $12,000[8]	High
Monitoring	Assessment of impacts of the Proposal	Regional	NA	Biodiversity monitoring surveys – either annual or six monthly; includes field work and report.	DENR	$20,000 per survey	High
	Increase knowledge of fauna species present outside of survey effort	Local	NA	Fauna sighting register and fauna incident register – including development of poster for species identification and database registers	DENR	$1,000	Moderate

Notes:

1. Pest fauna management plan – control to be discussed and costed if there is a substantial increase in pest fauna due to the Proposal.
2. Inductions will be developed and undertaken by LES with Tellus staff who will be carrying out inductions for on-site workers.
3. Assumed incorporation in other plans related to the Proposal – i.e. Safety Management Plan and therefore no extra cost.
4. Soil compaction should only occur on hardstands and road ways, and ripping to de-compact soil should happen in decommissioned areas as part of a rehabilitation plan and therefore no extra cost.
5. Should not be an issue as there will be no accessible water to attract more pest fauna, however, roadways may encourage travel by pest species.
6. Significance of impacts on threatened species has been assessed based on Table 2.
7. Approximate costings based on LES rates effective as 13/01/2017
8. Cost would depend on the extent of re-alignment and if the new alignment went through an area previously surveyed or if it would require additional survey effort

7 ENVIRONMENTAL OFFSETS

An assessment of significance undertaken in accordance with the *Significant Impact Guidelines 1.1-Matters of National Environmental Significance* (Department of Environment 2013) found that no threatened species recorded in the Proposal area would be significantly impacted as a result of construction or operation of the Proposal. Two species that were not recorded in the Proposal area but have a low-moderate likelihood of occurrence within the Proposal area, *Amytornis modestus indulkana* and *Liopholis slateri slateri,* may potentially be significantly impacted, if they are found to be present in the Proposal area. An additional survey targeting *Amytornis modestus* and *Liopholis slateri slateri* would be conducted prior to construction and ongoing six monthly survey as part of the Tellus Flora and Fauna Monitoring Plan (See BDMP in Appendix 6).

At present no offset policy is deemed necessary for the Proposal. Should a population of *Amytornis modestus indulkana* and *Liopholis slateri slateri* be found in subsequent site surveys, then this would be re-assessed.

8 CUMULATIVE EFFECTS

The Proposal is surrounded by Perpetual Pastoral Lease's (PPLs):

- Maryvale Station (3,244 km^2);
- Henbury Station (5,273 km^2); and
- Idracowra Station (4,628 km^2).

The cumulative impact is expected to be minimal as all the surrounding pastoral properties are well established, with a majority of required infrastructure already established. There are no non-pastoral use applications or land clearing applications currently or recently approved for within these PPL's.

The cumulative impact of livestock farming may have already lowered the resilience of the flora and fauna communities surveyed, rendering them more vulnerable to further disturbance. However due to the comparative small area of disturbance of the Proposal and the widespread representation of vegetation types and habitat in the surrounding area, there would be no additional cumulative impacts as a result of construction and operations of the Proposal.

9 CONCLUSION

The potential risks to biodiversity as a result of the Proposal have been assessed by LES. LES has prepared this document using the skill and care expected from professional scientists to provide factual and technical information and reasonable solutions to identified risks; it does not constitute legal advice.

This risks to biodiversity assessment combines information from desktop studies and six on-ground surveys conducted over the four year study period. Desktop studies included database and literature review of broad scale and fine scale environmental information relating to the Proposal area including climate, bioregions, soil types, vegetation types, land systems, hydrology, vegetation types, weeds and invasive species, flora and fauna species of conservation significance listed under the TWPC Act and EPBC Act, introduced fauna and other MNES. A literature review provided information on the species occurring or potentially occurring within the Proposal area.

Six field surveys were conducted between October 2012 to May 2016 at 69 sites in the area of interest, encompassing all proposed development areas; in total there was 1,840 field hours of survey effort by consultants and Traditional Owners. On-ground surveys included habitat searches, vegetation surveys, landscape description, fauna trapping, secondary sign searches, area search bird surveys, spotlighting, motion sensing camera trapping, and bat call detection. Survey methods for vegetation surveys and landscape description are based on *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* (Brocklehurst, *et al.*, 2007) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, *et al.*, 2004). Survey methodology for fauna follows the *Standard terrestrial vertebrate survey methods used by the DLRM* (in Northern Territory Environmental Protection Agency, 2013) and *A resource assessment towards a conservation strategy for the Finke Bioregion* (Neave, *et al.*, 2004). Survey methods used to determine the presence of threatened species followed those suggested in the *Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, Environment, Water, Population and Communities, 2011a), *Survey Guidelines for Australia's Threatened Reptiles* (Department of Sustainability, Environment, Water, Population and Communities, 2011b) and *Survey Guidelines for Australia's Threatened Birds* (Department of Environment, Water, Heritage and the Arts, 2010).

No threatened flora species were recorded in the Proposal area. One flora species listed as near threatened under the TPWC Act (*Maireana carnosa)* and two species listed as data deficient, under the TPWC Act *(Crotalaria eremaea* and *Calandrinia remota*) were recorded during on-ground surveys. An additional five near threatened or data deficient species have a moderate to high likelihood of occurring in the Proposal area. These species are not considered to have conservation significance in the Proposal area. There are no threatened ecological communities or sensitive vegetation communities within the Proposal area.

Two threatened fauna species were recorded in the Proposal area during the on ground surveys:

- *Notorcytes typhlops*, listed as vulnerable under the TPWC Act, was recorded on the eastern and western banks of the Finke River approximately 800 m north of the proposed Henbury Access Road; and
- Mulgara sp. - *Dasycercus cristicauda*, listed as vulnerable under the both the EPBC Act and TPWC Act/ *Dasycercus blythi*, listed as vulnerable under the TPWC Act. Mulgara tracks were

recorded outside the mine lease, approximately 0.5 km north of the proposed Chandler Haul Road route, although it was not possible to identify these to the species level, there is suitable habitat for both *D. blythi* and *D. cristicauda* in the Proposal area.

Five threatened fauna species were not recorded during the on-ground surveys but have a low-moderate or moderate likelihood of occurring within the Proposal area:

- *R. australis* (endangered EPBC Act, vulnerable TPWC Act);
- *L. s. slateri* (endangered EPBC Act, vulnerable TPWC Act);
- *A. m. indulkana* (vulnerable EPBC Act, critically endangered TPWC Act);
- *P. alexandrae* (vulnerable EPBC Act, vulnerable TPWC Act) and;
- *L. kintorei* (vulnerable EPBC Act, vulnerable TPWC Act);

Six fauna species listed as near threatened under the TPWC Act were recorded during on-ground surveys:

- *A. australis*;
- *B. grallarius*;
- *C. b. samueli*;
- *D. novaehollandiae*;
- *N. splendida*; and
- *P. brunneus*.

An additional seven species listed as near threatened or data deficient under the TPWC Act were not recorded during surveys but have a low-moderate, moderate or high likelihood of occurring within the Proposal area. These species are not considered to have conservation significance in the Proposal area:

- *A. striatus* (near threatened);
- *C. whitei* (data deficient);
- *C. castanotum* (near threatened);
- *E. scriptus* (near threatened);
- *L. isura* (near threatened); and
- *Antechinomys laniger* (near threatened).

Three species listed as migratory under the EPBC Act were recorded in the Proposal area during surveys:

- *M. ornatus*;
- *T. nebularia*; and
- *T. stagnatilis*.

An additional five migratory species have a moderate to high likelihood of occurring in the Proposal area:

- *A. pacificus*;
- *A. modesta*;
- *C. acuminata*;
- *C. veredus*; and
- *G. maldivarum*.

Seven introduced flora species were recorded in the Proposal area. Of these species, one species is a Weed of National Significance (WoNs) and declared weed (Class B and Class C) in the NT, *Tamarix aphylla* (athel pine). Additionally, two species are declared weeds in the NT; *Datura leichardtii* (native thorn apple) (Class C), *Tribulus terrestris* (caltrop) (Class B).

Seven introduced fauna species were recorded during on-ground surveys of the Proposal area. These include *Bos taurus* (domestic cattle), *Camelus domaradius* (camel), *Canis lupis familiaris* (domestic dog), *Equus asinus* (donkey), *Equus caballus* (horse), *Felis catus* (cat), *Mus musculus* (house mouse), *Oryctolaugs cuniculus* (rabbit) and *Vulpes vulpes* (red fox).

Assessment of significance of impact

The potential for significant impacts on 16 threatened, migratory and marine species listed under the EPBC Act and TPWC Act that were recorded during surveys or have a low- moderate, moderate to high likelihood of occurring in the Proposal area. were assessed using the criteria set out in the *Significant Impact Guidelines 1.1-Matters of National Environmental Significance* (Department of Environment, 2013):

- *A. m. indulkana*;
- *D. blythi;*
- *D. cristicauda*;
- *L. kintorei*;
- *L. s. slateri*;
- *N. typhlops*;
- *P. alexandrae*;
- *R. australis*;
- *A. pacificus;*
- *A. modesta*;
- *C. acuminata*;
- *C. veredus;*
- *G. maldivarum*;
- *M. ornatus*;
- *T. nebularia;* and
- *T. stagnatilis*.

The findings of the assessment of significance are:

- There would be no significant impact as a result of the Proposal on the threatened species recorded in the Proposal area (*D. cristicausda*, *D. blythi* and *Notoryctes typhlops*).
- There would be no significant impact to the eight species listed as migratory under the EPBC Act.
- For the remaining five threatened species with a low-moderate or moderate likelihood of occurring within the Proposal area, there would be no significant impact on three of these species if they did occur in the Proposal area. Two of the species, *A. m. indulkana* and *L. s. slateri*, both with a low-moderate likelihood of occurring, were identified as having a potential to be significantly impacted as a result of the Proposal if the species did occur in the Proposal area:

Although the closest records of *A. m. indulkana* are approximately 167 km south east, potentially suitable habitat for *A. m. indulkana* occurs in a number of areas on the Henbury Access Road. Despite considerable survey effort, the species was not recorded during on-ground surveys. However due to the cryptic nature of the species and the difficulty associated with recording the species and the presence of suitable habitat, there is a low-moderate likelihood *A. m. indulkana* could occur in the proposal area. As a population of *A. m. indulkana* would meet the criteria for being an important population, there is the potential for significant impact on this species from reduction of the occupancy of this population, fragmentation or the disruption of the breeding cycle. If this species is found to be present, significant impacts would be avoided through changes to the alignment of the Henbury access road, or alternatively through trapping and translocation. If significant impacts could not be avoided, the need for offsets would be discussed with the DoEE.

There is suitable habitat for *L. s. slateri* on the proposed Henbury Access Road on the Finke River floodplain, on which makes up approximately 10 ha of theproposed disturbance area. If the species is present in the Proposal area, it is possible that an isolated population of the species would be significantly impacted through habitat loss and by the potential encroachment of buffel grass into suitable habitat following the removal of vegetation. Targeted surveys would be undertaken of the proposed access road alignment prior to construction. If the species is found to be present, significant impacts would be avoided through changes to the proposed alignment of the Henbury Access Road. Alternatively, a program of trapping and relocating would be implemented to avoid significant impacts to the species. If significant impacts could not be avoided, the need for offsets would be assessed in consultation with the DoEE.

The overall risk to biodiversity assessment identifies the potential hazards to biodiversity and a risk rating for these hazards based on their level of likelihood and potential consequences. Scientific evidence, knowledge and experience, where possible, have informed the risk assessment process to reduce the uncertainty in the rating; where this is not possible the level of uncertainty has been stipulated. This risk assessment has identified the following four key risks with regards to biodiversity as a result of construction and operations of the Proposal:

- Weeds spread and introduction;
- Increase in introduced species;
- Increased predator species; and
- Fire.

Following the risk assessment to biodiversity, mitigation and monitoring measures were developed to reduce these risks to an acceptable level. Risk reduction would be measured by comparable survey effort resulting in no change to:

- The populations of threatened flora and fauna species,
- Prevalence and spread of introduced weeds and invasive species;
- Abundance of predators;
- Numbers of individuals of introduced fauna species;
- Erosion and sedimentation;
- Hydrology;
- Groundwater quality and standing water level (SWL);
- Fire;

- Habitat availability, fragmentation or edge effects;
- Vegetation community abundance and condition; and
- Long-term stability of the surrounding environment.

Mitigation and monitoring measures that would be implemented for the four risks listed above are provided in Figure 9-1. A Biodiversity Monitoring Plan is provided in Appendix 6. An additional survey targeting *A. m. indulkana* and *L. s. slateri* would be conducted prior to construction and ongoing six monthly or annual survey as part of the Tellus Flora and Fauna Monitoring Plan. At present no offset policy is deemed necessary for the Proposal as there would be no significant impact to conservation significance species. Should a population of *A. m. indulkana* and *L. s. slateri* be found in subsequent site surveys, then this would be re-assessed.

Based on this assessment, it can be concluded that with the application of the recommended avoidance, mitigation and monitoring techniques, the remaining risks to biodiversity as a result of construction and operations at the Proposal are negligible. The conservation status, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels in the Proposal area and adjacent areas would be maintained. Tellus would implement best practice avoidance mitigation and management techniques to prevent the introduction and/or spread of invasive and pest species. The Proposal is highly unlikely to result in significant impact to threatened species and communities, and migratory species listed under the EPBC Act, and species listed under the TPWC Act.

Figure 9-1 Four key risk identified and proposed mitigation and monitoring measures

Risk	Mitigation and Monitoring Measure
Weeds spread and introduction	• Induct all staff into the requirements of the weed management plan see Appendix 6. • Vehicle/machinery wash-down prior to leaving Alice Springs or entering an area uncontaminated by weeds. • Avoid contact with any weed or invasive species seed, plant matter or soil potentially contaminated with weed seeds. • Avoid clearing or removal of any weed or invasive species during seeding • Remove seed and mud from vehicle tyres and front grill daily. • Ensure weed identification and reporting procedures are included in inductions • Annual weed mapping of the Proposal area • Removal of any weeds identified following specialist advice from third party qualified consultant or Weeds Branch, NT Government • Removal of weed or invasive species outside of seeding times • Avoid driving in wet and muddy conditions, where possible
Increased introduced species	• Prevent access to artificial water and heat sources through construction of fences • Dispose of all waste in predator proof bins. • Develop and implement a no tolerance policy to the introduction of pest species by contractors, suppliers and personnel. • Place brush or vegetation stockpiles across linear developments no longer required (seismic lines, access tracks etc.) to inhibit movement of predators and introduced herbivores. • Annual flora and fauna survey to record numbers of introduced fauna species • Develop, implement and maintain fauna sighting register. • Develop and implement an introduced fauna control program • Carry out feral animal control as required in consultation with stakeholders.
Increased Predator Species	• Reduce artificial standing water. • Install fauna proof fence around all infrastructure • Close off and rehabilitate any cleared areas no longer required for safe operation, e.g. construction camp • Ensure waste receptacles are fauna proof • Do not feed fauna. • Remove any dead fauna or insects from the Proposal and either dispose off-site or bury > 50 cm deep to avoid predators uncovering • Trap and relocate predator species if they are noticed to have increased in numbers and habituate around facilities. Appropriate third party advice would be sought before any action taken.
Fire	• Develop and implement a Bushfire Management Plan, refer to Appendix 4. • Keep up to date with bushfire website and state services. • Construct and maintain firebreaks around all infrastructure and significant habitats. • No open flames outside of designated areas unless hot works permit is approved. • Flammable material clearly labelled • Adequate firefighting equipment stored on site and staff trained in use • Provide designated smoking area. • Organise and implement strategic back burning with CLC • Limit unauthorised third party access • Implement and carry out annual fuel load surveys in September, before high risk fire season

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11 APPENDICES

Appendix 1: Timing of surveys and locations of sites and the land systems each site is situated within following Perry et al. (1960).

Survey	Site	Latitude	Longitude
Oct-12	S01a	24°53'43.21"S	133°59'19.01"E
	S02a	24°45'55.19"S	133°57'36.95"E
	S03a	24°42'46.15"S	133°58'29.43"E
	S04a	24°46'19.11"S	133°56'57.90"E
	S05a	24°49'1.98"S	133°53'10.66"E
	S06a	24°48'0.82"S	133°54'59.68"E
	S07a	24°45'45.24"S	133°48'28.14"E
Sep-13	CNP01	24°47'36.82"S	133°56'47.02"E
	CNP03	24°47'4.06"S	133°56'11.68"E
	Sl1-5	24°47'41.48"S	133°56'36.55"E
	CMP	24°48'23.34"S	133°57'9.05"E
	S04b	24°46'9.96"S	133°55'12.83"E
	S08	24°47'39.98"S	133°56'34.49"E
	S10	24°47'11.22"S	133°55'47.92"E
	S11	24°48'18.80"S	133°57'1.94"E
Jun-15	S01b	24°45'06.44"E	133°57'48.98"E
	S03b	24°47'3.57"S	133°52'57.83"E
	S05b	24°45'33.03"S	133°52'45.68"E
	S07b	24°47'5.41"S	133°57'14.10"E
	S09	133°56'52.74"E	24°45'56.02"S
	S12	24°47'46.81"S	133°58'0.90"E
	S13	24°40'55.99"S	134° 0'23.31"E
	S14	24°47'1.38"S	133°51'19.32"E
	S16	24°46'3.46"S	133°53'38.35"E
	S18	24°48'17.92"S	133°54'15.45"E
	S20	24°47'39.11"S	133°51'59.93"E
	S22	24°45'21.35"S	133°49'41.87"E
	S24	24°40'23.65"S	134° 2'44.60"E
	S26	24°45'23.02"S	133°42'9.99"E
	S27	24°45'22.77"S	133°40'53.27"E
Oct-15	S02b	24°43'20.08"S	133°57'36.95"E
	S06b	24°45'42.21"S	133°53'52.52"E
	S13	24°40'55.99"S	134° 0'23.31"E
	S15	24°46'30.88"S	133°51'13.62"E
	S17	24°42'42.54"S	133°58'24.66"E
	S19	24°49'35.73"S	133°54'43.29"E
	S21	24°48'31.49"S	133°50'52.89"E

Survey	Site	Latitude	Longitude
	S23	24°45'22.71"S	133°49'57.67"E
	S29	24°44'16.10"S	133°41'1.19"E
	S30	24°44'51.72"S	133°41'3.88"E
Nov-15	SD1	24°41'6.07"S	133°24'42.95"E
	RE1	24°41'34.18"S	133°29'2.67"E
	SN1	24°43'22.72"S	133°29'44.04"E
	CSW1	24°41'34.34"S	133°21'57.98"E
	CH1	24°41'36.09"S	133°21'23.92"E
	R1	24°41'0.18"S	133°25'0.55"E
	SN1	24°45'23.02"S	133°42'9.99"E
	SD2	24°45'12.71"S	133°29'43.13"E
	AN1	24°45'44.62"S	133°38'17.19"E
	AN2	24°41'36.49"S	133°19'3.20"E
	CH2	24°41'35.43"S	133°15'9.95"E
	R2	24°45'43.48"S	133°39'43.28"E
	MDG1	24°41'34.05"S	133°15'50.70"E
	MDG2	24°41'36.71"S	133°28'34.77"E
	MDG3	24°41'48.43"S	133°29'43.52"E
May-16	Si-a	24°45'44.78"S	133°45'27.37"E
	An-a	24°45'44.69"S	133°37'42.44"E
	Ch-a	24°45'44.41"S	133°35'48.96"E
	Sn-a	24°41'34.34"S	133°21'57.98"E
	Re-a	24°41'36.06"S	133°29'30.68"E
	Fi-a	24°45'44.30"S	133°33'55.51"E
	CSW-a	24°45'44.80"S	133°31'4.20"E
	Sd-a	24°45'44.98"S	133°30'47.80"E
	Ch-a2	24°45'45.20"S	133°40'58.23"E
	Sn-a-2	24°41'27.15"S	133°25'34.05"E
	Sn-a-cp	24°41'27.15"S	133°25'34.05"E
	An-ar-a	24°44'24.81"S	133°35'23.79"E
	Au-ar-a	24°43'22.26"S	133°33'46.01"E
	Ch-ar-a	24°42'49.95"S	133°32'5.16"E
	Sn-ar-a	24°43'22.26"S	133°33'46.01"E
	Ch-ar-sc	24°44'39.19"S	133°32'14.91"E

Appendix 2: Flora list from on-ground surveys undertaken between October 2012 and April 2016, the site at which each species was recorded, and status under the EPBC Act and TPWC Act.

*Denotes introduces species; LC: least concern under the TPWC Act, DD: data deficient under the TPWC Act

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Acanthaceae	*Rostellularia adscendens*		LC				Sn			
Aizoaceae	*Trianthema triquetra*	Red spinach	LC							Cn
Amaranthaceae	*Pterocaulon sphacelatum*	Fruit salad/apple bush	LC		Sn					
Amaranthaceae	*Ptilotus calostachyus*	Weeping mulla mulla	LC					An		
Amaranthaceae	*Ptilotus macrocephalus*	Large green pussytails	LC					An		
Amaranthaceae	*Ptilotus obovatus*	Silver pussytails	LC		Si, Sn	Re	Sn	An	Re, Si, Sn, Cn	An, Sn, Cn, Re
Amaranthaceae	*Ptilotus polystachyus*	Long pussytails	LC		Si, Sn	Si, Sn	Si, Sn	Ru, Sn		
Amaranthaceae	*Ptilotus sessilifolius*	Crimson foxtail	LC				Sn	Cn, An		
Amaranthaceae	*Ptilotus whitei*		LC				Sn			
Amaranthaceae	*Tecticornia pergranulata*	Black samphire	LC		Sn					
Apocynacea	*Carissa lanceolata*	Conkerberry	LC						Re	Sn
Asteraceae	*Bracteantha bracteata*	Yellow paper daisy	LC		Si, Sn					
Asteraceae	*Brachyscome tesquorum*		LC				Sn			
Asteraceae	*Calocephalus knappii*	Billybuttons	LC			Sn				
Asteraceae	*Calotis erinacea*	Tangled bur daisy	LC					Si		
Asteraceae	*Calotis hispidula*	Bogan flea	LC			Si, Sn		Fi, Si		
Asteraceae	*Chrysocephalum apiculatum*	Yellow buttons	LC				Sn		Sn	Si, Fi
Asteraceae	*Helipterum floribundum*	Paper daisy	LC			Si				
Asteraceae	*Pluchea sp.*		LC						Si	Cn
Asteraceae	*Polycalymma stuartii*	Poached egg daisy	LC			Si, Sn				
Asteraceae	*Rutidosis helichrysoides*	Grey wrinklewort	LC				Sn	An		

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Asteraceae	*Schoenia cassiniana*	Pink everlasting	LC			Si		An		
Asteraceae	*Senecio gregorii*	Annual yellowtop	LC			Si, SN				
Boraginaceae	*Heliotropium curassavicum*	Smooth heiltrope	LC						Sn	An
Boraginaceae	*Heliotropium ovalifolium*		LC						Sn	An
Boraginaceae	*Trichodesma zeylanicum*	Cattle bush	LC		Sn		Sn	An		
Campanulaceae	*Wahlenbergia communis*	Tufted bluebell	LC			Si, Re, Sn				
Capparaceae	*Capparis spinosa nummularia*	Wild passionfruit	LC					Fi		
Capparidaceae	*Cleome viscosa*	Tickweed	LC				Si	Fi		
Casuarinaceae	*Allocasuarina decaisneana*	Desert oak	LC		Si, Sn	Si, Sn			Fi, Cn	Sn, Si
Chenopodiaceae	*Atriplex spongiosa*	Saltbush	LC		Sn			Si		
Chenopodiaceae	*Atriplex vesicaria*	Bladder saltbush	LC						Si	Cn
Chenopodiaceae	*Dissocarpus paradoxus*	Cannonball Burr	LC				Cn			
Chenopodiaceae	*Enchylaena tomentosa*	Ruby saltbush	LC		Si	Sn	Sn		Re, Si	Cn, Sn, Re
Chenopodiaceae	*Maireana astrotricha*	Low bluebush	LC					Cn	Re, Si, Cn	Cn, Sn, Re
Chenopodiaceae	*Maireana carnosa*	Cottony bluebush	LC				Sn		Sn	An
Chenopodiaceae	*Maireana georgei*	Satiny bluebush	LC				Cn			
Chenopodiaceae	*Rhagodia eremaea*	Tall saltbush	LC					Cn	Sn, Re	An
Chenopodiaceae	*Rhagodia spinescens*	Spiney saltbush	LC						Cn, An	Si
Chenopodiaceae	*Salsola tragus*		LC					Si, Ru		Cn
Chenopodiaceae	*Sclerolaena bicornis*	Goatshead burr	LC						Re, Sn	Cn, An, Sn
Chenopodiaceae	*Sclerolaena convexula*	Tall copper burr	LC				Cn	Sn	Sn, Cn, An	An, Si, Cn
Chenopodiaceae	*Sclerolaena cornishiana*	Cartwheel burr	LC				Sn		Si	Re

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Chenopodiaceae	*Sclerolaena costata*		LC					Sn, Ru, Cn	Fi	Cn, Si
Chenopodiaceae	*Sclerolaena cuneata*	Succulent copper burr	LC						Sn	An
Chenopodiaceae	*Sclerolaena diacantha*		LC				Cn			
Chenopodiaceae	*Sclerolaena ericantha*		LC					Cn		
Chenopodiaceae	*Sclerolaena lanicuspis*		LC				Sn, Gi-2			
Chenopodiaceae	*Sclerolaena pataenticuspis*	Spear-fruit copper burr	LC						An	Si
Chenopodiaceae	*Tecticornia halocenemoides*		LC						Si	Cn
Chenopodiaceae	*Tecticornia indica*		LC						Si	Cn
Chenopodiaceae	*Tecticornia tenuis*		LC				Cn			
Convolvulaceae	*Evolvulus alisinoides*		LC			Si, Sn	Sn			
Convolvulaceae	*Ipomoea muelleri*	Poison morning glory	LC		LSNR			Sn		
Cucurbitaceae	*Austrobryonia centralis*	Telford	LC						Sn	Fi
Cucurbitaceae	*Citrullus colocynthis**	Paddy melon	LC		LSNR					
Cucurbitaceae	*Citrullus lanatus*		LC						Sn	Fi
Cyperaceae	*Bulbostylis barbata*	Delicate sedge	LC				Sn, Gi-1			
Cyperaceae	*Cyperus gymnocaulos*	Spiny flat-sedge	LC						Sn	Fi
Cyperaceae	*Fimbristylis dichotoma*	Eight day grass	LC			Re				
Euphorbiaceae	*Euphorbia australis*	Hairy caustic weed	LC					Fi		
Euphorbiaceae	*Euphorbia biconvexa*		LC					Ru, Cn	Sn, An	Fi, Si
Euphorbiaceae	*Euphorbia coghlanii*		LC						Sn	An
Euphorbiaceae	*Euphorbia drummondii*	Caustic weed	LC		Sn	Sn				
Euphorbiaceae	*Euphorbia tannensis*	Caustic bush/desert spurge	LC				Gi-1, Sn	Si, An	Sn, Si	Sn, Si, An
Fabaceae	*Acacia abrupta*		LC							An

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Fabaceae	*Acacia aneura*	Mulga	LC		Si, Sn	Si, Sn, Re, Ru	Si, Sn, Gi-1		Re, Sn, Si, Fi, An	Sn, An, Cn, Si
Fabaceae	*Acacia dictyophleba*	Sandhill wattle	LC			Sn		Si, Sn, Gi, Cn, An		
Fabaceae	*Acacia estrophiolata*	Ironwood	LC		Si, Sn	Si, Sn, Re, Ru			Cn	Cn, Si
Fabaceae	*Acacia kempeana*	Witchetty bush	LC		Si, Sn	Si, Sn	Si, Sn	Si	Si, Cn	Cn, Re
Fabaceae	*Acacia ligulata*	Umbrella bush	LC		Si		Fi	Sn, Si	Sn, Re	Fi
Fabaceae	*Acacia melleodora*	Waxy wattle	LC						Fi	Si, Sn
Fabaceae	*Acacia murrayana*	Colony wattle	LC		Si	Sn	Si	Si	Sn	Fi
Fabaceae	*Acacia sessiliceps*	Curly-pod wattle	LC						Fi, Re	
Fabaceae	*Acacia tetragonophylla*	Dead finish	LC		Si, Sn	Sn, Re, Ru	Sn, Si	Si, Sn, Ru	Re, Sn, Si	Cn, An, Sn, Re
Fabaceae	*Acacia victoriae*	Prickly acacia	LC				Fi		Re	Sn
Fabaceae	*Crotalaria eremaea*	Bluebush pea	DD		Sn					
Fabaceae	*Indigofera linnaei*		LC				Sn			
Fabaceae	*Petalostylis cassioides*	Butterfly bush	LC							Cn
Fabaceae	*Senna artemisioides alicia*		LC		Sn		Sn	Ru	Re	An, Sn
Fabaceae	*Senna artemisiodes artemisioides*	Silver cassia	LC				Sn		Re, Sn, An	Sn, Si
Fabaceae	*Senna artemisioides filifolia*	Desert cassia	LC		Si	Si, Sn	Si, Sn		Si, Sn, Cn, Re	Cn, An, Sn, Re, Si
Fabaceae	*Senna artemisioides helmsii*	Blunt-leafed cassia	LC		Si	Re	Sn		Re	

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Fabaceae	*Senna artemisioides oligophylla*	Oval-leafed senna	LC		Sn	Re		Sn, Gi	Si	Cn, Re
Fabaceae	*Senna artemisioides quadrifolia*	Silver cassia	LC						Re, Si	Cn, Sn
Fabaceae	*Senna artemisioides sturtii*	Grey cassia	LC		Si	Sn, Re, Si, Ru	Sn		Re, Si	Cn, Sn, Re
Fabaceae	*Swainsona affinis*		LC				Sn			
Fabaceae	*Senna pleurocarpa*		LC		Sn			Sn		
Fabaceae	*Swainsona phacoides*	Dwarf swainsona	LC				Sn	Si	Si	Cn
Fabaceae	*Templetonia agena*	Desert broom bush	LD					Si		
Fabacaeae	*Tephrosia sphaerospora*		LC				Sn			
Fabaceae	*Vachellia farnesiana farnesiana*	Mimosa bush	LC				Fi			
Frankeniaceae	*Frankenia cordata*	Salty heath	LC					An	An	Si
Frankeniaceae	*Frankenia serphylliofolia*	Sedge	LC				Sn		Si	Cn
Goodeniaceae	*Brunonia australis*	Blue pincushin	LC		Sn	Si, Si,Sn				
Goodeniaceae	*Goodenia goodeniacaea*		LC						Si	Cn
Goodeniaceae	*Goodenia lunata*		LC				Sn			
Goodeniaceae	*lechenaultia divaricata*	Tangled leschenaultia	LC		Si, Sn			Sn	Re	Sn
Goodeniaceae	*Scaevola depauperata*	Skeleton fan-flower	LC		Sn					
Goodeniaceae	*Scaevola glabrata*	Scaevola	LC						Re	Sn
Goodeniaceae	*Scaevola parvifolia*	Fan-flower	LC							Si
Gyrostemonaceae	*Codonocarpus cotinifolius*	Desert poplar	LC		Sn			An		
Haloragaceae	*Haloragis* sp.						Si			
Lamiaceae	*Newcastlia spodiotricha*		LC		Si					
Lamiaceae	*Prostanthera stratiflora*	Stripped mintbush	LC						Re	

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Loranthaceae	*Amyema preissii*	Wire-leaf mistletoe	LC		Si					
Loranthaceae	*Lysiana exocarpi*	Harlequin mistletoe	LC						Re	Sn
Malvaceae	*Abutilon otocarpum*	Desert chinese lantern	LC			Sn	Si, Sn, Gi		Sn, Cn	An, Si
Malvaceae	*Hibiscus krichauffianus*	Velvet-leaf hibiscus	LC		Sn					
Malvaceae	*Rulingia loxophylla*	Desert fire weed	LC			Sn				
Malvaveae	*Sida argillacea*		LC				Sn			
Malvaceae	*Sida fibulifera*	Fire sida	LC						Sn, Re	Cn, An
Malvaceae	*Sida filiformis*		LC							An, Fi, Sn
Malvaceae	*Sida platycalyx*	Lifesaver burr	LC		Si, SnSi	Si, Sn	Sn		Re, Sn, Si, An	Sn, An, Si
Malvaceae	*Sida rohlenae*	Shrub sida	LC					Sn, An		
Malvaceae	*sida sp.*					Sn		Si	An	
Myrtaceae	*Corymbia opaca*	Bloodwood	LC					Gi		
Myrtaceae	*Eucalyptus camaldulensis*	River red gum	LC				Fi	Fi, Gi	Fi, Sn	Fi
Myrtaceae	*Eucalyptus coolabah arida*	Coolabah	LC					Fi	An	Si
Myrtaceae	*Eucalyptus gamophylla*	Blue mallee	LC		Sn		Sn			Si
Myrtaceae	*Eucalyptus intertexta*	Bastard coolibah	LC		Si					
Myrtaceae	*Melaleuca glomerata*	Inland paper bark, desert honey myrtle	LC		Si				Sn	Fi
Nyctaginaceae	*Boerhavia coccinea*	Tar vine	LC				Sn	Fi	Sn, Si	Sn, An
Pedaliaceae	*Josephinia eugeniae*		LC				Sn			
Poaceae	*Amphipogon caricinus*	Long greybeard grass	LC					Ru, Si, An	Sn	Si, An

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Poaceae	*Aristida contorta*	Bunched kerosene grass	LC		Si, Sn		Si, Sn, Gi-1		Sn	An
Poaceae	*Aristida holothera*	Erect kerosene grass	LC		Si, Sn	Si, Sn, Ru	Si, Sn, Gi-1	Sn, Gi, Cn, An	Sn, Fi, Cn, Re, Si	Cn, Sn, An, Si
Poaceae	*Aristida inaequiglumis*	Unequal threeawn	LC					Si, Sn, Gi, Cn, An	Si	Sn
Poaceae	*Aristida strigosa*	Rough treeawn	LC				Sn	Si		
Poaceae	*Brachyachne ciliaris*	Native hairy couch	LC				Sn			
Poaceae	*Cenchrus ciliaris**	Buffel grass	LC		Si, Sn	Sn	Fi, Si	Si, Sn, An	Re, Si, Sn, Cn, An	Cn, An, Sn, Fi, Si
Poaceae	*Cynodon dactylon**	Couch	LC		LSNR		Fi	Fi, Rn, Sn	Fi, Sn	Fi
Poaceae	*Digitaria brownii*	Cotton panic grass	LC					Fi		
Poaceae	*Digitaria coenicola*	Finger panic grass	LC				Gi-1, Sn	Gi		Cn
Poaceae	*Enneapogon avenaceus*	Native oat-grass, bottlewashers	LC				Sn, Si		Si	Cn, Re
Poaceae	*Enneapogon cylindricus*	Jointed nineawn	LC				Sn	Sn, Gi, Rn, Cn		
Poaceae	*Enneapogon polyphyllus*	Oat-grass, leafy nine-awn	LC		Si, Sn	Si	Gi-1, Sn	Sn, An		
Poaceae	*Enteropogon acicularis*	Curly windmill	LC		Si, Sn			Si, An		
Poaceae	*Enteropogon fascicularis*		LC					Gi		
Poaceae	*Enteropogon ramosus*	Creek windmill grass	LC					Gi		Cn
Poaceae	*Eragrostis dielsii*	Mallee lovegrass	LC						Si	Cn

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Poaceae	*Eragrostis eriopoda*	Woolybutt grass	LC		Si, Sn	Si, Sn	Si, Sn, Gi-1		Re, Sn, Fi, Cn, Si, An	Cn, Sn, An, Sn, Si
Poaceae	*Eragrostis setifolia*	Narrow-leaf neverfail	LC					Si, Sn, Gi	Re	Cn
Poaceae	*Eriachne aristidea*	Three-awn wanderrie	LC							Cn
Poaceae	*Eriachne mucronata*	Mountain wanderrie	LC					Gi, An		
Poaceae	*Eriachne obtusa*		LC					Si		
Poaceae	*Eriachne sp.*		LC					Gi	Sn	An
Poaceae	*Monachather paradoxus*	Bandicoot grass	LC		Si, Sn	Si, Sn	Si, Sn		Cn	Si
Poaceae	*Paraneurachne muelleri*	Spinifex couch	LC					Si, Sn, Gi, An		Si
Poaceae	*Sporobolus actinocladus*	Katoora	LC					Gi		
Poaceae	*Sporobolus australasicus*	Australian dropseed	LC				Si	Ru		
Poaceae	*Themeda triandra*	Kangaroo grass	LC				Sn			Cn
Poaceae	*Thyridolepis mitchelliana*	Mulga mitchell grass	LC							
Poaceae	*Triodia basedowii*	Hard spinifex	LC		Si, Sn	Si, Sn		An, Si		
Poaceae	*Triodia longiceps*	Giant grey spinifex	LC				Gi-1			
Poaceae	*Triodia pungens*	Gummy spinifex	LC				Si, Sn		Fi, Cn, Si	Sn, Si
Poaceae	*Yakirra australiensis*	Desert flinders grass	LC					Si, Sn, Rn, Cn		Si
Poaceae	*Zygochloa paradoxa*	Sandhill canegrass	LC				Fi	Fi	Sn, Fi	Sn, Fi
Polygonaceae	*Muehlenbeckia cunninghamii*	Lignum	LC					Fi	An	Si
Polygonaceae	*Muehlenbeckia florulenta*	Tangled lignum	LC					Si, Sn		Si

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Portulacaceae	*Calandrinia balonensis*	Broad-leaf parakeelya	LC		Sn	Sn		Si		
Portulacaceae	*Calandrinia remota*		DD			Si				
Portulacaceae	*Portulaca oleracea*	Munyeroo, pigweed	LC			Sn	Sn			
Proteaceae	*Grevillea eriostachya*	Honey grevillea	LC					Cn		
Proteaceae	*Grevillea junicifolia*	Desert grevillea	LC		Si, Sn			Cn	Cn	Si
Proteaceae	*Grevillea stenobotrya*	Rattlepod grevillea	LC		Sn	Sn			Re	
Proteaceae	*Grevillea striata*	Beefwood	LC					Si		Si
Proteaceae	*Hakea leucoptera*	Needlewood	LC				Si		Re, Sn	Cn, An, Sn
Proteaceae	*Hakea lorea ssp. lorea*	Long-leafed corkwood	LC			Sn		Si		
Santalaceae	*Santalum lanceolatum*	Plumbush	LC							Cn
Sapindaceae	*Atalaya hemiglauca*	Whitewood	LC				Sn		Si, Re	Re
Sapindaceae	*Dodonaea viscosa angustissima*	Sticky hopsbush	LC		Si, Sn	Sn, Ru	Si	Si, Fi	Re, Si, Sn	Cn, Sn, An, Sn, Si
Scrophulariaceae	*Eremophila duttonii*	Harlequin fuchsia bush	LC				Sn, Si	Si, Fi, Rn, Ru	Re, Sn	An, Sn, Si
Scrophulariaceae	*Eremophila freelingii*	Rock fuchsia	LC		Si, Sn	Re	Sn	Cn	Re, Si, Cn	Sn, Cn
Scrophulariaceae	*Eremophila gilesii gilesii*	Mulga fuschia	LC				Sn			
Scrophulariaceae	*Eremophila latrobei*	Native fuschia	LC		Si, Sn	Si, Ru	Sn		Sn	Si, An
Scrophulariaceae	*Eremophila longifolia*	Weeping emu bush	LC		Sn	Sn	Si, Sn	Si, Gi, An	Re, Cn	Sn, Si
Scrophulariaceae	*Eremophila sturtii*	Turpintine bush	LC						Sn, Re	Cn, An
Scrophulariaceae	*Eremophila willsii*	Sandhill native fushia	LC		Si, Sn			Si		Si

Family	Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
			TPWC	EPBC						
Solanaceae	*Datura leichhardtii**	Native thornapple	LC						Fi	
Solanaceae	*Nicotiana rosulata*		LC				Sn			
Solanaceae	*Solanum centrale*	Desert raisin	LC		Si, Sn	Si	Sn	An		Cn
Solanaceae	*Solanum cleistogamum*		LC							Cn
Solanaceae	*Solanum ellipticum*	Native tomato, potato bush	LC				Sn		Si	Sn
Solanaceae	*Solanum lasiophyllum*		LC						Re	Sn
Solanaceae	*Solanum lithophyllum*		LC					Cn		
Solanaceae	*Solanum nigrum**	Blackberry nightshade	LC		LSNR		Ru			
Solanaceae	*Solanum quadriloculatum*	Wild tomato	LC		Si, Sn	Si, Sn, Re, Ru	Sn, Si		Re, Sn, Si, Fi, Cn, An	Cn, Sn, An, Sn, Si
Tamaricaceae	*Tamarix aphylla**	Athel pine	LC		LSNR			Si, Sn, Gi, Cn, An	Fi	
Zygophyllaceae	*Tribululs terrestris**	Caltrop	LC						Cn, Re, Si	Sn, Si
Zygophyllaceae	*Tribulus eichlerianus*	Bindieye	LC						Re, Sn, An	Sn, Si, Fi

Appendix 3: Fauna lists from on-ground surveys undertaken between October 2012 and April 2016, the site at which each species was recorded, and status under the EPBC Act and TPWC Act

*Denotes introduced species, # denotes extinct species (relict secondary signs were recorded), Mi: migratory under the EPBC Act, Nt: near threatened under the TPWC Act, Vu: vulnerable under the EPBC Act and TPWC Act, Ex: extinct under the EPBC Act and TPWC Act

		Status							
Scientific name	**Common name**	**TPWC**	**EPBC**	**Oct-12**	**Sep-13**	**Jun-15**	**Oct-15**	**Nov-16**	**Apr-16**
Aves									
Acanthagenys rufogularis	Spiny-cheeked honeyeater	LC		Si				LSNR	Si
Acanthiza apicalis	Inland thornbill	LC		Si			Cn		
Acanthiza chrysorrhoa	Yellow-rumped thornbill	LC		Si		Gi-1	An		
Acanthiza robustirostris	Slaty-backed thornbill	LC					An	An	
Acanthiza sp.	Thornbill	LC				Sn		Si, Re, An	
Acanthiza uropygialis	Chestnut-rumped thornbill	LC		Si		Sn	An	Sn	
Accipiter cirrhocephalus	Collared sparrowhawk	LC						LSNR	
Accipiter fasciatus	Brown goshawk	LC					Si		
Aegotheles cristatus	Australian owlet-nightjar	LC		LSNR					
Anthus novaeseelandiae	Australasian pipit	LC		Si				Sn	
Aphelocephala leucopsis	Southern whiteface	LC		Si		Sn		LSNR	
Aphelocephala nigricincta	Banded whiteface	LC		LSNR					Re, Cn
Aquila audax	Wedge-tailed eagle	LC				Sn			LSNR
Ardea alba	Great egret	LC						LSNR	
Ardea pacifica	White-necked heron	LC							Fi
Ardeotis australis	Australian bustard	Nt						Sn	
Artamus cinereus	Black-faced woodswallow	LC		LSNR		Sn	Rn, Si, Sn	Re, Sn	Si, Cn
Artamus personatus	Masked woodswallow	LC		Si					
Barnardius zonarius	Australian ringneck	LC		Si		Fi	An	Si, Fi	Si, Fi

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Burhinus grallarius	Bush stone-curlew	Nt		LSNR					
Calidris acuminata	Sharp-tailed sandpiper	LC	M	LSNR					
Calyptorhynchus banksia samueli	Red tailed black cockatoo	Nt						LSNR	Fi
Cheramoeca leucosterna	White-backed swallow	LC		Si		Sn			
Cinclosoma cinnamomeum cinnamomeum	Cinnamon quail-thrush	LC		Si		LSNR	LSNR		LSNR
Circus assimilis	Spotted harrier	LC		LSNR					
Colluricincla harmonica	Grey shrike-thrush	LC		LSNR		Si	Gi, Sn		
Coracina novaehollandiae	Black-faced cuckoo-shrike	LC		Si			Gi		
Corvus bennetti	Little crow	LC		LSNR		Si, Fi			
Corvus orru	Torresian crow	LC		LSNR		Si, Fi, Sn	Si	Fi	Fi
Corvus sp.	Crow	LC			Si	Sn			
Cracticus nigrogularis	Pied butcherbird	LC		Si		Si, Fi		Si, Sn	Fi
Cracticus tibicen dorsalis	Australian magpie	LC		Si					Fi
Cuculus pallidus	Pallid cuckoo	LC					An		
Daphoenositta chrysoptera	Varied sittella	LC					Sn		
Dicaeum hirundinaceum	Mistletoebird	LC		Si			An		
Dromaius novaehollandiae	Emu	Nt		LSNR	Si	Sn		Sn, Re	Si
Elseyornis melanops	Black-fronted dotterel	LC		LSNR				LSNR	
Eolophus roseiocapillus	Galah	LC		Si				Sn	Fi
Epthianura tricolor	Crimson chat	LC		Si		Fi			
Eurostopodus argus	Spotted nightjar	LC		LSNR					
Falco berigora	Brown falcon	LC		Si		Sn	Si	LSNR	
Falco cenchroides	Nankeen kestrel	LC					An	LSNR	

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Geopelia cuneata	Diamond dove	LC		Si					
Geopelia placida	Peaceful dove	LC						Cn	
Geophaps plumifera	Spinifex pigeon	LC							
Gerygone fusca	Western gerygone	LC		Si					
Grallina cyanoleuca	Magpie-lark	LC		LSNR			Gi		Fi
Haliastur sphenurus	Whistling kite	LC		LSNR					Fi
Hirundo ariel	Fairy martin	LC				Sn		Re, Sn, Cn	Si
Lalage sueurii	White-winged triller	LC		Si					
Lichenostomus keartlandi	Grey-headed honeyeater	LC				Sn			
Lichenostomus penicillatus	White-plumed honeyeater	LC				Fi	Gi	Si, An	
Lichenostomus virescens	Singing honeyeater	LC		Si		Si, Sn	Si, Cn, An	Sn, Fi, Re	
Lichmera indistincta indistincta	Brown honeyeater	LC		LSNR					
Lophochroa leadbeateri	Major Mitchell's cockatoo	LC		Si			Gi	Si	LSNR
Malurus lamberti	Variegated fairy-wren	LC		Si			Si, Rn, An		Re
Malurus leucopterus leuconotus	White-winged fairy-wren	LC		Si					
Malurus sp.	Fairy wren	LC				Sn		An	
Malurus splendens	Splendid fairy-wren	LC		Si			Sn, An, Cn		Si
Manorina flavigula	Yellow-throated miner	LC		Si		Fi	Gi	Si, Fi	Fi
Melanodryas cucullata	Hooded robin	LC				Si			
Melopsittacus undulatus	Budgerigar	LC		Si		Sn	Si	Sn	Fi
Merops ornatus	Rainbow bee-eater	LC	Mi	Si			Si, Sn, Gi, Rn	LSNR	
Milvus migrans	Black kite	LC		Si					

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Neophema splendida	Scarlet-chested parrot	Nt		LSNR					
Neopsephotus bourkii	Bourke's parrot	LC		Si					
Ninox boobook	Southern boobook owl	LC						LSNR	
Nymphicus hollandicus	Cockatiel	LC		Si					
Ocyphaps lophotes	Crested pigeon	LC		Si			Si	Cn, Re	Fi
Oreoica gutturalis	Crested bellbird	LC		Si		Si, Sn, Fi	Gi, An	Re, Si, Sn, Fi	Si, Cn, Fi, Re
Pachycephala rufiventris	Rufous whistler	LC		Si		Sn	An		
Pardalotus rubricatus	Red-browed pardalote	LC		Si			Si, Sn, Gi, Rn		
Pachycephala rufiventris	Rufous whistler	LC		Si		Sn	An		
Petroica goodenovii	Red-capped robin	LC		Si					
Phaps chalcoptera	Common bronzewing pigeon	LC		Si				LSNR	
Podargus strigoides	Tawny frogmouth	LC							LSNR
Pomatostomus superciliosus	White-browed babbler	LC				Sn	An		Sn
Pomatostomus temporalis	Grey-crowned babbler	LC		Si			Sn, Gi	Fi	
Psephotus varius	Mulga parrot	LC		Si		Sn, Gi-1	Si, Gi, Sn, An	LSNR	Fi, Si
Psophodes occidentalis	Chiming wedgebill	LC		Si			Cn, Sn, An, Si	Si	Cn, Re
Pyrrholaemus brunneus	Redthroat	Nt		LSNR					
Rhipidura albiscapa	Grey fantail	LC							Fi
Rhipidura leucophrys	Willie wagtail	LC		Si	Sn		Si, Gi, Rn, Cn, Sn, An	Si, Fi, Sn, Cn, Re, An	Fi

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Smicrornis brevirostris flavescens	Weebill	LC		Si					
Taeniopygia guttata	Zebra finch	LC		Si		Si, Fi, Sn, Gi-1	Si, Sn, Cn, Rn, An	Cn, Si	Si
Todiramphus pyrrhopygius	Red-backed kingfisher	LC		Si					
Todiramphus sp.	Kingfisher sp.	LC						Sn	
Tringa stagnatilis	Marsh sandpiper	LC	Mi					LSNR	
Turnix velox	Little button-quail	LC				Si, Sn			
Tyto alba	Eastern barn owl	LC				LSNR			
Mammalia									
Bettongia lesueur graii#	Burrowing bettong	Ex	Ex			Sn	Ch, Sn	Ch	
*Bos taurus**	Cattle	LC	Int		Si	Sn	An	Re, Sn, Si, Fi, An, Cn	Si, Cn, An, Fi, Re, Sn
*Camelus dromerdarius**	One-humped camel	LC	Int		Si, Sn, Re				Si, Re
Canis lupus dingo	Dingo	LC		LSNR	Si	Gi-1, Sn		Si, Fi, An	Si
Dasycercus sp.	Mulgara	D. blythii = Vu D.cristicauda = Vu	D.cristicauda = Vu			Sn			
*Equus asinus**	Donkey	LC	Int		Re	Sn		Re	Si, Re, Sn
*Felis catus**	Cat	LC	Int	LSNR	Si	Sn		Si, An	Si, Fi
Leporillus apicalis#	Lesser stick-nest rat	Ex	Ex			Sn			
*Mus musculus**	House mouse	LC	Int			Sn	Sn, An	Fi	An

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Notomys alexis	Spinifex hopping mouse	LC			Sn				An, Si
notoryctes typhlops	Southern marsupial mole	Vu							
*Oryctolagus cuniculus**	Rabbit	LC	Int			Sn		Fi, An, Re	Cn, Sn
Osphranter robustus	Euro	LC		LSNR		Sn		Sn	Si, Cn
Osphranter rufus	Red kangaroo	LC		LSNR	Si	Sn, Gi-1	An	Re, Si, Fi, An, Cn, Re	Cn, Sn, An, Sn
Pseudantechinus macdonnellensis	Fat-tailed false antechinus	LC				Ru			
Pseudomys hermannsburgensis	Sandy inland mouse	LC				Si, Sn, Fi	Si, Sn		
Sminthopsis crassicaudata	Fat tailed dunnart	LC							Cn
Sminthopsis youngsoni	Lesser hairy-footed dunnart	LC				Ru			
Tachyglossus aculeatus	Echidna	LC			Si, Re	Sn			
*Vulpes vulpes**	Fox	Int		LSNR	Si	Sn			Cn, Fi, Sn
	Mouse sp.	LC						Cn, An	Si, An
Chalinolobus morio	Chocolate wattled bat	LC			LSNR	LSNR			
Austronomus australis	White striped free tailed bat	LC			LSNR				
Chalinolobus gouldii	Gould's wattled bat	LC			LSNR	LSNR			
Mormopterus sp.	Free tailed bat sp	LC				LSNR			
Nyctophilus geoffroyi	Lesser long-eared bat	LC			LSNR	LSNR			
Scotorepens balstoni	Western broad-nosed bat	LC			LSNR	LSNR			
Scotorepens greyii	Little broad-nosed bat	LC			LSNR	LSNR			

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Taphozous hilli	Hill's sheath-tailed bat	LC				LSNR			
Vespadelus baverstocki	Inland forest bat	LC			LSNR	LSNR			
Vespadelus finlaysoni	Finlayson's cave bat	LC			LSNR				
Reptilia									
Carlia triancantha	Desert rainbow-skink	LC				Sn			
Ctenophorus isolepis	Military dragon	LC		Si	Si		Sn		Si
Ctenophorus nuchalis	Central netted dragon	LC			Re	Si	Cn, An	Re, Sn	Cn, Sn
Ctenotus leonhardii	Leonhard's ctenotus	LC					Cn, Sn, An		
Ctenotus pantherinus ocelifer	Leopard ctenotus	LC				Sn	Sn		
Ctenotus quattuordecimlineatus	Fourteen-lined skink	LC			Si				
Ctenotus schomburgkii	Schomburk's ctenotus	LC				Sn			
Ctenotus sp.	Ctenotus				Si		Cn	Re	Sn
Delma nasuta	Sharp-snouted delma	LC			Si				
Demansia psammophis	Yellow-faced whip snake	LC					Fi	Cn	
Diplodactylus conspicillatus	Fat-tailed gecko	LC		Si				Si, Sn, Cn	LSNR
Diplodactylus stenodactylus	Sandplain gecko	LC		LSNR					An
Diporiphora winneckei	Canegrass dragon	LC					Si		An, Re
Furina ornata	Orange-naped snake	LC							Sn
Gehyra purpurascens	Purplish dtella	LC			Re				
Gehyra variegata	Tree dtella	LC					Fi, An	Si	
Lerista bipes	Two-toed slider	LC		Si			Fi	Sn	Sn
Lerista sp.	Lerista				Sn				
Morethia ruficauda	Red-tailed snake-eyed skink	LC					An		
Nephrurus levis	Knob-tailed gecko	LC					Sn		

Scientific name	Common name	Status		Oct-12	Sep-13	Jun-15	Oct-15	Nov-16	Apr-16
		TPWC	EPBC						
Pogona vitticeps	Central bearded dragon	LC		LSNR	Si	Sn			LSNR
Strophurus ciliaris	Northern spiny-tailed gecko	LC		Si					
Tiliqua multifasciata	Centralian blue-tongue	LC			Si				
Varanus brevicauda	Short tailed monitor	LC					Si, Sn		
Varanus giganteus	Perentie	LC			Si		Si	Sn, Fi, Cn, An	An
Varanus gouldii	Gould's sand monitor	LC		Si					Si, Cn, An
Varanus sp.	Goanna				Si	Sn		Sn, An, Cn, Re, Si	Sn, An, Re, Si
	Dragon					Sn	An	Sn, Cn	An, Fi, Re, Sn
	Gecko				Si, Sn	Gi-1		Sn, Si, Fi, Cn	
	Legless lizard							Si, Sn, Re	
	Lizard				Si, Sn	Sn		Si, Sn, Cn, An	Fi, Si, Sn
	Snake				Si			Si, Fi	Si

Appendix 4

Draft Bushfire Management Plan

For

TELLUS

Tellus Holdings Ltd

Chandler Project

Prepared by: Low Ecological Service

September 2016

Low Ecological Services P/L

PO Box 3130, Alice Springs, NT 0871

Ph: (08) 89 555 222 Fax: (08) 89 555 722

Email: lowecol@lowecol.com.au

Frontispiece: Top: rocky hill overlooking the sandplain at the Chandler Facility Site, Bottom (left to right): *Crotalaria eremaea* (bluebush pea), *Varanus gouldii* (sand goanna) and *Solanum ellipticum* (bush tomato).

DISCLAIMER

ACKNOWLEDGEMENTS

LES acknowledges the assistance of Sophy Townsend and Richie Phillips of Tellus, Central Land Council Santa Teresa rangers (Shannon, Petria, Bronwyn, Norbert, Gibson and Charlie) and Central Arrernte people, Marilyn Kenny, Peter Kenny and Dennis Kenny, from Walkabout Bore (60km NNW of Halfway Dam) for their assistance in developing this BFMP.

DOCUMENT DETAILS

Document Number:	TCH-5-30-20-10-DR-LES-BFMP-vA_FinalDraft
Name of Document:	Bushfire Management Plan (BFMP)
Authors:	Jeremy Snowdon-James and Katie Degnian
Client:	Tellus Holdings Ltd
Name of Project:	Chandler Salt Mine

DOCUMENT CONTROL

Approvals	Name	Signature	Date
Originator:	Low Ecological Services		
Reviewer:	Tellus Holdings Ltd	×	
Administrator:	Tellus Holdings Ltd	×	
Approver:	Dep't of Mines and Energy	×	
Custodian:	Tellus Holdings Ltd	×	

PREFACE

This preliminary document will remain a working document until it is finalised as an operational document and can be used as such by operators in the field.

The final version will incorporate any comments or recommendations resulting from any government approval processes; it is not anticipated that any major changes to the document will be required.

All information on proposed operations contained in this document has been supplied by Tellus.

EXECUTIVE SUMMARY

This draft Bushfire Management Plan (BFMP) has been developed to identify potential bushfire hazards and risks at the Proposal and provide mitigation measures and implementation strategies to reduce these risks. For determination of high bushfire risk areas at the Proposal the following environmental factors have been considered:

- Climate:
  - Rainfall;
  - Wind;
  - Humidity; and
  - Temperature.
- Topography
- Vegetation type and density.

From desktop GIS mapping analysis and on-ground truthing a bushfire risk map was created. This map rates the environmental risk for bushfires into three risk categories:

1. Low – Moderate;
2. Low; and
3. Very Low.

The vegetation and land systems present at the Proposal area have a low overall fire risk. Only following periods of productive growing conditions (rainfall and warm weather) will grass and shrub density increase the fire risk above these levels. In most cases a hot windy fire will be needed to create a bushfire of significant spread and intensity to cause potential damage to human life, infrastructure or the environment.

Fire scar mapping from the North Australian Fire Information website (North Australia Fire Information, 2016) indicated records of one fire affecting the Proposal area in the last 16 years. This fire occurred in the late dry season of 2011, which followed two years of above average rainfall (Australian Government, 2016). This gives an approximate fire frequency at the Proposal area of 1 in 15 years, and emphasises that the highest risk of bushfires will be following prolonged favourable vegetation growing conditions.

The one Low – Moderate fire risk area is in the Finke land system, this is due to the presence of buffel grass along the Finke River system. It is important to note that most the Finke River will have a Low fire risk, with only patches dominated by buffel grass having a Low - Moderate fire risk.

This bushfire risk map will be updated annually and reflect:

- Any incidents or bushfires in the year previous;
- Results of bushfire fuel load assessments;
- Infrastructure changes or new locations of potential ignition sources;
- Indication of any new fire breaks; and
- Any back or patch burning activities conducted.

This map will be used to effectively apply the mitigation measures proposed to reduce the identified bushfire risks for the Proposal. The key mitigation measures proposed by this draft BFMP are:

- Implement and update a bushfire risk map annually;
- Conduct annual bushfire fuel load assessments following the method prescribed in this BFMP;
- Consult with surrounding pastoralist, land managers, traditional owners and the Central Land Council to plan back and/or patch burning activities;
- Conduct back and/or patch burning based on stakeholder consultation and results of bushfire fuel load assessment;
- Develop and maintain fire breaks of at least 4 m width (*Bushfires Act)* around all infrastructure and facilities; and
- Keep up to date with the latest fire ban, climatic conditions or bushfires warnings from internet and government sources as provided in this BFMP.

Bushfire risk areas are determined in relation to the Proposal based on vegetation type and land systems. This draft bushfire management plan provides mitigation measures and control actions applicable across the whole of the Proposal site. Due to the changing environment and climatic conditions this draft BFMP will continually be reviewed and updated based on the most up to date and current survey information and bushfire risk assessment data.

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1. INTRODUCTION

1.1. Overview

Tellus Holdings Limited (Tellus) has requested Low Ecological Services (LES) to prepare this Bushfire Management Plan (BFMP) as a standalone document to accompany the Environmental Impact Statement (EIS) for the proposed Chandler Facility (the Proposal).

The Proposal is located approximately 120 km south of Alice Springs in the Northern Territory (NT). The Proposal involves the construction and operation of the following:

- A private access road from the Stuart Highway (Henbury Access Road) to the proposed Apirnta Facility;
- Private rail siding and temporary storage and transfer facility named the Apirnta Facility, adjacent to the Central Australian Railway;
- Private haul road (Chandler Haul Road) from the Apirnta Facility to the Chandler Facility; and
- A salt mine and dual business storage and isolation facility named the Chandler Facility.

This BFMP for the Proposal has been developed using best practise guidelines and knowledge from arid land ecology specialists with extensive experience in the Proposal area, and surveys with Aboriginal Traditional Owners (TOs), pastoralists, land managers and the Central Land Council (CLC).

The BFMP consists of:

- A description of the local environment and climatic conditions;
- A bushfire risk assessment within the Proposal area;
- Mitigation and preventative measures to reduce bushfire risks;
- Delegation of roles and responsibilities;
- Key activities in response to bushfires;
- A plan for the continual monitoring and assessment of bushfire fuel load;
- Necessary distances for strategic fire breaks;
- Maintenance procedures for peripheral and strategic fire breaks;
- A plan for strategic fuel reduction burns in collaboration with TOs, pastoralists, land managers and the CLC; and
- A commitment for the continual review and improvement of this BFMP.

1.2. Objective

The objective of the BFMP is to manage and minimise key bushfire risks to (in order of importance):

- Protect human life;
- Protect assets to maintain capability before, during and after the passage of destructive bushfires;
- Minimise the environmental impact of bushfires, particularly impacts on biodiversity and species listed as threatened under the *Environmental Protection and Biodiversity Conservation* (EPBC) Act and *Territory Parks and Wildlife Conservation* (TPWC) Act;

- Provide for bushfire prevention and mitigation that is environmentally sustainable and cost effective, including co-operating with surrounding pastoral property management, TOs and the CLC; and
- Manage bushfire control and patch/back burning preventative programs as appropriate and necessary for the Proposal.

1.3. Scope

The scope of this draft BFMP is limited to bushfires associated with and/or impacting on the construction, operation, decommissioning and rehabilitation activities at the Proposal, including but not limited to the following facilities:

- The proposed Henbury Access Road from the Stuart Highway to the Apirnta Facility (approximately 60 km);
- The proposed Apirnta Facility;
- The proposed Chandler Haul Road from the Apirnta Facility to the proposed Chandler Facility (approximately 30 km); and
- The Chandler Facility:
    - Key underground infrastructure including: underground rock salt mine (with complementary storage business); mine access decline; and ventilation shafts. Products that would be stored include equipment, archives and waste materials (including hazardous and intractable waste).
    - Key aboveground infrastructure including: salt processing facilities; waste unloading area; waste storage warehouse; surface hydraulic backfill plant and underground reticulation; salt and overburden stockpiles; maintenance buildings; administration buildings; worker accommodation; solar/diesel hybrid power plant; clean and raw water dams; water and sewage treatment; fuel storage facility; utility reticulation; and possible technology recovery park.

2. LEGISLATION AND OTHER REGULATORY REQUIREMENTS

The key legislation and regulatory requirements applicable to the draft BFMP are:

- *Bushfires Act* 2014;
- Bushfire Regulations 2014;
- *Fire and Emergency Act* 2015; and
- Fire and Emergency Regulations 2011.

The *Bushfires* Act defines the legal responsibilities and requirements in relation to bushfires in the NT. The essential requirement of the *Act* is that bushfire control is the responsibility of the landholder.

3. FIRE INFORMATION AND ENVIRONMENTAL FACTORS

3.1. Fire Triangle

Fires require three elements to exist – fuel, oxygen and heat. Control or extinguishing fires is achieved by controlling or removing one or more of these elements.

3.1.1. **Fuel**

Fuel is classified as any combustible material; it is characterised by its:

- Type - Some sources are more flammable than others;
- Moisture content - Higher moisture content is less likely to burn;
- Size – Larger fuel particles, i.e. large logs, take longer to burn than smaller fuel particles, i.e. grasses;
- Quantity – Large quantities can produce more heat leading to higher intensity fires; and
- Arrangement – The distribution of fuel loads impacts the spread and intensity of fires, closely packed can limit oxygen but widely spaced may reduce connectivity.

3.1.2. **Oxygen**

Fire generally requires 16% oxygen to burn with air typically containing approximately 21% oxygen. Oxygen is required to support the chemical process of combustion which in turn produces heat, gasses and by-products like ash and smoke. An increase in oxygen will increase the intensity of the burn and aid in complete combustion.

3.1.3. **Heat**

Heat is defined as the initial energy source required to start a fire. Heat energy will initially remove the moisture content or other volatile components of the fuel source; this is why higher moisture content can reduce the available bushfire fuel load. Heat is required to maintain a fire and effectively transmit it to the next source. Once a fire is burning it can effectively heat the next fuel source through three main transfer pathways:

- Convection – Transfer of heat through air displacement, hot air rising carries heat away with cooler oxygen replaced at the base of the fire. This can lead to spot fires, as embers can be transported up and away by wind.
- Conduction – Transfer of heat through physical objects from areas of higher temperature to lower temperature.
- Radiation – Transfer of heat outside of any physical interaction, e.g. heat from the sun. It works by transferring heat through thermal radiation of particles; it requires no mass transfer or medium.

3.2. Fire Danger Ratings

The Fire Danger Rating is a standardised scale of fire danger likely to be experienced; it is derived from information provided to the fire authorities by the Bureau of Meteorology (BOM). The level is calculated by combining variables that will have an impact on the danger of a fire should it occur and the difficulty in putting it out. Table 3-1 explains each rating and the actions to be taken.

Table 3-1: Fire danger ratings from the Northern Territory fire and rescue service

Fire Danger Rating	Fire Danger Index	Fire Behaviour and Impact potential	Recommended Action
Catastrophic	100+	Fire will threaten without warning. It will be difficult to see, hear and breathe. Fires may be uncontrollable and fast moving. A significant amount of burning embers will be blown around and spot fires will start, often many kilometres ahead of the main fire. There is a strong likelihood that people unprepared may suffer serious, if not life threatening injury. Property in the path of the fire is likely to be destroyed. Even well prepared homes may not survive as house building standards do not require a dwelling to be constructed to withstand fire in excess of a fire danger index of 100, and many will be ignited by spot fires caused by burning embers. Expect wide scale power, telephone and water supply failure. **Do not expect a fire truck or firefighters to attend.**	**Ensure that your survival is the first priority in implementing your Bushfire Survival Plan in these conditions.** For maximum probability of survival, leaving early in the day of catastrophic conditions is the best option. It will not be safe to stay and defend even the best prepared property. Stay well informed of the current fire situation throughout a day of catastrophic fire danger by remaining tuned to local media on a battery powered radio.

Fire Danger Rating	Fire Danger Index	Fire Behaviour and Impact potential	Recommended Action
Extreme	75-99	Fire will threaten suddenly and it will be hot, windy and difficult to see, hear and breathe. Fires will be very difficult to control and fast moving. Burning embers will be blown around and start spot fires. There is a potential for property in the path of the fire, or impacted by ember attack to be lost, and people may suffer serious if not life threatening injury. Only very well prepared homes will be likely to offer any degree of safety. Expect power, telephone and water supply failure. **Do not expect a fire truck or firefighters to attend.**	**Ensure that your survival is the first priority in implementing your Bushfire Survival Plan in these conditions.** For maximum probability of survival, leaving early on a day of Extreme fire danger is the best option. If your Bushfire Survival Plan includes the decision to stay and defend, only do so if your home is prepared to the highest level and constructed to withstand bushfire, and you are physically able to do so. Stay well informed of the current fire situation throughout a day of catastrophic fire danger by remaining tuned to local media on a battery powered radio.
Severe	50-74	Fires can be difficult to control and will burn unpredictably. Embers will be blown around and it will be uncomfortable and dangerous to be out in the open. There is a potential for property in the path of the fire, or impacted by ember attack to be lost, and people may suffer serious if not life threatening injury. Only very well prepared homes and substantial, solid construction buildings will be likely to offer any degree of safety. Expect localised power, telephone and water supply failure. **Do not expect a fire truck or firefighters to attend.**	Ensure that your survival is the first priority in implementing your Bushfire Survival Plan in these conditions. For maximum probability of survival, leaving early is the best option. If your Bushfire Survival Plan includes the decision to stay and defend, only do so if your home is well prepared and constructed to withstand bushfire and you are physically able to do so. Stay well informed of the current fire situation throughout a day of Extreme fire danger by remaining tuned to local media on a battery powered radio.
Very High	25-49	Fires can be difficult to control. Embers may be blown around. Loss of property and injury is less likely, but significant damage could occur. Well prepared homes and substantial buildings can offer safe shelter. Some local infrastructure may be temporarily	Implement your Bushfire Survival Plan. Leaving early is the best option. If your Bushfire Survival Plan includes the decision to stay and defend, only do so if your home is well prepared and

Fire Danger Rating	Fire Danger Index	Fire Behaviour and Impact potential	Recommended Action
		unavailable.	constructed to withstand bushfire and you are physically able to do so. Stay well informed of the current fire situation Very High fire danger by remaining tuned to local media on a battery powered radio.
High	12-24	Fire can be controlled. Loss of property is unlikely but damage may occur. Well prepared homes and substantial buildings can offer safe shelter.	Stay well informed of the current fire situation throughout a day of High fire danger by remaining tuned to local media. Know how to get further information if required.
Low - Mod	0-11	Fire can be easily controlled. Little risk to life and property.	Stay well informed of the current fire situation throughout a day of Low-Moderate fire danger by remaining tuned to local media. Know how to get further information if required.

3.3. Fire Forecast and Updates

Fire tracking is an important part of the BFMP and effective risk mitigation. There are several internet based systems that provide details on tracking, forecasts, information on emergency notices and current weather conditions. Table 3-2 shows several internet-based sites that will be used to monitor bushfires for the Proposal.

Table 3-2: Fire tracking and warning internet sites

System	Website	Information	Monitoring
Bureau of Meteorology – Fire Forecast Map	http://www.bom.gov.au/nt/forecasts/fire-map.shtml	Fire forecast for the region on a daily basis.	As required
Bushfires NT – Alerts and Warnings Central Australia	https://nt.gov.au/emergency/cyclones/current-bushfire-alerts-and-warnings	Department of Environment and Natural Resources NT summary of bushfire alerts and warnings.	
ABC Website – Summary of Alerts and Warnings	http://www.abc.net.au/news/emergency/state/nt/	Official warnings will be issued through the ABC as and when released.	
North Australia Fire Information –	http://www.firenorth.org.au/nafi3/	Mapping of hotspots and fire scars in the area.	

System	Website	Information	Monitoring
Bushfire Map			
Secure NT – Bushfire Map	http://www.securent.nt.gov.au/	Bushfire tracking map.	

3.4. Climatic Contributions

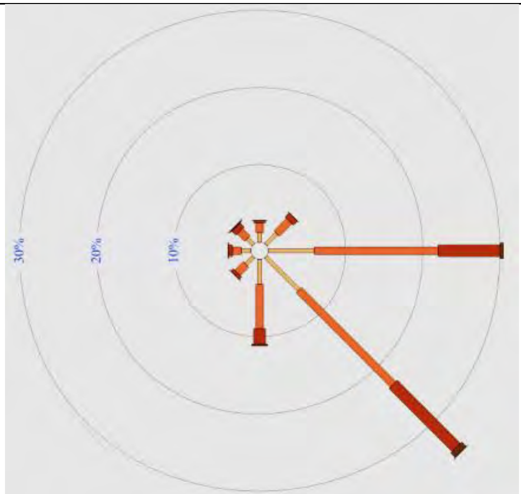
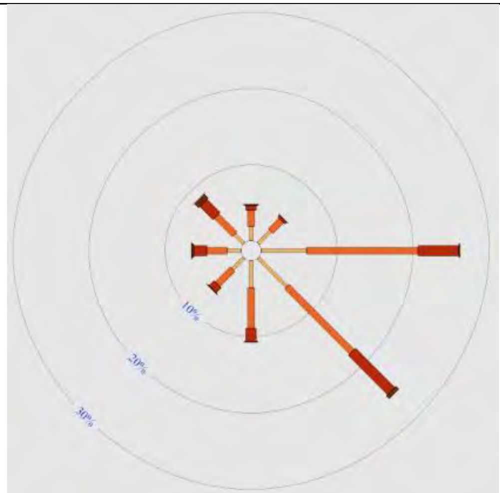
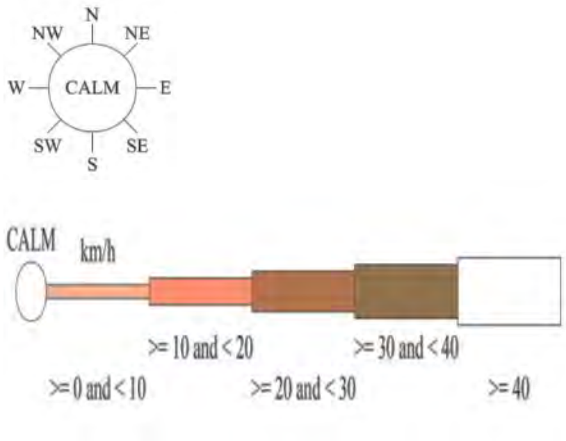
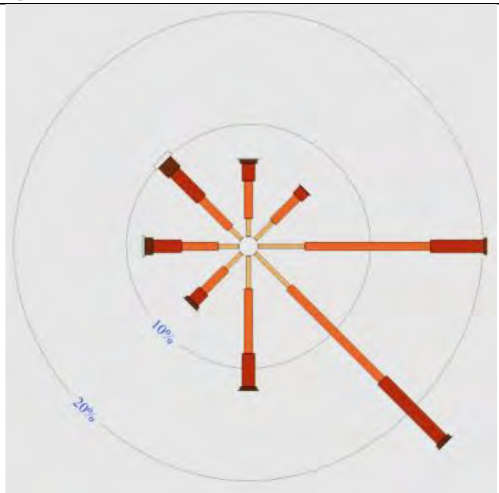
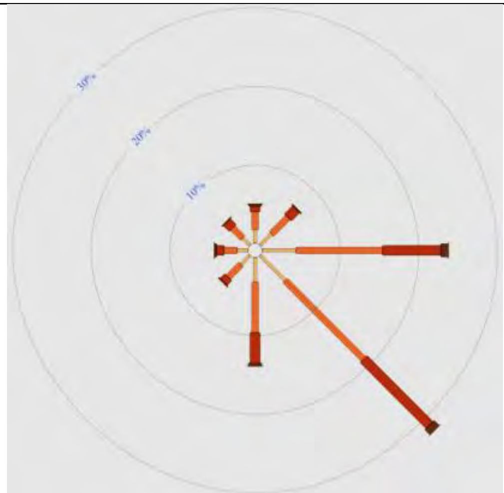
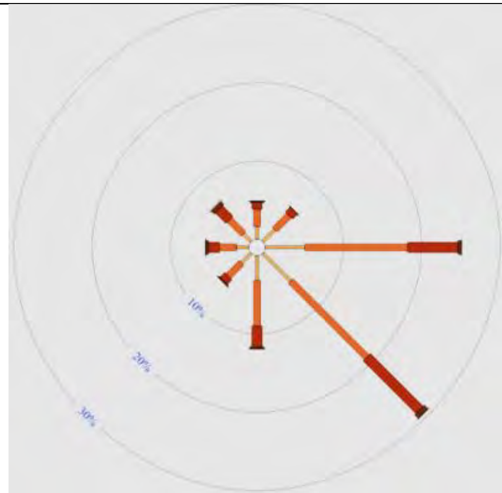
3.4.1. Wind

Wind influences the direction and speed of a bushfire. Wind supplies oxygen and can remove soot and ash from the flame; increasing its ability to burn. Wind can slant a bushfire front, carry embers causing spot fires and dictate the direction of the bushfire front. Unpredictable wind changes can occur during a bushfire which alter the direction of the bushfire front.

The dominant wind direction at the Proposal area is from the south east and is generally the strongest in autumn and summer with average wind speeds of 16 km/h, up to a maximum of 40 km/h (Australian Government, 2016). Wind rose diagrams for the Proposal area for each season are shown in Table 3-3. Wind rose diagrams have been taken from the Alice Springs Airport which is the closest reliable weather station of a comparable environment; it is located approximately 115 km to the north.

It is important to be aware that wind patterns follow a counter clockwise progression (varying around a week long periodicity), but are normally from high pressure systems that result in south west and east dominance of wind direction. However, during the spring and autumn equinoxes and during the unpredictable summer wet season, storms more commonly come from the west and north-west.

Table 3-3: Wind rose diagrams from Alice Springs Airport (BOM, 2016) used as reference for wind speed, direction and frequency for the Proposal area (Australian Government, 2016)

Autumn	**Winter**	**Key**
		
Spring	**Summer**	**Annual**
		

3.4.2. **Lightning**

BOM information for Alice Springs lightning strikes shows a high rate of lightning strikes during summer storms. Lightning caused fires are relatively common throughout the region and is a risk at the Proposal area.

3.4.3. **Temperature and Humidity**

The Proposal area experiences hot, dry and arid conditions most the year; with cool humid winters. Daily mean maximum temperatures in summer are above 35^{0}C, with mean minimum temperature of 18^{0}C. Winter mean maximums are below 23^{0}C, with minimums not above 10^{0}C (Australian Government, 2016). Information on temperatures is taken from the Alice Springs Airport which is the closest reliable weather station with temperature records of a comparable environment; it is located approximately 115 km to the north.

On average there is a 10-15% difference in humidity from 9am to 3pm throughout the year. The highest humidity is during winter where it can reach 64% (June) with the lowest 9am humidity at 30% (October to December) (Australian Government, 2016).

The highest risk time for bushfires is during periods of low humidity and high temperature. This is generally from October through to February within the Proposal area.

3.4.4. **Rainfall and Evaporation**

There are two weather stations with records of rainfall within proximity of the Proposal area; Maryvale, 20 km to the north east and Idracowra, 25 km to the south east (Table 3-4 and Table 3-5). The average rainfall for these two sites is 521 mm and 577 mm, respectively. Both sites receive the dominant proportion of the annual rainfall over the summer months, from December through to March (Australian Government, 2016).

This period also coincides with the highest evaporation. The Proposal area is within a region receiving on average 3,000 mm of evaporation per annum; with approximately 1,150 mm during the summer months (Australian Government, 2016).

Periods of high rainfall followed by hot dry conditions provide the ideal conditions for bushfires in this area.

Table 3-4: Maryvale weather records of monthly rainfall statistics (Australian Government, 2016)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	25.9	24.3	21.6	12.1	17.5	13.1	12.5	8.3	8.0	17.0	18.0	27.0	197.4
Lowest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	45.3
Highest	198.1	191.9	132.6	101.3	86.0	78.4	50.8	59.2	57.1	89.9	105.6	226.3	521.8

Table 3-5: Idracowra weather records of monthly rainfall statistics (Australian Government, 2016)

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean	25.4	26.1	20.6	13.9	16.7	12.8	12.0	7.9	7.6	15.8	19.4	25.4	196.1
Lowest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.3
Highest	214.3	281.5	153.8	101.0	174.9	74.2	201.0	71.0	54.8	119.5	158.0	159.7	577.3

Rainfall is important for determining if bushfires will occur, as when there is no rainfall there is limited vegetation growth. The summary of climate statistics from the Alice Springs Airport and fire risk based on this information is provided in Table 3-6.

Table 3-6: Climatic statistics for Alice Springs Airport (1954-2014) used as a basis for assessment of the bushfire risk for the Proposal area (Australian Government, 2016).

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature												
Mean maximum temperature (°C)	36.3	35.1	32.7	28.3	23.1	19.8	19.7	22.7	27.3	31.1	33.7	35.4
Mean minimum temperature (°C)	21.4	20.7	17.5	12.6	8.3	5.0	4.0	6.0	10.3	14.8	17.9	20.2
Rainfall												
Mean rainfall (mm)	40.7	43.0	31.2	17.2	18.9	13.3	15.3	8.8	8.1	20.5	28.4	37.9
9 am conditions												
Mean 9am relative humidity (%)	34	39	39	44	56	64	59	46	35	30	30	30
3 pm conditions												
Mean 3pm wind speed (km/h)	16.1	16.5	16.0	14.4	13.3	12.9	13.6	14.8	15.6	16.0	15.5	14.8
Bushfire Risk[1]												
-	High	High	High	Med	Med	Low	Low	Low	Med	High	High	High

[1]Bushfire risk rating is based on rainfall and humidity; low humidity coupled with high rainfall increases the bushfire risk.

3.4.5. **Vegetation Types and Quantity**

The Proposal area is dominated by undulating sand plains with tall shrublands of *Acacia aneura* (mulga) or *Acacia kempeana* (witchetty bush) with scattered *Allocasuarina decaisneana* (desert oak) over an understorey of short grasses, predominantly *Aristida* and *Enneapogon* species, but also *Triodia pungens and Triodia basedowii* (soft and hard Spinifex). Disturbance is limited to livestock grazing, past bushfires and *Cenchrus ciliaris* (buffel grass) invasion in disturbed sites and along creek lines. Vegetation is generally sparse and only after significant rainfall events does density increase.

3.5. Topographic Factors

3.5.1. General

Topographic features affecting the rate, spread, intensity and movement of bushfires:

1. Wind – Ridge lines or the top of hills can experience higher wind speeds than downslope sections;
2. Aspect – Northern and western facing slopes will generally burn faster due to lower moisture content of vegetation as these two slopes receive higher solar intensity annually; and
3. Slope – Fires will travel faster uphill than downhill.

3.5.2. Specific to the Proposal

All facilities constructed at the Proposal will be on flat to gently undulating topography, therefor the impact of topographic features on the bushfire impacts at the Proposal will be minimal to non-existent for infrastructure. It is important to understand these characteristics of bushfire in the case of an emergency.

All slopes and hillsides in the area generally have a low bushfire risk due to vegetation type and sparse density. They are generally dominated by saltbushes that have a low fire carrying capacity.

3.6. Past Bushfire History

Mapping obtained from the North Australia Fire Information website (North Australia Fire Information, 2016) shows fire scarring in the Proposal area in 2011 from late dry season fires. A site visit by LES in October 2012 noted signs of past fire at most survey sites; however only two out of the seven sites surveyed appeared to have been burnt within the last two years. Similar results were found on all subsequent surveys at the Proposal.

Figure 4-1 and 4-2 show areas that have been burnt since 2000 overlayed with the land systems. Figure 4-1 suggests that the Rumbalara land system, with higher topography, acts as a fire break for the area for the proposed Chandler Facility. It is believed that this, along with the proposed Chandler Haul Road (which will double as a fire break) will reduce the risk of bushfire coming from the south east, which due to wind direction is a higher risk area.

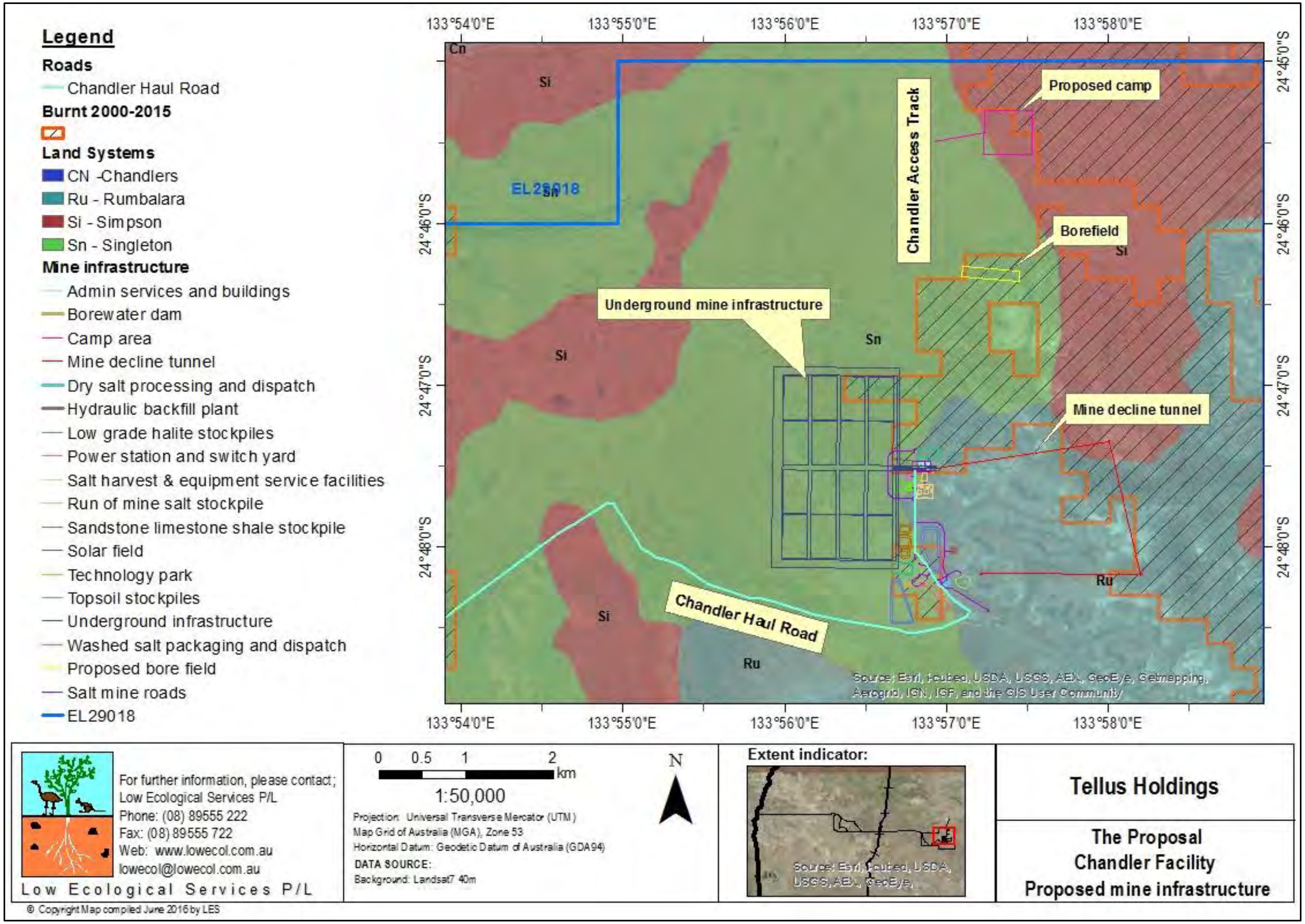


Figure 3-1 Map of the Chandler Facility with land units and fire history

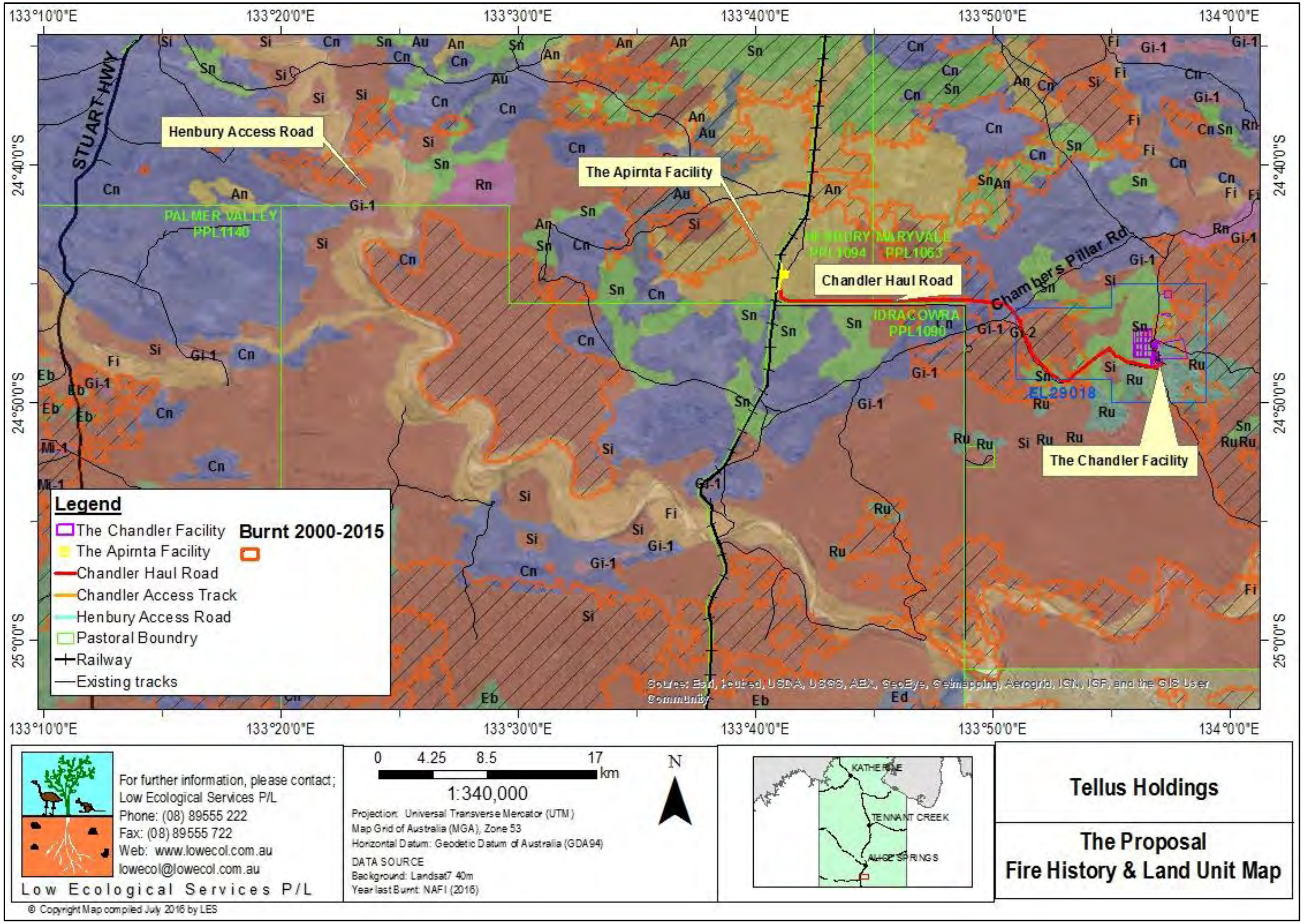


Figure 3-2 Map of the Proposal area with land systems and fire history

4. BUSHFIRE RISK ASSESSMENT

4.1. Key Definitions

Key definitions relating to bushfire risk management are provided in Table 4-1.

Table 4-1: Key definitions relating to bushfire risk management

Key Definitions	
Incident Event	An event capable of causing critical, major, moderate, minor or negligible damage.
Hazard	A physical situation with the potential to start a bushfire impacting human health, damage to property, environmental assets or some combination of these.
Risk	The likelihood of a specified undesired event occurring within a specified period or in specified circumstances. It may be either a frequency (the number of specified events occurring in a time unit) or a probability (the probability of specified event following a prior event), depending upon circumstances.

4.2. Risk Assessment Methodology

This section describes the risk assessment for potential events that may impact the probability of a bushfire during construction and operational activities.

The purpose of this risk assessment is to identify potential bushfire hazards and develop risk-reducing measures to prevent and mitigate impacts from construction and operational activities. This assessment also outlines recommended management actions that help to reduce the risk to as low as reasonably possible (ALARP).

Risk assessment consists of five basic steps:

1. Hazard identification;
2. Risk analysis;
3. Risk evaluation;
4. Risk management; and
5. Residual risk analysis.

These steps are described briefly below.

4.2.1. **Hazard Identification**

Hazard identification involves identifying the sources of risk i.e. those activities or incidents that could result in a bushfire impact. Hazards are categorised into those arising from routine construction and operations, and those arising from incidents. Other hazards involve natural environmental aspects that may influence the occurrence and spread of a bushfire, including rainfall, humidity, topography, wind and vegetation density.

4.2.2. **Risk Analysis**

Risk analysis determines the likelihood of an activity or event occurring, and the consequences of that activity or event on bushfires. The risk ranking matrix, given in Appendix was used to assess the consequence and likelihood of all identified events. The matrix is based on six classifications of severity and six for the likelihood of a hazard.

4.2.3. **Risk Evaluation**

Risk evaluation prioritises the risks, that is, determining if the risk of an activity or incident is ALARP, or if management actions are required to reduce the risk to ALARP. The risk evaluation presented in Table 5-2 represent the residual risk with existing or planned safeguards in place.

4.2.4. **Risk Management**

Table 4-2 presents the detailed assessment of risks, impacts and their management for the Proposal. Sections 6 focus on the management measures and implementation plan Tellus will employ to minimise the environmental risks identified to ALARP.

4.2.5. **Residual Risk Analysis**

Residual risk is the risk rating once additional management measures have been implemented. This rating will be ALARP.

4.3. Bushfire Risk Assessment Table

The bushfire risk assessment for the Proposal is presented in Table 4-2 it considers the risk to areas based on current environmental consideration at site (vegetation type and density, wind direction and speeds, climate, rainfall and topographic features) and location of facilities at the Proposal This risk assessment will be utilised in the development of bushfire mitigation measures to be developed and implemented for the Proposal as outlined in Section 5 of this draft BFMP. It is also used in the development of the bushfire risk map which outlines areas of bushfire risk. This map is updated at least annually or more frequently if climatic conditions dictate, to represent current bushfire risk areas.

Table 4-2: Bushfire risk assessment for the Proposal

Hazard Identification			Risk Analysis			Prevention and Mitigation	Residual Risk Analysis		
Hazard	**Impacts and Receptors**	**Causes**	**S[1]**	**L[2]**	**Risk Rating**	**ALARP**	**S[1]**	**L[2]**	**Risk Rating**
Construction	People Assets Environment	• Hot works • Increased vehicles • Clearing and stockpiling vegetation • Increased ignition sources	6	3	18	• All hot works to have a permit and safety assessment in line with the appropriate Tellus policy. • Only diesel vehicles used onsite • No open flames unless permit approved • Vegetation stockpile in low mounds to reduce large fuel source • Vehicles checked and cleaned daily for build-up of grasses or vegetation around engine and undercarriage • All vehicles to be fitted with firefighting equipment • All vehicles fitted with spark arrestors • A permit obtained and the Minister informed not less than 48 hours before any planned back and/or patch burning activities performed	3	2	6
Operation	People Assets Environment	• Ignition sources • Use of flammable materials • Hot works • Increased vehicles • Increased use of Proposal area	6	3	18	• At least a 4 m fire break around all working areas • All hot works to have a permit and safety assessment in line with the appropriate Tellus policy. • No open flames outside of designated areas • Designated smoking area	3	2	6

Hazard Identification			Risk Analysis			Prevention and Mitigation	Residual Risk Analysis		
Hazard	**Impacts and Receptors**	**Causes**	**S[1]**	**L[2]**	**Risk Rating**	**ALARP**	**S[1]**	**L[2]**	**Risk Rating**
						• No wastes burnt onsite • Weather and bushfire conditions assessed daily from internet sites listed in Table 3-2 • All vehicles fitted with spark arrestors • A permit obtained and the Minister informed not less than 48 hours before any planned back and/or patch burning activities performed			
Open Flames	People Assets Environment	• Smoking • Cooking • Hot works	4	4	16	• Smoking only permitted in a designated smoking area. • All hot works to have a permit and safety assessment in line with the appropriate Tellus policy. • No hot works to be carried out next to flammable material or dense vegetation • Firefighting equipment to be readily available during hot works • Cooking with open flames to be conducted within designated area with sufficient firefighting equipment • Any gas stored onsite is to be clearly labelled and stored as per supplier's requirements	2	2	4
Hazardous Materials, Chemicals and	People Assets	• Flammable hazardous material stores	5	3	15	• Ensure all flammable material is stored within a bunded area away from any flame source	3	2	6

Hazard Identification			Risk Analysis			Prevention and Mitigation	Residual Risk Analysis		
Hazard	**Impacts and Receptors**	**Causes**	**S[1]**	**L[2]**	**Risk Rating**	**ALARP**	**S[1]**	**L[2]**	**Risk Rating**
Fuels	Environment	• Flammable chemicals • Flammable and volatile fuels				• Appropriate fire extinguishers and fighting equipment to be located next to flammable material • All staff trained in the use and location of appropriate firefighting equipment • If volatile fuels are required onsite they will have an individual risk assessment undertaken and stored in separate area with appropriate controls.			
Bushfire	People Assets Environment	• Natural event • Back and/or patch burning on adjacent properties • Deliberate fire lighting outside of the Proposal area	5	4	20	• Develop fire breaks at least 4 m wide and in sufficient locations around the Proposal to allow for access during bushfire control activities • Obtain a permit and engage with TOs, pastoralists, land managers and the CLC in routine back and/or patch burning to reduce fuel loads surrounding the Proposal; Minister to be informed not less than 48hours before burning to commence • All staff to be inducted into this BFMP • A dedicated bushfire response team of 3-5 staff members during construction and 2-3 during operations to be present on site at any one time. Teams to have rural bushfire management training • Strict no open flame policy within the Proposal area	2	3	6

Hazard Identification			Risk Analysis			Prevention and Mitigation	Residual Risk Analysis		
Hazard	**Impacts and Receptors**	**Causes**	**S[1]**	**L[2]**	**Risk Rating**	**ALARP**	**S[1]**	**L[2]**	**Risk Rating**
						• Designated smoking area • Liaise with local TOs, CLC, land managers and pastoralists in back and/or patch burning planning • Use of fire tracking websites to monitor and inform bushfire management actions • If the bushfire is beyond control, then a bushfire warden or control officer will be notified and all surrounding land owners and managers of the area which the fire is likely to spread will be notified.			
Third Party Access	People Assets Environment	• Increase in ignition sources • Open flames outside of designated areas • Unapproved back and/or patch burning	4	4	16	• Liaise with local TOs, CLC, land managers and pastoralists in back and/or patch burning operation planning • Inform local TOs, CLC, land managers and pastoralists on the boundaries of the Proposal area and no open flame policy • All visitors must sign in and undergo visitor site induction • All visitors must be accompanied by a site representative • Visitors must not deviate from formal access routes.	2	2	4

[1] – Severity

[2] – Likelihood

[3] – *Bushfires Act*

Risk assessment conducted by Low Ecological Services in conjunction with Tellus Holdings Pty Ltd.

4.4. Bushfire Risk Specific to Facility

4.4.1. **Chandler Facility**

The Chandler Facility is surrounded by Low to Very Low bushfire risk vegetation and land system types as shown in Figure 4-1. Only under several years of good growing conditions (sufficient rainfall and appropriate temperatures) will the vegetation pose a significant risk to cause a bushfire with potential to impact on his facility. The facility is blocked from the dominate wind direction by a very Low bushfire risk area, which further reduces its susceptibility to bushfires.

4.4.2. **Apirnta Facility**

The Apirnta facility is surrounded by a Low bushfire risk environment (Figure 4-1). There is potential for this area to be upgraded to a Low - Moderate bushfire risk area following good vegetation growth and favourable bushfire conditions, i.e. high wind and low humidity. Patch burning will be the most effective mitigation and preventative measure for this area.

4.4.3. **Chandler Haul Road**

The Chandler Haul Road crosses sections of Low to Very Low bushfire risk areas (Figure 4-1). The road itself will act as an effective fire break for low intensity fires with light winds. If mitigation measures prescribed in the BFMP are followed, the long-term risk of bushfires affecting the Chandler Haul Road is Low.

4.4.4. **Maryvale Access Road**

The Maryvale Access Road crosses the only area identified as having a Low – Moderate bushfire risk (Figure 4-1). This is along the Finke River and is due to the presence of buffel grass along several sections of the River. If buffel grass management and other mitigation measures prescribed in Section 6 of the BFMP are followed then the risk of bushfire to the Maryvale access road will be Low.

4.4.5. **Chandler Access Road**

The Chandler Access Road crosses sections of Low to Very Low bushfire risk areas (Figure 4-1). The road itself will act as an effective fire break to low intensity fires with light winds. If mitigation measures prescribed in the BFMP are followed, the long-term risk of bushfires affecting the Chandler Access Road is Low.

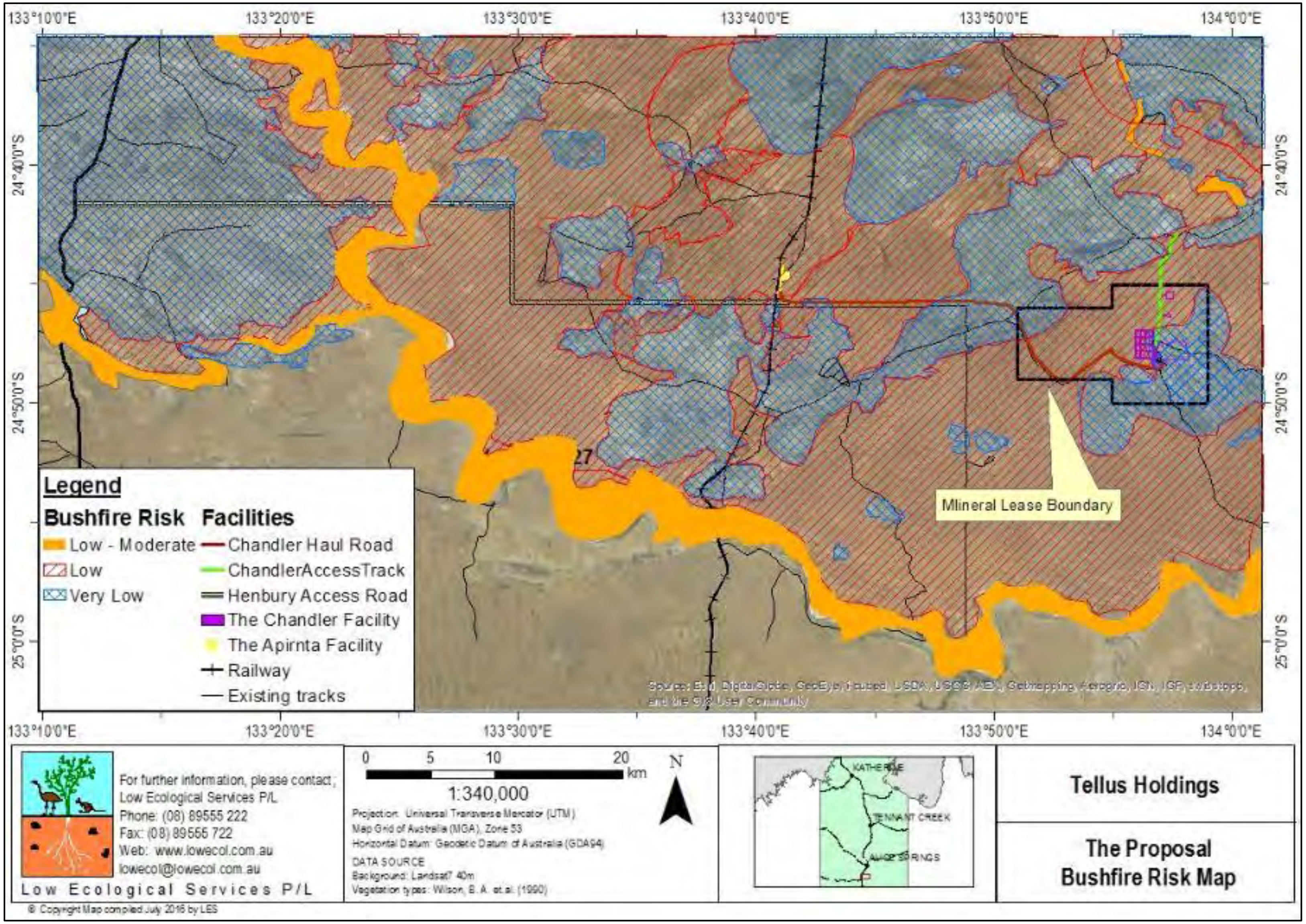


Figure 4-1: Bushfire risk map showing bushfire risk areas based on vegetation types and land systems for the Proposal area.

5. BUSHFIRE CONTROL ACTIONS

Rural bushfire management is broken into four distinct facets:

- Prevention – Measures taken to reduce the possibility of bushfires occurring;
- Mitigation – Measures taken to minimise the impacts of bushfires;
- Suppression – Response measures to contain and ultimately extinguish bushfires; and
- Habitat management – Maintain biodiversity, surface cover and aesthetic values.

The following methods for bushfire control have been adapted from the Bushfire NT Firefighting course and the Basic Wildfire Awareness Guidance, ACT Fire and Rescue Community Fire Units Leaners Guide (2011).

5.1. Prevention

As a part of this BFMP it is recommended that bushfire fuel load assessments (see Appendix and Appendix) are conducted annually to assess bushfire potential and need for pro-active controls, e.g. back and/or patch burning. The timing of this is recommended in August or September. *C. ciliaris* and other grasses including spinifex are a concern for the spread and intensity of bushfires and, as such, are key species in bushfire fuel load assessment. Spinifex will require 3-4 years after being burnt to be of concern for bushfire risk again. Saltbushes have a low bushfire carrying capacity and are dominant over a large proportion of the site

All survey lines/areas, vegetation densities and high bushfire fuel load areas will be identified and recorded with global positioning system (GPS) coordinates. Additional locations of interest (such as flora and fauna of conservation significance and habitat) will be determined by associated flora and fauna surveys and additional important sites will also be recorded and identified. This information will be mapped using GIS mapping and form a key part of the BFMP.

The assessment method for bushfire fuel loads is based on The Overall Fuel Hazard Guide for South Australia (2012). This is to be implemented at designated observation points across the Proposal area. This assessment technique is based on the visual assessment of *C. ciliaris,* native grasses and forbs, woody shrubs and trees. It is a risk rating based assessment and is described in Table 5-1 Additional assessment of bushfire fuel loads will be recorded opportunistically on a data sheet like that in Appendix.

The result from annual and opportunistic bushfire fuel load assessments will be used to develop bush fire management strategies and update this draft BFMP and the bushfire risk map. The annual survey results will be available in the site manager’s office for emergency referral.

Table 5-1: Criteria for visual inspection of bushfire fuel load risk assessment (Department of the Environment and Natural Resources, 2011)

Overall Fire Risk	Criteria
1	Virtually no risk of fire spread. Little Buffel grass and forbs with sparse shrubs.
2	Slight risk of a fire spreading, but only under extreme conditions. Existing fuel is patchy and discontinuous.
3	Risk of fire spreading under extreme conditions. Small but continuous Buffel tussocks.
4	Area able to support the spread of a low or medium intesity fire under favourable conditions. Contiuous fuel load with consisting of shrubs and/or Buffel.
5	Area will burn readily under most conditions

Grasses and Forbs	Criteria
1	Sparse. Not sufficient to carry fire
2	Scattered. Sufficient to carry a fire in high wind.
3	Dense. Sufficient to carry a fire between Buffel tussocks or shrubs.

Buffel Grass	Criteria
1	Sparse. Not sufficient to carry fire
2	Scattered. Sufficient to carry a fire in high wind.
3	Dense. Sufficient to sustain a fire under most conditions.

Trees and woody shrubs	Criteria
1	Not present
2	Sparse to scattered. Not sufficient to support a fire.
3	Dense. Sufficient to sustain a fire under most conditions.

5.2. Mitigation

Table 5-2 details mitigation and management measures to control the spread, development and severity of bushfires within the Proposal area. This BFMP should be read in conjunction with the Biodiversity Management Plan, Waste Management Plan, Water Management Plan and Hazardous Material Management Plan.

Table 5-2: Mitigation, implementation, responsibility, reporting and auditable criteria and measures for bushfire control within the Proposal area during construction and operation

Mitigation Measure	Effectiveness	Responsible	Reporting	Audit
Bushfire risk map – highlighting risk areas for bushfires and potential direction of approach. This map is to be updated annually or following significant rainfall periods with results of	High	Site Manager	At least annually or more frequently if required	Map showing latest update of bushfire risk and reference to bushfire fuel load assessment

Mitigation Measure	Effectiveness	Responsible	Reporting	Audit
bushfire fuel load assessment surveys				
All staff inducted into this BFMP, the Emergency Response Plan (ERP) and other management plans associated with bushfire management	Moderate	Site Manager	Annual Report	Annual report showing details of all completed inductions
Firebreaks developed around all assets and strategically to most effectively stop or slow incoming bushfires	High	Construction Manager	End of construction	All firebreaks are at least 4 m (*Bushfire Act)* wide, surrounding all assets, locations.
Firebreaks maintained and cleared of vegetation to at least 10 cm in height	High	Construction and Site Manager	End of construction report, then annually	Records of work completed and all fire breaks with vegetation below 10 cm
Appropriate signage and Safety Data sheets (SDS) near hazardous and flammable material stores around site	Moderate	Construction Manager	Annual Report	Signage at all hazardous and flammable material stores
Firefighting equipment and fire extinguisher onsite	High	Construction Manager	Annual Report	Location map and fire extinguishers present on site
Fire extinguishers maintained and inspected every 6 months	High	Site Manager	6 months	Records show inspection every 6 months
ERP clearly displayed	Moderate	Emergency Response Officer	Annual Report	Annually audit to inspect plans and muster points
A dedicated bushfire response team of 3-5 staff members during construction and 2-3 during operations to be present on site at any one time trained in bushfire fighting by NT or state/territory equivalent	Moderate	Site and Construction Manager	Annual Report	Records show 100% satisfactory completion by all staff
Fire drills conducted	Moderate	Site Manager	Annual Report	Annual report shows fire drills conducted regularly
Open flames or ignition sources prohibited within 20 m of flammable material	High	Site Manager	Annual Report	Signage marking no open flame zones
Designated smoking area	Moderate	Construction Manager	Annual Report	Designated smoking zones clearly signed and designated no smoking zones clearly signed
Back and/or patch burning conducted as required in co-ordination with key stakeholders and following provision of permits: CLC; TO's;	High	Site Manager	Annual Report	Evidence of stakeholder engagement; records of back and/or patch burning work conducted and permits granted

Mitigation Measure	Effectiveness	Responsible	Reporting	Audit
Minister; and Surrounding pastoralists and land managers				
Vehicles inspected daily for build-up of vegetative matter in undercarriage and engine bay	Moderate	Site Manager	Daily	Records show daily checks and clean out of vehicles, as required
Monitor bushfires and climatic conditions through websites in Table 3-2	Moderate	Site Manager	Daily	Records show daily updates from bushfire advice websites and use during fire season
Any hot work requires a permit and a bushfire spotter if in areas next to flammable material	High	Site Manager	As required	Annual report shows indication of hot works permits approved
Enforce no open flames or hot works during designated fire bans	Moderate	Site Manager	As required	Records show evidence of enforcing fire bans
Incident report lodged for any fire	Low	Site Manager	As required	Annual report shows records of any fire incident reports
Annual BFMP compliance and performance review	Moderate	Site Manager	Annual Report	Audit of BFMP criteria and management measure
All vehicles to carry fire extinguisher and UHF radio	Moderate	Site Manager	During new vehicles fit out	Records of compliance with all vehicles or visual inspection

5.3. Suppression

If a bushfire is deemed to potentially impact the Proposal area, then bushfire suppression techniques will be activated. During construction, there will be a dedicated team of 3-5 staff at any one time present on site that will be adequately trained in the methods of bushfire management. During operation, the workforce on site will be reduced and the number of potential ignition sources also reduced, so the number personnel in the dedicated team can be reduced to 2-3 staff members.

5.3.1. Components of a Bushfire

A bushfire can be broken down into components to aid in on-ground co-ordination of control methods; these are described in Table 5-3 and displayed in Figure 5-1.

Table 5-3: Parts of a bushfire

Component	Description
Head	Is the part of the fire making the most progress, it will have the most intense and hottest fires and can also be called the fire front.
Flank	These are the sides of the fire between the front and the heel (rear). They are generally of lower intensity than the head and often described in direction, eastern flank, or location, left flank.
Fingers	Long slender sections of fire that extend beyond the head or flanks. Usual caused by variations in wind and fuel loads.
Heel	This is the rear of the fire, which is the lowest intensity part of the fire with the least spread. It is generally upwind or downslope of the head.
Spot Fire	Fires caused by wind transported embers, outside of the area of the main fire; usually in front of the head of the fire.

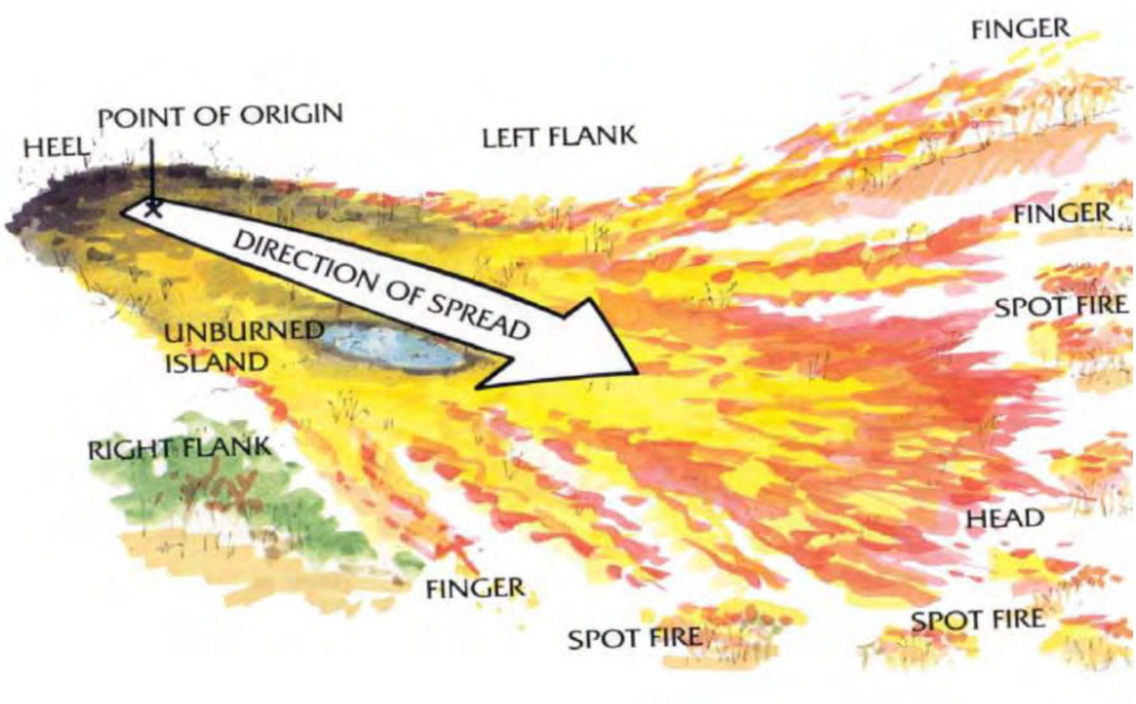


Figure 5-1: Graphic representation of components of a bushfire

5.3.2. Bushfire Control Approaches

The two main approaches to bushfire management are direct and indirect as detailed in Table 5-4.

Table 5-4: Bushfire management techniques as adapted for the Proposal area from the ACT Fire and Rescue, 2011 & Bushfires NT, 2016 references

Control Method	**Details**	
Direct Attack		
Head	Attacking the head of the fire either by developing a control line (clearing a line in front of the fire) or using fire retardants or water to extinguish the head of the flame. Only recommended for low intensity fires.	
Flank	Like head attack but work is done on the flanks of the bushfire, generally moving from the rear to the head to try and pinch the fire out. Useful if the fire is too intense to attack from the Head	
Parallel	Develop a control line a short distance ahead of the fire, useful when the fire is too intense to attack at close range. The attack line should be placed as close as possible to the main fire and if possible a second unit can burn out the fuel between the main fire and the control line	
Equipment	**Advantages**	**Disadvantages**
• Mechanical, e.g. bulldozers • Hand tools, e.g. shovels • Fire retardants, e.g. foam, chemicals, water • Source of fire, e.g. drip torches	• Less area burnt • Quickly contain the fire • Edges where fire extinguished can be turned into the control line	• Obstacles (e.g. fences) can impede on the control line • Limited to low intensity fires • Places firefighters in direct path or contact with the fire • Needs constant patrol of fire line • Irregular fire line constructed quickly
Indirect Attack		
Back and/or patch burning	A control line is established some distance from the head or flanks of the fire and the fuel in between is burnt out. This can be advantageous when the intensity is too great or the terrain makes it difficult to attack the fire at close range	
Equipment	**Advantages**	**Disadvantages**
• Mechanical, e.g. bulldozer • Hand tools, e.g. shovels • Source of fire, e.g. drip torch • Fire retardants, e.g. foam, chemicals, water	• Removes firefighters from direct contact with fires • Allows for strategic placement of control line • Allows more time and consideration in control of the fire • Choice of location for control line	• Increases size of fire • Allows for more intense fires to develop • Larger area to control • Back and/or patch burning may result in intense fires at intersection, potentially causing spotting outside of control lines • Need to monitor and patrol large line

5.3.3. Fire Control Equipment

A summary of the location and type of firefighting equipment available on the Proposal site is provided in Table 5-5.

Table 5-5: Summary of firefighting equipment on the Proposal site

Type	Location	Capacity
To be updated prior to commencement of activities at the Proposal, but to include as a minimum: • A dedicated bush fire trailer or utility with a 5,000L water tank and motorised water pump and hose; • Fire extinguishers appropriate to potential fire type – chemical, electrical etc.; and • Fire hoses around facilities		

A map of the location of firefighting equipment is shown in Figure 5-2.

To be provided after Proposal is constructed

Figure 5-2: Location map of firefighting equipment

5.4. Habitat Management

Through effective fire preventative and mitigation measures the biodiversity and potential habitat for species of conservation significance will be maintained. Several species of conservation significance identified as having moderate to high likelihood of occurrence in the Proposal area with high risk of fire impact include:

- Slater's Skink *Liopholis slateri slateri*
- Crest-tailed Mulgara *Dasycercus cristicauda*
- Great Desert Skink *Liopholis kintorei*
- Brush-tailed Mulgara *Dasycercus blythi*
- Thick-billed grasswren *Amytornis modestus indulkana*

All other species of conservation significance are also indirectly affected by bushfires through habitat and food loss. Of concern to increased fire severity and occurrence is the invasive species *C. ciliaris* (buffel grass). This species readily colonises disturbed areas after fires. It outcompetes native grasses and substantially increases the bushfire fuel load of the environment; resulting in hotter more intense fires. *C. ciliaris* has been identified during on-ground surveys within the Proposal area, although at present it is restricted to several localised populations.

Adequate fire management and mitigation measures as outlined in this BFMP and Weed Management Plan will ensure that the spread and introduction of *C. ciliaris* into new areas does not occur.

6. IMPLEMENTATION STRATEGY

6.1. Roles and Responsibilities

6.1.1. **Construction Manager**

It is the responsibility of the Construction Manager to ensure the following occurs during the construction phase of the Proposal:

- All staff are inducted and trained in this BFMP and ERP;
- Adequate firefighting equipment and staff trained in use on site;
- A dedicated team of 3-5 staff member during construction to be present on site at any one time accredited with bushfire management from the NT or state/territory equivalent;
- Placement of appropriate signage and firefighting equipment around flammable material stores;
- Issuing of hot work permits;
- Development of designated smoking area;
- Development and maintenance of fire breaks;
- Ensure fire extinguishers are maintained and tested every 6 months;
- Ensure vehicles are checked and cleaned daily of any vegetative build up;
- Ensure all vehicles are maintained in accordance with the manufacturers requirements;
- Check for regular updates with internet-based fire and climatic condition websites;
- Report any incident to Emergency Response Officer for further action;

- Ensure bushfire fuel load assessments conducted annually or more frequently if required;
- Consultation with TOs, pastoralists, land managers and the CLC to plan back and/or patch burning operations;
- Application and granting of a permit to conduct back and/or patch burning; and
- Notification to the Minister not less than 48 hours before any planned back and/or patch burning occurs.

6.1.2. Site Manager (or equivalent)

- All staff are inducted and trained in this BFMP and ERP;
- Maintenance and provision of firefighting equipment and staff trained in its use on site. This will include a dedicated bushfire trailer or utility with a 5,000L water tank and motorised water pump and hose;
- A dedicated team of 2-3 staff during operations to be present on site at any one time accredited with bushfire management from the NT or state/territory equivalent;
- Placement of appropriate signage and firefighting equipment around flammable material stores;
- Issuing of hot work permits;
- Development of designated smoking area;
- Maintenance of fire breaks;
- Ensure fire extinguishers are maintained and tested every 6 months;
- Ensure vehicles are checked and cleaned daily of any vegetative build up;
- Ensure all vehicles are maintained in accordance with the manufacturers requirements;
- Check for regular updates with internet-based bushfire and climatic condition websites;
- Ensure bushfire fuel load assessments conducted annually or more frequently if required;
- Consultation with TOs, pastoralists, land managers and the CLC to plan back and/or patch burning operations;
- Application and granting of a permit to conduct back and/or patch burning;
- Notification to the Minister not less than 48 hours before any planned back and/or patch burning occurs;
- Annual report;
- Incident reports;
- Stakeholder engagement;
- Annual BFMP compliance and performance audit;
- Vehicles fitted with fire extinguisher and UHF radio; and
- Report any incident to Emergency Response Officer for further action

6.1.3. Emergency Response Officer

- Develop emergency response plan;
- Designate emergency muster points;
- Responsible for co-ordinating emergency response;
- Audit and review emergency response plan;
- Update emergency response plan;

- Ensure emergency response drills are conducted regularly;
- Develop emergency response induction;
- Ensure adequate emergency evacuation maps and signage is adequately displayed;
- Co-ordinate with relevant government, Northern Territory Fire and Rescue Service (NTFRS), Country Fire Service (CFS) and other stakeholders in response to a bushfire or large fire event;
- Determine level of threat and appropriate action required; and
- Co-ordinate with Site or Construction Manager for staff response.

6.1.4. **Staff**

- Meet requirements of this BFMP;
- Have appropriate training for use of basic firefighting equipment;
- Aware of locations of all firefighting equipment and emergency procedures;
- Daily check of vehicles;
- Report any fire incident to Site Manager;
- Apply for hot work permits;
- Maintain fire breaks as directed by site or construction manager;
- Follow bushfire advice as given by Site Manager, Construction Manager or Emergency Response Officer;
- Smoking in designated smoking areas only; and
- No open flames outside of designated areas during high fire risk periods.

6.2. Training and Competency

A dedicated team of 3-5 staff member during construction and 2-3 during operations to be present on site at any one time will be appropriately trained in the management and control of bushfires by the NT bushfire unit or equivalent qualification from another state/territory. All staff will be familiar with and inducted into this BFMP. As part of the induction all staff will be made aware of the potential fire sources, bushfire risk map and location of control equipment available relevant to the Proposal.

Staff will be given cultural competency training to work effectively with TOs and CLC in bushfire management and mitigation measures.

7. REPORTING

7.1.1. **Routine Reporting**

An annual Bushfire Management Report will be compiled containing the following information:

- Any fire incidents or near misses;
- Any bushfire mitigation work conducted – back and/or patch burning, development of fire breaks or other;
- An assessment of bushfire fuel loads in the surrounding area, including GPS locations;
- Update of the bushfire risk map;

- Records of all staff inductions into this BFMP;
- Records of required staff in bushfire training with satisfactory completion;
- Fire equipment maintenance;
- Fire and emergency response drills;
- Fire break maintenance;
- Stakeholder engagement – CLC, pastoralists, land managers, TOs and other;
- Results of audits; and
- Review and update of the BFMP.

7.1.2. **Incident Reporting**

An incident report will be generated and submitted to the site manager who will then distribute the results to Bushfires NT, the ABC (broadcast updates), the Department of Environment and Natural Resources (DENR), the Department of Primary Industry and Resources (DPIR) and other affected stakeholders as soon as possible.

Bushfires NT, DENR and the DPIR will be notified immediately if there is a serious fire on site.

An incident report will typically include the following:

- Location of fire;
- Date and time fire noticed;
- Updated bushfire map including all past bushfire or fires at the Proposal;
- Cause or source of fire (if known);
- Mitigation and management response;
- Damages – personal, assets or environment;
- Recommendations for future fire management;
- Rehabilitation work; and
- Stakeholder engagement.

7.2. Stakeholder Engagement

Tellus will engage the following stakeholders to determine concerns and attain information and advice relating to bushfire risk and management in the Proposal area:

- Tellus representative responsible for fire safety;
- CFS and NTFRS representative/s;
- Adjacent landholders;
- TOs;
- CLC;
- Appropriate consultant with relevant experience; and
- Bushfires NT.

Tellus will engage with TOs, CLC, land managers and pastoralists in the planning of bushfire fuel load assessment surveys and controlled burn planning at the site. There will be ongoing management of firebreaks, ground fuel surveys and consultation on frequency and timing of controlled burning.

TOs, surrounding pastoralists and land managers, and when required, an appropriately experienced consultant, will be used to provide specialist advice and notified of any planned fire activities at the Proposal.

Concerns, information and advice resulting from stakeholder consultation and engagement will be incorporated in the annual review and audit of the BFMP.

There will be direct engagement of Aboriginal Rangers wherever possible in the ongoing development of the BFMP, particularly through participation in field surveys.

8. BUSHFIRE RESPONSE

Table 8-1 details the bushfire action response plan delegating responsibilities and required actions based on bushfire threat and occurrence. This plan will be annually reviewed and updated to improve the safety of all staff, assets and environmental values within the Proposal area. The information is derived with reference to the ACT Fire and Rescue (2011) community fire training manual and the national bushfire warning system alert levels.

Table 8-1: Bushfire action response plan for the Proposal

Responsibility	Situation			
	No fire: *Carry out maintenance and scheduled inspection requirements of this BFMP*	**Advice:** *Either inspection identifies specific local bushfire risk or advice is issued of potential bushfire risk in the area*	**Watch and Act:** *A bushfire is approaching. Action should be taken to protect life and assets*	**Emergency Warning:** *Unplanned fire or bushfire imminent. Immediate action required; prioritise human life.*
General Staff	• Maintain strict adherence to this BFMP • Maintain fire breaks • Assist with pre-bushfire season back and/or patch burning, as required	• Notify Site Manager of potential risk • Mitigate risk by all available methods without placing staff at risk	• Maintain safe distance from bushfire • Report to Emergency Response Officer and Construction Manager/Site Manager • Review location of bushfire fighting equipment, evacuation procedures and muster points	• If small fire, use available firefighting equipment and control fire • Report to Emergency Response Officer or Construction Manager/Site Manager; • If large fire, follow emergency response and evacuation plan • Follow instructions from Emergency Response Officer or

				Construction Manager/Site Manager
Construction/ Site Manager	• Organise maintenance of fire breaks, fire extinguishers, waters sources, firefighting equipment and staff training • Run emergency drills regularly • Co-ordinate back and /or patch burning • Inspection of site for bushfire fuel loads and fire risk • Co-ordinate bushfire fuel load assessments	• Follow advice on internet sources • Prepare for mitigation response • Respond to site specific hazard • Report on incident • Review ERP	• Follow bushfire on internet sources • Determine level of bushfire and potential risk to on site personnel through on-ground assessments • Prepare bushfire response team; • Review ERP and evacuation procedures • Actions need to be implemented to protect life and assets	• Assess bushfire on-ground and internet • Implement fire control techniques, if appropriate • Alert Bushfire NT, DENR, DPIR and appropriate stakeholders • Follow instructions from Emergency Response Officer
Emergency Response Officer	• Provide advice to site/construction manager as required; • Ensure emergency response plan in place • Liaise with site/construction manager to ensure emergency response drills conducted regularly • Ensure appropriate emergency muster points signage clearly displayed and intact.	• Provide advice to site/construction manager as required; • Review emergency response plan and • Ensure bushfire response team and equipment is on standby	• Provide advice to site/construction manager as required; • Engage emergency response plan; • Engage bushfire response team and equipment; • Assess and develop bushfire mitigation plan in consultation with internet sources and site/construction manager	• Assess bushfire on-ground and internet • Inform site/constructio n manager of appropriate emergency response plan; • Organise and manage dedicated bushfire response team

9. REVIEW AND AUDIT

There will be an annual review and audit of this BFMP. This information will be used to improve the BFMP for subsequent years and update the bushfire risk map. This BFMP is a constantly improving plan.

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11. APPENDICES

Appendix 1: Risk matrix

SEVERITY – Consequence of Harm / Loss		Low Risk | Moderate Risk | High Risk	Likelihood – Probability of Harm / Loss					
			1	2	3	4	5	6
		Environmental Impact	Unlikely/Unknown; Not expected to occur	Remote Potential; May occur only on exceptional circumstances	Possible; Could occur at some time	Probable; Expected to occur at some time	Frequent; Likely to occur regularly	Highly Likely/Ever present; occurs in most circumstances
	1	Alteration/disturbance within the limits of natural variability; effects not transmitted or accumulating; resources not impaired. Minimal pollution effect, contained locally.	1	2	3	4	5	6
	2	Temporary alteration/disturbance beyond natural variability; effects confined to site and not accumulating; resources temporarily affected. Minor pollution, slight or negligible impact, negligible remedial or recovery work. Short term, localised and insignificant impacts to habitat or populations. Rapid recovery – measured in hours.	2	4	6	8	10	12
	3	Alteration/disturbance of a component of an ecosystem; effects not transmitted or accumulating. Pollution with some onsite impact and recovery work; possible outside assistance to contain. Incidental changes to abundance/biomass of biota in affected area; insignificant changes to overall ecological function. Recovery period measured in days – months.	3	6	9	12	15	18
	4	Alterations to one or more ecosystems or component levels, but which are recoverable; effects can be transmitted/accumulating. Significant pollution with offsite impact and recovery work. Impact that will cause a detectable effect in local ecosystem factors. Recovery period measured in months.	4	8	12	16	20	24
	5	Irreversible alteration to one or more ecosystems or several component levels; effects can be transmitted, accumulating; lost sustainability of most resources. Massive site impact and recovery work. Detrimental effect that will cause a significant effect on local ecosystem factors. Recovery period measured in years.	5	10	15	20	25	30
	6	Irreversible alteration to one or more ecosystems or several component levels; effects can be transmitted, accumulating; lost sustainability of most resources. Massive pollution with significant recovery work. Large scale detrimental effect that is likely to cause a highly significant effect on local ecosystem factors such as water quality, nutrient flow, community structure and food webs, biodiversity, habitat availability and population structure. Long term recovery period measured in decades.	6	12	18	24	30	36

Appendix 2: a) Bushfire fuel load assessment data sheet for use to maintain up to date information during high risk bushfire periods (to be finalised once the Proposal is approved and final site layout is confirmed). Appendixa-f indicate potential regions for bushfire fuel load assessments; final regions, assessment sites and data sheet to be refined once the Proposal is approved and final site layout chosen. Criteria for assessing bushfire fuel hazard ratings and equivalent bushfire fuel loads in tonnes per hectare (t/ha); adapted from the *Overall Fuel Hazard Guide for South Australia, 2011* is provided in Appendix 3*.*

a) Bushfire load assessment data sheet

Site details			2017						2018					
Site	Easting	Northing	Fuel	Grass & Forbs	Buffel	Shrub & Trees	Overall Fire Hazard	Fuel (t/ha)	Fuel	Grass & Forbs	Buffel	Shrub & Trees	Overall Fire Hazard	Fuel (t/ha)

b) Bushfire fuel assessment sites located in the south-western region of The Proposal.

Property Region	Assessment Site	Overall Fuel Hazard Rating 2017[1]	Overall Fuel Hazard Rating 2018[1]	Overall Fuel Hazard Rating 2019[1]
South-western				
[1]L = Low, M = Moderate, H = High, VH = Very High, E = Extreme				

c) Bushfire fuel assessment sites located in the south-eastern region of The Proposal.

Property Region	Assessment Site	Overall Fuel Hazard Rating 2017[1]	Overall Fuel Hazard Rating 2018[1]	Overall Fuel Hazard Rating 2019[1]
South-eastern				
[1]L = Low, M = Moderate, H = High, VH = Very High, E = Extreme				

d) Bushfire fuel assessment sites located in the north-eastern region of The Proposal.

Property Region	Assessment Site	Overall Fuel Hazard Rating 2017[1]	Overall Fuel Hazard Rating 2018[1]	Overall Fuel Hazard Rating 2019[1]
North-eastern				
[1]L = Low, M = Moderate, H = High, VH = Very High, E = Extreme				

e) Bushfire fuel assessment sites located in the central region of The Proposal

Property Region	Assessment Site	Overall Fuel Hazard Rating 2017[1]	Overall Fuel Hazard Rating 2018[1]	Overall Fuel Hazard Rating 2019[1]
Central				
[1]L = Low, M = Moderate, H = High, VH = Very High, E = Extreme				

f) Bushfire fuel assessment sites located in the north-western region of The Proposal.

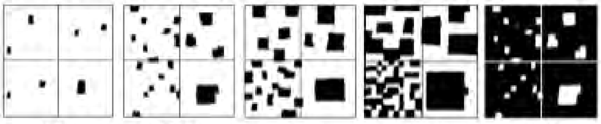
Property Region	**Assessment Site**	**Overall Fuel Hazard Rating 2016[1]**	**Overall Fuel Hazard Rating 2017[1]**	**Overall Fuel Hazard Rating 2018[1]**
North-western				
[1]L = Low, M = Moderate, H = High, VH = Very High, E = Extreme				

Appendix 3: Bushfire fuel hazard assessment guide

a) **This table will be used to perform the bushfire fuel load assessments at the Proposal. This table has been taken from the *Overall Fuel Hazard Guide for South Australia, 2011*.**

Assessing Surface Fuel Hazard					
Surface Fuel Hazard Rating	Low	Moderate	High	Very High	Extreme
Litter depth (mm)	<15	15 - <25	25 - <35	25 - <50	>50
Litter load (t/ha)	<4	4 - 8	8 - 12	12 - 20	>20
Litter cover (%)	<60	60 - 80	80 - 90	90 - 95	>95

Assessing Near-surface Fuel Hazard					
Near-surface Fuel Hazard Rating	Low	Moderate	High	Very High	Extreme
Tussock Grasses (eg. Buffel)	Near surface fuel absent or virtually absent.	10-20% cover Little or no suspended bark and leaves	20-40% cover >20% dead May have suspended bark and leaf material	30-60% cover >30% dead grass or leaf and bark litter	>60% cover >50% dead grass or leaf and bark litter
Hummock Grasses (eg. Spinifex)		10-20% cover	20-35% cover	40-60% cover	>60% cover
Low sedges/rushes		10-20% cover	20 -40% cover >20% dead	30-60% cover >30% dead grass or leaf and bark litter	>60% cover >50% dead grass or leaf and bark litter
Low shrubs		10-20% cover Little or no suspended bark, leaves or twigs	20-40% cover May have suspended bark, leaves or twigs	40-60% cover	>60% cover
Cover	<10% ground cover	Very large gaps between fuel patches. <20% dead material.	Gaps between fuel patches > fuel patches.	Fuel patches > gaps between fuel patches	Very small gaps between fuel patches



2% 10% 20% 50% 90%

Adjusted Surface Fuel Hazard					
Surface Hazard Rating	Near Surface Hazard Rating				
	L	M	H	VH	E
L	L	L	M	H	VH
M	M	M	H	VH	E
H	H	VH	VH	VH	E
VH	VH	VH	E	E	E
E	E	E	E	E	E

Adjusted Surface Fuel Hazard

Assessing Elevated Fuel Hazard					
Elevated Hazard Rating	Low	Moderate	High	Very High	Extreme
Description	Easy to walk through in any direction	Easy to walk through, but vegetation brushes against legs occasionally	Moderately easy to walk through, but brush against or step over vegetation most of the time	Difficult to walk through. Need to carefully select path and step high	Very difficult to see where you're going. Need to use arms to push through vegetation
% dead material	Virtually absent	<20%	<20%	20-30%	>30%
% fuel cover	<20%	20-30%	30-50%	50-80%	>80%

Assessing Bark Fuel Hazard					
Bark Hazard Rating	Low	Moderate	High	Very High	Extreme
Stringybarks	None present	None present	Few pieces of bark loosely held	Significant amounts of bark loosely held	Outer bark loosely attached, bark easily dislodged
Platy and subfibrous barks	None present	Very tight bark	Tight bark, long unburnt	Loose bark	Does not occur
Smooth (gum) barks	Entirely smooth bark	No long ribbons present	Long ribbons of bark, but smooth trunk	Long ribbons of bark to ground level	Does not occur

b) Criteria for assessing bushfire fuel hazard ratings and equivalent fuel loads in tonnes per hectare (t/ha); adapted from the *Overall Fuel Hazard Guide for South Australia, 2011*

Overall Fuel Hazard

Bark hazard: L/M						
Elevated Hazard Rating	Adjusted Surface Hazard Rating					
	L	M	H	VH	E	
L	L	M	M	H	H	Overall Fuel Hazard
M	L	M	M	H	H	
H	L	M	H	VH	VH	
VH	VH	VH	VH	VH	VH	
E	E	E	E	E	E	

Bark hazard: H						
Elevated Hazard Rating	Adjusted Surface Hazard Rating					
	L	M	H	VH	E	
L	L	M	H	H	H	Overall Fuel Hazard
M	L	M	H	H	H	
H	L	H	H	VH	VH	
VH	VH	VH	VH	VH	E	
E	E	E	E	E	E	

Bark hazard: VH/E						
Elevated Hazard Rating	Adjusted Surface Hazard Rating					
	L	M	H	VH	E	
L	L	VH	VH	VH	E	Overall Fuel Hazard
M	M	VH	VH	VH	E	
H	M	VH	E	E	E	
VH	E	E	E	E	E	
E	E	E	E	E	E	

Equivalent Fuel Loads (t/ha)[1] for Given Hazard Rating					
Fuel	Low	Moderate	High	Very High	Extreme
Bark	0	0	2	5	7
Surface[2]	2	5	10	16	20
Elevated	0	0	2	6	10

[1]Fuel Load = Bark + Surface + Elevated
[2]Adjusted for Near-surface fuel



Appendix 5

Draft Biting Insect Management Plan

For

Tellus Holdings Ltd

Chandler Projec

Prepared by: Low Ecological Services

January 2017

Low Ecological Services P/L

PO Box 3130, Alice Springs, NT 0871

Ph: (08) 89 555 222 Fax: (08) 89 555 722

Email: lowecol@lowecol.com.au

Frontispiece: Top: rocky hill overlooking the sandplain at the Chandler Facility Site, Bottom (left to right): *Crotalaria eremaea* (bluebush pea), *Varanus gouldii* (sand goanna) and *Solanum ellipticum* (bush tomato).

DISCLAIMER

ACKNOWLEDGEMENTS

LES acknowledges the assistance of Sophy Townsend and Richie Phillips of Tellus, Central Land Council Santa Teresa rangers (Shannon, Petria, Bronwyn, Norbert, Gibson and Charlie) and Central Arrernte people, Marilyn Kenny, Peter Kenny and Dennis Kenny, from Walkabout Bore (60km NNW of Halfway Dam) for their assistance in developing this BFMP.

DOCUMENT DETAILS

Document Number:	
Name of Document:	Biting Insect Management Plan
Authors:	Jeremy Snowdon-James and Katie Degnian
Client:	Tellus Holdings Ltd
Name of Project:	Chandler Salt Mine

DOCUMENT CONTROL

Approvals	Name	Signature	Date
Originator:	Low Ecological Services		
Reviewer:	Tellus Holdings Ltd	×	
Administrator:	Tellus Holdings Ltd	×	
Approver:	Dep't of Mines and Energy	×	
Custodian:	Tellus Holdings Ltd	×	

PREFACE

This preliminary document will remain a working document until it is finalised as an operational document and can be used as such by operators in the field.

The final version will incorporate any comments or recommendations resulting from any government approval processes; it is not anticipated that any major changes to the document will be required.

All information on proposed operations contained in this document has been supplied by Tellus.

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1. INTRODUCTION

1.1. Scope

The following Biting Insect Management Plan (BIMP) has been compiled to address Section 4.10.6 of the Terms of Reference for the Preparation of an Environmental Impact Statement – Chandler Salt Mine (the Terms of Reference or ToR) issued by the NT EPA in September 2016 under the EA Act. The plan outlines the existing environment with regards to biting insects, relevant legislation and policy, potential impacts of biting insets and necessary management and mitigation measures that would be implemented over the life of the Proposal to safeguard any potential adverse effects from biting insects.

1.2. Objective

The objective of the BIMP is to reduce the risk of harm or discomfort caused by biting insects to workers in the Proposal area and to decrease the potential for the spread of mosquito borne diseases in the area. This objective is to be achieved by preventing increased biting insect populations by reducing favourable breeding environments.

2. LEGISLATION AND OTHER REGULATORY REQUIREMENTS

The key legislation and regulatory requirements applicable to the draft BIMP are:

- *Work Health and Safety (National Uniform Legislation) Act* (NT);
- *Public Health Act* (NT);
- *Public and Environmental Health Act* (NT); and
- *Public Health (General Sanitation, Mosquito Prevention, Rat Exclusion and Prevention) Regulations* (NT).

3. EXISTING ENVIRONMENT

The presence of biting insects within the Proposal area is highly variable and dependent on favourable breeding conditions; rainfall with warm temperatures. The surface hydrology of the Proposal area consists of ephemeral watercourses, and a purpose built pastoral dam called Halfway Dam. Halfway Dam is the only permanent surface water source located in the region. Clay pans occur within the Proposal area, mostly on the downstream side of the proposed Chandler Haul Road and at various locations along the Henbury Access Road. There are no clay pans present within the proposed Chandler Facility, Apirnta Facility or Camp Site location.

There are two major ephemeral water courses surrounding the Proposal area, the Hugh River and Finke River. These are both greater than 20 km from the proposed Chandler Facility. Duck Swamp, located approximately 1 km north and east of the Henbury Access Road, and associated coolabah swamps and clay pans can retain surface water for hours or days depending on the duration of rainfall (i.e. storm event) and the volume of water received within the local catchment. The associated Coolabah swamp extends downstream across the Henbury Access Road. Surface water holes can be found for a small amount of time after rainfall in creek lines, drainage depressions, interdunal swales and clay pans. The site experiences evaporation rates more than 3 metres per annum while annual rainfall averages approximately 250 mm per annum, consequently water holes dry quickly during the summer.

There are records of several mosquito species within the Proposal area, some of which have the potential to cause discomfort and others that have the potential to carry disease (Table 2). Collection of mosquitoes in relation to spread of myxomatosis in rabbits on pastoral properties adjacent to the Proposal area in 1980 to 1983 by Low, Strong and Williams (1984) showed up to 17 species of mosquitoes on adjacent areas during warm parts of the year. Most of these species breed in holes in trees and do not prey on humans. Although not collected, biting mosquitoes were present during surveys of the Proposal area based in the Finke River by LES in 2015. An overview of common mosquitoes of the NT is provided in Appendix 1.

Ross River virus (RRV) and Murray Valley Encephalitis (MVE) are potential risks in the Proposal area for spread from mosquitos. The highest risk period for mosquito born disease at the Proposal area is during summer rainfall events, as they provide suitable breeding habitat for mosquitoes, increasing the risk of RRV and MVE during the summer months.

Table 2: Species of mosquitos potentially preying on humans likely to occur in the Proposal area (Whelan, 2010)

Common name	**Scientific name**	**Likelihood of occurrence in Alice Springs Area**	**Typical breeding places within the Alice Springs region**	**Disease potential**
Brown house mosquito	*Culex quinquefasciatus*	Likely - Found domestically in towns throughout the Northern Territory.	Septic tanks, stormwater drains, sumps, gully traps and any artificial receptacle holding water.	Low
Common banded mosquito	*Culex annulirostris*	Present in Finke River riparian zone in 2015 (LES) and likely widespread	Freshwater swamps, vegetated streams, storm water drains, grassy edges of sewage ponds, inundated low lying grassy areas. It has been found in brackish water, although is not usually found in areas exceeding one third salt water.	Vector of Murray Valley encephalitis virus in Australia, capable of carrying Kunjin virus, Ross River virus and Barmah Forest virus
Receptacle mosquito	*Aedes notoscriptus*	Infrequent	Holes in trees/stumps, rock pools, fallen palm fronds and rain filled receptacles.	Suspected vector of Ross River virus
Pale larvae mosquito	*Aedes tremulus*	Regularly recorded in Alice Springs	Holes in trees/stumps and artificial receptacles.	Not known to carry diseases in Australia
Salt water anopheles mosquito	*Anopheles hilli*	Highly unlikely, recorded once in Alice Springs	Brackish coastal swamps margins and flood plains.	Capable of carrying malaria – disease not present in NT
Common Australian anopheline	*Anopheles annulipes*	Found commonly in Ilparpa Swamp, Alice Springs	Temporary and permanent fresh water pools with grassy edges and artificial receptacles.	Capable of carrying malaria– disease not present in NT
The Northern Salt Marsh Mosquito	*Aedes vigilax*	Found rarely (usually following cyclonic or monsoonal weather systems in the Top End)	Sunlit brackish to salt water swamps and temporary pools.	Vector of Ross River and Barmah Forest virus

4. POTENTIAL IMPACTS

The Proposal has the potential to effect and possibly increase the mosquito population through development of favourable breeding environments. The creation of infrastructure such as surface water retention ponds, drainage swales, check dams and weirs can provide mosquito breeding environments. However, none of these would contain standing water for a sufficiently long time with the high evaporation rates experienced in the Proposal area except under exceptional climatic conditions. Artificial receptacles such as containers, tins, tyres or drums can also create favourable breeding environments after rainfall events. Water needs to be stagnant for at least five days to provide suitable conditions for mosquito breeding.

Any container coming from North Queensland that can pond water has the potential to introduce *Aedes aegypti*, which has drought resistant eggs and is a vector of the dengue virus. Therefore, increased traffic to the site has the potential to introduce new mosquito species as well as bring in people who may be carriers of arboviruses.

5. MITIGATION AND MANAGEMENT CONTROLS

Over the life of the Proposal, biting insects, including mosquitoes, are likely to affect personnel. The severity of the impact of biting insects depends on an individual's immunity, presence of disease, rainfall and weather events and the use of suitable Personal Protective Equipment (PPE). Personnel protection measures will be in accordance with the NT Government Department of Health *Personal Protection from Mosquitoes and Biting Insects in the NT*, provided in Appendix 2.

Biting insects are seasonal and of low risk for the Proposal area. Management of potential breeding sites through mitigation measures described in this BIMP can reduce these risks to acceptable levels throughout the life of the Proposal. Subject to approval, the control and management of potential breeding sites will be in accordance with the NT Government Department of Health *Guidelines for Preventing Mosquito Breeding Sites Associated with Mining Sites* (Appendix 3). The prevention of suitable breeding environments is considered the best method to control mosquito populations.

Biting insect mitigation measures derived from the guideline recommendations relative to the Proposal area are discussed in Table 3.

Table 3: Hazards potentially increase the risk of biting insects in the Proposal area, mitigation measures for each hazard and the effectiveness of each mitigation measure

Hazard	Mitigation Measure	Effectiveness
Dam	Half Way Dam adjacent to the Chandler Facility will be decommissioned and replaced for cattle watering several kilometres downwind. The dam will be constructed with relatively steep sides, which will prevent semi-aquatic vegetation and grass growth and minimise mosquito breeding habitat.	Moderate
Weirs	Erosion prevention structures must be in place to prevent scouring and siltation on creek lines during periods of overflow. They will slope downstream to avoid retaining water ponds.	Moderate
Drainage swales	Natural drainage patterns should be maintained where possible and roads across drainage lines may need culverts or creek bottom	High

Hazard	Mitigation Measure	Effectiveness
	crossings with erosion prevention structures. Evaporation during summer when mosquitoes are present will not persist for the 4 to 5 days required for mosquito life cycle to complete. Important to ensure any culverts are routinely cleared of any debris that may cause water to pond inside.	
Artificial containers	Any container capable of ponding water should be stored under cover, contain drainage holes, emptied within five days, treated with appropriate insecticide or disposed of appropriately per the Proposal Waste Management Plan. NTG guidelines suggest possibility of import of the tropical *Aedes aegypti* in or on any potentially water holding containers brought from tropical areas of north Australia should be reduced by cleaning and treating with chlorine or appropriate insecticide to kill mosquito eggs.	High
Rubbish and waste dumps	There must be no receptacle capable of ponding water for longer than five days.	High
Accommodation	For personnel, should be located away from biting insect breeding sites and adequately screened; e.g. halfway dam, Duck Swamp, associated coolabah swamp and any other standing water body. The residential camp will be in a sand swale more than 15 km removed from any areas of standing water.	High
Decommissioning and rehabilitation	The rehabilitation and decommissioning plan will safeguard that no actual or potential mosquito breeding sites remain after cessation of mining operations. All disturbed areas are to be rehabilitated and free draining. Infrastructure with the potential to pond water is to be removed.	High
General	If necessary, the use of chemical control methods may be implemented. This may include the use of approved mosquito larvicide as part of an organised control program. Any chemical control program will be discussed with the Medical Entomology Branch of the Department of Health and Community Services prior to implementation.	Moderate

6. MONITORING MEASURES

The proponent will liaise with the relevant NT Department to discuss the need for a mosquito monitoring plan. If required, it would be in accordance with the *Guidelines for Preventing Mosquito Breeding Sites Associated with Mining Sites.*

7. TRIGGERS AND CORRECTIVE ACTION

If visual inspections, monitoring results or staff/visitor complaints indicate that there is reason for concern the trigger and corrective action plan would be initiated (Table 4).

Table 4: Triggers and corrective actions for the presence of biting insects in the Proposal area

Situation	Triggers	Corrective action
No trigger	• No mosquito borne viruses contracted by staff or visitors • No discomfort to staff or visitors caused by biting insects • No stagnant ponds and receptacles that can cause the ponding of water	• Wear PPE • Opportunistically record presence of any biting insects • Advise HSES Manager if recently returned from overseas or areas known to have mosquito borne viruses
Trigger 1	• Staff and visitors report discomfort and nuisance due to biting insects • Ponding water and receptacles that can cause the ponding of water are noted on site	• Report to HSES Manager • Manager to report incident, review PPE, remove ponded water and review activities creating mosquito breeding environment.
Trigger 2	• Staff and visitors become ill from biting insects • Breeding of insects noted on site	• Report to HSES Manager • Ill personnel to attend first aid facility • Manager to report incident, communicate any reported illness to staff and identify symptoms, review PPE, remove pooled water and review activities creating mosquito breeding environment. • Manager to consult with Department of Health regarding the illness caused by biting insects, engage professional to undertake site survey of biting insects and undertake recommended control measures.

8. PERFORMANCE INDICATORS

Performance for assessing the effectiveness of mitigation measures and corrective actions are discussed in Table 5.

Table 5: Performance indicators for the assessment of the effectiveness of mitigation measures

Target	Indicator
No mosquito borne viruses contracted by staff during construction and operation of the Proposal	The number of personnel reporting mosquito borne viruses
No discomfort to staff caused by biting insects in the Proposal area	The number of personnel reporting discomfort caused by biting insects
No stagnant ponds and receptacles that can pond water for longer than five days	The presence of stagnant ponds and water ponding receptacles in the Proposal area

9. REFERENCES

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10. APPENDICES

Appendix 1: Common mosquitoes of the Northern Territory

Northern Territory Government

DEPARTMENT OF **HEALTH AND FAMILIES**

Common Mosquitoes
of the Northern Territory

Descriptions of species, habitats and disease potential

Medical Entomology
Centre for Disease Control
Department of Health and Families
Northern Territory Government

Revised edition May 2010

Common Mosquitoes of the Northern Territory

Descriptions of Species, Habitats and Disease Potential

Introduction

Mosquitoes are small, slender bodied, two winged flies belonging to the family *Culicidae*. They differ from all other flies in having a prominent proboscis or feeding tube projecting from the front of the head.

A pair of sensory palps is on either side of the proboscis. In *Anopheles* species the palps are as long as the proboscis, but in the females of most other species the palps are considerably shorter. The palps of the male mosquito are usually as long as the proboscis and are often more hairy and sometimes ornate. The males also have more bushy antennae when compared with the sparse antennae of the female.

The body and wings of mosquitoes are clothed in scales. Colour, size, shape, and arrangement of the scales are used to identify the different species of mosquitoes. In the Northern Territory there are approximately 100 different species of mosquitoes. Of these only about 40 species are known to bite people and only about 20 species occur in numbers large enough to cause pest problems. The mosquitoes which are known to occur in the Northern Territory are listed in Appendix A.

Both the male and female mosquitoes feed on plant nectar, but the female of most species also requires a blood meal to supply sufficient protein for egg development. Mosquitoes show considerable variation in their preference for hosts, with some species feeding variously or preferentially on mammals such as cattle, horses, marsupials or people. Some species are fastidious about the source of their blood meal. For example *Uranotaenia* feed on reptiles and frogs, and *Aedeomyia* feed on birds. Other species, such as *Culex annulirostris* will generally feed on whatever source of blood is available, although it has a preference for mammals.

The time of feeding varies for different species. Many mosquitoes feed just after sundown, while others such as some *Anopheles* species can have minor biting peaks later in the night, and others will bite preferentially in the early morning. Some species of *Aedes* bite preferentially during the day or around crepuscular times of dawn and dusk.

The place of feeding also varies, with some species flying far in search of a blood meal, while others remain very close to the breeding site. Some species will enter buildings in search of a host, others will only bite outdoors.

After feeding, the female chooses a suitable resting place, usually cool and humid, where the blood meal can be digested and egg development can proceed. A time lapse of two to three days usually occurs from blood meal to egg laying.

Mosquitoes have four distinct stages in their life history – egg, larva (or wriggler), pupa (or tumbler) and adult. The larval and pupal stages occur only in water, while the adult is an active flying insect.

Eggs are laid singly on the water surface by *Anopheles* mosquitoes, in rafts on the water surface by *Culex* mosquitoes, and singly on moist surfaces above the water level or on moist substrates by *Aedes* mosquitoes. *Aedes* eggs can withstand drying for many months without ill effect, and will hatch when the water level rises and the eggs are flooded.

The larvae emerge from the eggs and live in the water through four growth stages. The skin is moulted between each growth stage as the larva increases in size and complexity. Most larvae feed by drawing water into their mouths by means of fan shaped mouth brushes on the front of the head. Particles of food are drawn in with the water. Some species of larvae are predaceous on other larvae and have modified mouth brushes for capturing and holding their prey.

Most species of mosquitoes have larvae which come to the surface of the water to breathe. Most larvae have a siphon on the last segment of the abdomen, which carries the breathing tubes. They obtain air by hanging suspended by the siphon from the water surface. *Anopheles* mosquitoes do not have a siphon, but instead have breathing tubes on the surface of the last segment of the abdomen, and lie flat at the water surface to breathe. Some species with very short siphons may be mistaken for *Anopheles* at first glance.

Some genera, such as *Mansonia* and *Coquillettidia*, obtain air from submerged aquatic or semi-aquatic plants. They have a specially modified tip on the siphon with which they can pierce the air chambers in submerged stems or roots of plants. These species have no need to regularly come to the water surface.

At the conclusion of the last larval growth stage, the skin is shed and the pupa emerges. The pupa is a non-feeding stage, during which the adult form develops within the pupal skin. When the adult has developed, the pupal skin splits along the dorsal surface, and the adult emerges onto the surface of the water. The pupal stage usually lasts around two days.

The time taken from egg to adult varies, depending initially upon the species concerned, but secondly on temperature, food availability and the extent of crowding. In the Northern Territory 10 to 14 days would be sufficient time for most species to mature from egg hatch to adult. For species in temporary situations such as tidal pools or ephemeral flooded areas in the inland, the period can be around 6 days. Typical coastal mosquito breeding situations are depicted in Appendix B.

DEPARTMENT OF **HEALTH AND FAMILIES**

The following text describes some of the more common and important mosquitoes occurring in the Northern Territory, with some detail of biology, adult habits, distribution and their association with disease.

Culex quinquefasciatus

"The Brown House Mosquito"

Description of female

A brown mosquito with a square tipped abdomen. Tarsi of hind legs all dark with no white bands. Curved white transverse bands on top of the abdomen at the base of each segment. Pale underneath the abdomen, with a variable amount of dark scales medially, sometimes in medial patches. Palps are much shorter than proboscis. Proboscis all dark on top with pale scaling underneath on basal ¾.

Description of larvae

Grey brown larvae with a light brown head and siphon. Antennae a grey colour. Siphon medium length with a characteristic bottle shape with 3-4 groups of hairs on the underside. Hangs down by siphon from surface of water.

Breeding Places

Polluted or organic water close to human habitation. A very important source of large numbers of this species is the unscreened septic tank. Other sources are polluted ground pools, stormwater drains, sumps, gully traps and any artificial container holding water such as tins, tyres, drums, disused swimming ponds and rain water tanks. Eggs are laid in rafts on the water surface. Found throughout the Northern Territory where suitable sites are available.

Adult Habits

Bites mainly at night both indoors and outdoors and is frequently the cause of complaints in domestic situations in the Northern Territory. It will feed readily on poultry when available and commonly bites dogs. *Culex quinquefasciatus* is the mosquito most commonly found inside houses. It will remain inside houses to digest a blood meal. It will harbour in dark humid areas like cupboards, underneath sinks and near toilets and baths. This species travels 1 to 2 km from the breeding place. It bites mainly at night, and stands with the body horizontal to skin. The wings make an annoying buzzing sound that is frequently heard as it approaches.

Distribution

Worldwide in tropics and subtropics. Found domestically around towns throughout the Northern Territory.

Disease potential

It is capable of carrying heartworm of dogs. Has been shown in laboratory trials to be a poor vector of Murray Valley encephalities virus and Ross River virus. In other neighbouring tropical countries it is a vector of human filariasis.

Mansonia uniformis

"The aquatic plant mosquito"

Description of female

A gingery speckled mosquito with mottled wings of broad dark and pale scales and a dark wing fringe. It has a broad deep tip to the abdomen. There are white basal bands on tarsi of hind legs with apical sections dark. In fresh specimens the eyes are green. Proboscis mottled on basal half and dark on apical half.

Description of larvae

A grey larvae and a very sluggish swimmer. The tip of the black siphon pointed and serrated which is an adaption for insertion into the roots and stems of aquatic plants to obtain air

Breeding Places

In permanent and semi-permanent freshwater swamps and water-holes with aquatic and semi aquatic plants. Eggs are laid in clusters under the surface of floating leaves such as water lillies. The larvae attach by the siphon to roots or stems of aquatic and semi aquatic plants such as *Eleocharis* sp, *Typha* sp, *Nymphae* sp *or Nelumbo* sp to obtain air. Larvae do not need to come to the surface of the water to obtain air. The lavae are very difficult to locate.

To find the larvae, these water plants should be quickly dumped in a bucket of clear water and shaken vigorously and the plants and water examined closely. In the Darwin area they are found in Marrara Swamp, Holmes Jungle Swamp, Knuckey's Lagoon and regionally in Nhulunbuy Lagoon, Coonjimba Lagoon near Jabiru, and large semi permanent swamps and wetlands around the flood plains of the larger river systems.

Adult Habits

The adult rests by day amongst dense vegetation near swamps and waterholes. Females bite mainly in the evening and night, but are also active in daytime, especially near breeding areas with shady trees. Bites people, domestic animals, birds, and other mammals. It is strongly attracted to light. This species will travel up to 4 km in search of a blood meal, but is generally in high numbers within 1 km of the breeding site. It is a serious pest during the early dry season in areas where there are extensive swamps and lagoons with aquatic vegetation.

Distribution

Australasia, Orient, Africa, Moluccas, Island of New Guinea, mainly coastal to sub-coastal in Australia from north west of Western Australia, tropical Queensland to Brisbane, north NSW to Conjola, and Victoria in the Mildura area. Found throughout the Top End and coastal areas of the Northern Territory in association with permanent to semi-permanent vegetated swamps, creeks and wetlands. In the NT this species has not been recorded further inland than Mataranka and extends coastally and sub-coastally from Bradshaw Station in the west to Borroloola in the east.

Disease potential

Not known to spread human disease in Australia but can carry filariasis in neighbouring countries.

DEPARTMENT OF **HEALTH AND FAMILIES**

Culex sitiens

"The Salt Water Culex Mosquito"

Description of female

A medium sized mosquito with a square tipped abdomen and a narrow white band on the middle third of the proboscis, with the white band shorter when viewed from above compared with from below. The wings are all dark scaled. The femora of the hind legs are mottled and the tarsi of the hind leg have narrow basal bands of white scales. There are basal straight white bands on the top of the abdomen on each segment and uninterrupted apical black bands on the segments under the abdomen.

Description of larvae

The larvae are similar to *Culex annulirostris* except that the anal segment has small rounded transparent papillae and the saddle is cut away at the side, to roughly resemble a riding saddle. The larvae have a medium length siphon with a gentle taper to the tip and with 5 to 6 pairs of ventral hair tufts and one pair of lateral tufts

Breeding places

Brackish to salt ground pools, including artificial receptacles, influenced by the high tides or sea spray. Often found with *Aedes vigilax* and *Anopheles hilli* in salt marshes or pools that have at least some salt influence. Eggs are laid in rafts on top of the water and contain up to 150 eggs. The larvae are found in the Darwin area at Casuarina Coastal Reserve, Leanyer Swamp and Coconut Grove Swamp.

Adult habits

Culex sitiens bites mainly in the evening and at night. It will bite humans, birds and other animals, although it is not as avid a biter of humans as *Cx annulirostris*. It is only an appreciable human pest in the NT when very productive breeding sites are nearby. It may travel up to 10 km, but is mainly found in relatively high numbers within 2-3 km of prolific breeding places. High numbers biting usually indicates a breeding site within 1km. When biting it stands horizontal to the skin.

Distribution

Widespread throughout coastal South East Asia and adjacent tropical area of the Oriental region. Also Micronesia, South Pacific and Australasia, including Timor and New Guinea. In Australia it is recorded from coastal areas from as far south as Perth and north in WA, up to the NT and across to Qld and down to NSW as far south as Batemans Bay.

In the NT it has been recorded inland as far as Katherine and Mataranka but at low numbers.

Disease potential

No evidence of causing disease in Australia, although a possible vector of Ross River virus.

Culex annulirostris

"The Common Banded Mosquito"

Description of female

A medium sized, brown mosquito with a square tipped abdomen and a wide white band on the middle quarter of the probocis. The legs have mottled femora and the tarsi of the hind legs have narrow white basal bands with tarsi five all dark .

The segments on the top of the abdomen have basal white bands produced into a triangular point in the middle, while the segments on the underside of the abdomen has black transverse bands interrupted in the middle by white scales. Can be confused with *Cx. palpalis* which generally has a wider band up to almost ½ on the proboscis, tergal basal bands not produced into marked triangular points and has a white splash on the hind tibia.

Description of larvae

Larvae are pale with a long siphon with 6 groups of hairs along each side underneath the siphon. Antennae on the head have the bottom 2/3 white and the tip of the antennae dark. Has pointed pale transparent anal papillae at the hind end of the abdomen. Larvae hang down from the surface of the water when obtaining air. Feed amongst submerged vegetation.

Breeding Places

Natural freshwater swamps, pools, streams that have vegetation, but will also breed in many artificial situations such as stormwater drains, grassy edges of sewerage ponds and disused swimming pools . They may breed in large numbers in low lying grassy areas where the water lays for 1-3 weeks.

It has been found in brackish water in salt marshes, although is not usually found in areas exceeding one third salt water. This species may breed in large numbers in the dry season in vegetated sewage lagoons and stormwater drains. Eggs are laid in rafts on the water surface and can contain up to 200 eggs. In the Darwin area it breeds in large numbers in the wet season and early dry season in Leanyer Swamp, Marrara Swamp and Coconut Grove Swamp. Commonly in high numbers around Nhulunbuy Lagoon, Ilparpa Swamp in Alice Springs, sewage evaporation areas in Tennant Creek, sewage pond areas in Katherine, and the extensive wet season floodplains of all the major rivers and creeks in the Top End.

Adult Habits

Culux annulirostris commonly bites people, birds and other animals after sundown and in the early part of the night. It is the chief non-domestic mosquito pest in Australia and the most common mosquito biting in the Northern Territory. It can fly from 4 to 10 km from its breeding place, but generally is in higher numbers within 2km of productive breeding sites.

Distribution

New Guinea and island of Timor. Common throughout Australia. In the NT found in high numbers seasonally from Darwin to Alice Springs wherever and when suitable breeding sites exist.

Disease potential

Culex annulirostris is the confirmed and major vector of Murray Valley encephalitis (MVE) virus in Australia, and is capable of carrying Kunjin virus, Ross River virus, Barmah Forest virus and other viruses. It is probably the major vector of Ross River virus in the NT from January to April. It can transmit heartworm of dogs and is capable of carrying human filariasis in New Guinea .

Aedes notoscriptus

"The Receptacle Mosquito"

Description of female

A small to mid sized black mosquito with a conspicuous lyre shaped pattern and fine white lines on the top of the thorax. The proboscis has a white band around the middle, and the palps are very short compared with the proboscis. The abdomen tapers towards the apex. Tarsi of all legs have distinct wide white basal bands.

Description of larvae

A dark grey larvae with a light brown head and short siphon. The relativly long larvae have a sinuous movement, and the dorsal and ventral pairs of the anal papillae are pointed at the ends and unequal in length. There is a distinctive row of spines at the apex of the saddle.

Larvae often forage at the bottom of receptacles but hang down at the water surface when obtaining oxygen through their siphon.

Breeding Places

The natural breeding places are tree holes, rockpools and fallen palm fronds. This mosquito is domestic in settled areas and breeds in all types of artificial rain filled receptacles such as boats, tyres, tins, drums, domestic water tanks, roof gutters, pot plant drip trays and plant striking containers, particulary where there is some rotting vegetable matter. Eggs are laid singly just above the water line and can withstand considerable periods of drying until they are flooded.

Found commonly throughout the Top End, previously frequently in Tennant Creek but now very rare after the *Aedes aegypti* eradication program in 2006, and infrequently in Alice Springs, Found domestically wherever there are water filled tyres, drums and other receptacles.

Adult Habits

Aedes notoscriptus bites people and mammals. It bites by night or by day in the shade, and is a persistent but easily disturbed minor domestic pest in the Northern Territory. Stands with its body horizontal to the skin when biting. The adults are capable of flying 2-3 km but domestic pest situations are usually from sources within 200 metres of the pest problem.

Distribution

South West Pacific Australia and New Zealand. Found Australia wide. In the Northern Territory from Darwin to Alice Springs wherever artificial receptacles or natural tree holes exist.

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Disease potential

It is a very good vector of heartworm of dogs. A suspected vector of Ross River virus in other parts of Australia in urban situations when cases of Ross River virus disease are present. Ross River virus and other viruses have been isolated from this species in the Northern Territory, but its ability to act as a domestic vector of Ross River virus in the Northern Territory is suspected but unconfirmed.

Verrallina funerea

"The Brackish Forest Mosquito"

Description of female

Small dark mosquito with proboscis, head, thorax and legs all dark. White transverse sub basal bands on the top of the abdomen. Apex of abdomen tapering. Palps are short and less than 1/8 length of proboscis.

Description of larvae

Larvae are very dark and have a medium length siphon and relatively long pointed anal papillae. The pair of hair tufts on the siphon are closer to the apex, compared with most other *Aedes* species.

Breeding Places

Brackish to freshwater pools. Usually in shaded swampy areas of paperbarks, brackish ferns, Casuarina forests, beach Hibiscus thickets and sedges near tidal areas. Found just inland from typical *Aedes vigilax* breeding areas although the larvae are often found together. In the Darwin area the larvae have been found at Leanyer Swamp, Coconut Grove Swamp, Casuarina Coastal Reserve, Vesteys Beach swamp and the Botanical Gardens area. Eggs are laid singly on moist substrate at edges of suitable pools or damp areas.

Habits

A vicious and painful biter. Can be an appreciatable pest near productive breeding sites. Bites mainly by day in the shade and does not travel far from the breeding places. Does not disperse outside of dense shade near breeding sites during the day. Many harbour in the mangroves or dense vegetation near their breeding places and large numbers will attack rapidly in these areas during the day in the wet season. Retreating out of the shaded mangrove or paperbark areas during the day is usually sufficient to escape from their biting. Peaks of adults can occur in the breeding sites at the times of spring tides and around 8-15 days after spring tides.

Distribution

Australia and New Guinea. In Australia found in coastal New South Wales, north coast of Queensland, Northern Territory and extreme north west of Western Australia. Extensively in coastal to subcoastal Top End of the NT from Port Keats in th ewest, south to Mataranka and Roper River (Ngukurr), and west to Borroloola.

Diseases potential

Probable vector of Ross River virus in tropical Australia, and potential vector of Murray Valley encephalitis and Kunjin viruses.

DEPARTMENT OF **HEALTH AND FAMILIES**

Aedes tremulus

"The pale larvae mosquito"

Description of female

A small thick-set black mosquito with distinct wide basal white bands on the hind tarsi with the last tarsi all white. It has indistinct pale markings on top of the thorax, sometimes resembling a diffuse lyre-shaped pattern. The abdomen apex is laterally flattened and abdominal segment have white lateral patches. Has a relatively short all dark proboscis.

Description of larvae

A relatively long white larvae with a light brown head and dark siphon. The siphon is short, stout and tapering. The anal papillae are long, white and have rounded ends. There is a distinctive hardened lateral plate with 4 to 5 long spines on the last abdominal segment. The larvae have a sinuous motion and remain on the bottom when disturbed. A number of other closely related species with undescribed larvae eg Ae. sp 76 have similar looking larvae.

Breeding Places

Natural breeding places are holes in trees and stumps, especially narrow holes in eucalypts, paperbarks, and mangroves that have been filled with rainwater. It is often found in domestic sites in artificial receptacles such as tins, tyres, tanks and plant pot bases which have been filled with rain water or artificially flooded. Eggs are laid singly on the insides of receptacles with water and can survive long dry periods. *Aedes tremulus* can become a minor domestic pest anywhere in the Northern Territory where suitable breeding sites exist.

Adult Habits

The adult mosquitoes rest out of doors and do not travel more than 500 metres from their breeding sites. They frequently bite at dawn and during the late afternoon. They will enter houses to bite and sometimes can penetrate mosquito gauze screens because of their small size. They are painful biters, although are not usually present in large numbers. Often males are observed flying around the ankles and landing on the skin or clothes.

Distribution

New Guinea, New Britain and Australian mainland from Geraldton in Western Australia, across the NT and inland South Australia and Victoria to tropical Queensland. Found throughout the Northern Territory. More common in the Top End but has been regularly recorded in inland towns including Tennant Creek and Alice Springs.

Disease potential

Not known to carry diseases in Australia.

Anopheles hilli

"The Salt Water Anopheles Mosquito"

Description of female

A speckled grey mosquito with extremely spotted wings. The palps are as long as the proboscis. There are two dark bands and two wide white bands on the apical half of the palps. The proboscis is dark. There are wide white bands across the joints of the tarsi, on the hind legs. The abdomen is pale on top, with a mottling of scattered pale scales on the underside.

Description of larvae

Larvae has no siphon, and are generally pale in colour, with relatively narrow inter segmental plates. All clypeal hairs are long with the outer ones frayed. Rests horizontally to surface of the water, feeds by filtering particulate matter from the surface of the water.

Breeding Places

Found in natural and artificial coastal ground pools, coastal swamp margins and tidally influenced flood plains in sunlit to partly shaded sites, and with or without ground vegetation present. Breeds almost exclusively in brackish to salt water, and often in typical *Aedes vigilax* salt marsh breeding sites. Larvae in darwin have been found at Coconut Grove/Ludmilla Swamp, Leanyer Swamp and Casuarina Coastal Reserve. This species is most numerous in the Northern Territory at the end of the wet season.

Adult Habits

Bites people, cattle and horses. It is most active after sunset for the first two hours of the night and will enter houses. Fed females can be found inside houses. Flight range is approximately 4 km, with very high numbers often found close to brackish swamps such as Leanyer and Howard Swamps in the late dry season. Like other *Anopheles*, it stands at an angle to bite.

Distribution

Australia and southern part of Irian Jaya. Common across Northern Australia from north west Western Australia, coastally and subcoastally in the Northern Territory to coastal east Queensland, and down to the New South Wales border. Has been found in inland areas of the Northern Territory, occasionally to Katherine, rarely to Larrimah, a few times in Tennant Creek, and one record from Alice Springs at Ilparpa swamp.

Disease potential

Anopheles hilli is capable of carrying malaria. It was a secondary vector in malaria outbreaks in Queensland, and is a suspected vector in the Northern Territory.

DEPARTMENT OF **HEALTH AND FAMILIES**

Anopheles meraukensis

"The fresh-water reed Anopheles"

Description of female

A speckled grey mosquito with spotted wings. The palps are as long as the proboscis, and there are three wide white bands on the apical half of the palps, separated by two narrower black bands. The proboscis is dark scaled. The underside of the abdomen has paired rounded patches of white scales laterally on most segments, with a few scattered scales in the midline. The top of the thorax has a darker "shoulder patch" on either side sub apically.

Description of larvae

The larvae have no siphon, and the head is as long as it is broad. The outer clypeal hairs on the front of the head are strongly branched. This species can be confused with *An. annulipes* on the appearance of the outer clypeals, but can be separated by the air scoop on the last abdominal segment. In *An. meraukensis* the median plate of the scoop is anteriorly elongated, and has two distinct lateral projections.

Breeding places

Breeds predominantly in sunlit grass or reed fresh water swamps and is often associated with *Eleocharis* reeds. It has been collected occasionally from artificial breeding places such as wheel ruts and bomb craters. It has also been collected breeding in a rain filled 200 litre drum.

Adult habits

Readily bites people, domestic animals and kangaroos. The preferred biting time is just after sunset. Like all *Anopheles* it stands at an angle to the skin to bite. It can be especially numerous during the late wet season when extensive breeding areas are filled with water and lodged reeds.

Distribution

Merauke/Kumbe area in Irian Jaya. In Australia it occurs in the northern areas of Western Australia, Northern Territory and Queensland. It is commonly recorded throughout the Top End of the Northern Territory as far south as Larrimah, to Borroloola in the east, and has been collected rarely as far south as Lajamanu and very rarely at Elliot.

Disease potential

A suspected but unproven vector of malaria. It is not known to transmit viral diseases to humans in Australia, although a number of viruses have been isolated from this species.

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Anopheles farauti s.l.

"The Australian Malaria Mosquito"

Description of female

A speckled grey mosquito with extensively spotted wings and with palps as long as proboscis. There are three narrow black bands on the apical half of the palps, with the two most basal of these dark bands seperated by a narrow white band. The proboscis is dark, and the abdomen is all dark, with no pale scales on the udersurface..This is a species complex with at least three species occurring in the Northern Territory, which are not able to be seperated using morphological characters.

Description of larvae

Like all *Anopheles* larvae, it has no siphon. Head is as long as it is broad. This species can be easily distinguished from *An. hilli* as it has larger inter segmental plates. Larvae feeds and rests horizontal to the surface of the water.

Breeding Places

Anopheles farauti s.l occurs in many kinds of permanent and semi-permanent fresh and brackish water sites. It is usually in sunlit locations and uncommon in deep shade. The freshwater species *An. farauti* No. 3 breeds in the margins of shallow vegetated freshwater swamps and streams. *An farauti* No. 1, the brackish water breeding species is found in open brackish pools or swamps near the coast, often in association with *An. hilli, Culex sitiens* or *Cx. annulirostris*.

Adult Habits

Anopheles farauti s.l bites people readily and also bites other mammals and birds. It stands at an angle to the skin to bite. Flight range approximately 2 km. It is normally most numerous in the late wet season and early dry season.

Distribution

An farauti s.l occurs from the Moluccas, New Guinea, Solomon Islands to Vanuatu as a number of sibling species. In Australia it occurs in North Queensland, Top End of the Northern Territory north of Katherine including occasionally in Katherine, very rarely in Ngukurr, and very rarely in the north east coastal area of Western Australia. In the Darwin area larvae have been found in Marrara Swamp, Casuarina Coastal Reserve, Leanyer Swamp and Coconut Grove swamp. *An. farauti* No. 1 has been collected in Leanyer Swamp, Holmes Jungle Swamp, Micket Swamp and Ludmilla Creek swamp, while *An. farauti* No. 3 has been collected in the fresher water swamp areas of Holmes Jungle, Marrara Swamp, the Jabiru area and the Nhulunbuy-Yirrkala area.

Disease potential

An efficient and confirmed vector of malaria. *An. farauti* s.l (probably *An. farauti* No. 1) was the confirmed vector in a past epidemic in North Queensland, and *An.farauti* No. 1 is the suspected vector in the northern section of past malaria occurrences in the Northern Territory. A vector of human filariasis in West Irian.

Anopheles annulipes

"The Common Australian Anopheline"

Description of female

This is a species complex of more than 5 species, of which propably at least two species occur in the Northern Territory. A speckled grey mosquito with extensively spotted wings, although a ginger species occurs in inland areas. The palps are as long as the proboscis. Three wide white bands on the apical half of the palps are separated by two narrow black bands. The proboscis is usually pale scaled on the apical half in northern specimens. The southern specimens may have only slight paler scaling on the apical half of proboscis. Both the top and bottom of the abdomen are dark except for a few white scales both dorsally and ventarlly near the apex.

Description of larvae

The larvae are very variable in colour. They have no siphon. The head is as long as it is broad. The inner clypeal hairs on the front of the head are wide apart, and the outer clypeals are branched. This species can be simular in appearance to An. meraukensis in respect of the outer clypeal hairs, but can be differentiated by the air scoop on the last abdominal segment. In An. annulipes the median plate of the scoop is broad and has no lateral projections. It rests parallel to the surface of the water and feeds on particles on top of water by filtering with a series of brushes near its mouth.

Breeding Places

Anopheles annulipes s.l can breed in all kinds of temporary and permanent fresh water ground pools, stream and vegetated swamp edges and amongst floating algae or vegetation away from banks of streams and swamps. It also occurs in rock pools and large open artificial containers such as drums and disused swimming pools, and is sometimes found in slightly brackish water. Eggs are laid singly on the water and float by means of floats on each side. In the Darwin area larvae have been found at Leanyer Swamp, Ludmilla Swamp, Marrara Swamp, and at Casuarina Coastal Reserve. Found commonly at the edges of Nhulunbuy Lagoon, in Ilparpa Swamp in Alice Springs, and throughout the Northern Territory where suitable sites exist.

Adult Habits

Like all *Anopheles* species, it stands on its head to bite. Bites by night, particularly dusk and dawn and will enter houses. Bites people readily but will also feed on cattle. Resting places in hollow stumps, drums, banks of streams and stormwater pipes. This species is abundant in the Northern Territory from February to April near extensive paperbark and freshwater reed swamps but rarely becomes an appreciable human pest in the Top End, and never very numerous in coastal situations. Flight range is approximately 2 km from breeding areas.

Distribution

Papua New Guinea and throughout Australia, including Tasmania. Occurs throughout the Northern Territory from Darwin to Alice Springs.

Disease potential

Capable of carrying malaria, and is a suspected vector in the Northern Territory, particularly in areas south of the distribution of *Anopheles farauti s.l.*. A vector of myxomatosis of rabbits

Anopheles bancroftii

"The Black Australian Anopheline"

Description of female

A large black mosquito with bushy black palps and a black proboscis. Wings are mostly dark with few small white patches on the front edge. The top of the abdomen is black. The underside of abdomen has a central row of pale scale patches. Palps are as long as the probocis.

Description of larvae

A dark larvae often with some irregular white patches. Has no siphon. The antennae have a conspicuous branched hair at mid length, with bushy branched outer clypeals on the apical section of the front of the head. Feeds parallel to the surface of the water by drawing in particles on the surface with a series of brushes near its mouth.

Breeding Places

Usually found in shaded freshwater swamps, waterholes and stream margins. Sometimes found in slightly brackish reed swamps where reeds shade the water. Paperbark trees and the areas of spike rush reeds such as *Eleocharis sphacelata* are often good indicators of suitable breeding places. In the Darwin area larvae have been found in Leanyer Swamp, Marrara Swamp, Coconut Grove swamp areas and the Casuarina Coastal Reserve. Common around Nhulunbuy Lagoon and at Baralil Creek near Jabiru.

Adult Habits

An. bancroftii stands almost vertically on its head when biting. It bites principally at night, but readily attacks people by day in the Northern Territory in shaded areas near it's breeding grounds. It also attacks other mammals readily including cattle. The flight range of 2 to 4 km from the breeding areas. This species is usually more numerous in the late wet season and early dry season.

Distribution

Irian Jaya, Admiralty Islands and Northern Australia. In the Northern Territory it is found broadly throughout the Top End, and is seasonally commonly from Wadeye (Port Keats) aropund the north coast to Ngukurr and Boroloola and south to Katherine and Mataranka. In the Darwin area he larvae have been found in Leanyer Swamp, Marrara Swamp, Coconut Grove swamp, and Casuarina Coastal Reserve. It is common in Nhulunbuy and Jabiru and around the extensive coastal flood plains and vegeteated swamp and lagoon areas associated with the larger rivers.

Disease potential

Capable of carrying malaria, and is a suspected vector in the Northern Territory but usually not long lived enough to be an effective vector. A vector of filariasis in New Guinea.

DEPARTMENT OF **HEALTH AND FAMILIES**

Coquillettidia xanthogaster

"The Golden Mosquito"

Description of female

A medium sized mosquito with a bright gold/orange thorax and abdomen. The legs are dark, and have purple reflections.

Description of larvae

A pale/white larvae with tip of siphon dark and modified for piercing plants. A very sluggish swimmer. Larvae are attached to aquatic plants and rarely seen.

Breeding places

Permanent and semi permanent swamps with aquatic vegetation. Larvae attach to underwater roots or stems of plants. In the Northern Territory it is most frequently associated with the semi aquatic reeds *Eleocharis* sp and *Typha* sp, and the water lilies *Nymphaea sp*. Pandanus, grasses and sedges may be suitable habitats in some localities.

Adult habits

Bites mainly at night, but also in the daytime in shade. It bites people, domestic animals and birds, and may travel up to 4 km from the breeding places. It is attracted to light and is seasonally numerous.

Distribution

The islands of New Guinea, New Caledonia and Vanuatu. Occurs widely in Australia. In Queensland it occurs mainly in tropical coastal areas but is also recorded inland as far as Charleville, and south to near Sanford and Bunya near Brisbane. Found also in the Northern Territory, North West Western Australia and coastal and sub coastal northern New South Wales. It is found widely and common in the Top End of the Northern Territory coastally to sub coastally from Port Keats in the west to Borroloola in the east, and south to Katherine and Mataranka. It has not been recorded inland further south than just south of Mataranka at Warlock ponds except briefly in Ilparpa Swamp near Alice Springs in 2000.

Disease potential

Not known to transmit human disease although a potential vector of Ross River virus and a vector of reptile filariasis in frill neck lizards.

Aedes vigilax

"The Northern Salt Marsh Mosquito"

Description of female

Aedes vigilax is a small, dark, robust mosquito with a pointed abdomen. The proboscis is pale scaled on the basal 2/3 on the underside. There are basal white bands on each segment on top of the abdomen with lateral white patches. The tarsi have basal white bands on each segment, and these are particularly noticeable on the hind legs. Stands with its body horizontal to the skin when biting.

Description of larvae

The larvae of *Aedes vigilax* are moderate size and relatively dark, with a short siphon, and short, pointed anal papillae. The major head hairs are single. Generally larvae feed on the substate at the bottom of pools and tend to congregate around sheltered areas of vegetation. If the larvae are disturbed they rapidly move to the bottom of the pool.

Breeding Places

Aedes vigilax commonly breeds in sunlit brackish to salt water swamps and temporary pools that are filled after the highest tides of the month and after rain. In Darwin tides over 7.4 m are required to reach their normal breeding areas. These areas are usually sunlit so their development is rapid, with 4 days as larvae and 2 days as pupa. The breeding areas are often associated with salt water couch grass (*Sporobolus)* or various marsh grasses (*Xerochloa*) or salt tolerant succulents (*Tecticornia* and *Halosarcia*) and reeds such as *Shoenoplectus, Eleocharis* and *Typha* sp. Will breed in flooded grass areas above high tide limit where there is some salt influence from the soil or seaspray. Larvae are seldom found under a heavy mangrove cover with daily tide movement, but are often associated with *Avicennia* mangroves and *Shoenoplectus* reeds in brackish swamps reached by tides over 7.4 metres (Darwin area).

In some cases increased *Aedes vigilax* breeding has occurred when sand dunes or mangrove boundaries have been interferred with and the natural drainage of sea water has been blocked. Only complete reclamation by filling or the exclusion of salt water by tidegates and bund walls will remove these breeding areas. The eggs are laid singly in the moist mud, usually at the base of vegetation and are laid at the edges of the depressions as the water recedes. These eggs can resist periods of dryness for up to 12 months until the area is flooded again.

The larvae go through 4 stages in the water and then turn into a pupa which is much rounder and looks like a very small crayfish without legs. The adult mosquito hatches from this pupa as it rests at the surface of the water. The adult mosquito then rests on the surface of the water until the wings are sufficiently hardened to fly. The period from egg to adult is usually only 6 days. The larvae will grow in a range of salinities from slightly brackish to twice sea water. They are also found in freshwater when the breeding grounds are flooded by rains. Eggs are generally not laid at the edges of fresh water pools or freshwater swamps.

Only the females suck blood, which is needed for the development of their eggs. Both males and females suck plant juices or nectar. After the adults emerge they mate and then remain at their breeding site for 2 days while the females develop their first batch of eggs while harbouring at the breeding site. They do not require a blood meal for this first batch of eggs. Mass dispersal of newly emerged females may take place to points up to 40 km or more from the breeding sites, but are generally in highest numbers from 1–5 km from extensive breeding sites.

After strong prevailing winds from coastal breeding sites, large numbers of *Aedes vigilax* have been found as far from the coast as Pine Creek and Katherine. The adults shelter in vegetation during the day, especially in mangroves and dense forest near their breeding sites, but also in dense vegetation such as mango trees and shade trees in suburban areas.

The female mosquito will bite by day or night and will bite people, other mammals and birds. Peaks flying and biting times are just after sunset and before sunrise .

Plagues of *Aedes vigilax* in the Darwin area occur from the mid and late dry season to the early wet season, starting 9-10 days after the highest monthly tides or the first flooding rains. Numbers reduce rapidly after the wet season rains seasonally flood the extensive salt marsh breeding areas to allow predator fish access, as well as dramatically reducing egg laying sites. The most prolific breeding areas around Darwin are the Casuarina Beach area, Leanyer Swamp and the Ludmilla Creek area.

Distribution

Found in the Oriental region and the South West Pacific area including Australia, Timor, Solomons, New Guinea, New Caledonia, Fiji and Vanuatu. Found coastally in Australia from New South Wales, Qld, NT and WA to Mandurah south of Perth. Found in Victoria inland at Mildura. In the NT it is seasonally common across the Top End and subcoastally to inland, commonly to Katherine, occasionally to Tennant Creek, and rarely in Alice Springs (usually after monsoon or cyclones weather systems and associated north west winds)

Diseases potential

Aedes vigilax is a major pest in the Top End of the Northern Territory. It is regarded as the principle vector of Ross River virus and Barmah Forest virus in the late dry to early wet season, andis a potential vector of MVE. It is capable of carrying heartworm of dogs. It is a vector of filariasis in New Caledonia.

Control

Because of the relatively distant and scattered breeding sites and the large areas involved, larval control, except near residential development is not an economic or practical proposition. The usual method of control available near residential areas is the application of the insecticides *Bti* or methoprene. In large areas, timely applications have to be done by air. Hand application can be used in small areas. Personal protection is by using repellents, screening homes and avoiding their breeding and resting places during the day or at night.

Peter Whelan AM , Senior Medical Entomologist

Medical Entomology

Printed by the Government Printer of the Northern Territory, 2010.

An electronic version is available at: www.nt.gov.au/health/

General enquiries about this publication should be directed to:

Peter Whelan, Director, Medical Entomology
Department of Health and Families
PO Box 40596, Casuarina, NT 0811

Phone: (08) 8922 8901

Facsimile: (08) 8922 8820

Appendix 2: Personal protection from mosquitoes and biting insects in the Northern Territory

Personal protection from mosquitoes & biting midges in the NT

P. I. Whelan
Department of Health
October 2011
(Revised February 2016)

Adapted from paper by P. Whelan in "Australian Mosquito Control Manual" by a panel of authors, Editors C. Morris and P. Dale. Australian Mosquito Control Association, 1998, ISBN 0-646-35310-1.

1.0 MOSQUITOES AND BITING MIDGE BITES

Mosquitoes and biting midges (genus *Culicoides* and sometimes erroneously called sand flies) can reach sufficient numbers in various localities to be considered serious pests. The bites themselves can be painful and extremely annoying, and people suffer varying degrees of reaction to bites (Lee 1975). However the possibility of the spread of various diseases by their blood sucking habits to either humans or animals is a more serious outcome. Mosquitoes can carry viruses such as Murray Valley encephalitis, Kunjin, Ross River, and Barmah Forest virus, which cause human disease (Russell 1995). Biting midges do not carry any pathogens in Australia that cause human disease.

Female mosquitoes or biting midges bite to take blood from their hosts, which is necessary for the development of eggs.

Mosquitoes and biting midges show considerable variation in their preference for hosts. Some species feed selectively on cattle, horses, marsupials, amphibians, birds or humans, while other species are relatively indiscriminate feeders.

The time of feeding varies for different species. Many mosquitoes feed just after sunset while others are more active at other times including late in the night, in the late afternoon, or in the early morning. Biting midges are most active in the evening and early morning.

The place of feeding by mosquitoes or biting midges is varied. Some species, such as the brown house mosquito, readily entering houses to feed on people, while others will only bite people outdoors.

When a mosquito or biting midge bites, fine stylets sheathed in the proboscis are inserted into small capillaries in the skin. Blood is sucked up through one of the channels in the stylets, while saliva is injected down an adjacent channel. This saliva contains histamine like substances that the human body recognises as foreign and often stimulates a bite reaction. Sometimes the saliva can contain viruses or other pathogens that can cause disease.

Some people can become very sensitive after being bitten and suffer a general reaction from further bites. The bites may itch for days, producing restlessness, loss of sleep and nervous irritation. Scratched bites can lead to secondary infections and result in ugly scars. On the other hand, some people become tolerant to particular species and suffer little after-effects from repeated bites.

Biting insects create problems in the enjoyment of outdoor activities, causing a reluctance to enter certain areas after sundown or forcing people to be confined to insect-proof areas at certain times of the year. Personal protection and avoidance measures can offer considerable protection from bites, as well as offering protection against mosquito-borne disease.

2.0 MOSQUITO & BITING MIDGE AVOIDANCE

A sensible precaution to prevent biting insect attack is to avoid areas that are known to have high biting insect activity.

The upper high tide areas near creeks or low-lying areas, particularly near salt marsh habitats, can be significant sources of northern salt marsh mosquitoes *Aedes vigilax* and various other pest mosquitoes. The period of high salt marsh mosquito activity is usually during the late dry season and early wet season in tropical latitudes. Generally they are prevalent for one to two weeks after the highest tides of the month or appreciable rain. Salt marsh mosquito and midge pest calendars are available from the health website
http://www.health.nt.gov.au/Medical_Entomology/index.aspx

Dense vegetation near the breeding sites should be avoided during the day over this period. Pest problems during the evening and night can occur within 3 km of productive breeding sites (Whelan et al., 1997).

Other areas of high mosquito activity are the large seasonally flooded areas associated with rivers or drainage lines, flooded coastal swamps, extensive reed swamps and lagoons, ill defined or poorly draining creeks, extensive irrigation areas, and wastewater disposal facilities. Densely shaded areas near these habitats should be avoided during the day, and accommodation areas should be at least 3 km from extensive areas of these habitats.

Extensive areas of mangroves with small dendritic creeks or estuarine areas with muddy banks are potential sources of mangrove biting midges. These midges have seasonal and monthly population peaks with the monthly peaks usually associated with the tidal regime. When camping or choosing a permanent living site, a separation distance of at least 2 km from these areas is recommended unless specific biting insect investigations indicate there are no seasonal pest problems (Whelan 1990, Whelan, Hayes et al. 1997).

If camping or selecting house sites near creeks, rivers or lagoons, choose localities of the water body which have steep margins or little marginal emergent vegetation, have swiftly running water with little marginal pooling or vegetation, or do not arise from or empty into a nearby swamp area. Exposed beaches or cliffs away from mangrove or estuary areas are preferred sites to avoid both mosquitoes and biting midges. In more inland areas, locations on hills or rises at least 3 km from ill defined drainage lines, poorly flowing creeks and seasonally flooded areas should avoid the worst mosquito problems.

In residential areas, a local source of mosquitoes may be the cause of the problem. Check nearby potential artificial sources of mosquitoes such as disused swimming pools, receptacles such as tyres, drums, fallen palm fronds, pot plant drip trays, plant striking buckets, animal water, garden equipment, plastic sheeting, blocked roof gutters, old fishponds, or localised ponding of drains. Sites with mosquitoes breeding can be rectified by physically removing the source or through the use of insecticides. Fish ponds or ponds used for frogs can be rectified by the addition of a few fish.

3.0 SCREENING

The best method of avoiding attack at night is to stay inside insect-screened houses. Screens can be made of galvanised iron, copper, bronze, aluminium or plastic. Near the coast, iron or copper screens are not recommended because of the corrosive action of salt sprays. Homes near biting midge breeding sites require either fine mesh screens or lightproof curtains.

Screens should be of the correct mesh, fit tightly and be in good repair. Biting insects frequently follow people into buildings and for this reason, screen doors should open outward and have automatic closing devices. Insecticides such as permethrin, deltamethrin, bifenthrin, or alpha-cypermethrin sprayed on or around screens may give added protection against mosquitoes or biting midges, but care is needed as some insecticides affect screens.

It is advisable to use an insect proof tent when camping near potential biting insect areas. Coastal areas subject to attack by biting midges require tents to be fitted with a finer mesh screening. Tents can be made more mosquito effective by spraying them inside and out with bifenthrin or alpha-cypermethrin.

4.0 MOSQUITO NETS

Mosquito nets are useful in temporary camps or in unscreened houses near biting insect breeding areas. Generally standard mosquito nets are not sufficient to prevent biting midge attack. White netting is best as mosquitoes accidentally admitted into the net are easily seen and killed. The net is suspended over the bed and tucked under the mattress. An aerosol pyrethrin spray can be used to kill mosquitoes that enter the net. Care is needed not to leave exposed parts of the body in contact with the net, as mosquitoes will bite through the net. Nets can be made more effective by dipping impregnation with permethrin (Lines et al. 1985) or by spraying them inside and out with bifenthrin, lambda-cyhalothrin or alpha-cypermethrin..

5.0 INSECT PROOF CLOTHING

Head nets, gloves and boots can protect parts of the body, which are not covered by other clothing. Head nets with 1-1.5 meshes to the centimetre are recommended for good visibility and comfort, and additional treatment of the net with a repellent will discourage insect attack. Thick clothing or tightly woven material offers protection against bites. Light coloured, loose fitting long sleeved shirts and full-length trousers are recommended. Dark clothing such as dark blue denim or black clothing is much more attractive to salt marsh mosquitoes than white clothing. Many mosquitoes including salt marsh mosquitoes or *Anopheles bancroftii* will bite through tight fitting shirts or pants. For particular risk areas or occupations, protective clothing can be impregnated with permethrin or other synthetic pyrethroid insecticides such as bifenthrin to give added protection (Burgess et al. 1988). Sleeves and collars should be kept buttoned and trousers tucked in socks during biting insect risk periods. Protection is very necessary near areas of salt marsh, mangroves, or large fresh water swamps where the various species of mosquitoes may be very abundant during the day in shaded situations, as well as at night.

6.0 REPELLENTS

Relief from biting insect attack may be obtained by applying repellents to the skin and clothing (Schreck et al. 1984). Many repellents affect plastics and care is needed when applying them near mucous membranes such as the eyes and lips.

Repellents with the chemical diethyl-toluamide (DEET) or picaridin give good protection, with DEET based repellents the best. Some specific repellent products, such as standard Aerogard, which are formulated to repel flies, are generally not efficient against mosquitoes or biting midges. Brands with DEET such as Rid, Tropical Strength Aerogard, Bushman's, and Muskol, or products with picaridin such as Repel include specific products that are effective. Those products with higher amounts of DEET or picaridin are usually the most efficient. Many botanical based products do not offer sufficient protection. However, p-methane 3,8diol or PMD (extract of lemon eucalyptus) at a minimum concentration of 30% provides longer lasting protection compared to other botanicals and has a similar efficacy compared to the low DEET concentration products.

Application of repellents over large areas of the body or on extensive areas of children is not recommended particularly those repellents with concentrations of DEET greater than 20%. Protection from mosquito penetration through open weave or close fitting clothes can be obtained by applying a light application of aerosol repellent to the exterior of clothing. Repellents should be supplementary to protective clothing and should not be regarded as substitutes.

Personal repellents are available as sprays, creams or gels. The gels are best and creams usually last longer than the aerosol formulations. Repellents can prevent bites from 1 to 4 hours, depending on the repellents, the species of biting insect, or the physical activity of the wearer. In general aerosol alcohol based repellents will only give one hour protection in the tropics so reapplication is necessary. Products labelled low irritant generally mean less active ingredient.

There are some new metofluthrin vapour active pyrethroid spatial repellents on the market where there is passive evaporation from impregnated strips or pads. These have been shown to be very effective in preventing landing or biting of many species of mosquitoes and midges, even in outdoor situations within a close surround of the devices, or within rooms in more enclosed areas.

Insecticide impregnated mosquito coils offer good protection in relatively wind protected areas, while the allethrin pad candle heated mosquito lanterns or gas operated allethrin mosquito protection devices offer excellent protection in patio or veranda or other outdoor situations. Mosquito lanterns or gas powered pad dispensers are cost effective for events such as barbeques or congregations of people, with two or more dispersed around the group to cater for breeze direction. Candle devices need care with the candles, while the gas powered models are safe and effective in situation on boats and vessels. They work best in still or very light breeze conditions.

Electronic insect repellers that emit ultrasonic or audible sounds do not offer any protection against mosquitoes or biting midges. They are based on a false premise and have been found to have no repellent effect under scientific testing (Curtis 1986). Electronic ultrasonic repellers do not repel mosquitoes or biting midges and should not be relied upon for personal protection (Mitchell 1992).

Plants with reported insecticidal properties such as neem trees and the citrosa plant have not been shown to act as mosquito repellents just by growing in the vicinity of people (Mitchell 1992, Matsuda et al. 1996). Growing or positioning these plants near evening activity areas will not prevent mosquito attack. However some plants have some repellency effects as smoke or liniments (see section 12, emergency biting insect protection)

7.0 ANIMAL DIVERSION

Camping upwind near congregations of stock or domestic animals will serve to divert mosquitoes or biting midges to alternative hosts. Similar considerations can be made when planning residential sites and animal holding areas in a rural situation. Dogs of darker colour tend to attract some species of mosquitoes more than lighter colours and can divert some pest problems from people in close vicinity in outdoor situations in the evening.

8.0 LIGHTING DIVERSION

Many mosquito and biting midge species are attracted to white light. This can cause pest problems in unscreened houses or when camping. The use of yellow or even better red incandescent bulbs or fluorescent tubes rather than white light will reduce the attractiveness of lights to insects. An incandescent or ultra violet light placed at a distance from a house or camp can serve to attract insects to an alternative area. This is more effective if the light is close to the breeding site, or between the breeding site and the accommodation area. The attractive lights should not be close to accommodation or directly down wind of accommodation areas. Light proof curtains or similar screening can be very effective in reducing the attraction of biting insects to areas that are illuminated at night.

9.0 ADULT INSECT CONTROL

If mosquitoes or biting midges have entered a screened area or house or premises they can be knocked down with hand held pyrethrin aerosols. Care should be taken by reading the label to ensure only knockdown aerosols suitable for spraying in the air are used in proximity to people or food.

There are automatic wall mounted dispensers of aerosol for killing adult mosquitoes or flies that dispense mainly pyrethrins. These are registered for use either indoors or outdoors so care is needed in reading the labels. Generally these dispense aerosol in short bursts every 20 to 40 seconds and can last up to 40 hours before refilling. Outdoors devices need to be in wind protected areas such as verandas and patios.

Other devices that can be effective at killing and/or repelling biting insects include mosquito coils (Charlwood & Jolley 1984) and electric plug in insecticide pads. The plug in pad devices are every effective inside buildings but care is needed in reading the labels These devices are only effective in relatively protected or closed areas such as patios, inside buildings or where there are only slight breezes. Use of coils in outdoor or unscreened areas should be backed up with other measures such as suitable protective clothing or repellents.

Large scale adult biting insect control can be achieved for short terms (hours) by using portable or industrial fog generators, backpack misters, or heavy duty ultra-low-volume aerosol generators to knock down active adult insects. The insecticides of choice in these machines are maldison, bioresmethrin or pyrethrum. Control relies on good access, open vegetation, and light breezes in the direction of the breeding or harbouring sites. Application should only be during the peak biting insect activity period of those insects actually causing the problem, which is usually the late evening and early night.

There are some synthetic pyrethroid aerosol products available as outdoor yard or patio repellents. Control may only be temporary (hours) and re-invasion will usually occur within hours or from one to a few days, depending on the species, nearby vegetation, proximity to breeding sites, environmental conditions and times of activity of the pest species.

Application of the older residual insecticides such as maldison, or permethrin sprayed as a mist spray to point of run off on building surfaces or nearby vegetation can sometimes give short term (a few days to a few weeks) relief. This method is useful as a barrier protection when large numbers of mosquitoes or biting midges are present near accommodation or outdoor use areas (Helson & Surgeoner 1985).

There are some longer term residual synthetic pyrethroids such as bifenthrin, lambda-cyhalothrin and alpha-cypermethrin that can be used as barrier sprays and provide excellent (up to 6 weeks) protection (Standfast et al 2003, Li et al 2010). These residual insecticides can be applied according to label recommendations with the aid of a garden sprayer for dark coloured walls, fences and solid surfaces on the outside of houses or back pack mechanical misters in a band 1-2 m high on low thick vegetation and shrubbery areas around houses. If there is no vegetation screen, black weed matting or shade cloth 1-2 m high all around fence lines in urban settings can substitute for vegetation as the application surface. Application should be at label rates and made to the point of just before runoff. For vegetation care is needed to apply under leaves as well as on leaves and surfaces. Use of these insecticides can give immediate relief from salt marsh mosquito plagues on a house block scale and the effect should last up to 4 weeks.

Application can be done by householders with appropriate equipment and familiarization with the chemical and provisions and safeguards for use, although generally it is advisable for applications to be done by a licensed pesticide company.

Care must be taken with all synthetic pyrethroids around fishponds, fish tanks and other nearby fish habitats to avoid spray drift or run off, as these insecticides are efficient fish poisons.

10.0 INSECTOCUTORS AND INSECT TRAPS

Electric insect insectocutors and other trap or killing devices utilising an attracting light or carbon dioxide have been claimed to clear areas of biting insects and thus protect people. These claims have not been substantiated in outdoor situations with people nearby. While trap devices can attract biting insects, as well as a range of other insects, these devices can not be relied on for protection from biting insect attack (Mitchell 1992). When used in outdoor situations it is possible that they can increase local problems by attracting insects to the vicinity of people. Attractive odours and carbon dioxide emitted by humans then divert the insects from the trap device to the people.

11.0 TREATMENT OF BITES

Relief from bites and prevention of secondary infection can be obtained by the application of various products, either to the skin or internally. The effectiveness of various products is variable, depending on individual reaction. Skin application products include proprietary products such as Eurax, Stingose, Medicreme, Katers lotion, Dermocaine and Paraderm crème and topical antihistamine products, and non-proprietary products such as paw paw ointment, tea tree oil, eucalyptus oil, aloevera gel, ice, or methylated spirits.

Ice packs to the general bite site will give usually give immediate relief for painful and itchy bites and swelling or blisters from of mosquitoes and biting midges in particular. The sooner the ice pack is applied after bites or reactions, the better the relief, and can often avoid more intense reactions. Some people have had good results from the application of paw paw ointment following bite reactions in the reducing the itching and aiding the healing process.

Other products for internal application for more general symptoms include oral antihistamine products such as Phenergan, Telfast and Vallergan. Check with your doctor or pharmacist for any products for the latest product and safety information.

12.0 EMERGENCY BITING INSECT PROTECTION

There are a number of emergency measures that can be taken when exposed to biting insects with no protection. Sheltering downwind next to smoky fires can offer considerable protection. Burning dung or aromatic and oil producing foliage from plants such as *Hyptis* (horehound), *Vitex* (black plum), *Calytrix* (Turkey bush), *Melaleuca* species (Paper bark) and *Eucalyptus* species (gum trees) can make the smoke more effective. A small native plant *Pterocaulon serrulatum* (warnulpu) has sticky strongly aromatic leaves, and branches are burnt or the moist leaves are rubbed on the skin by Aborigines in the Katherine district to repel mosquitoes (Aborigines of the NT 1988). Climbing relatively high trees or choosing locations exposed to the wind can also offer protection from some species.

Some protection can be obtained by rubbing exposed skin areas with the leaves of certain plants such as eucalypts, turkey bush, warnulpu, paperbarks or tea-trees that contain volatile oils. However these are not as efficient as proprietary repellents containing DEET or picaridin. Other emergency protection measures include coating the skin with mud, or burying yourself in shallow sand with some form of head protection. If all else fails, keep running. The best form of protection and the most comfortable require an awareness of the potential problems and adequate preparation.

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An electronic version is available at:

http://www.health.nt.gov.au/Medical_Entomology/Publications/index.aspx

General enquiries about this publication should be directed to:

Medical Entomology
Department of Health
PO Box 40596, Casuarina, NT 0811

XPhone: (08) 8999 8901

XFacsimile: (08) 8999 8820

Appendix 3: Guidelines for preventing mosquito breeding sites associated with mining sites

Northern Territory Government DEPARTMENT OF **HEALTH AND FAMILIES**

Guidelines for Preventing Mosquito Breeding Sites Associated with Mining Sites

Medical Entomology
Centre for Disease Control
Department of Health and Families
Northern Territory Government
Darwin NT
November 2005

DEPARTMENT OF **HEALTH AND FAMILIES**

Guidelines for Preventing Mosquito Breeding Sites Associated with Mining Sites

Peter Whelan and Allan Warchot

General Comments

All mining operations need to include a section in an Environmental Management Plan for the monitoring and control of mosquitoes. This is necessary because of the potential of mine sites to provide extensive breeding sites for mosquitoes of pest and disease significance. Mine sites also provide the potential for the introduction of mosquito species and mosquito borne diseases into the NT that are either exotic to the NT or have previously been eliminated.

The monitoring of adult mosquitoes in any new mine should include trapping of adult mosquitoes once a month at a number of sites for the initial 12 months baseline mosquito monitoring program. The baseline mosquito-monitoring program provides an indication of the seasonal distribution of the mosquito species present and the relative potential impact of mosquito borne disease to mine personnel.

The monitoring and control of mosquito larvae should be an ongoing operation for the life of the mine. Mosquito larvae must be controlled with an approved mosquito larvicide (*Bacillus thuringiensis* var. *israelensis* or methoprene) as part of an organised monitoring and control program. Any mosquito control program should be discussed with the Medical Entomology Branch of the Department of Health and Community Services with regard to methods and insecticides.

Accommodation for personnel should be sited as far as possible from the most important biting insect breeding sites and be adequately insect screened or otherwise protected to reduce the impact of mosquitoes.

The potential for artificially created mosquito breeding sites can be minimised with the appropriate design of water holding facilities and water management procedures.

1. Water Dams

- All water storage dams should be constructed with relatively steep sides (45° slope minimum) to discourage the establishment of semi-aquatic vegetation (eg. *Typha* and *Eleocharis* reeds) that will provide suitable habitats for mosquito breeding.
- Dam margins should be as straight as possible to minimise the linear area available for the establishment of semi-aquatic vegetation.
- Where possible, any closely grouped dams should be joined together to minimise the linear margin of vegetation.
- The bottom of any dam should be graded as level as possible, with a slight slope to one end to form a deeper section for periods of low water. This will remove the potential for the formation of isolated pools as the water level recedes in the dry season.
- Areas surrounding any dam that will be flooded during the wet season should be graded to enable water to drain freely into the dam as the water level recedes, without the formation of isolated pools that are capable of retaining water for a period greater than 5 days.
- There must be no islands formed within any dam. All areas of impounded water should have a relatively deep (2 m) wet season stabilised water level to prevent the emergence of semi-aquatic vegetation.
- Any drainage line directed into a dam must be fitted with a sediment trap or erosion prevention structures just upstream from the dam. This is necessary to prevent the formation of "alluvial fans" that will promote the establishment of semi-aquatic vegetation in the area of the fan where silt will be progressively deposited.
- Any overflow areas from dams should have erosion protection measures to prevent the creation of plunge pools.
- Local native fish should be introduced or have access into any dams where the water quality is suitable for their survival, to provide natural predators for the control of mosquito larvae.
- The margins of any water dam should be inspected annually for vegetation growth such as semi-aquatic vegetation and grass. Any dense marginal vegetation should be herbicided or physically removed, to prevent the vegetation from creation suitable mosquito breeding sites.

2. Wet land filters

- Wetland filters have the potential to provide prolific breeding sites for mosquito species of pest and disease significance. If no other alternative is available for the treatment and disposal of waste water, a wetland filter should incorporate the ability to annually reduce the build up of any dead vegetation. Plans for wetland filter design and siting should be forwarded to the Department of Health and Community Services (Medical Entomology Branch) at the planning stage to ensure that their potential impact on the health of mine site personnel is minimised.

- Annual maintenance could be achieved by dividing a wetland filter into separate sections. A dual system will enable water to be directed into one section of the filter while vegetation is burnt or otherwise reduced in the other section. An ability to manipulate the water level in the filter to strand or drown vegetation would be beneficial for the management of vegetation and mosquito numbers.

- Stocking the wetland filter with local native fish will provide a significant measure for controlling mosquito larvae. The provision of fish however will not remove the need for annual maintenance of the wetland filter.

- Where appropriate, consideration should be given to the provision of a fish ladder on any overflow facility to enable the dispersal of fish into and upstream of the filter.

- Wetland filters may need to be removed after mining operations are completed to enable the future development of adjacent land.

3. Weirs

- Any spillways must be fitted with erosion prevention structures to prevent scouring and siltation of creek lines during periods of overflow.

- Fish ladders should be constructed where appropriate to enable the upstream dispersal of fish following periods of dam overflow.

4. Mine Waste Dumps

- The final surface of mine waste dumps should be contoured so that the surface area is free draining and has no surface depressions.

- Any runoff from a waste dump should be directed to a silt trap to prevent any siltation of natural creek lines. Siltation in creek lines can promote the formation of isolated pools or disrupt fish ecology and may lead to the subsequent establishment of mosquito breeding sites.

- Mine waste dumps should be located away from natural drainage lines, to prevent the upstream impoundment of natural surface water flows. If impractical to locate mine waste dumps away from natural drainage lines, diversion drains will be required to direct surface water flows around the waste dump.

5. Sediment Traps

- Sediment traps need to be designed where possible to be free draining within a period of 5 days after flooding.
- Sediment traps that can not be free draining within 5 days must be steep sided and have a sloping bottom base to one end, with erosion protection (e.g. reno mattress) at the inflow and overflow facility.
- Sediment traps should be maintained by silt and vegetation removal on an annual basis. There should be a designated and designed access path for silt removal.
- Sediment traps with dry season low flows should be sampled for mosquito larvae monthly in the dry season and appropriate mosquito control programs arranged with the appropriate authority.

6. Borrow Pits

- Borrow pits, costeans or scrapes must be rehabilitated, where possible, such that they do not hold water for a period greater than 5 days. These sites within 5km of urban residential areas must be rehabilitated either by filling or rendering them to be free draining.
- Borrow pits that cannot be rehabilitated must be steep sided, have a sloping floor to one end and have surrounding stormwater catchments directed to the upper end, so that they will fill with silt over time.
- There should be no dry season low flows from storm water drainage directed into borrow pits.

7. Drainage Paths

- Natural drainage patterns should be maintained where possible. Access roads across drainage lines may need to be fitted with culverts of sufficient size to prevent upstream flooding for periods that will enable mosquito breeding. Culverts should be installed flush with the upstream surface level. Erosion prevention structures will need to be constructed on the downstream side of any culvert, and erosion prevention structures may also be required at the headwalls of any culvert.
- Any disruption to surface drainage should be removed at the end of the mining operations.

DEPARTMENT OF **HEALTH AND FAMILIES**

8. Pit Dewatering

- Pit water discharge should be free of silt. Dry season pit water discharge should be directed into a water dam, and not into natural drainage lines or creek lines unless there is provision to prevent the growth of semi-aquatic reeds in the discharge area.

9. Waste Water Disposal

- Septic tanks must be installed to DHCS guidelines and should be inspected on an annual basis by the Environmental Officer to ensure that tanks and their effluents do not breed mosquitoes.
- Discharge, overflow or excess effluent from sewage treatment systems must be disposed of in a manner approved by DHCS. A sprinkler disposal system is suitable under most situations. Infiltration systems are acceptable if soil conditions are favourable. The discharge of excess effluent into ephemeral creek lines is not acceptable.
- Sewage ponds should be constructed with steep sides with an impervious lining and be regularly maintained to prevent vegetative growth at the margins (see *"The prevention of mosquito breeding in sewage treatment facilities"*, available from the Medical Entomology Branch). Surface debris and algal scum should be removed on a regular basis. Monitoring of mosquito larvae should be conducted in sewage ponds on a regular basis and control treatments conducted when necessary.
- Disposal of water into "Application areas" must ensure that water does not pool for a period greater than 5 days.

10. Artificial Containers

- Rainwater tanks must be adequately screened to prevent the entry of mosquitoes.
- Any container capable of holding water, eg. Machinery tyres, drums, disused tyres, tanks, pots, etc. should be stored under cover, be provided with drainage holes, emptied on a weekly basis, treated with an appropriate insecticide on an appropriate schedule, or disposed of in an appropriate dump site to prevent the formation of mosquito breeding sites.
- No used tyres, machinery or other containers that have previously held rain water should be brought to the NT from Queensland unless the containers or machinery has been thoroughly treated with chlorine or an appropriate insecticide to remove the possibility of the introduction of drought resistant eggs of exotic *Aedes* mosquito species.

11. Rubbish and Garbage Dumps

- Rubbish and garbage dumps must be operated in such a matter that there is no ground surface or water filled receptacle pooling of water for a period greater than 5 days, to prevent the formation of mosquito breeding sites.
- Rubbish and garbage dumps must be rehabilitated by filling and surface contouring to ensure they are free draining and have no surface depressions.

12. Decommissioning and Rehabilitation

- A decommissioning and rehabilitation plan should be in place for all mining operations to ensure no actual or potential mosquito breeding sites remain after cessation of mining operations. All disturbed areas should be rehabilitated to be free draining where practical. The proponent should consult the Medical Entomology Branch for input when preparing this document.
- Aspects to consider when decommissioning and rehabilitating a mine site include removing and appropriately grading all sediment ponds, removing all bund walls created for the development, removing infrastructure and artificial receptacles that could pond water, removing water dams and reinstating existing flowpaths where practical, rehabilitating borrow pits, removing wetland filters, sediment traps, and other facilities that could pond water and breed mosquitoes.
- Facilities such as open pit voids and water dams can be left as water holding pits if they are constructed with steep sides (at least 1:2 slope), and stocked with fish during the rehabilitation process.

13. Notes

- These guidelines replace former guidelines 'Guidelines for preventing mosquito breeding sites associated with mining sites', by Brian Montgomery and Peter Whelan May 1997.

Appendix 6

Draft Biodiversity Management Plan

For

TELLUS

Tellus Holdings

Chandler Project

Prepared by: Low Ecological Services P/L

October 2016

Low Ecological Services P/L

PO Box 3130, Alice Springs, NT 0871

Ph: (08) 89 555 222 Fax: (08) 89 555 722

Email: lowecol@lowecol.com.au

Web: www.lowecol.com.au

Frontispiece: Rocky hill overlooking a sandplain at the Chandler Facility Site, Bottom (left to right): *Crotalaria eremaea* (bluebush pea), *Varanus gouldii* (sand goanna), and *Solanum ellipticum* (bush tomato).

DISCLAIMER

This document has been prepared by Low Ecological Services (LES) for Tellus Holdings Ltd (Tellus) in accordance with an agreement with Tellus. LES has prepared this document using the skill and care expected from professional scientists to provide factual and technical information and reasonable solutions to identified risks. It does not constitute legal advice.

ACKNOWLEDGEMENTS

LES acknowledges the assistance of Sophy Townsend and Richard Phillips of Tellus, Central Land Council Santa Teresa rangers (Shannon, Petria, Bronwyn, Norbert, Gibson and Charlie) and Central Arrernte people, Merilyn Kenny, Peter Kenny and Dennis Kenny, from Walkabout Bore (60km NNW of Halfway Dam) for their assistance in developing this BMP.

DOCUMENT DETAILS

Name of Document:	Biodiversity Management Plan
Authors:	Jeremy Snowdon-James, Katie Degnian, Lauren Young and Bill Low
Client:	Tellus Holdings Ltd
Name of Project:	Chandler Salt Mine

DOCUMENT CONTROL

Approvals	**Name**	**Signature**	**Date**
Originator:	Low Ecological Services		04/10/2016
Reviewer:	Tellus Holdings Ltd	×	
Administrator:	Tellus Holdings Ltd	×	
Approver:	Dep't of Mines and Energy	×	
Custodian:	Tellus Holdings Ltd	×	

PREFACE

This document will remain a working document until it is finalised as an operational document and can be used as such by operators in the field. The final version will incorporate any comments or recommendations resulting from any government approval processes; it is not anticipated that any major changes to the document will be required.

All information on proposed operations contained in this document has been supplied by Tellus.

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List of abbreviations	
BMP	Biodiversity Management Plan
BFMP	Bushfire Management Plan
BIMP	Biting Insect Management Plan
CEMP	Construction Environmental Management Plan
CLC	Central Land Council
DENR	Department of Environment and Natural Resources (Northern Territory)
DLRM	Department of Land Resource Management (Northern Territory), now DENR
DME	Department of Mines and Energy (Northern Territory), now DIPR
DoE	Department of Environment (Commonwealth), now DoEE
DoEE	Department of Environment and Energy (Commonwealth)
DoEWHA	Department of the Environment, Water, Heritage, and the Arts (Commonwealth) now DoEE
DPIR	Department of Primary Industries and Resources
EA Act	Environmental Assessment Act
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPBC Act	Environment Protection and Biodiversity Conservation Act (Commonwealth)
ERP	Emergency Response Plan
GPS	Global Positioning System
IECA	International Erosion Control Association
LES	Low Ecological Services
MM Act	Mines Management Act (Northern Territory)
MMP	Mine Management Plan
MNES	Matters of National Environmental Significance
MSDS	Material Safety Data Sheet
NEPM	National Environmental Protection Measures
NT	Northern Territory
NT EPA	Northern Territory Environment Protection Authority
RoM	Run of Mine
Tellus	Tellus Holdings Ltd
TO	Traditional Owner
ToR	Terms of Reference
TPWC Act	Territory Parks and Wildlife Conservation Act (Northern Territory)
WMP	Weed Management Plan

11. INTRODUCTION

Tellus Holdings Ltd (Tellus) propose to construct and operate an underground rock salt mine and storage facility (herein referred to as "the Chandler Facility"), a rail siding with storage and transfer facilities (herein referred to as "the Apirnta Facility") and haul and access roads (herein referred to as "the Chandler Haul Road" and the "Henbury Access Road", respectively). If approved, the Chandler Facility will be located on a current pastoral lease (Maryvale Station) approximately 120 km south of Alice Springs in the Northern Territory (NT). The Apirnta Facility would be located approximately 30 km to the west of the Chandler Facility, also on a pastoral lease (Henbury Station). The haul road would span the western half of Maryvale Station and the access road would span the eastern half of Henbury Station. Collectively, the two proposed facilities, and the haul and access roads are referred to as "the Proposal". Figure 11-1 shows the location of the Proposal and Figure 11-2 shows the proposed Chandler Facility layout.

Approximately 750,000 tonnes of salt product would be exported per annum from the Chandler Facility. The proposed Chandler Facility would also provide for the safe and secure storage and permanent isolation of up to 400,000 tonnes of waste per annum. The Apirnta Facility would allow for the temporary storage during transport of up to 400,000 tonnes of waste.

Tellus Holdings Limited (Tellus) has contracted Low Ecological Services (LES) to prepare a Biodiversity Management Plan (BMP) to accompany the Environmental Impact Statement (EIS) for the Proposal.

The environmental objectives of the Proposal are to:

- Maintain the conservation status, diversity, geographic distribution and productivity of flora and fauna at local species and ecosystem levels through the avoidance or management of adverse impacts on the Proposal area and on adjacent areas that may be impacted.
- Minimise the risk of significant impacts to threatened species and migratory species listed under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act), and *Territory Parks and Wildlife Conservation Act* (TPWC Act).
- Prevent the introduction and/or spread of invasive and pest species.

This BMP for the Proposal has been developed using best practice guidelines and standards, knowledge from arid land ecology specialists with extensive experience in the region, and consultations with Aboriginal traditional owners (TOs) and other stakeholders.

This BMP would be updated if the Proposal is approved by the Commonwealth and Northern Territory (NT) governments in accordance with approval conditions issued after formal assessment and other recommendations resulting from the Environmental Impact Statement (EIS). This BMP is a working document and would be reviewed in consultation with environmental regulators including the Commonwealth Department of Environment and Energy (DoEE), NT Department of Environment and Natural Resources (DENR), NT Environmental Protection Agency (EPA) and NT Dept of Primary Industries and Resources (DPIR) as required.

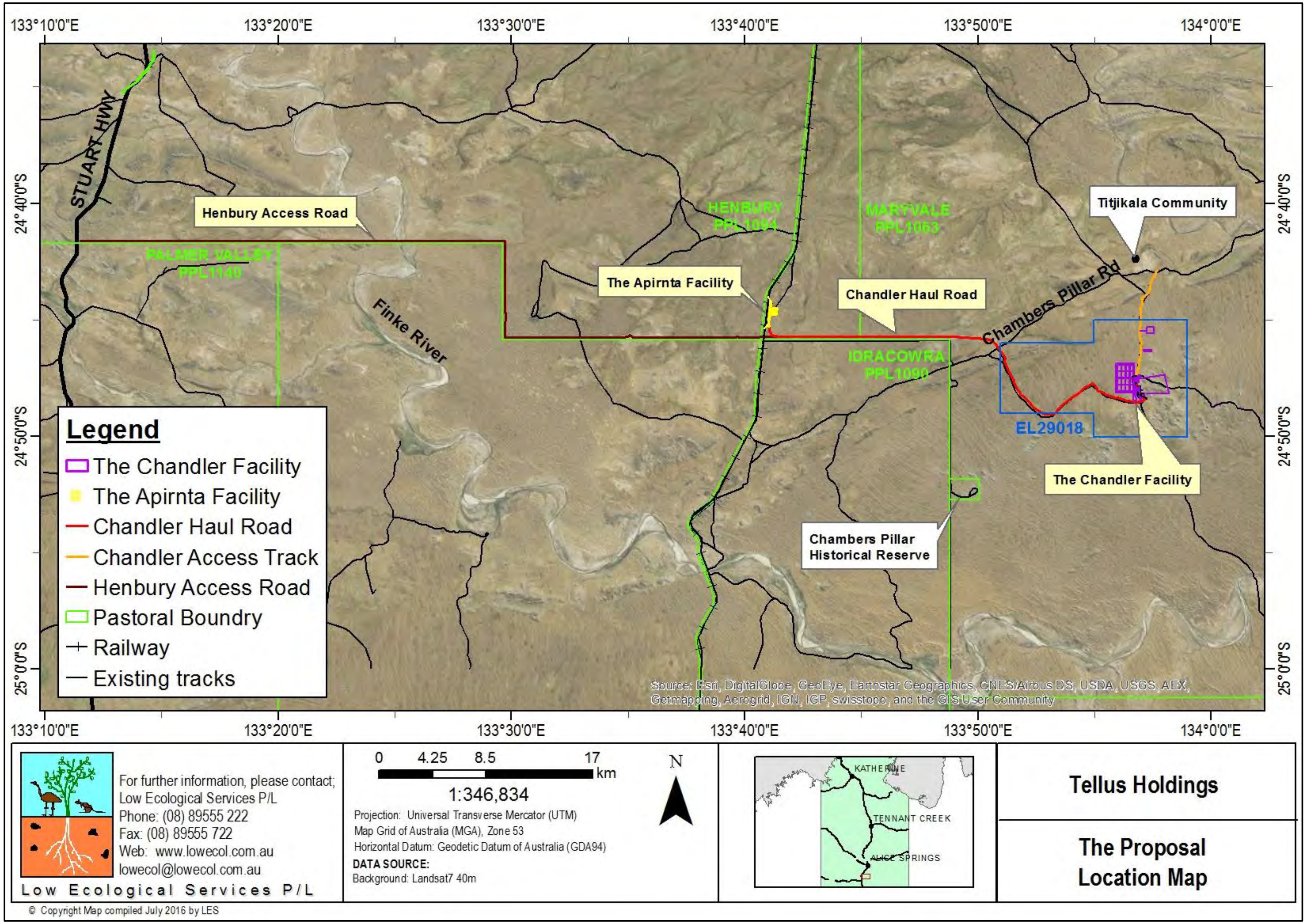

Figure 11-1: Location of the Chandler Facility, Apirnta Facility, Henbury Access Road and Chandler Haul Road on Maryvale Station and Henbury Station

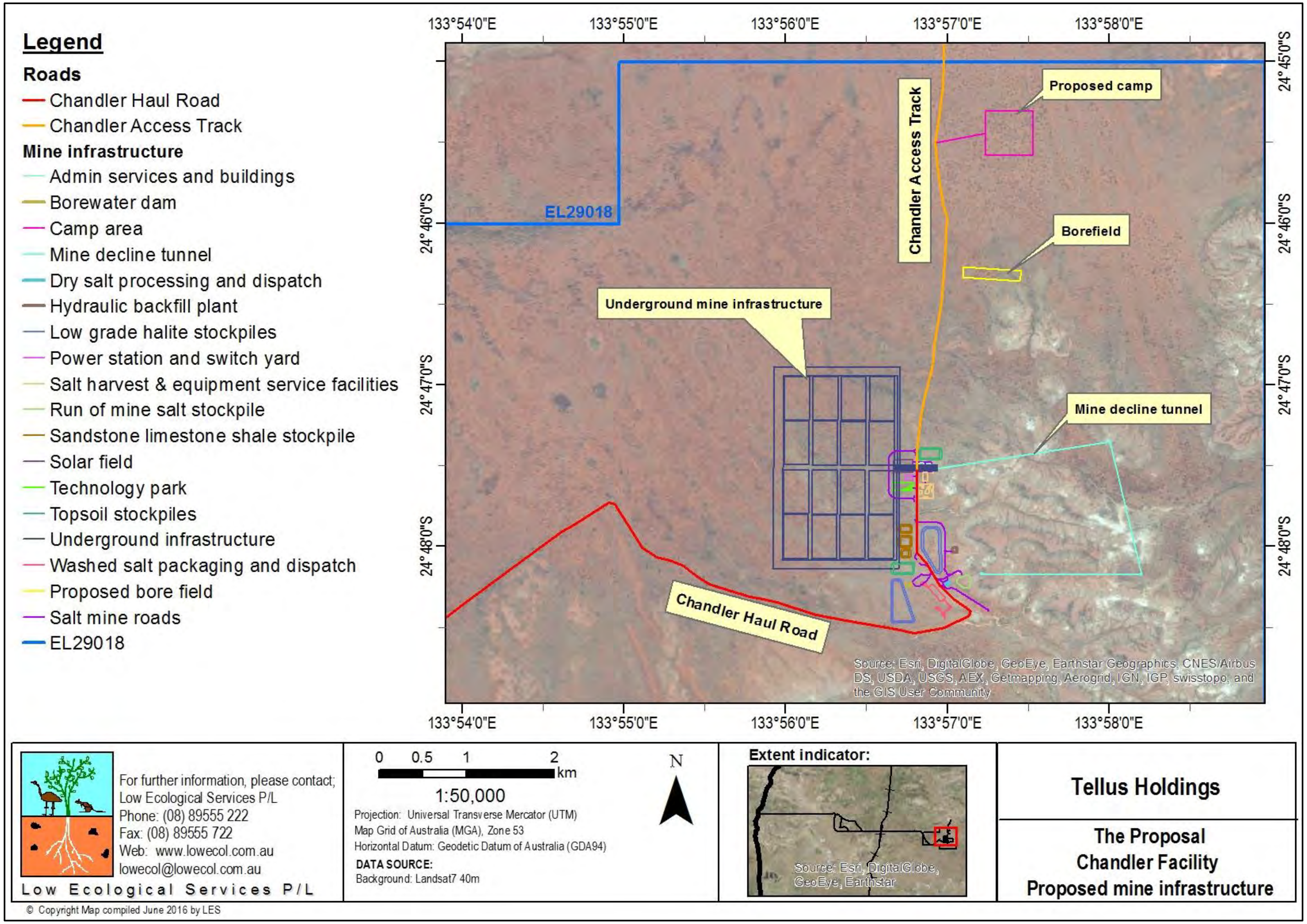

Figure 11-2 Location of the Chandler Facility infrastructure.
Note the decline descends from the surface at the south west end to about 800 m below ground.

11.1 Scope

The scope of this BMP is to outline clear and concise methods to mitigate and monitor potential impacts to biodiversity and do so in accordance with best practice advice from relevant NT and Commonwealth advisory agencies as well as from experienced researchers and experts in the field. It has been designed to exist as a standalone document and as an appendix to the Risks to Biodiversity Report. The BMP is a working document, subject to approval conditions and recommendations based on the technical assessment, and improvements as a result of annual review by Tellus. This document is to be used as a guide for operators in the field to implement best practise standards and measures to reduce potential environmental impacts from the construction and operation of the Proposal.

11.2 Purpose

This BMP has been compiled to meet section 4.4.3 in *Terms of Reference for the Preparation of an Environmental Impact Statement – Chandler Facility* (ToR) issued by the NT Environment Protection Authority (NT EPA) in September 2016 under the Environmental Assessment Act (EA Act). This BMP is limited to mitigating and monitoring impacts on biodiversity occurring in The Proposal area as a result of activities at the Proposal during construction, operation and closure.

11.3 Project Background

The Proposal includes an underground rock salt mine and a storage and permanent isolation facility (the Chandler Facility), as well as a supporting surface storage and transfer facility (the Apirnta Facility) and haul and access roads (the Chandler Haul Road and the Henbury Access Road). A location map is provided in Figure 11-1. A description of the facilities and roads is provided below.

The Chandler Facility

Tellus propose to develop a new underground rock salt mine and complementary storage business with supporting aboveground infrastructure that would export up to 750,000 tonnes of salt product per annum. The facility would also provide for the safe and secure storage and permanent isolation of up to 400,000 tonnes of waste per annum. The rock salt mine and complementary storage facility is referred to as the Chandler Facility.

Mining activities at the Chandler Facility would involve:

- Deep mining of rock salt using a ‘room and pillar’ system of mining;
- Transport of salt via shaft hoisting to the surface;
- Stockpiling of rock salt for processing and packaging; and
- Transport of rock salt to domestic and overseas market:
    - **Domestic market (via road and rail)** - road transport via truck on federal and state highways. Rail transport via a proposed new railway siding located at the Apirnta Facility.
    - **Overseas market (via rail)** - rail transport also via the proposed new railway siding located at the Apirnta Facility, predominantly south to a port facility in Adelaide. From there, rock salt would be shipped to overseas markets predominantly in Asia.

Storage at the Chandler Facility would involve:

- Transport of materials (equipment, archives, etc.) and waste, predominantly by rail, for receipt and temporary storage at the Apirnta Facility;
- Transfer of waste materials from the Apirnta Facility to the Chandler Facility via the proposed Chandler Haul Road;
- Transport of packaged materials via mine access decline or via hydraulic backfill into the voids left from the salt mining operation;
- Waste would be permanently isolated in line with a strict waste acceptance criteria and in accordance with operational management plans;
- Materials such as equipment and archives would be stored separately for future retrieval.
- Once full, sealing the underground voids permanently with an engineered barrier.

A map of the proposed Chandler Facility is provided in Figure 11-2. The facility would be designed and managed to allow for future waste recovery opportunities – that is, wastes would be stored like-with-like and the final disposal locations of all waste would be tracked and logged for future reference.

The salt would be mined from the Chandler Salt Bed which is located approximately 850 m below the surface. Materials stored within the voids left from the mining operation would, therefore, be situated within a salt bed approximately 200 m to 300 m thick allowing the waste to be permanently removed from the biosphere in a stable and dry environment.

The key underground infrastructure at the Chandler Facility would include:

- Underground mine.
- Mine access decline.
- Two ventilation shafts (one allowing for salt hoisting and personnel riding as well as downcast ventilation, and one for upcast ventilation).

The key aboveground infrastructure at the Chandler Facility would include:

- Salt processing facilities (salt processing and sales would be deferred for the first five years of salt mining);
- Waste unloading area;
- Waste storage warehouse;
- Surface hydraulic backfill plant and underground reticulation;
- Salt and overburden stockpiles;
- Maintenance buildings;
- Administration buildings;
- Worker accommodation;
- Solar/diesel hybrid power plant;
- Clean and raw water dams;
- Water and sewage treatment;
- Fuel storage facility;
- Utility reticulation: and
- Technology recovery park.

*Apirnta **Facility***

The Chandler Facility would be supported by a proposed new rail siding and a laydown area that would support the temporary storage of wastes; the Apirnta Facility. The purpose of the storage and transfer facility would be to provide a licensed facility that safely allows for the temporary storage of waste products prior to being transported by road for storage and permanent isolation at the Chandler Facility.

Waste would be brought to the storage and transfer facility via rail and off-loaded at the new rail siding. They would be transported into the Apirnta Facility for temporary storage prior to being transported, via the proposed Chandler Haul Road, for storage and/or permanent isolation at the proposed Chandler Facility.

The proponent is seeking approval for the Apirnta Facility to temporarily store a maximum of 400,000 tonnes of waste, although average volumes are expected to be less than this amount. The waste would be stored either in a warehouse, within an open storage yard or within a liquid storage tank depending on the type of waste.

The Apirnta Facility would receive waste materials transported by reputable companies licenced to transport dangerous goods. Waste arriving would be inspected, sampled, unloaded and appropriately stored in line with a strict waste acceptance criteria and in accordance with operational management plans.

Waste materials to be stored in the warehouse would be sealed in storage containers and wrapped in plastic on wooden pallets then stacked in high-bays. The storage yard would be used for the temporary storage of waste materials that would be sealed in shipping containers. The liquid storage tank would be used to store a variety of liquid wastes.

The Chandler Haul Road and Henbury Access Road

Haul and access roads would be constructed as part of the Proposal. The Chandler Haul Road would be approximately 30 km long and would connect the Chandler Facility to the Apirnta Facility. It would provide for the movement of salt from the Chandler Facility to the rail siding at the Apirnta Facility. It would also provide for the movement of waste temporarily stored at the Apirnta Facility to the Chandler Facility.

The Henbury Access Road would be approximately 60 km long and would connect the Apirnta Facility to the Stuart Highway. The main purpose of the access road is to provide for the movement of workers and delivery vehicles to and from the Stuart Highway to the Apirnta Facility and through to the Chandler Facility. The Henbury Access Road would be constructed once mining operations have begun. During construction, all workers, equipment and delivery vehicles would access the Chandler Facility via the existing Maryvale Road (a public road).

Both roads would be unsealed and would be designed appropriate to their proposed end use. The Henbury Access Road is proposed to be single lane with passing places and the Chandler Haul Road is proposed to be dual lane. Both roads would be designed and constructed to appropriate industry standards.

11.4 Legislation and Regulatory Requirements

11.4.1 Commonwealth Legislation

EPBC Act

The EPBC Act is the Australian Government's key piece of environmental legislation which came into force on July 16, 2000. The objective of the EPBC Act is to provide for the protection of matters of national environmental significance (MNES) and to promote the conservation of biodiversity. The EPBC Act focuses Australian Government interests on the protection of MNES, with the states and territories having responsibility for matters of state and local significance. The EPBC Act identifies MNES as:

- World heritage properties;
- National heritage places;
- Wetlands of international importance (Ramsar wetlands);
- Threatened species and ecological communities;
- Migratory species;
- Commonwealth marine areas;
- Great Barrier Reef Marine Park;
- Nuclear actions (including uranium mining); and
- A water resource, in relation to coal seam gas development and large coal mining development.

The Proposal was referred to the DoEE (the then Australian Government Department of Sustainability, Environment, Water, Population and Communities) and on 21 February 2013 and was determined to be a Controlled Action under the EPBC Act as the proposed action has the potential to result in significant impacts to listed threatened species and communities (sections 18 & 18A) which is a matter protected under Part 3 of the EPBC Act.

The Proposal would be assessed at the level of EIS under the NT EA Act. This would be done under the NT/Commonwealth bilateral environmental assessment process. If approved, this BMP would be updated based on approval conditions of the NT EPA technical assessment.

11.4.2 State Legislation

NT Parks and Wildlife Conservation Act 2000

The *Territory Parks and Wildlife Conservation Act 2000* (TPWC Act) is "an Act to make provision for and in relation to the establishment of Territory Parks and other Parks and Reserves, and the study, protection, conservation and sustainable utilisation of wildlife". Under the TPWC Act, all threatened species are classed as protected wildlife. The Act includes 'Principles of Management', which require that a threatened species be managed in a manner that "maintains or increases their population or the extent of their distribution at or to a sustainable level.

This BMP ensures that species protected under the TPWC Act species are managed in accordance with the TPWC Act.

Environmental Assessment Act 1982 and Environmental Assessment Administrative Procedures 1984

The EA Act and the *Environmental Assessment Administrative Procedures 1984* are administered by the NT EPA. The EA Act provides a framework for the assessment of potential environmental impacts as a result of developments. The objective of the EA Act is to ensure that matters affecting the environment to a significant extent are fully examined and taken into account in decisions by the NT Government. The assessment process also evaluates the effectiveness of the proposed safeguards to mitigate these impacts during construction and operational phases of the development.

The Proposal was referred on November 23, 2012 to the NT EPA for assessment under the EA Act. On 7 March 2013, the NT EPA determined that the Proposal required formal assessment under the EA Act at the level of an EIS.

Mining Management Act 2001

The *Mining Management Act 2001* (MM Act) is administered by the DPIR. The objectives of the MM Act are to ensure that mining in the NT is conducted in accordance with best practice standards for health, safety and the environment. Under the MM Act, an application for authorisation to carry out mining activities must include a Mining Management Plan (MMP). If the Proposal is approved by the NT EPA, Tellus would submit a MMP.

Weeds Management Act 2001

The *Weeds Management Act 2001* is administered by DENR. The objective of the *Weeds Management Act* is to prevent the spread of weeds in to and out of the NT and to ensure that the management of weeds is an integral component of land management in accordance with the Alice Springs Regional Weed Management Plan 2013–2018 (Department of Land and Resource Management Weed Management Branch, 2013) or any other strategy adopted to control weeds in the NT.

If a weed species is ‘declared’ under Section 7 of the Act, the mining operator is required to comply with the following action;

- Class A: To be eradicated;
- Class B: Growth spread to be controlled; and
- Class C: Introduction to the NT is to be prevented.

Other legislation

Other legislation that may relate to this BMP includes:

Land Use:

- *Mineral Titles Act 2016;*
- *Soil Conservation and Land Utilization Act 2016;*
- *Bushfires Act 2014;* and
- *Pastoral Land Act 2016.*

Water Quality and Biodiversity Conservation:

- *Water Act 2016;*
- *Biological Control Act 2016;* and

- *Public and Environmental Health Act 2016.*

Air Quality, Noise and Waste Management:

- *Waste Management and Pollution Control Act 2016*; and
- *Public and Environmental Health Act 2016*.

Safety and Environmental Compliance:

- *Work Health and Safety (National Uniform Legislation) Act 2016*;
- *Environmental Offences and Penalties Act 2011*;
- *Transport of Dangerous Goods by Road and Rail (National Uniform Legislation) Act 2016*; and
- *Dangerous Goods Act 2012.*

12 MITIGATION MEASURES, PERFORMANCE STANDARDS

12.1 Objective

Tellus aim to maintain the conservation status, diversity, geographic distribution and productivity of flora and fauna at species and ecosystem levels through the avoidance or management of adverse impacts.

12.2 Outcomes

In order to meet the objective, the following targets are set in this BMP:

1. Vegetation clearing does not exceed that which is approved;
2. No additional weed species (not previously recorded on site) recorded on site, no increase to weed spread in the Proposal area and weeds are managed in accordance with the NT Weeds Management Act;
3. No injury or fatality to fauna;
4. No increase in pest fauna species in the Proposal area;
5. No spills or leak of hazardous material into surrounding environment;
6. No notable impacts to surrounding vegetation as a result of airborne salt;
7. No construction or operational waste left uncontained in the Proposal area;
8. No significant increase in dust in the Proposal area;
9. No bushfires as a result of the Proposal;
10. No impacts to surrounding properties due to groundwater drawdown at the Proposal;
11. No contamination of groundwater as a result of the Proposal;
12. No significant increase in erosion and sedimentation as a result of the Proposal;
13. No long term alterations to hydrology as a result of the proposal; and
14. All areas of the Proposal rehabilitated to agreed criteria.

12.3 Mitigation measures for potential impacts to biodiversity

The mitigation measures review would adopt an adaptive approach, with the actual cost and monitored effectiveness of each mitigation measure assessed in order to improve the effectiveness and efficiency of mitigation measures at the Proposal.

Mitigation measures would be reviewed annually and best practice industry and government advice to be incorporated to improve the efficiency of mitigation measures at the Proposal. Table 12-1 outlines how these outcomes would be achieved though mitigation measures that would be implemented for potentially significant impacts to biodiversity.

Table 12-1 Overview of general management plans, preventative and mitigation measures to reduce impacts to the biodiversity as a whole.
Note: C – Construction phase; O – Operation phase; D – Decommissioning phase; & R – Rehabilitation phase.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Vegetation clearing, habitat loss and fauna displacement	Pre-clearance survey checklist, based on the NT Land Clearing Guidelines (Department of Natural Resources, Environment, The Arts and Sport, 2010) detailing the following: • confirmed extent of clearing area has required approvals; • land to be cleared is clearly marked; • checked for signs of threatened species; • check for fauna, and re-locate if necessary; • number of mature trees (>5m high). Avoid clearing if possible; • number of large trees with hollows, avoid clearing if possible • number of fallen logs >15 cm in diameter, relocate to surrounding environment; • stockpiles within defined areas; • Topsoil stockpiles <1.5 m in height; • clearing is progressive for environmental benefits;		C.O.	Zero unapproved clearing. Adhere to buffers around watercourses and boundaries set by the NT Land Clearing Guidelines. Maintain vegetation buffers. No threatened flora/ fauna harmed as a result of clearing. Pre-clearance survey for every clearing event. All staff inducted into this BMP.	Pre-clearance survey checklist. Staff induction records. Check cleared area register is consistent with approved cleared area for the annual operations performance reporting.	If non-compliance with pre-clearing checklist occurs: • Incident investigation would be raised under Tellus' incident report procedure. • Cause would be investigated as part of the procedure and addressed to ensure the likelihood of reoccurrence is reduced. • If significant incident would, be reported to the DPIR. • Rehabilitation would be commenced immediately.	Environmental manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	• land clearing supervised; and • once clearing is completed, the supervisor would register the total cleared area in a cleared area register. Stockpile vegetation top soil and spoil separately in low mounds, less than 1.5 m in height. Delay clearing following exceptionally high rainfall events until the ground is sufficiently dry to hold machinery. Induct all staff into this BMP.						
Introduction and spread of weeds	Develop and implement a Weed Management Plan (WMP). Induct staff into the requirements of the WMP. Vehicle/machinery wash-down prior to leaving Alice Springs or entering an area uncontaminated by weeds. Develop a vehicle wash-down weed report. All personnel to avoid spreading weed or invasive species seed, plant matter or soil potentially contaminated with weed seeds. Avoid clearing or removal of any weed or invasive species during seeding, or put plastic bag over seed heads if removing isolated plants.		C.O.D. R.	No additional weed species (not previously recorded on site) recorded on site. No increase to weed spread in the Proposal area. Manage declared weeds in accordance with the NT Weeds Management Act.	Annual weed mapping of the Proposal area, using GPS, during flora and fauna monitoring survey. Vegetation health monitoring conducted annually See Flora & Fauna Monitoring Plan). Data would be compared between surveys as part of annual operations performance reporting.	If a WoNs or declared weed is recorded on site that was not previously recorded on site, Tellus will inform the relevant government authorities. Weeds will be managed in accordance with the NT Weeds Management Act. If the existing extent of weeds spreads, Tellus	Environmental manager, staff contractors.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	Annual weed mapping of the Proposal area. Removal of weed or invasive species before seeding times. Avoid driving in wet and muddy conditions, where possible. Annual flora and fauna survey to record numbers and distribution of introduced flora and fauna species.				Vehicle wash down weed reports.	would increase weed management effort to rectify the spread of weeds.	
Increased pest fauna species	Carry out feral animal control as required in consultation with stakeholders. Reduce artificial standing water. Develop and implement a pest fauna management plan. Develop, implement and maintain fauna sighting register. Install fauna proof fence around all infrastructure. Develop and implement a no tolerance policy to the introduction of pest species by contractors, suppliers and personnel. Replace cleared brush or vegetation stockpiles on all cleared areas no longer required (to inhibit movement of predators and introduced herbivores Ensure waste receptacles are fauna		C.O.D. R.	No additional introduced fauna species (not previously recorded on site) recorded in the Proposal area. No increase to introduced fauna populations as a result of the Proposal.	Track-based monitoring, fauna trapping and spotlighting conducted annually (Flora & Fauna Monitoring Plan). Data can be compared with between surveys. Fauna sighting register.	If an introduced fauna species is recorded that was not previously recorded on site, Tellus would inform the relevant government authorities. If there is an increase in pest fauna species, Tellus would increase pest fauna management.	Environmental manager, staff, contractors.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	proof. Do not feed fauna. Remove any dead fauna or insects from the Proposal and either dispose off-site.						
Fauna Strike or Injury	Induct all staff and contractors into the requirements of the BMP and other associated management plans. Traffic to adhere to speed limits and local road rules. Minimal use of vehicles required for safe operation of plant site. No off-road driving. Develop and maintain a fauna incident register. Minimise driving at night, where possible. Limit access of third parties to mining lease. Speed limit and potential fauna crossing signs clearly displayed on Chandler Haul Road, Henbury Access Road and other access tracks within the Proposal area. Driving restricted at dusk, dawn and at night, where possible.		C.O.D. R.	No fauna strike.	All fauna strikes recorded in fauna fatalities register.	A fauna injury or fatality would trigger: • An Incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed reduce the likelihood of reoccurrence. • If significant (i.e. involving > 1 individual or a listed species), incident, would be reported to the appropriate government	Staff, contractors and environmental manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
						authorities.	
Airborne Salt	Cover all salt during transport. Store salt in open stockpile for minimum time required. Survey/monitor flora in dominant down wind direction from salt mine for impacts.		C.O.D. R	No notable impacts to surrounding vegetation as a result of airborne salt.	Vegetation health monitoring conducted annually (See Flora & Fauna Monitoring Plan).	If there is a significant decrease to vegetation health as a result of airborne salt: • An incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed to ensure the likelihood of reoccurrence is reduced. • If significant, the incident would be reported to the relevant government authorities.	Staff, contractors, environmental manager.
Noise and Vibrations	Turn off machinery when not in use.		C.O.D. R.	Reduce noise and vibration.	Noise complaints register.	Noise complaint or non-compliance	Staff, contractors,

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	Establish and maintain a noise complaints register. Ensure blasting works restricted between 7am to 5pm, as practicable. Maintain and regularly service all generators, engines and vehicles on site. Ensure vehicles carry full loads, where possible, to limit the number of vehicles on the Chandler Haul Road and Henbury Access Road.				Vehicle & generators and service logbooks.	with vehicle & machinery servicing would trigger: • Incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed reduce the likelihood of reoccurrence.	environmental manager.
Hazardous Material	All hazardous waste to be contained within a bunded area sufficient to hold 110% of all material. Minimum amount of hazardous materials required for construction, operation, decommissioning and rehabilitation to be stored. Use of suitably qualified consultants for remediation and contaminated site assessments. Hazardous material to be stored outside flood zones and away from watercourses, at the distances		C.O.D. R.	Minimal spills or leak of hazardous material into surrounding environment.	Hazardous material storage log. Incident log. Bund integrity would be monitored weekly by the Environmental manager or delegated staff.	Any break in bund integrity to be immediately remediated and actions recorded in incident log. In the case of a hazardous material spill, an incident investigation would be raised under Tellus' incident report procedure.	Staff, contractors and environmental manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	specified for clearing in the NT Land Clearing Guidelines. Hazardous material to be at least 4 m or outside the canopy of large trees (>10m) or significant vegetation. Develop and maintain a hazardous material storage log. All contaminated waste, from spills or accidental loss, to be classified and either remediated on site or transported to nearest licensed waste disposal facility. National Environmental Protection Measure (NEPM) guidelines Volume B, 2013 to be used in remediation and contamination assessments. No open flames or heat sources near flammable material, appropriate signage used. Material Safety Data Sheets (MSDS), spill kits and appropriate firefighting equipment (water, chemical or foam, etc.) stored next to hazardous material storage and use areas. Site inductions to cover storage, handling and use procedures for all hazardous materials used at the Chandler and Apirnta facilities.					The cause would be investigated as part of the procedure and addressed to ensure likelihood of re-occurrence is reduced. If the spill quantity is over the reportable quantities for spills set by the NT Worksafe, the incident would be reported to the department immediately.	

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Waste	Develop and implement a Waste Management Plan. Ensure all domestic waste stored in fauna proof bins. All waste stored in appropriate labelled containers. Bund liquid waste where required. Implement waste hierarchy triangle – Avoid/minimise, reuse, recycle, recovery, and then disposal. All waste disposed off-site by licensed contractor. All waste stored in appropriate labelled containers. All hazardous waste and hydrocarbons stored separately in bunded area, with appropriate signage.		C.O.D.R.	No construction or operational waste left uncontained in the Proposal area.	Weekly checks of bins by environmental manager to ensure they are secure and fauna proof.	If uncontained waste as a result of the Proposal is found in the Proposal area, the cause would be investigated and the problem rectified. If bins were found to be not sufficiently fauna proof, this would be fixed.	Environmental manager, staff, contractors.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Dust	Avoid clearing during dry windy conditions. Conduct dust monitoring. Clear with blade up, where possible, for plant and soil retention. Use water trucks during construction, operation, decommissioning and rehabilitation to control dust. Leave vegetation 10 cm in height on firebreaks and non-crucial tracks. Stage clearing operations to reduce total exposed cleared surface at any one time. Inspect flora for signs of stress along edges of roads and cleared areas. Develop and implement a Soil Conservation Management Plan.		C.O.D. R	No significant increase in dust in the Proposal area.	Dust monitoring results to be analysed every month during construction period and every 3 months during operation period. Vegetation health monitoring conducted annually (See Flora & Fauna Monitoring Plan). Data would be compared between surveys.	A significant increase in dust would trigger: • An incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed to ensure likelihood of re-occurrence is reduced. • If significant, incident it would be reported to the appropriate government authorities.	Staff, contractors, environmental manager

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Fire	Implement Bushfire Management Plan (see Risks to Biodiversity Report - Appendix 4). Keep up to date with bushfire website and state services. Construct and maintain firebreaks around all infrastructure and significant habitats. No open flames outside of designated areas unless hot works permit is approved. Flammable material clearly labelled. Adequate firefighting equipment stored on site and staff trained in use. Provide designated smoking area. Organise and implement strategic controlled burning with CLC and TOs to reduce rise of wildfire.		C.O.D. R.	No bushfires as a result of the Proposal.	Site manager/ Environmental manager to keep up to data with bushfire warnings Routine checks to ensure all flammable material is labelled. Weekly check of firefighting equipment during fire season.	Bushfire as a result of the Proposal would trigger: • Incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed reduce the likelihood of reoccurrence. • The bushfire would be reported to the appropriate government authorities as soon as possible.	Staff, contractors, environmental manager, site manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Groundwater drawdown and contamination	Install well caps on monitoring wells. Fence off bores to avoid damage from fauna and large herbivores. Ensure no spill or contamination enters wells. Record extraction rate and amount. Monthly sampling of water quality and depth from all extraction bores.		C.O.D. R	No drawdown significant to impact on surrounding properties. No contamination of groundwater as a result of the Proposal.	Baseline standard physical chemical and metals analysis of water quality and SWL measurements of all production and monitoring wells. Monthly sampling of water quality and depth from all extraction bores. Borewater extraction rates. Monthly monitoring of well surface hygiene to ensure no foreign material enters wells.	If drawdown as a result of extraction from the Proposal impacts stakeholders, this would trigger: • An incident investigation under Tellus' incident report procedure. • A re-assessment of extraction rates. If groundwater is contaminated as a result of the Proposal, this would trigger: • An incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and	Staff, contractors, environmental manager, site manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
						addressed reduce the likelihood of reoccurrence. The groundwater contamination would be reported to the relevant government departments and rectified immediately.	
Erosion and Sedimentation	Leave 5-10 cm of surface vegetation during clearing where appropriate; Avoid clearing in water courses, drainage depressions or slopes greater than 2%; Adhere to land clearing buffers in the NT Land Clearing Guidelines (Department of Natural Resources, Environment, The Arts and Sport, 2010) Construct erosion control devices in line with The DENR, and IECA (International Erosion Control Association) best practise guidelines. Ensure all road water crossings are developed to base level of natural watercourse or adequate culverts are established to reduce flow constriction of watercourses.		C.O.D. R	No significant increase in erosion and sedimentation as a result of the Proposal.	Environmental manager would undertake Monthly site inspection for any signs of erosion including checking watercourse and drainage depression crossings for signs of sediment accumulation. Environmental manager would routinely monitor erosion control devices to ensure integrity.	Significant erosion and sedimentation observed as a result of the proposal would trigger: • An incident investigation would be raised under Tellus' incident report procedure. • The cause would be investigated as part of the procedure and addressed to reduce the likelihood of	Environmental manager, site manager, staff, contractors

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	Locate roads, access tracks and required operational areas on solid surfaces, with low erosion risks where possible. Maintain roads and drains. Limit compacted areas to minimum required Ensure cleared areas are rehabilitated as soon as no longer required for safe operation of the Proposal. Remove all windrows and any concentration points to promote overland sheet flow, where possible along roads, tracks and cleared surfaces. Install flat bottom off-let drains along roads and access tracks. Use whoa-boys or diversion bunds on roads and tracks to dissipate and direct water flow into the surrounding vegetated or stable environment; reducing erosion potential. Diversion drains would be used to separate clean water from dirty water. We would also use these drains to maintain flows to downstream vegetation communities.					reoccurrence. • The issue would be rectified as soon as possible.	

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	Ensure waste rock and other stockpiles are sloped at < 18-20% (preferably 12%) to reduce run-off velocities. Develop roads and tracks along the contour where possible to limit the velocity of surface water flow directly down gradient. Construct sediment control devices in line with DENR and IECA best practise guidelines. Install sediment catch fences during construction, if required.						

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
Altered Hydrology	Implement a Water Management Plan. Allow natural surface drainage to continue without interruption. Avoid clearing or disturbance and infrastructure developments to any watercourse or drainage depression. Develop any creek crossing to natural contours of creek bed. Remove any concentrations points that would impede natural sheet flow. Remove all windrows from access and haul roads. No disturbance within watercourse buffer zones set in NT Land Clearing Guidelines. Leave large mature trees and shrubs, where possible. Construct drains with flat bottom.		C.O.D. R.	No long term alterations to hydrology as a result of the Proposal.	Routine inspection and maintenance of drains and water courses, particularly following major run-off. Vegetation health monitoring conducted annually (See Flora & Fauna Monitoring Plan). Data would be compared between surveys to monitor any change as a result of altered surface flows.	A significant change in surface hydrology as a result of the Proposal would trigger: • An incident investigation would be raised under Tellus' incident report procedure.	Staff, contractors, environmental manager, site manager.
Rehabilitation	Develop and implement a decommissioning and rehabilitation management plan. Install erosion and sediment control temporary structures to assist with rehabilitation. Respread spoil first, then top soil and last cleared vegetation over surfaces. Leave any infrastructure, plant or		D.R	The Proposal area is rehabilitated in accordance to agreement with future land managers. Soil is be stable and in relatively uniform with	Site manager/ Environmental manager would ensure performance standards are met. Third party rehabilitation audit.	If results of audit show non-conformance against performance standards, the issues will be resolved.	Environmental manager, site manager.

Risk	Mitigation measure	Effectiveness of measure	Timing	Performance standards	Monitoring actions	Contingency actions	Responsibility
	cleared area as so detailed in a land use agreement with the land manager. Remove all infrastructure, plant, machinery and operational and construction wastes. Re-contour all cleared surfaces to match surrounding topography, as close as possible. Rip any compacted area ensuring final surface is rough to increase infiltration. Block all access points to roads and tracks, unless agreed with land manager. Fill in sumps or turkey nest, unless agreed otherwise with land manager. Close off and seal all groundwater wells. Leave underground salt mine in condition as stipulated in rehabilitation plan.			surrounding topography. No new weeds or additional spread of existing weeds as a result of the Proposal. No waste left behind as a result of the Proposal. All infrastructure removed.			

13 SPECIES SPEICIFIC BIODIVERSITY MANAGEMENT PLANS

The findings assessments of significance found two threatened species with a low-moderate likelihood of occurring in the Proposal area, were identified as having a potential to be significantly impacted as a result of the Proposal if the species did occur in the Proposal area:

- *Amytornis modestus indulkana* (thick-billed grass wren); and
- *Liopholis slateri slateri* (Slater's skink).

If these species are identified in the Proposal area, a species specific management plan would be developed and implemented.

14 FLORA AND FAUNA MONITORING PROGRAM

14.1 Introduction

The following Flora and Fauna Monitoring Plan has been developed based on industry best practise, government guidelines, consultation with TOs and the Central Land Council (CLC), threat abatement and recovery plans, and LES's extensive experience in arid lands ecology.

14.2 Scope/Purpose

The purpose of the Flora and Fauna Monitoring Plan is to monitor for threatened species, pest fauna and vegetation health to determine the effectiveness of mitigation measures that would be implemented for the Proposal.

This monitoring plan targets threatened fauna species that were recorded in surveys or have a low-moderate to high likelihood of occurring within the Proposal area, including:

- Thick-billed grass wren (*A. m. indulkana*);
- Princess parrot (*Polytelis alexandrae*);
- Australian painted snipe (*Rostratula australis*);
- Brush-tailed mulgara (*Dasycerus blythi*);
- Crest-tailed mulgara (*Dasycerus cristicauda*);
- Southern marsupial mole (*Notorcytes typhlops*);
- Great desert skink (*Liopholis kintorei*);
- Slater's skink (*L. s. slateri*);
- Migratory birds
    - Fork-tailed swift (*Apus pacificus*);
    - Eastern great egret (*Ardea modesta*);
    - Sharp-tailed sandpiper (*Calidris acuminata*);
    - Oriental plover (*Charadrius veredus*);
    - Oriental pratincole (*Glareola maldivarum*);
    - Rainbow bee-eater (*Merops ornatus*);
    - Australian painted snipe (*Rostratula australis* as *R. benghalensis*) (also listed as endangered under the EPBC Act);
    - common greenshank (*Tringa nebularia*); and
    - Marsh sandpiper (*Tringa stagnatilis*).

Pest fauna species targeted:

- Feral cats;
- Foxes;
- Rabbits;
- Camel;
- Donkey; and
- Dingoes.

There are no threatened flora species, threatened ecological communities or sensitive vegetation types that have a moderate or high likelihood of occurring in the Proposal area.

14.3 General methodology

The methodology for the monitoring program would include:

- Track based monitoring;
- Fauna trapping;
- Spotlighting;
- Area searches;
- Mole trenches; and
- Vegetation health monitoring.

Surveys would occur annually during construction and operation periods. Timing and survey effort of flora and fauna monitoring at the Proposal is provided in Table 14-1. Traditional owners would provide expertise for the surveys. Where possible, each site would be used for a number of modules for efficiency. The survey methodology would generally follow the *Standard terrestrial vertebrate survey methods* used by the DLRM (In Northern Territory Environmental Protection Agency, November 2013). Targeted survey methods area based on *Survey Guidelines for Australia's Threatened Mammals* (Department of Sustainability, 2011a), *Survey Guidelines for Australia's Threatened Reptiles* (Department of Sustainability, Environment, Water, Population and Communities, 2011b) or *Survey Guidelines for Australia's Threatened Birds* (Department of the Environment, Water, Heritage and the Arts, 2010).

Table 14-1 Flora and fauna monitoring to be carried out within the Proposal area from year of approval

Phase	Survey purpose	Timing/ frequency	Survey Effort
Pre-construction	Baseline survey & targeted threatened species search	Before construction	Targeted survey for thick-billed grass wren and Slater's skink 3 nights – all flora and fauna monitoring modules
Construction & operation	Flora and fauna monitoring	Annually	3 nights – all flora and fauna monitoring modules

14.4 Site descriptions

At each survey site, a landscape description would be completed within a 50 m x 50 m quadrat to provide an overall snapshot of the landscape, geology, soil, dominant flora species, vegetation structure and density at each site. The presence of termite mounds, woody debris, impact from disturbance, weeds and current vegetation condition would also be noted. Representative photographs of the landscape and vegetation community would be taken at each site, facing north, south, east and west. Data would be entered into a site description data sheet based on *Northern* Territory Guidelines and Field Methodology for Vegetation Survey and Mapping (Brocklehurst, et al., 2007) (Appendix).

14.5 Track-based monitoring

Methodology	
Description	Track counts have been widely used in Australia to monitor the presence and changes in abundance of native and feral animals (Forsyth, et al., 2005; Southgate, et al., 2007). It provides a practical means to monitor the presence of species that are elusive or found in low densities (Allen *et al.*, 1996). The method is intended to monitor both temporal and spatial differences in abundance. The assumption is that the number of tracks counted is proportional to the abundance of animals in the area, however, this method cannot determine precise abundance of a given species in an area. Factors that affect the effectiveness of track-based monitoring include the substrate, weather conditions leading up to the and during the survey and the skill and experience of the trackers. Generally, only animals over 35 g in mass leave sufficiently distinguishable tracks (Southgate & Moseby, 2008).
Purpose	Monitor threatened fauna: • Brush-tailed mulgara; • Crest-tailed mulgara; • Great desert skink; and • Slater’s skink. Monitor pest fauna species: • Feral cats; • Foxes; • Rabbits; • Camel; • Donkey; and • Dingoes.
Methodology	Track-based monitoring methodology would be conducted according to Southgate and Moseby (2008). • Observers walk an area of 2 ha (100 x 200 m) in 30 min. • This time can be divided if there are a number of trackers (ie. 2 searchers= 15 min each). • The area is walked strategically so that most of the ground is covered eg. Zig-zag up one side of the area and zig-zag down the other side. • All signs of fauna including tracks, scats, burrows, diggings, bones, feathers etc. are recorded including the age of the sign and estimated abundance. • A photograph is taken with an object for scale and GPS locations of threatened species tracks or for verification of tracks. • If potential burrow systems of threatened species are identified, a remote camera would be set on the burrows to verify identification and monitor activity.

<table>
<tr><th colspan="2">Methodology</th></tr>
<tr><td></td><td>Data would be recorded in the track-based monitoring data sheet in Appendix.</td></tr>
<tr><td>Site selection</td><td>For Slater's skink, great desert skink, brush-tailed mulgara and crest-tailed mulgara: Sand dunes, sandplains, riverine plains and alluvial areas.
For pest fauna species: One site representing each land system present selected in areas adjacent and down-wind to the Chandler Facility and adjacent to the camp and the Apirnta Facility. Control sites would be selected in replicated land systems away from areas of impact and up-wind from the salt mine.</td></tr>
<tr><td>Timing</td><td>Track-based monitoring would be conducted bi-annually, every 6 months to obtain data on seasonal variability of populations. This is particularly important for fauna with seasonal breeding cycles, such as reptiles that are only active during warmer months.</td></tr>
<tr><td>Data collection and reporting</td><td>Data collection would be conducted every 6 months, followed by data analysis and reporting. Data would be recorded in the track-based monitoring data sheet in Appendix.Appendices
After each survey, data sheets would be scanned and data would be stored electronically. This would allow data to be compared with other track-based monitoring projects and between surveys within the Proposal area.</td></tr>
</table>

Threshold and contingency measures	
Threshold	**Contingency measures**
A threatened species that has not previously been recorded within the Proposal area is recorded in the Proposal area.	• A GPS location would be taken and a photograph if possible. • Tellus would report to the appropriate government departments. • If mining activity is a threat to the species or their habitat, operations would stop in the area of the species habitat. Experts would be consulted with and appropriate avoidance or mitigation measures would be implemented.
Significant decrease in a threatened species population as a result of the Proposal.	Operations would stop in the area the species habitat if appropriate. Tellus would investigate and consult with experts to determine the cause of the species decline and implement appropriate measures to resolve the issue.
Significant increase in signs of introduced species as a result of the Proposal	Tellus would investigate and consult with experts to determine the cause of the species increase and increase pest fauna management effort in the most appropriate manner.

14.6 Fauna trapping

Methodology	
Description	Quadrat trapping survey - Elliot traps and pitfall traps.
Purpose	To determine the presence and if present, the abundance of threatened species: • Brush-tailed mulgara; • Crest-tailed mulgara; • Great desert skink; and • Slater's skink.
Methodology	Fauna trapping methodology would be based on *Standard terrestrial vertebrate survey methods used by the DLRM* (In NT EPA, November 2013). Survey methods • 80 x 80 m grid quadrat with five rows of five Elliott traps at 20 m spacing. A quadrat with equivalent area, but different shape, may be used to sample narrow patches e.g. riparian areas. • Elliott traps would be baited with a mixture of oats and peanut butter. • Four pitfall traps scattered within the quadrat. Each pitfall trap comprises a 20 litre plastic bucket dug into the ground with 10 m of drift-fence set across it to channel small ground-dwelling fauna into the bucket. Pits are located in different microhabitats in the quadrat e.g. open area, dense grass, close to trees, rocky areas. If practical, semi-permanent pitfall traps can be set, and the bucket closed with a lid between surveys. • Eight funnel traps - placed at the end of each drift fence. • All traps would be marked clearly with flagging tape and a GPS location so they can be easily located. • Elliott traps would be checked within 2 hours of sunrise each morning and closed for the day. Elliott traps would be rebaited and opened each afternoon. • Pitfall traps would be checked at the same time as Elliott traps each morning and when Elliott traps are opened in the afternoon. • Trapped animals would be identified and released at point of capture. Note: cage traps have been omitted from the survey methodology as there are no target threatened species in the size range appropriate for cage traps. Presence and abundance of predator populations would be monitored by track-based monitoring.
Site selection	Quadrat location • Quadrats would be located within areas of relatively homogeneous vegetation and landform, and not near boundaries, e.g. fences or roads. With the exception of when a deliberate decision is made to sample a small patch, edge or ecotone. • Quadrats would be well separated (i.e. >500 m apart). • The location of each quadrat would be recorded using a GPS reading. <u>Monitoring sites</u> - Sites would be selected, at least one site representing each land system present in areas adjacent and down-wind from the Chandler Facility, the camp and the Apirnta Facility. <u>Control/ analogue sites</u> - Control sites would be selected in replicated land systems away from areas of impact and up-wind from the Chandler Facility. Data from control sites would be used to compare with the impact sites.
Timing	Fauna trapping would be conducted bi-annually, every 6 months to obtain data on

Methodology	
	seasonal variability of populations.
Data collection and reporting	Data collection, analysis and reporting would be conducted every 6 months. Data would be recorded in the fauna trapping data sheet in Appendix 3. After each survey, data sheets would be scanned and data would be stored electronically. This would allow data to be compared with other track-based monitoring projects and between surveys within the Proposal area.

Threshold and contingency measures	
Threshold	**Contingency measures**
A threatened species that has not previously been recorded within the Proposal area is recorded in the Proposal area.	• A GPS location would be taken. • Photographs would be taken of the threatened species and the habitatit was recorded in. • Tellus would report to the appropriate government departments. • If mining activity is a threat to the species or their habitat, operations would stop in the area of the species habitat. Experts would be consulted with and appropriate avoidance or mitigation measures would be implemented.
Significant decrease in a threatened species population as a result of the Proposal.	• Operations would stop in the area the species habitat, if appropriate. • Tellus would investigate and consult with experts to determine the cause of the species decline and implement appropriate measures to resolve the issue.
Significant increase in signs of introduced fauna as a result of the Proposal	Tellus would investigate and consult with experts to determine the cause of the species increase and increase pest fauna management effort in the most appropriate manner.

14.7 Spotlighting

Methodology	
Description	Spotlighting is a survey method used at night to detect nocturnal species while they are active. The survey is conducted at night with the aid of a spotlight to detect the animals in the dark, usually as a result of their eye shine (light reflected from animals' eyes), or movement. Spotlighting can be conducted along clearings or tracks either by an observer on foot, or from a vehicle, or on foot by an observer away from tracks or clearing in intact habitat.
Purpose	Monitor threatened fauna that are active at night: • Brush-tailed mulgara; and • Crest-tailed mulgara Monitor pest fauna species that are active at night: • Feral cats; • Foxes; • Donkey; and • Dingoes.

Methodology	Spotlighting methods are based on *Survey guidelines for Australia's Threatened Mammals* (Department of Sustainability, 2011a) and are as follows:
	• Use of a light hand-held spotlight (minimum of 30 watt).
	• The spotlight would be held near the observer's line of vision to maximise the chance of detecting eye shine.
	• The spotlight beam would be moved slowly at a consistent speed over the relevant habitat.
	• If necessary, binoculars would be used once an animal has been spotted to confirm the species identity.
	• The observers move a known distance at a set speed:
	  ○ Approximately 10 m per minute walking; or
	  ○ Approximately 5 km per hour in a vehicle.
	• Spotlighting should be conducted as quietly as possible, so that animals are less likely to be disturbed and the observer is more likely to hear any calls or other noises that may indicate the species presence and location.
	• Avoid very windy or rainy nights as these conditions can reduce fauna activity and the observers' ability to detect fauna.
	• Spotlight surveys along transects should be repeated on two separate nights, where possible.
	All fauna species observed would be recorded.

Site selection	• The location of transects would be along existing tracks or in suitable habitat for targeted fauna. • **For brush-tailed mulgara and crest-tailed mulgara:** Sand dunes, sandplains and plains.
Timing	Spotlighting would be conducted bi-annually, every 6 months to obtain data on seasonal variability of populations. This is particularly important for fauna with seasonal breeding cycles, such as reptiles that are only active during warmer months.
Data collection and reporting	Data collection would be conducted every 6 months, followed by data analysis and reporting. After each survey, data sheets would be scanned and data would be stored electronically. This would allow data to be compared with other track-based monitoring projects and between surveys within the Proposal area.

Threshold and contingency measures	
Threshold	**Contingency measures**
A threatened species that has not previously been recorded within the Proposal area is recorded in the Proposal area.	• A GPS location would be taken and a photograph if possible. • Tellus would report to the appropriate government departments. • If mining activity is a threat to the species or their habitat, operations would stop in the area of the species habitat. Experts would be consulted with and appropriate avoidance or mitigation measures would be implemented.
Significant decrease in a threatened species population as a result of the Proposal.	• Operations would stop in the area the species habitat if appropriate. • Tellus would investigate and consult with experts to determine the cause of the species decline and implement appropriate measures to resolve the issue.
Significant increase in signs of introduced species as a result of the Proposal	Tellus would investigate and consult with experts to determine the cause of the species increase and increase pest fauna management effort in the most appropriate manner.

14.8 Area search bird survey

Methodology	
Description	Area search bird surveys.
Purpose	To determine the presence of threatened and migratory bird species: • Thick-billed grasswren (*A. m. indulkana*); • Australian painted snipe (*R. australis*); • Princess parrot (*P. alexandrae*); and • Migratory bird species o Fork-tailed swift (*A. pacificus*); o Eastern great egret (*A. modesta*); o Sharp-tailed sandpiper (*C. acuminata*); o Oriental plover (*C. veredus*); o Oriental pratincole (*G. maldivarum*); o Rainbow bee-eater (*M. ornatus*); o Australian painted snipe (*R. australis* listed as *R. benghalensis*); o Common greenshank (*T. nebularia*); and o Marsh sandpiper (*T. stagnatilis*).
Methodology	Survey methodology is based on the *Survey Guidelines for Australia's Threatened Birds* (Department of the Environment, Water, Heritage and the Arts, 2010). **Thick-billed grasswren** Area searches and broadcast surveys would be employed in suitable habitat for 1 hour each day for 3 days. Call broadcast detection involves playing a recording of the vocalisations of the thick-billed grasswren and detecting individuals that respond to the call vocally, or are attracted by the call and can be detected by movement. **Princess parrot** Area searches would be undertaken for 1 hour each day for 3 days in suitable habitat. **Australian painted snipe** Targeted stationary observations and area searches will be undertaken at dawn or dusk for 2 hours a day for 3 days. **Migratory species** Area searches would be undertaken in and around suitable water bodies, including Halfway Dam and ephemeral water bodies, within the area of interest for 0.5 hours a day for 3 days.
Site selection	**Thick-billed grasswren** Low shrublands 0.5-2 m tall with approximately 15 % cover of predominantly chenopod species, especially *Atriplex* spp. and *Maireana* spp. on bare and rocky ground. The population near Charlotte Waters was found along drainage lines and run-on areas dominated by *A. nummularia*. Sites with similar vegetation are found along the Henbury Access Road, and this is where survey effort would be focused. **Princess parrot** Area searches for princess parrots would be undertaken in habitat where large hollow bearing trees are present (e.g. Finke River, creek 1.8 km west of the railway on the Henbury Access Road or sand dunes where *Allocasuarina decaisneana* is present. **Australian painted snipe** Searches for Australian painted snipe would be undertaken near shallow vegetated

Methodology	
	wetlands with standing water. For example, Duck Swamp on the Henbury Access Road or claypans near the Chandler Facility. **Migratory species** Halfway Dam, or ephemeral waterbodies that are present in the Proposal area after rainfall.
Timing	Surveys would be undertaken biannually, every six months. Most migratory species are most likely only present during summer migration and after high rainfall. The princess parrot is more likely to be in the Proposal area during and just after periods of continuous high rainfall, when they irrupt out of their core range. The thick-billed grasswren is sedentary and is thought to only call in the height of breeding season in June to September (Rowley & Russel, 1997)
Data collection and reporting	All birds observed during surveys would be recorded in the data sheet provided in Appendix. After each survey, data sheets would be scanned and data would be stored electronically for long-term accessibility and analysis. This would allow data to be compared with other data from other projects and between surveys within the Proposal area.

Threshold and contingency measures	
Threshold	**Contingency measures**
A threatened or migratory species that has not previously been recorded within the Proposal area is recorded in the Proposal area.	• A GPS location would be taken • Photographs of the species and the habitat in which it is found would be taken. • Tellus would report to the appropriate government departments. • If mining activity is a threat to the species or their habitat, operations would stop in the area of the species habitat. Experts would be consulted with and appropriate avoidance or mitigation measures would be implemented.
Significant decrease in a threatened species population as a result of the Proposal.	• Operations would stop in the area of the species habitat if appropriate. • Tellus would investigate and consult with experts to determine the cause of the species decline and implement appropriate measures to resolve the issue.

14.9 Mole trenches

<table>
<tr><th colspan="2">Methodology</th></tr>
<tr><td>Purpose</td><td>To increase knowledge of the distribution of the southern marsupial mole in the Proposal area.</td></tr>
<tr><td>Methodology</td><td>Southern marsupial mole survey method would follow the Manual for Marsupial Mole Survey and Monitoring by Trenches, Version 1.0 (Benshemesh, 2005).

Trenches 120 cm long x 40 cm wide x 80 cm deep (Figure 14-1);
Excavate trenches on the northern or western side of a dune to maximise drying by sunlight;
The longest side of the trench faces north to maximise sunlight on the southern side;
A step can be dug into the northern wall to maximise sunlight on the southern side;
The southern side of the trench is rubbed to make it smooth;
Leave trench for three days for the surface to dry;
After this time, inspect the surface of the southern wall for any symmetrical, sand-filled circular shaped structures larger than 25 mm (Figure 14-2).

Figure 14-1: Mole trench


Figure 14-2: Back-filled mole tunnel observed during on-ground surveys of the Proposal area</td></tr>
</table>

Methodology	
Site selection	Areas with soft sand on river banks, sand dunes or sandy plains. A new trench must be dug for each survey.
Timing	Surveys would be undertaken bi-annually, every 6 months.
Data collection and reporting	If potential mole tunnels are found, photographs and GPS locations would be taken. Photographs would be sent to an expert for verification. Results from mole trench surveys would be recorded and after each survey and the completed data sheets would be scanned and stored electronically for long term accessibility and analysis This would allow data to be compared with other data from other projects and between surveys within the Proposal area.
Threshold and contingency measures	
Due to the subteranean and cryptic nature of the southern marsupial mole it is difficult to survey appropriately and and mole trench surveys can not give an indication of the abundance of the population. Therefore, mole trench surveys do not have associated thresholds and contingency methods.	

14.10 Vegetation health monitoring

Methodology	
Description	100 m point-line transects for permanent vegetation health monitoring sites.
Purpose	To monitor the effects of the construction and operations of the Proposal on adjacent vegetation, particularly the potential effect of weeds, airborne salt, dust, erosion and sedimentation.
Methodology	The vegetation survey methodology is based on the *Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping* and utilises a standard rangelands vegetation survey technique of a point-line transect. • Star pickets would be inserted at the start and the end of the permanent vegetation health monitoring sites and GPS locations taken; • Using a measuring tape, ever 1 m the substrate is recorded (bare ground, litter, rock cover etc.) along with the species intersecting the point and a height class; • Species lists would be completed by walking the area surrounding the transects to record additional species that were not recorded on the transect. • Voucher specimens would be taken where plants cannot be identified in the field.
Site selection	Sites would be located within areas of relatively homogeneous vegetation and landform. Sites of potential impact- Sites would be selected, at least one site representing each vegetation unit/land system present in areas adjacent and down-wind from the Chandler Facility and the camp and the Apirnta Facility. Sites would be within relatively homogenous vegetation. Control/ analogue sites - Control sites would be selected in replicated vegetation units/ land systems away from areas of impact and up-wind from the Chandler Facility. Data from control sites would be used to compare with the impact sites.
Timing	Vegetation transects would be conducted bi-annually every six months to incorporate seasonal variability into the data collection
Data collection and reporting	Data would be recorded in the vegetation data sheet in Appendix. After each survey, data sheets would be scanned and data would be stored electronically. This would allow data to be compared with other regional projects and between surveys within the Proposal area.

Threshold and contingency measures	
Threshold	**Contingency measures**
Significant decrease in vegetation condition within the Proposal area as a result of mining activity	• Operations would stop in the area affected if appropriate. • Tellus would investigate and consult with experts to determine the cause of the species decline and implement appropriate measures to resolve the issue.
Significant increase in weeds as a result of mining activity	Tellus would investigate and consult with experts to determine the cause of the spread of weeds and increase weed management effort to rectify the issue. The weeds would be controlled in accordance with the NT Weeds Management Act.

14.11 Weed mapping

Weed and introduced species identified during survey would be recorded with a GPS to generate a weed map of the Proposal area.

15 IMPLEMENTATION STRATEGY

15.1 Roles and Responsibilities

This section outlines the roles and responsibilities of staff members in relation to biodiversity at the Proposal. These include the environmental (including biodiversity) manager, construction manager, site manager (or equivalent), Tellus staff and all contractors.

15.1.1 Environmental manager

It is the responsibility of the environmental manager and staff to ensure the following occurs during the construction and operation phases of the Proposal:

- Consultation with TOs, Pastoralist and the Central Lands Council (CLC) to perform back burning;
- Organise the Flora and Fauna Monitoring Program;
- Develop, implement and maintain a fauna incident register;
- Develop, implement and maintain a fauna sighting register;
- Develop, implement and maintain a noise complaints register;
- Develop, implement and maintain a hazardous material storage log;
- Develop and implement a Surface Water Management Plan;
- Develop and implement a Decommissioning and Rehabilitation Management Plan;
- Ensure pre-clearance checklists are completed when clearing is undertaken;
- Organise annual weed mapping of the Proposal area;
- Plan weed and introduced fauna species controls;
- Ensure all personnel are aware of driving restrictions to prevent fauna death by vehicle strike;
- Ensure all bins are secure and fauna proof;
- Conduct dust monitoring;
- Monitor bund integrity around hazardous material weekly;
- Ensure all waste is stored in appropriately labelled containers;
- Organise annual sampling of water quality from all extraction bores;
- Conduct monthly monitoring of well surface hygiene to ensure no foreign material enters wells;
- Annual biodiversity report;
- Organise and implement strategic back burning with CLC and TOs;
- Routine monitoring for any signs of erosion and sedimentation including checking watercourse and drainage depression crossings for signs of sediment accumulation;
- Routine monitoring of erosion control devices to ensure integrity;
- Review this BMP annually and update as a result of flora and fauna monitoring results, up to date best practise techniques etc., changes in government regulation etc.;
- Annual BMP compliance and performance audit to review the effectiveness of this BMP;
- Update appropriate NT government department(s) with results from any survey work conducted;
- Ensure all corrective incidents have been investigated and closed out; and
- Ensure all agreed rehabilitation criteria are met.

15.1.2 Construction manager

It is the responsibility of the construction manager to ensure the following occurs during the construction phase of the Proposal:

- All construction staff are inducted and trained in this BMP and Emergency Response Plan (ERP);
- Compliance with all other environmental management plans, including Bushfire Management Plan (BFMP) and Biting Insect Management Plan (BIMP);
- Adequate firefighting equipment and staff trained in use onsite;
- Ensure all vehicles and plant are weed free before mobilisation to site;
- Ensure clearing works contained within designated area;
- Ensure no impacts to watercourse or drainage lines outside of clearance area;
- Install temporary erosion and sediment control devices in reference to DENR and International Erosion Control Association (IECA) best practise guidelines;
- Approve hot works permits;
- Any sightings of significant fauna and pest species recorded in the relevant registers;
- Any fauna strikes recorded;
- Ensure all hazardous materials are stored, handled and used according to Material Safety Data Sheet (MSDS);
- Appropriate use of dust control techniques;
- Communication with appropriate stakeholders before any major operations;
- Ensure any standing water is fenced;
- Potential mosquito breeding sites drained or treated during warm weather;
- All waste disposed of in animal proof bins; and
- Adequate ablution facilities available and maintained.

15.1.3 Site manager (or equivalent)

It is the responsibility of the site manager to ensure the following occurs during the operation phase of the Proposal:

- Ensure all staff are inducted and trained in this BMP and the ERP;
- Adequate firefighting equipment and staff trained in its use onsite;
- Compliance with all other environmental management plans, including the BFMP;
- Ensure all vehicles and plant are weed free before mobilisation to site;
- No increase in predator or introduced species;
- No clearing of habitat or threatened flora and fauna species;
- Ensure all personnel are aware of driving restrictions to prevent fauna death by vehicle strike;
- Develop a vehicle washdown weed report and ensure these are completed;
- Maintenance of fire breaks;
- Monitor site for erosion and sedimentation processes;
- Ensure natural drainage patterns remain;
- Implement weed and introduced fauna control plans;
- Approve hot works permits;
- Potential mosquito breeding sites drained or treated during warm weather;
- Manage fire control;
- Ensure all vehicles are maintained in accordance with the manufacturers and motor vehicle registry requirements;

- Ensure bore water extraction rates and amounts are recorded;
- Investigate and close out any incident records;
- Monitor for bushfires and emergencies through websites;
- Liaise with stakeholders and maintain a register of stakeholder engagement;
- Rehabilitate areas no longer required for safe operation of the site and ensure all agreed rehabilitation criteria are met; and
- Organise a third party rehabilitation audit.

15.1.4 Staff

It is the responsibility of all staff to ensure the following occurs during the operation phase of the Proposal:

- The requirements of the BMP are met;
- They have appropriate training for use of firefighting equipment;
- They are aware of locations of all firefighting equipment, emergency procedures and muster points;
- Perform daily check of vehicles;
- Report any fire incident to site manager;
- Apply for hot work permits from site manager to ensure fire safety;
- Maintain fire breaks;
- Follow bushfire advice as given by site manager or construction manager;
- Follow road use advisory signs and instructions to avoid incidents with livestock and native fauna on the haul and access roads; and
- Ensure that there are no open flames outside of designated areas.

15.1.5 Contractors

It is the responsibility of all contractors to ensure the following occurs during the operation phase of the Proposal:

- Support the management of biodiversity conservation within the Proposal area;
- Ensure all contractors are trained in biodiversity management and this BMP;
- Comply with all legal requirements and requirements of this BMP; and
- Seek advice and consult with Tellus if in doubt about any issue in relation to biodiversity.

15.2 Training and Competency

All staff and contractors would be appropriately trained or inducted in the management of biodiversity conservation values within the Proposal area. All staff would be familiar with and inducted into this BMP. All staff and contractors would be made aware of flora and fauna species of conservation significance potentially present within the Proposal area (including their identification and management). Threatened species identification kits would be made available and posters would be put on display. All personnel would be encouraged to report sightings of species of conservation significance, including road fatalities.

Staff would be given cultural competency training in order to work effectively with TOs and the CLC in biodiversity management and mitigation measures.

15.3 Stakeholder Engagement

Tellus would engage the following stakeholders to determine concerns and attain information and advice relating to biodiversity risk and management in the Proposal area:

- Tellus Environmental Manager;
- Government departments (e.g. DPIR and DENR);
- Adjacent pastoral managers;
- TOs;
- CLC; and
- LES or other appropriate environmental contractors.

Tellus would consult with these stakeholders in the planning of controlled burns, fire breaks, survey work, management of introduced flora and fauna and any planned disturbances or land clearing works at the site or other areas of concern. Concerns, information and advice resulting from stakeholder consultation and engagement would be recorded in a register and incorporated in the annual review and audit of the BMP.

There would be direct engagement of Aboriginal Rangers or other local TOs in the ongoing development of the BMP, particularly through participation in field surveys, and their assistance would be actively sought wherever possible.

15.4 Incident Management

Tellus incident management procedures are designed to:

- Ensure all near misses and incidents are reported in a standard format so that consistency and accuracy of the process is maintained;
- Identify the underlying and basic causes of all near misses and/or incidents;
- Implement mechanisms to prevent the recurrence of similar near misses/incidents;
- Provide information to prepare the Tellus near miss/incident statistics, and
- Identify potential losses and suitable corrective actions.

An incident in this BMP is defined as any activity which results in either direct or indirect change to the environment, whether adverse or beneficial. These could include, but are not limited to:

- Uncontrolled hazardous material spill;
- Erosion or sedimentation;
- Fauna or domestic stock strike;
- Unapproved land clearing;
- Clearing of conservation significant habitat or flora species;
- Uncontrolled fire;
- Food or domestic waste exposed;
- Vehicle speed limits not adhered to; and
- Vehicles not washed down prior to site access;

All work is to cease in the area of an incident and construction manager/site manager notified. They would then seek advice from the appropriate government agency, if required, before implementing remedial actions. The incident would be logged in the corrective actions register for close-out. The incident would be investigated to determine improvement plans needed to reduce the possibility or severity of the risk re-occurring.

15.5 Emergency Contingency Plan

Tellus' emergency planning includes:

- ERP;
- Dedicated trained emergency response personnel;
- Dedicated emergency response vehicles and equipment;
- Emergency simulation training exercises (drills); and
- Preventative maintenance programs.

Types of emergency situations that may arise during construction and operations include:

- Spills – chemical or hazardous substance (particularly hydrocarbons);
- Fire (naturally occurring bushfire or accidental bushfire resulting from construction or operational activities);
- Medical; and
- External communications (e.g. bomb threat).

Table 15-1 provides an overview of key emergency response documents.

Table 15-1 Key emergency response documents relevant to the Proposal

Document Title	Description
Tellus Emergency Response Plan (ERP)	Details the high level arrangements to prepare for, respond to, manage and recover from any realistically foreseeable crisis.
Tellus Incident Investigation Procedures	Details the requirements for the reporting and investigation of incidents and to establish root causes, ensuring preventative actions to be planned and implemented.

Tellus would ensure all personnel, contractors and visitors are aware of the emergency response framework and are adequately trained in emergency response procedures relevant to their role/position.

Tellus' ERP would be reviewed and up-dated to incorporate new information arising from incidents, near misses and emergency simulation training sessions.

15.6 Reporting

15.6.1 Routine Reporting

An annual report would be compiled containing the following information:

- Any fauna incidents, fatalities or near misses;
- Any clearing works undertaken;
- Bushfire management operations (to be contained in detail in the BFMP report);
- Dust control measures implemented;
- Any sightings of fauna or flora of conservation significance;
- Records of targeted and non-targeted flora and fauna survey efforts;
- Any spills, leaks or contamination;
- Groundwater standing water levels;

- Erosion or sedimentation processes observed;
- Any soil or land rehabilitation work conducted;
- Records of all staff inducted into this BMP;
- Stakeholder engagement – CLC, Pastoralist, TOs, government and other;
- Results of audits; and
- Review and update of the BMP.

15.6.2 Incident Reporting

An incident report would be generated and submitted to the site manager who would then distribute the results to the DPIR and other affected stakeholders as required.

The DPIR would be notified immediately if there is a serious fire on site.

An incident report would typically include the following:

- Location of biodiversity incident;
- Date and time;
- Cause or source;
- Mitigation and management response;
- Damages – personal, assets or environment;
- Recommendations for future biodiversity management;
- Rehabilitation work; and
- Stakeholder engagement.

15.7 Auditing

The BMP and other management plans related to biodiversity (listed below), would be audited internally annually and externally every two years. Auditing of the BMP and other plans related to biodiversity would be the responsibility of the Environmental Manager.

- Bushfire Management Plan;
- Weed Management Plan;
- Pest Fauna Management Plan;
- Soil Conservation Management Plan;
- Waste Management Plan;
- Surface Water Management Plan;
- Biting Insect Management Plan; and
- Decommissioning and Rehabilitation Management Plan.

15.8 Continuous Improvement

This BMP would be continuously reviewed and improved based on:

- Government legislation and regulation changes;
- Changes to conservation listing of flora and fauna;
- Results of survey efforts;
- Audit and review of this BMP;
- Stakeholder consultations; and
- Results from the review of other management plans.

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17 APPENDICES

Appendix 1: Site description data sheet (Adapted from Neave et al., 2004 & DLRM, 2013).

Site No.:	**Survey number:**	**Quad. size:** 30x30 50x50 other:

Date:		**Observer:**	
Site description & location details:			**Landform pattern:**
Zone:	**GPS AMG:** E	N	**Datum:**
Precision:		**GPS elevation:**	

Topographic position:		**Photo ref. no.:**
Land unit:	**Run:** on off plain	**Patch size (ha):** <1 1-5 5-50 50-500 500+
Edge: ecotone ***or*** closest distance:		**Road Type in Vicinity:** 1 2 3 4
Perm. Water: 0 <50m 50-500m 0.5-5km >5km		**Curr. water:** 0 <50m 50-500m 0.5-5km >5km
Climate: 1 = Dry, plant stress 2 = Dry, no plant stress 3 = Recent rain, no vegetation response 4 = Recent rain, noticeable vegetation response		

Disturbance: **0 =** no visible impact **1 =** disturbance present but negligible impact **2 =** low level of disturbance throughout quadrat, *or* moderate level in patches in the quadrat **3 =** moderate level of disturbance throughout quadrat, *or* high level in patches in the quadrat **4 =** high level of disturbance throughout quadrat, *or* major level in patches in the quadrat **5 =** major impact affecting all of quadrat		
Fire impact: 0 1 2 3 4 5	**Last fire:** this year last year 2+ years ago long unburnt	
Rabbit damage: 0 1 2 3 4 5	**Introduced herbivores:** 0 1 2 3 4 5	**Camels:** 0 1 2 3 4 5
Weeds: 0 1 2 3 4 5	**Other:** 0 1 2 3 4 5 **describe:**	

Bare soil (%):	%	**Vegetation Litter (%):**	%	**Rock type**
Rock cover (%):	%	**Ground Vegetation (%):**	%	Sandstone Conglomerate Other sedimentary: Metamorphic Granite Quartzite Limestone Basalt Colluvium Other:
Outcrop: %	**Rock / stone:** %	**Bare ground:** %		
Pebbles (<0.6cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Small stones (0.6-2cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Stones (2-6cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Small rocks (6-20cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Rocks (20-60cm):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Big rocks (60cm-2m):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Boulders (>2m):	0 <2 2-10 10-20 20-50 50-70 70-90 >90			
Outcrop / slab:	0 <2 2-10 10-20 20-50 50-70 70-90 >90			**Lithology:**

Soil texture: sand sandy loam loam loamy clay clay loam clay cracking clay peat rock other: **Soil colour:**

Soil depth (cm): 0 <10 10-40 >40	**Soil pH - surface**: ___cm:	
Soil crust, termites, log habitat and vegetation strata structure		
Crust present: no black green clear	**Crust cover (%):** %	**Crust pH:**
Termite mounds (no.):	**Max. ht. (m):**	**Profile:** tower dome underground
Number of fallen logs >15cm diameter in the quadrat:		

Vegetation community: *(Circle one)*	**Percentage foliage cover of tallest plant layer**			
Life form and height of tallest stratum	**Dense (70-100%)**	**Mid-dense (30-70%)**	**Sparse (10-30%)**	**Very sparse (<10%)**
Trees > 30 m	Tall closed-forest	Tall open-forest	Tall woodland	Tall open-woodland
Trees 10-30 m	Closed-forest	Open -forest	Woodland	Open-woodland
Trees 5-10 m	Low closed-forest	Low open-forest	Low woodland	Low open-woodland
Shrubs 2-8 m	Closed -scrub	Open-scrub	Tall shrubland	Tall open-shrubland
Shrubs 0-2 m	Closed -heath	Open-heath	Low shrubland	Low open-shrubland

Three most dominant species:		
Overstorey	**Midstorey**	**Lower storey**
1.	**1.**	**1.**
2.	**2.**	**2.**
3.	**3.**	**3.**

Strata	**Average ht. (m) of strata**	**Cover (%) of strata** (% cover classes)
Emergent tree layer:		<10 10-30 30-70 >70
Mid storey:		<10 10-30 30-70 >70
Lower storey:		<10 10-30 30-70 >70

Environmental variables for site description

Site No.	Unique label for each site.
Survey number	Number of survey
Quad. size	Size of the survey quadrat (most quadrats in the Southern region would be 50 x 50 metres)
Region	Usually park name, station name or sample region.
Date	DDMMYYYY format
Observer	The person deciding what data values go onto the sheet (not necessarily the scribe); given and surname in full.
Description & location	Details about the site and its location in relation to roads, tracks, creeks, landscape features etc, sufficient for someone else to relocate it.
Landform pattern	Choose from the following landform patterns (relief is metres above the plain): (see table below)
Zone	Map zone for AMG readings.
GPS AMG	Precise location / geocode (easting and northing) from GPS. Use averaged readings from large Magellans if possible, or differential if nearby base station

Landform pattern		Relief	Modal slope
1	Level plain	<9m	<1%
2	Great undulating plains	<9m	1-3%
3	Undulating plains	<9m	3-10%
4	Rolling plains	<9m	10-32%
5	Badlands	<9m	>32%
6	Gently undulating rises	9-30m	1-3%
7	Undulating rises	9-30m	3-10%
8	Rolling rises	9-30m	10-32%
9	Steep rises	9-30m	32-56%
10	Badlands	9-30m	>56%
11	Undulating low hills	30-90m	3-10%
12	Rolling low hills	30-90m	56-100%
13	Steep low hills	30-90m	32-56%
14	Very steep low hills	30-90m	56-100%
15	Badlands	30-90m	>100%
16	Undulating hills	90-300m	3-10%
17	Rolling hills	90-300m	10-32%
18	Steep hills	90-300m	32-56%
19	Very steep hills	90-300m	56-100%
20	Precipitous hills	90-300m	>100%
21	Rolling mountains	>300m	10-32%
22	Steep mountains	>300m	32-56%
23	Very steep mountains	>300m	56-100%
24	Precipitous mountains	>300m	>100%
25	Drainage line	variable	variable

	available.
Datum	The datum in which geocode was collected (AGD66 is the default – record if different from AGD66).
Precision	The precision of the geocode expressed in metres (this may be given by some GPS units).
GPS level	The level of GPS reading used to generate geocode (e.g. single reading; averaged readings; differential).
Topographic position	Brief description of landscape setting of site (landform element). Choose from the following landform elements listed in the "Yellow Book" (McDonald *et al.*, 1990): crest; hillock; ridge; simple slope; upper slope; mid-slope; lower slope; flat; open depression (vale);closed depression.
Photo ref. no.	If a photograph of the site is taken, record a photo reference number.
Land unit	Where available, from land unit mapping.
Run-on / run-off / plain	Run-off sites shed rainfall (e.g. hill crests, upper slopes); run-on sites receive run-off (e.g. swamps, base of hills); plains are extensive flat areas – circle the appropriate category.
Patch size (ha)	Contiguous area of sampled habitat type (most relevant for restricted habitats such as Lancewood, rock outcrop) – circle the appropriate category. The following two edge variables are relevant where deliberately sampling ecotones or fragmented landscapes. In most cases however, sampling homogenous habitats / vegetation communities.
Edge	Indicate if sampling an ecotone (site on the boundary) or the distance to nearest boundary (metres).
Adjacent land unit	The vegetation type or land unit adjacent to habitat being sampled.
Slope	Measured in degrees using a clinometer – estimate a mean slope for heterogeneous sites
Aspect	The direction the slope faces expressed as degrees from north – leave blank for zero slope.
Altitude	Most reliably read off a topographic map (metres above sea level).
Permanent water	Estimated distance to nearest permanent water (including artificial sources).
Current water	Distance to nearest water at time of survey (may be the same as for permanent water or there may be a temporary source closer to the site.
Climate	Time since rain assessed on a 1 to 4 scale where: 1 = Dry, and there is evidence of plant stress;

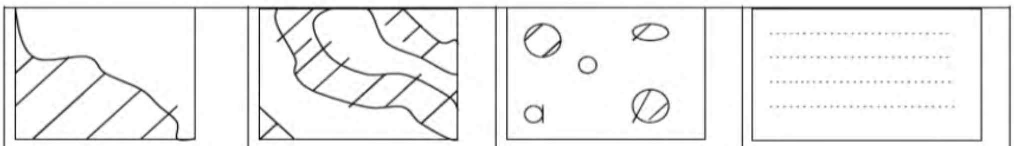
	2 = Dry, but no evidence of plant stress; 3 = Recent rain but no evidence of vegetation response; 4 = Recent rain and noticeable vegetation response. Additional notes: Dry – survey conducted during prolonged period in which no rain has fallen. Plants may show signs of stress depending on the length of time since rain. Recent rain (no visible impact on vegetation) – Some rain prior to or during survey, but either insufficient quantity or too recent to have made a visible impression on the plant community, other than some slight greening of shallow-rooted perennials. Recent rain (visible impact on vegetation) – Effective rain prior to survey (may be still raining during survey), sufficient to stimulate germination, especially of ephemeral species. With sufficient soil moisture, ephemeral plants would develop to maturity and growth and regeneration of perennials would be evident.
Disturbances	Various disturbances (fire, rabbits, introduced herbivores (horses/ donkeys / camels / cattle), pigs, weeds, other) are scored on a scale of zero to 5 where: 0 = No visible impact; 1 = Disturbance present but negligible impact; 2 = Low level of disturbance throughout quadrat, or moderate level in patches in the quadrat; 3 = Moderate level of disturbance throughout quadrat, or high level in patches in the quadrat; 4 = High level of disturbance throughout quadrat, or major level in patches in the quadrat; 5 = Major impact affecting all of the quadrat.
Last fire	Estimate from fire scars and regeneration whether the site was burnt during the current year (this year); the previous year (last year); fire scars present but apparently old (2+ years ago); or no sign of fire or its effects (long unburnt) – circle the appropriate category
Substrate and soils data	Bare soil (%): Estimate % cover of bare ground / soil other than rock for the quadrat that can be seen. Vegetation litter (%): Estimate % cover of fixed and loose vegetation litter for the quadrat that can be seen (e.g. dead Spinifex attached to living clumps is included as fixed vegetation litter). Rock cover (%): Estimate % cover of rock for the quadrat that can be seen. Ground vegetation (%): Estimate % cover of ground vegetation for the quadrat that can be seen. Note: The % bare soil, % vegetation litter, % rock cover and % ground cover vegetation that can be seen should equal 100% for the quadrat. Outcrop: Estimate % cover of outcropping rock for the quadrat including outcropping rock under vegetation and litter. Rock / stone: Estimate % cover of rocks and stones for the quadrat including rocks and stones under vegetation and litter. Bare ground: Estimate % cover of bare ground / soil for the quadrat including bare ground / soil under vegetation and litter.

	Note: Imagine the vegetation and litter has been removed from the quadrat; the % outcrop, % rock / stone and % bare ground should equal 100% for the quadrat.
Rock size	Estimate total cover of rocks (which includes rock/s covered by vegetation and litter) within the quadrat in size classes – circle appropriate % cover category for each size class. Rock sizes refer to the longest dimension on the rock. As there can be different sized rocks lying on other rock (e.g. boulders or rocks lying on rock outcrop or slab), the sum of the values given for each size class does not necessarily equal 100% (i.e. may be>100%).
Rock type	Broad classifications of the principal rock types – add others if you can determine them.
Lithology	An optional field for the underlying lithology from a geological map.
Soil texture	Broad texture classes relating to the amount of clay in the soil – circle the appropriate category; if other then choose the most appropriate texture class from the following texture classes listed in the "Yellow Book" (McDonald *et al.*, 1990): sand; loamy sand; clayey sand; sandy loam; fine, sandy loam; light, sandy clay loam; loam; loam, fine sandy; silt loam; sandy clay loam; clay loam; silty clay loam; fine sandy clay loam; sandy clay; silty clay; light clay; light-medium clay; medium clay; heavy clay).
Soil depth (cm)	Estimate or record when taking pH samples or installing pitfall traps/ mole trenches – circle appropriate category.
Soil pH	Measure soil pH at the surface (avoid including any biogenic crust in the sample as this would be tested separately if present) and at 50cm or nearest depth that can be reached – record the depth at which the sample taken in the space provided (portable field kit adequate).
Crust present	Is a biogenic soil crust present? (may be black, green or clear) – circle no or if present, circle the crust colour/s present (can circle more that one colour). To determine if a clear crust is present, look for filaments on the under-surface of a soil sample.
Crust cover (%)	If biogenic soil crust is present, estimate % of the soil in the quadrat covered by crust.
Crust pH	If biogenic soil crust is present, measure its pH (portable field kit adequate).
Termite mounds	Estimate the total number in the quadrat, the maximum height and whether they are tall & thin (tower) or squat & wide (dome) mounds and/or whether underground nests are present (underground).
No. of logs >15cm diameter	Number of fallen logs greater than 15cm in diameter in the quadrat.
Vegetation community	In the matrix circle the life form and height of tallest strata and corresponding percent foliage cover of tallest strata.
Dominant species	Record in order the three most dominant species for each layer;

	Emergent tree layer: Generally single stemmed trees. Upper shrub layer: >2 metres tall multi-stemmed woody plants and single stemmed sapling trees. Lower shrub 1–2 metres tall single or multi-stemmed woody and slightly woody plants). Ground layer: Grasses, other herbaceous plants and slightly woody plants up to 1 metre tall), record the dominant species (in order of dominance), the average height (metres) of the strata overall and % cover of the strata overall (% cover classes).
Height and % cover of strata	Estimate the average height and circle the appropriate % cover class in each height zone in different height zones listed above.

Appendix 2: Track-based monitoring datasheet (adapted from Southgate and Moseby 2008)

Surveyor Name (s)							
Contact details							
Date			Start time		End time		
Datum		Easting			Northing		
Location							
Distance from watersource							
Habitat (circle): Sand dune Sand Plain Creekline Other							
Main long-lived veg type							
Time since strong wind/rain							
Time since fire							
Visability (circle): Distinct Shadow Slight Shadow No Shadow							
Length of Shadow (as % of your own actual height):							
HINT: Stand with your back to the sun and look at your own shadow							
♦ How good is the tracking surface? (circle one) 1- can distinguish camel, human, dingo, emu, kangaroo tracks only 2- can distinguish all of the above plus fox, cat rabbit, large reptiles, goanna etc. 3- can distinguish all of the above plus hopping mice, rodents, small birds, insects HINT: only look at the parts of the substrate where you would be able to see tracks							
• What percentage of the quadrat is actually suitable for tracking ? (Areas not suitable include rock, bushes, lichen, green pick etc) %							
• What is the continuity of the tracking surface like? (circle one below- the hatched area is unsuitable substrate)							



1	3	3	4

Species	Tracks	Animal or skeletal remains	Burrows/ diggings	Scats	Abun. of all signs (1,2,3)	Age of most recent sign (1, 2,3)	Comments
NATIVE							
Bilby							
Mulgara							
Kangaroo							
Rodent/dasyurid <35g							
Hopping Mouse							
Emu							
Bustard							
Corvids							
Other birds							
Dragons							
Large skinks							
Snakes							
other reptiles							
Dingo							
INTRODUCED							
Fox							
Cat							
Camel							
Cow							
Horse							
Donkey							
Rabbit							
OTHER							

Abundance
1= sign in all four quarters and super abundant
2= sign in half to ¾ of quarters of quadrat
3= one individual only or sign only found in ¼,

Age of sign
1= fresh 1-2 days old
2=older, 3 days to 1 week
3= imprinted in mud or hard substrate, older than 1 week (scats- white and crumbly, no smell)

The datasheet explained (From Southgate & Moseby, 2008)

Visibility

Visibility refers to how much shadow is present during the track search. In general, the more shadow the easier it is to see tracks and track detail. Walking into the sun increases the shadow and improves visibility. On the datasheet you need to record whether there is a dark shadow (distinct), slight shadow (generally in poor light such as overcast etc) or no shadow (the sun is directly overhead or is entirely blocked by cloud). Measuring the length of your shadow as a proportion of your height gives a less subjective measure of visibility. Stand with your back to the sun and look at your shadow. If it is taller than you it is more than 100% of your height and if it is shorter than your true height it is less than 100% of your height. Give an estimate.

How good is the tracking surface?

The quality of the tracking surface is another factor which influences accurate identification of tracks. If the surface of the sand is soft, powdery, dry and comprised of fine-grained sand then it is possible to distinguish tracks of even the smallest insects. Conversely if the sand is coarse, wet, compacted or wind driven it may only be possible to distinguish tracks of large animals such as camels. In this section you must decide what sort of animals would be able to be identified if they were present. ie if insect tracks were present would you be able to see them or is the surface too hard or wet? This gives an indication of what type of species may be missed during your search and allows researchers to determine false negatives (chance of a species being present but not seen by the recorder).

Percentage of quadrat suitable for tracking

Although the substrate may be perfect and the shadows long and distinct, some parts of the quadrat would be still be unsuitable for tracking. Trees, rocks, bushes, hard ground, leaf litter etc would all obscure tracks. Estimate the percentage of the 2 ha area that is able to be used for identifying tracks.

Continuity of the tracking substrate

It is not just the percentage of the quadrat that is suitable for tracking that is important but also the distribution of that suitable substrate. It is easier to accurately identify a species if multiple gaits can be viewed. If all of the suitable areas for tracking on a 2ha quadrat are less than half a metre wide it can be difficult to see and distinguish tracks. Thick vegetation cover, carpet cover of small ephemerals or extensive lichen coverage can all reduce the continuity of the tracking substrate to very short sections.

Age of tracks

It is important to estimate how much time has elapsed since the animal passed and a range of clues need to be used to judge track age. Generally, very fresh tracks in good substrate (a tracking surface score of 1) have crisp edges and you can make out the individual pads and their features or see distinct claw marks. As they age, the details of the track become blurred and finally only the general gait can be seen with none of the track detail. The condition of tracks from small, common animals such as insects and mice can be used to benchmark last night’s activity and compare with older looking tracks and sometimes these tracks may pass over an existing track. Another tip is to look at the other tracks in the quadrat and see if you can see any tracks that look fresher.

Age of scats

Fresh scats are usually dark, moist, soft, smelly and often would have some sand grains stuck to them. As they age they become lighter in colour and harder, very old scats would crumble easily and have little or no smell. Only record scats as age score 1 if you are sure they are VERY fresh.

Age of burrows

Active burrows that are being used by animals can still look old. However, in general, active burrows have fresh tracks and/or scats outside their entrance and have a clean hole that is not blocked by spiderwebs or vegetation. Always search for multiple entrances to a burrow as some entrances may be fresh and others old in the same warren system.

Gait Length and Width

Gait refers to the pattern of feet placement used when an animal moves and these gait characteristics can be used to help identify a species and indicate an individual's activity. Some animals can move bipedally (move on two legs) whilst others are quadrapedal (move on four legs). Measurements should be taken using a tape measure or ruler and recorded to the nearest millimetre. Width of the gait is recorded at the widest point whilst length is the total length of one set of tracks. Ten separate measurements should be taken where the animal is travelling on flat ground at an even pace. Avoid measuring tracks that are travelling up or down hill or where there is a sudden change in pace. Also record whether the tracks are placed on top of each other (superimposed) or slightly offset.

Track length and width

Track width and length refers to the measurements of a single spoor (print) rather than the gait. These measurements can still be important for identification and can help to verify species. Front and hind feet would usually have different measurements so it is important to measure both.

Appendix 3: Fauna trapping data sheet

Fauna Trapping Data Sheet

Observer ______ Surname ______ Given Name **Site** ______

ID # ______ **Date** Day ______ Month ______ Year ______ **Survey** ______

AMG/MGA Zone ______ Easting ______ Northing ______ **Precision** Metres ______

Location ______

MAMMALS					
Species Code	Species Name	Sex	Age	Breed	Collection Method
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					
M					

REPTILES					
Species Code	Species Name	Sex	Age	Breed	Collection Method
R					
R					
R					
R					
R					
R					
R					
R					
R					
R					
R					
R					
R					
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R					
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R					

Appendix 4: Area search bird observation data sheet

Bird Observations

Observer ______ **Site** ______

ID # ______ **Date** ______ Day ______ Month ______ Year ______ **Survey** ______

AMG/MGA ______ Zone ______ Easting ______ Northing ______ **Precision** ______ Metres

Location			
Start time		**Finish time**	

Species Code	Species Name	AM	PM	AM	PM	AM	PM	TOTAL	Comments

Appendix 5: Vegetation transect data sheet

VEGETATION POINT LINE TRANSECT DATA Sheet	
Date:	**Site Number:**
Location:	**Observer:**
Site description:	**Photo reference:**
Dominant veg:	

#	Species 1	HC	Sp. 2	HC	Sp. 3	HC	#	Species 1	HC	Sp. 2	HC	Sp. 3	HC
1							51						
2							52						
3							53						
4							54						
5							55						
6							56						
7							57						
8							58						
9							59						
10							60						
11							61						
12							62						
13							63						
14							64						
15							65						
16							66						
17							67						
18							68						
19							69						
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45							95						
46							96						
47							97						
48							98						
49							99						
50							100						